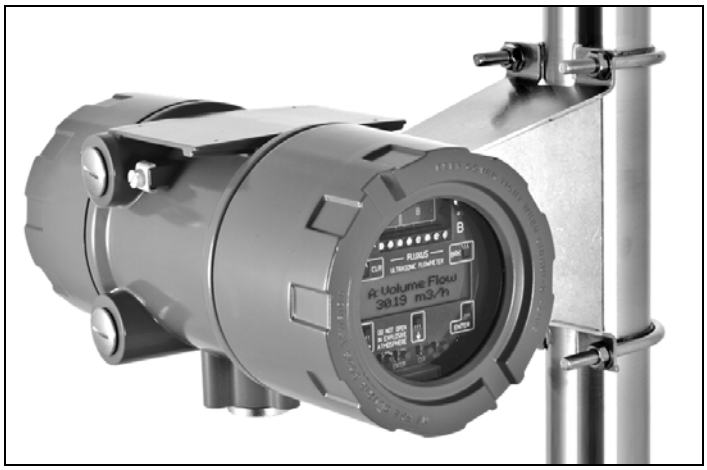
Ultrasonic flowmeter for liquids in explosive atmospheres



FLUXUS F808-A1**

FLUXUS F808-F1**

FLUXUS F808-F2**

FLUXUS F809-A1**

FLUXUS F809-F1**

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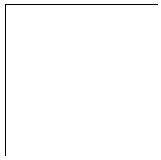


User manual for
FLUXUS F808, F809
UMFLUXUS_F808_8091V1-2EN, 2016-09-26
Firmware version: 6.26

Die Sprache, in der die Anzeigen auf dem Messumformer erscheinen, kann eingestellt werden (siehe Abschnitt 9.6).

The transmitter can be operated in the language of your choice (see section 9.6).

Il est possible de sélectionner la langue utilisée par le transmetteur à l'écran (voir section 9.6).

El caudalímetro puede ser manejado en el idioma de su elección (ver sección 9.6).

De transmitter kan worden gebruikt in de taal van uw keuze (zie paragraaf 9.6).

Имеется возможность выбора языка информации, отображаемой на экране преобразователя (смотри подраздел 9.6).

Table of Contents

Annex

1 Introduction

1.1 Regarding this user manual

This user manual has been written for users 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 atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

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 specification.

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 enhance 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.

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!

	This text contains safety instructions for the use in explosive atmospheres.

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 serviced conscientiously, no troubles should appear.

In case of a problem which cannot be solved with the help of this user manual (see chapter 18), 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 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 atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

FLUXUS is a precision measuring instrument and has to be handled with care. In order to obtain good measurement results and avoid damaging 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 will only be ensured if the cables fit firmly and tightly in the cable glands, the cable glands are firmly tightened and the housings are tightly screwed.
- Keep the transducers clean. Manipulate the transducer cables with caution. Avoid excessive cable bends.
- 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 specification).
- Observe the degree of protection (see Technical specification).

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 fluid flowing in a pipe is determined. Further physical quantities (e.g., volumetric flow rate, mass 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 fluid 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.

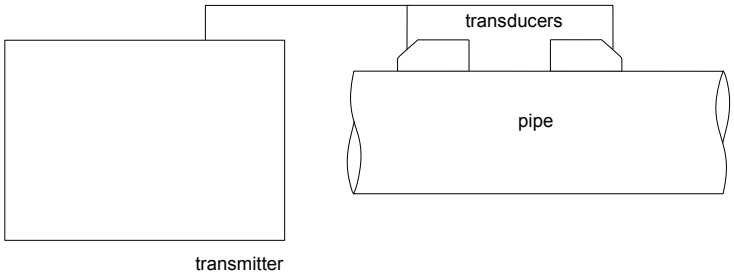


Fig. 3.1: Example of a measurement setup

3.2 Measurement principle

The flow velocity of the fluid is measured in the TransitTime mode 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 fluid in the pipe. The Reynolds number Re is calculated from the flow velocity, the kinematic viscosity of the fluid and the inner pipe diameter.

If the Reynolds number exceeds a critical value (usually approx. 2 300, if the fluid flows in a pipe), a transition from a laminar flow to a turbulent flow takes place.

Laminar flow

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

Turbulent flow

A flow in which turbulence (swirling of the fluid) 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 fluid 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 fluid 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 fluids 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 transducer parameter 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 fluid 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 $\dot{V}$

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

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

Mass flow rate $\dot{m}$

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

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

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 fluid moves, the signals propagating in the fluid are displaced with the flow. This displacement causes a reduction in distance for the signal in flow direction and an increase in distance for the signal against the flow direction in the section 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 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 fluid is calculated as follows:

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

with

v – average flow velocity of the fluid

k_{Re} – fluid mechanics correction factor

k_a – acoustic calibration factor

Δt – transit time difference

t_{fl} – transit time in the fluid

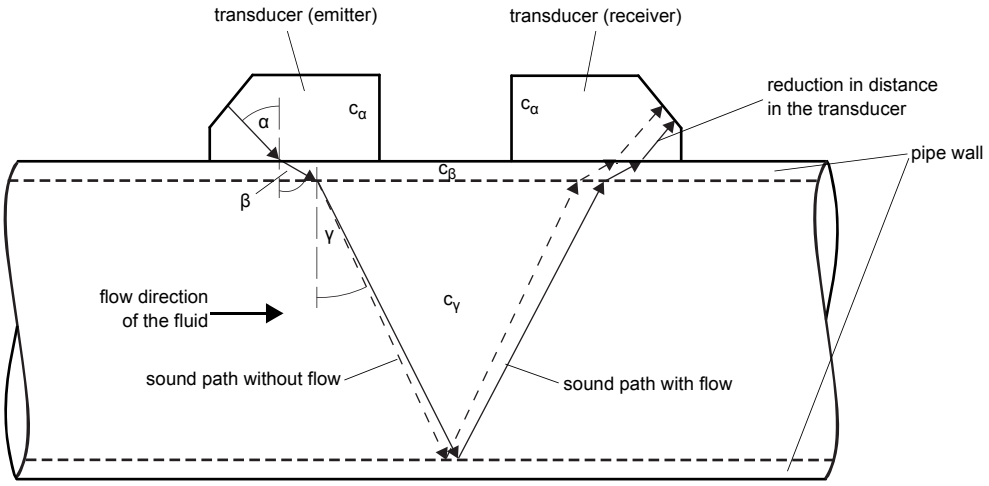


Fig. 3.2: Sound path of the signal in the flow direction

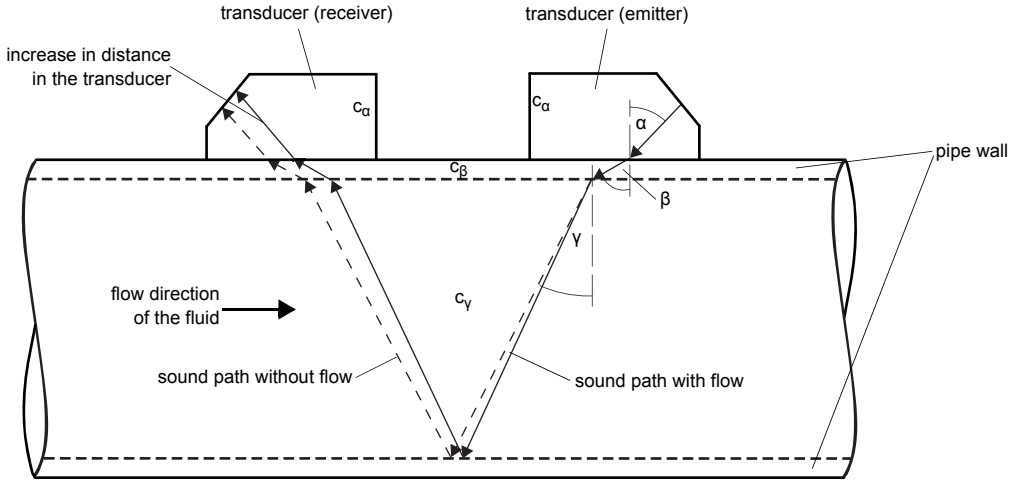


Fig. 3.3: Sound path of the signal against the flow direction

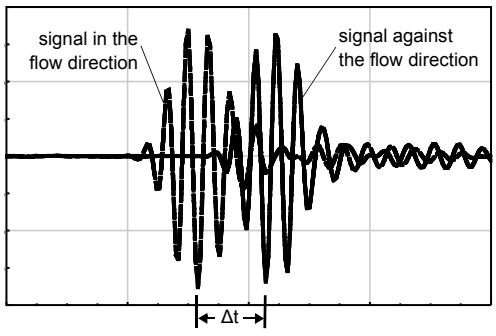


Fig. 3.4: Transit time difference Δt

3.2.3 Measurement of the flow velocity in the NoiseTrek mode

When fluids 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 fluid. A measurement in the TransitTime mode is no longer possible.

The NoiseTrek mode uses the presence of gas bubbles and solid particles in the fluid. The measurement setup used in the TransitTime mode does not need to be changed. Ultrasonic signals are sent into the fluid 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 fluid:

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

with

v – average flow velocity of the fluid

k_{Re} – fluid mechanics correction factor

k_a – acoustic calibration factor

Δt – transit time difference of the measuring signals

t_s – time interval between the measuring signals

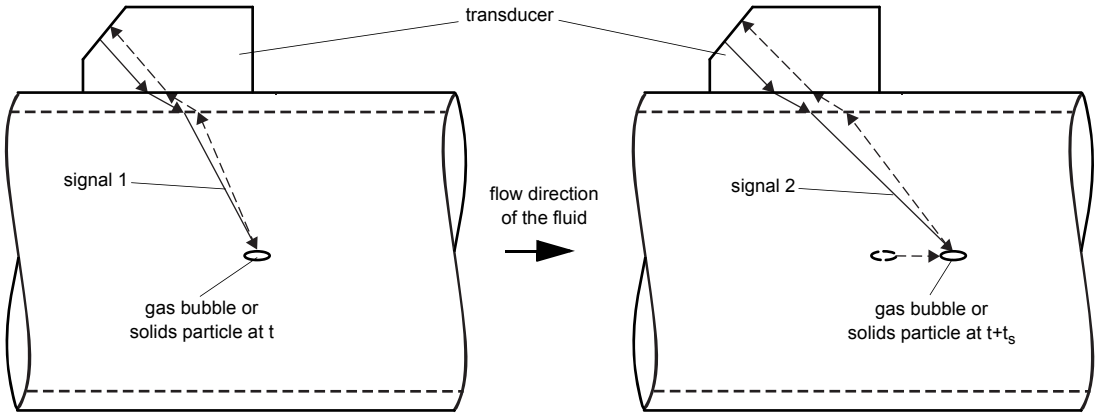


Fig. 3.5: Measurement of the flow velocity in the NoiseTrek mode

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

NoiseTrek parallel beam

For small pipes or highly damping fluids, the transit time of measuring signals can be very small due to scattering bodies and bubbles. This leads to a deterioration of the signal quality.

The NoiseTrek parallel beam mode works the same way the NoiseTrek mode does, the only difference is that the sending and receiving process do not occur in the same transducer. A better signal quality for small pipes and highly damping fluids is achieved by separating the sending and receiving signal. The transducers are mounted in parallel on the pipe at a small angle (see Fig. 3.6). A measurement in TransitTime mode is not possible when using this measurement arrangement.

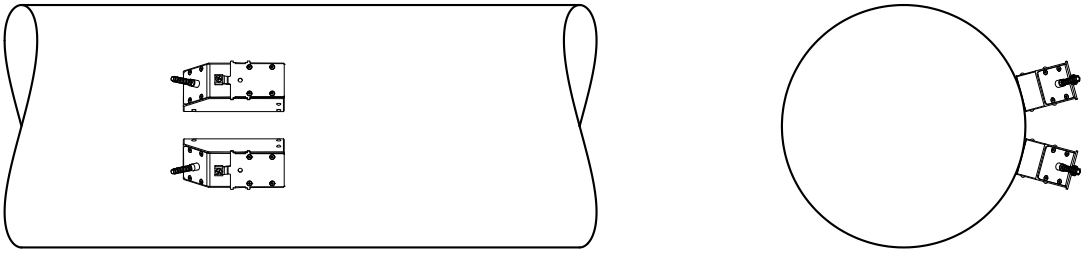


Fig. 3.6: Measurement arrangement in the NoiseTrek parallel beam mode

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. 3.7).

Reflection arrangement

The transducers are mounted on the same side of the pipe (see Fig. 3.8).

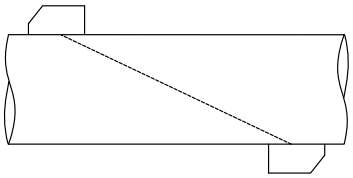


Fig. 3.7: Diagonal arrangement

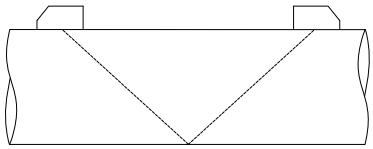


Fig. 3.8: Reflection arrangement

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. 3.7)
- even if the measurement is conducted in the reflection arrangement (see Fig. 3.8).

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. 3.9 or Fig. 3.10).

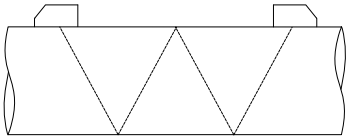


Fig. 3.9: 1 beam, 4 sound paths, reflection arrangement

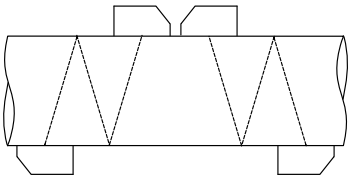
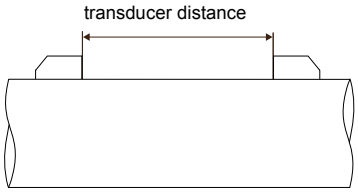


Fig. 3.10: 2 beams, 3 sound paths, diagonal arrangement

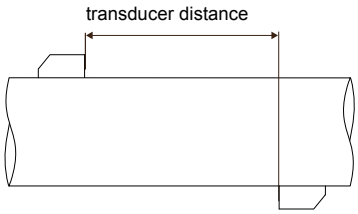
Transducer distance

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

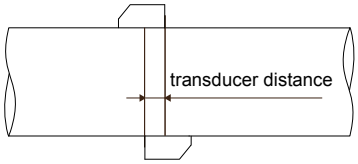
reflection arrangement



diagonal arrangement
(positive transducer distance)

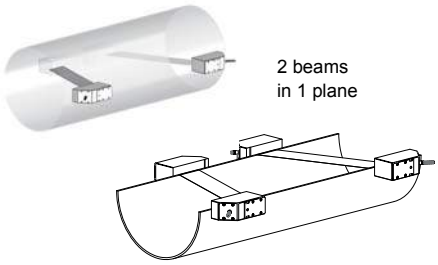


diagonal arrangement
(negative transducer distance)



Sound beam plane

A plane containing 1, 2 or more sound paths or beams (see Fig. 3.11).



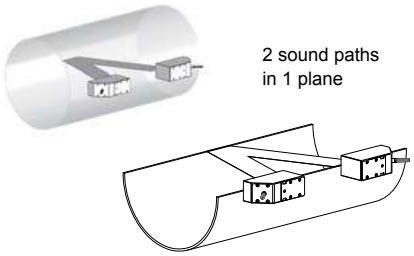
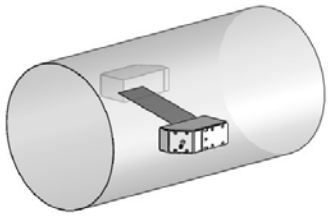
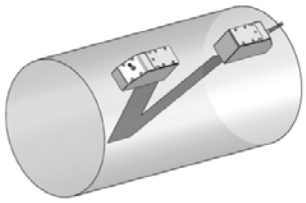
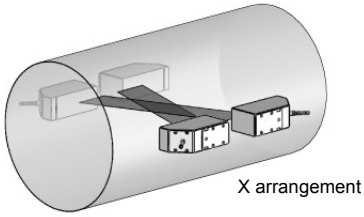
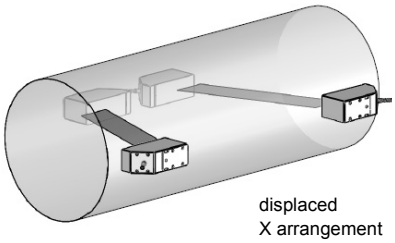
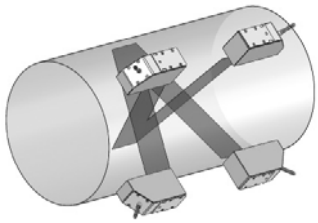


Fig. 3.11: Sound paths and beams in one plane

3.3.2 Examples

diagonal arrangement with 1 beam	**reflection arrangement with 1 beam**
1 transducer pair 1 sound path 1 beam 1 plane 	1 transducer pair 2 sound paths 1 beam 1 plane 
diagonal arrangement with 2 beams	**reflection arrangement with 2 beams and 2 planes**
2 transducer pairs 1 sound path 2 beams 1 plane  X arrangement  displaced X arrangement	2 transducer pairs 2 sound paths 2 beams 2 planes 

4 Description of the transmitter

4.1 FLUXUS F808

The transmitter consists of 1 housing (see Fig. 4.1). The command panel is on the front side of the housing. The keys are operated by a magnetic pen with closed housing.

The terminals for the connection of transducers, outputs and power supply are on the back side of the housing.

4.2 FLUXUS F809

The transmitter consists of 2 housings. The command panel is on the front side of the upper housing. The keys are operated by a magnetic pen with closed housing.

The terminals for the connection of the transducers are in the lower housing, the terminals for the connection of the outputs and the power supply are on the back side of the upper housing (see Fig. 4.2).

Fig. 4.1: FLUXUS F808

Fig. 4.2: FLUXUS F809

4.3 Keyboard

The keyboard consists of 5 keys.

Tab. 4.1: General functions

ENTER	confirmation of selection or input
BRK + CLR + ENTER	RESET: Press these 3 keys simultaneously to correct a malfunction. The reset has the same effect as restarting the transmitter. Stored data are not affected.
BRK	interruption of the measurement and selection of the main menu Be careful not to stop a current measurement by inadvertently pressing key BRK!

Tab. 4.2: Navigation

→	scroll to the right or up through a scroll list
↓	scroll to the left or down through a scroll list

Tab. 4.3: Input of digits

→	move the cursor to the right
↓	scroll through the digits above the cursor
CLR	Move the cursor to the left. If the cursor is on the left margin: • an already edited value will be reset to the value which was stored previously • an unedited value will be deleted If the entered value is not valid, an error message will be displayed. Press ENTER and enter a correct value.

Tab. 4.4: Input of text

→	move the cursor to the right
↓	scroll through the characters above the cursor
CLR	reset all characters to the last stored entry

5 Selection of the measuring point

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

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

• fluid

• gas bubbles in the fluid

Avoid measuring points:

• in the vicinity of deformations and defects of the pipe and in the vicinity of welds

• with deposit formation in the pipe

Make sure that the pipe surface at the selected measuring point is even.

The ambient temperature at the measuring point has to be within the operating temperature range of the transducers (see Technical specification).

Select the location of the transmitter within the cable range of the measuring point.

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

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 fluid 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 fluid depends on:

• kinematic viscosity of the fluid

• proportion of gas bubbles and solids in the fluid

• 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 fluids can form gas bubbles when the fluid expands, e.g., before pumps and after great cross-section extensions.

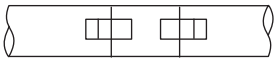
Observe the notes in the following table:

Tab. 5.1: Recommended transducer position

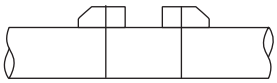
horizontal pipe

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, solids on the bottom or gas bubbles at the top of the pipe will not influence the propagation of the signal.

correct:



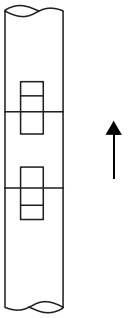
disadvantageous:



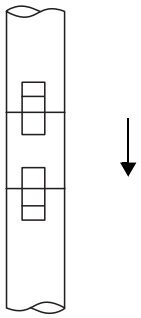
vertical pipe

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

correct:



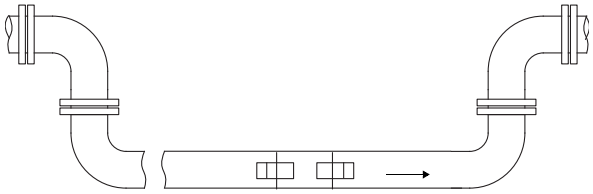
disadvantageous:



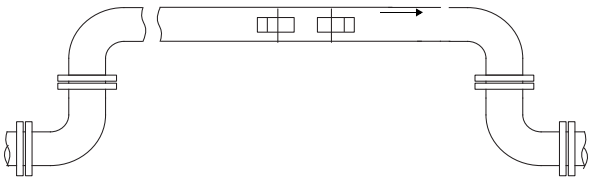
free inlet or outlet pipe section:

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

correct:

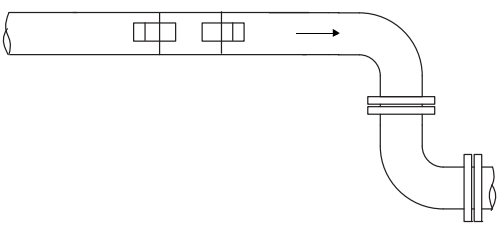


disadvantageous:



correct:

disadvantageous:



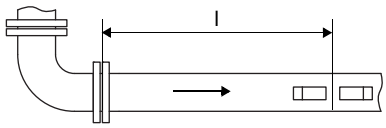
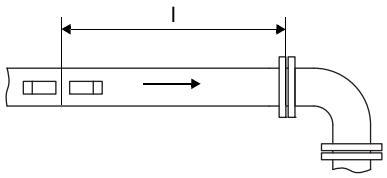
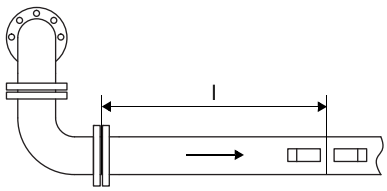
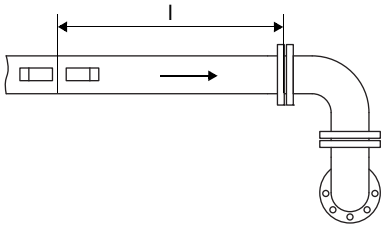
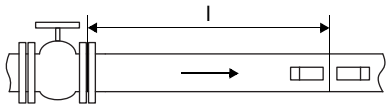
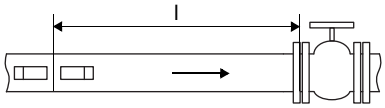
5.2 Undisturbed flow profile

Some flow elements (e. g., 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.

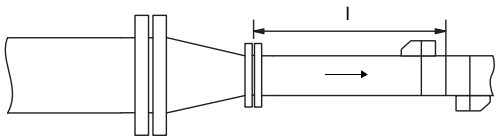
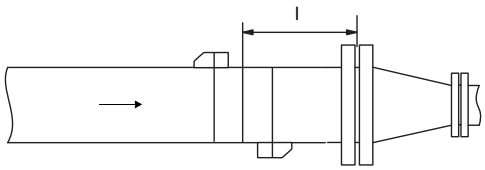
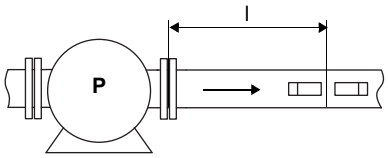
It is most important that the measuring point is chosen at a sufficient distance from any disturbance sources. Only then it can be assumed that the flow profile in the pipe is fully developed. However, measuring results can be obtained even if the recommended distance to disturbance sources cannot be 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, l - recommended distance between disturbance source and transducer position

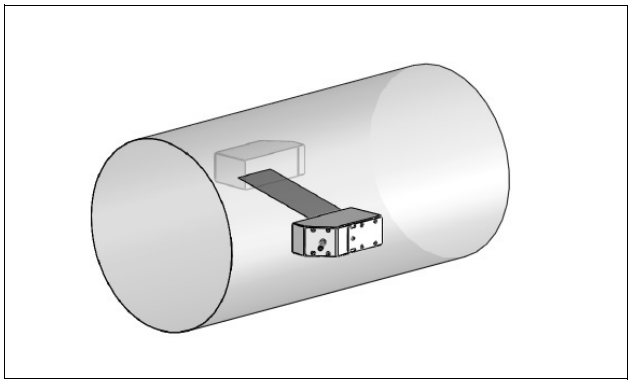
disturbance source: 90° elbow	
supply line: l ≥ 10 D	return line: l ≥ 5 D
	
disturbance source: 2 x 90° elbow in different planes	
supply line: l ≥ 40 D	return line: l ≥ 5 D
	
disturbance source: valve	
supply line: l ≥ 40 D	return line: l ≥ 5 D
	

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>
<tr><td>disturbance source: reducer
supply line: l ≥ 10 D
 
</td><td>return line: l ≥ 5 D
 
</td></tr>
<tr><td colspan="2">disturbance source: pump
supply line: l ≥ 20 D
 
</td></tr>
</table>

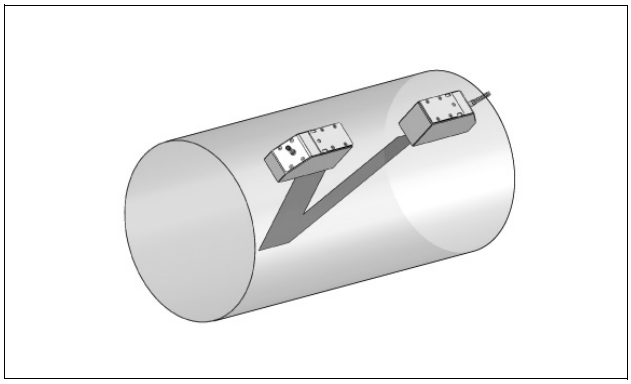
5.3 Selection of the measurement arrangement taking into account the measuring range and the measuring conditions

Diagonal arrangement with 1 beam



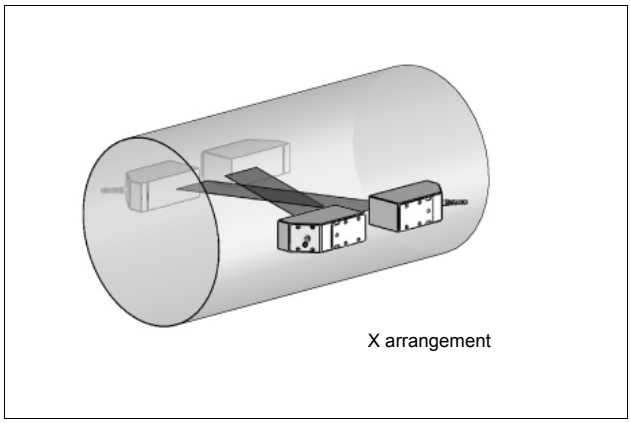
- wider flow velocity and sound speed range compared to the reflection arrangement
- use in the presence of deposits on the inner pipe wall or with strongly attenuating fluids (only 1 sound path)

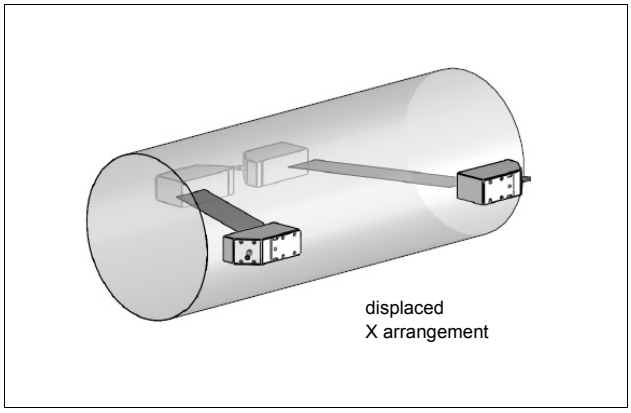
Reflection arrangement with 1 beam



- 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

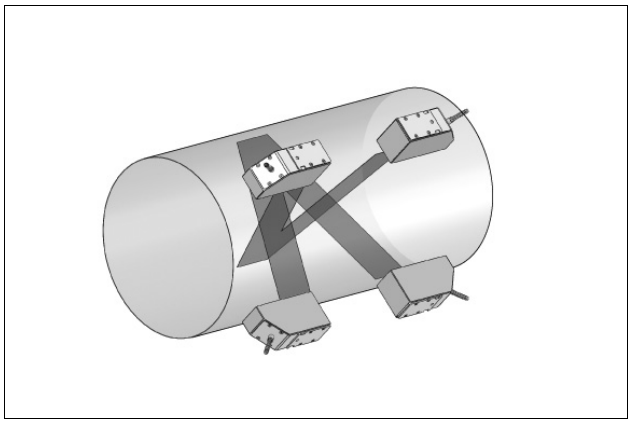
Diagonal arrangement with 2 beams





- 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

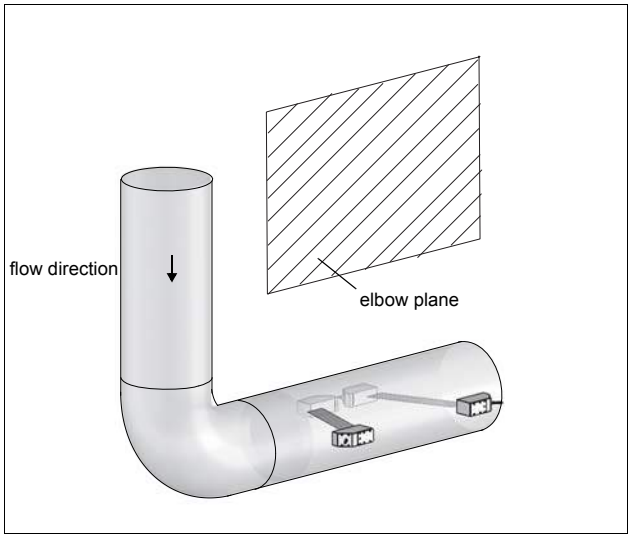
Reflection arrangement with 2 beams and 2 planes



- 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

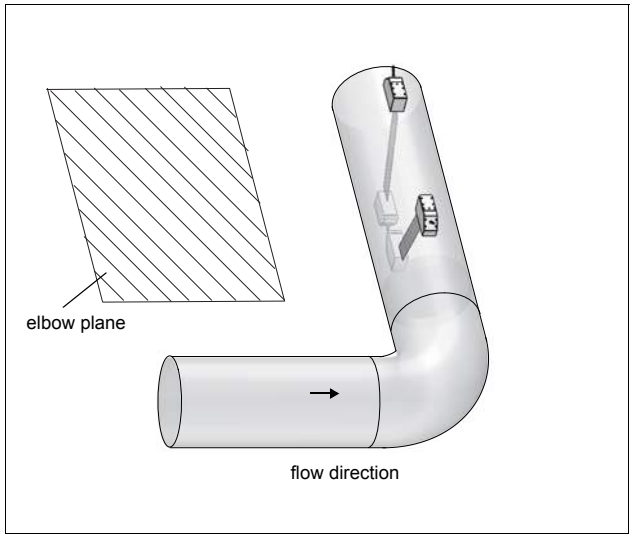
5.4 Selection of the sound beam plane near an elbow

Vertical pipes



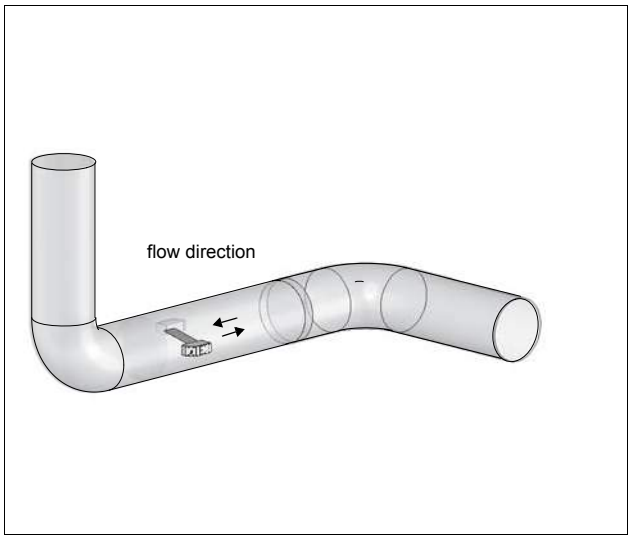
- The sound beam plane (see section 3.3.1) has an angle of 90° to the elbow plane. The elbow is upstream of the measuring point.

Horizontal pipes



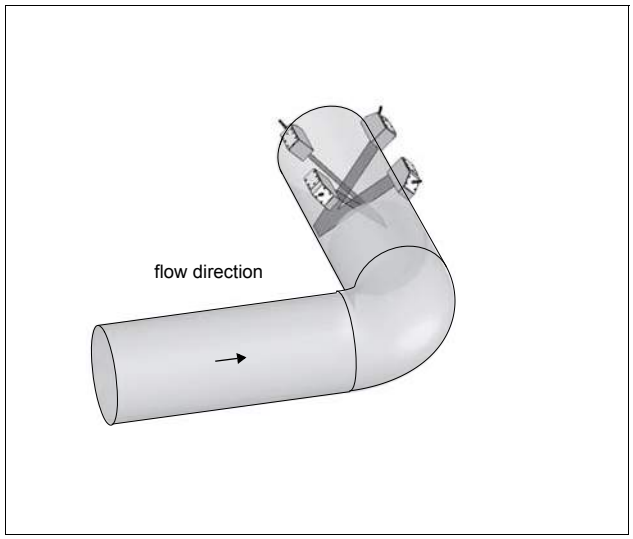
- The sound beam plane (see section 3.3.1) has an angle of 90° ± 45° to the elbow plane. The elbow is upstream of the measuring point.

Measurements in both directions



- The sound beam plane (see section 3.3) is selected according to the nearest elbow (horizontal or vertical, depending on the pipe orientation – see above).

Measurements in reflection arrangement with 2 beams and 2 planes



- The 2 sound beam planes (see section 3.3) 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 of FLUXUS F808

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

6.1 Location

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

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 Opening and closing the housing

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

The transmitter has 2 set screws which have to be unscrewed before the housing can be opened. After the installation of the transmitter, make sure that the housing is closed correctly and that the set screws are tightened (see Fig. 6.1).

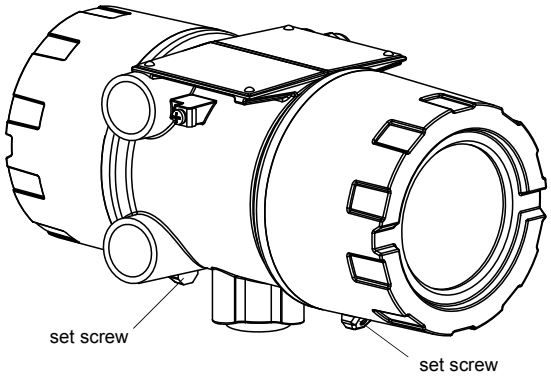


Fig. 6.1: Transmitter FLUXUS F808

6.3 Installation

6.3.1 Wall installation

- Fix the housing to the instrument mounting plate (2) (see Fig. 6.2).
- Fix the transmitter to the wall.

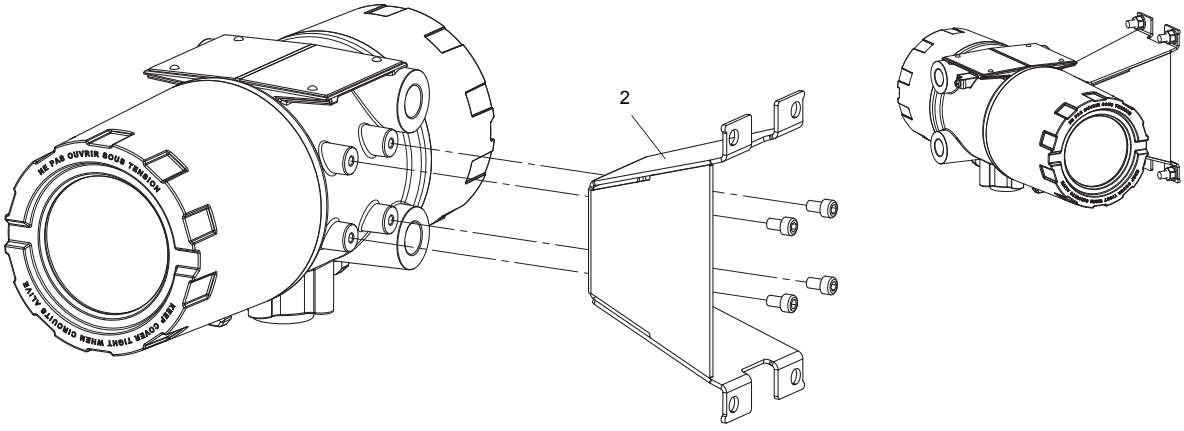


Fig. 6.2: Wall installation

6.3.2 Pipe installation

Installation on a 2" pipe

The instrument mounting plate (2) is fixed to the pipe using a shackle (1) (see Fig. 6.3).

- Fix the transmitter to the instrument mounting plate.
- Tighten the nuts (3) to fix the transmitter with the shackle to the pipe.

Installation on a pipe > 2"

- Fix the transmitter to the instrument mounting plate.
- Fix the instrument mounting plate (2) to the pipe using tension straps instead of shackles (1).

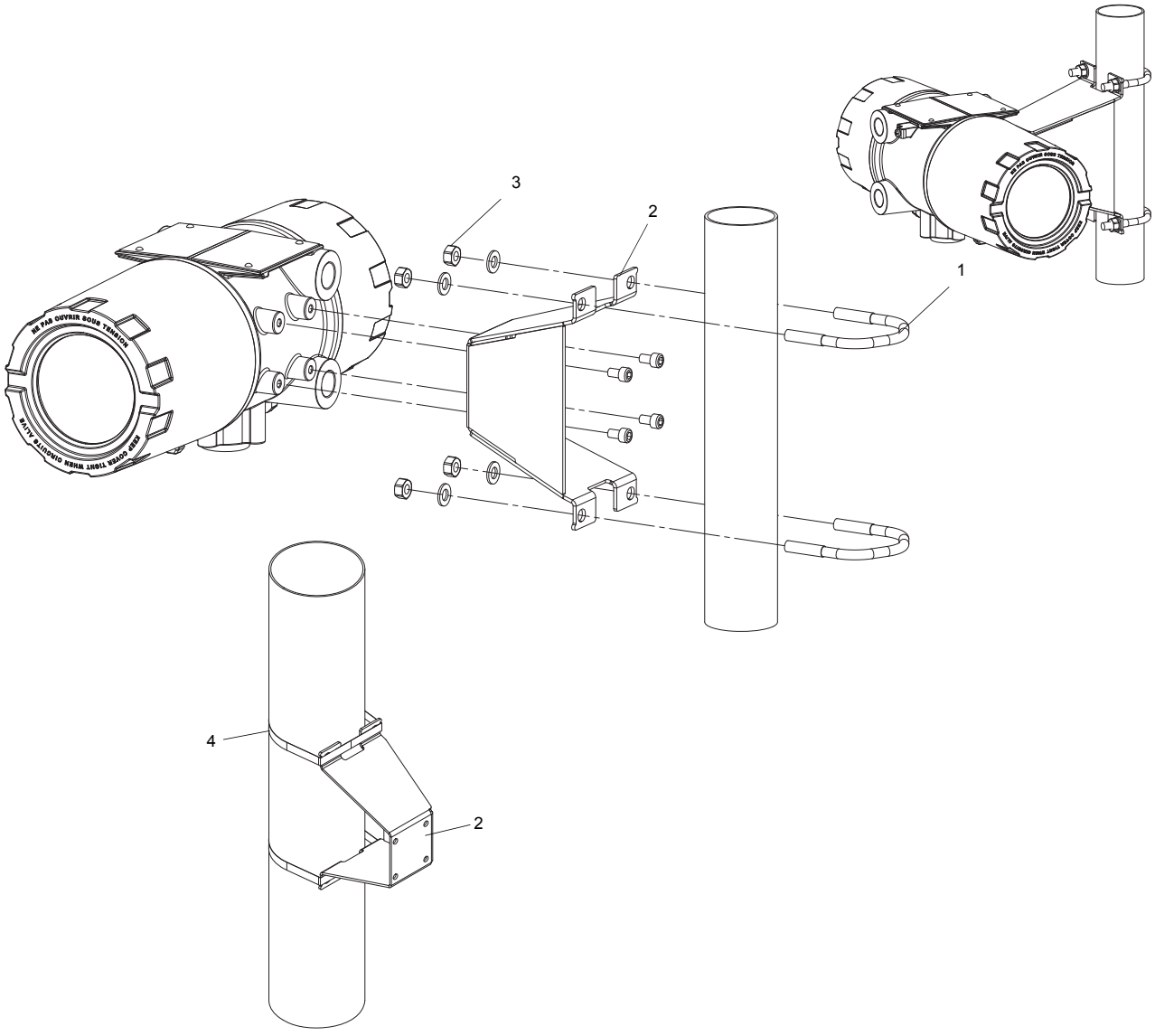


Fig. 6.3: Pipe installation

6.4 Connection of the transmitter

Attention!	Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

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

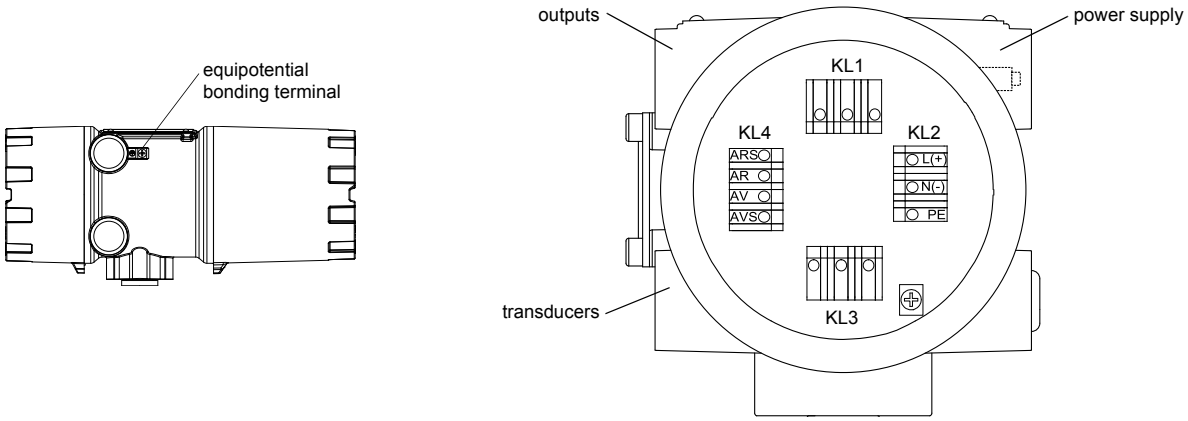


Fig. 6.4: Connections of the transmitter

6.5 Connection of the transducers to the transmitter F808**-A1

Note!	If transducers are replaced or added, the sensor module also has be replaced or added (see section 6.11).

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 6.5.1.

For the connection of the extension cable to the transmitter see section 6.5.2.

For the connection of the transducer cable to the junction box see section 6.5.3.

For the connection of the extension cable to the junction box see section 6.5.4.

6.5.1 Connection of the transducer cable to the transmitter

6.5.1.1 Transducer cable with stainless steel conduit and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- The transmitter has 1 cable gland for the connection of the transducers.
- Remove the left blind plug for the connection of the transducer cable (see Fig. 6.5).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Press the cap nut with the compression part on the cable until the thin rim of the compression part is flush with the external cable jacket.
- Insert the transducer cable into the housing.
- Tighten the gasket ring side of the basic part into the transmitter housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the transmitter (see Fig. 6.5 and Tab. 6.1).

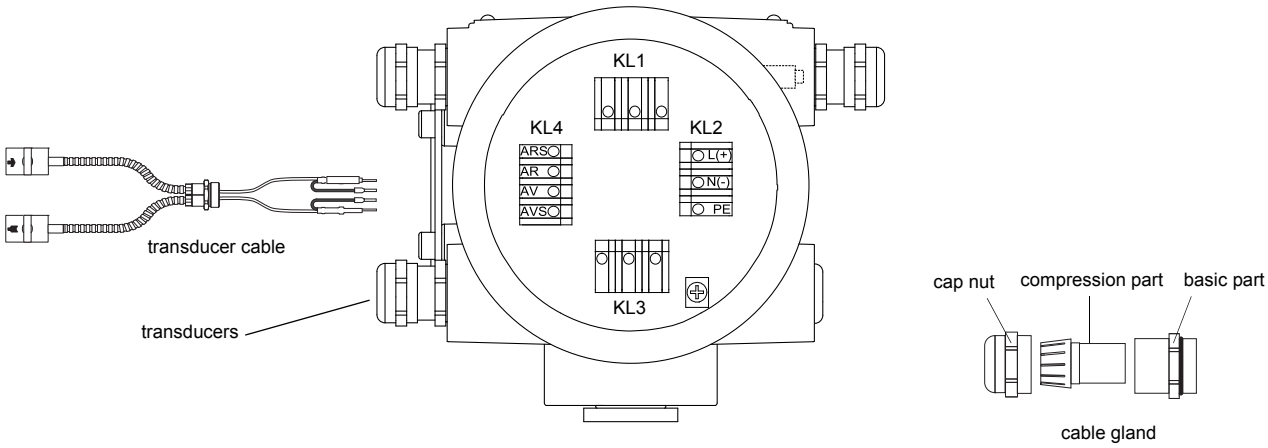


Fig. 6.5: Connection of the transducer cable

Tab. 6.1: Terminal assignment (transmitter, KL4)

terminal	connection (transducer cable)
AV	transducer ↑ (brown cable, marked white)
AVS	transducer ↑ (red cable)
ARS	transducer ↓ (red cable)
AR	transducer ↓ (brown cable)

6.5.1.2 Transducer cable with plastic cable jacket and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- The transmitter has 1 cable gland for the connection of the transducers.
- Remove the left blind plug for the connection of the transducer cable (see Fig. 6.6).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Shorten the external shield and brush it back over the compression part.
- Tighten the gasket ring side of the basic part tightly 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 thus to 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 (Fig. 6.6 and Tab. 6.2).

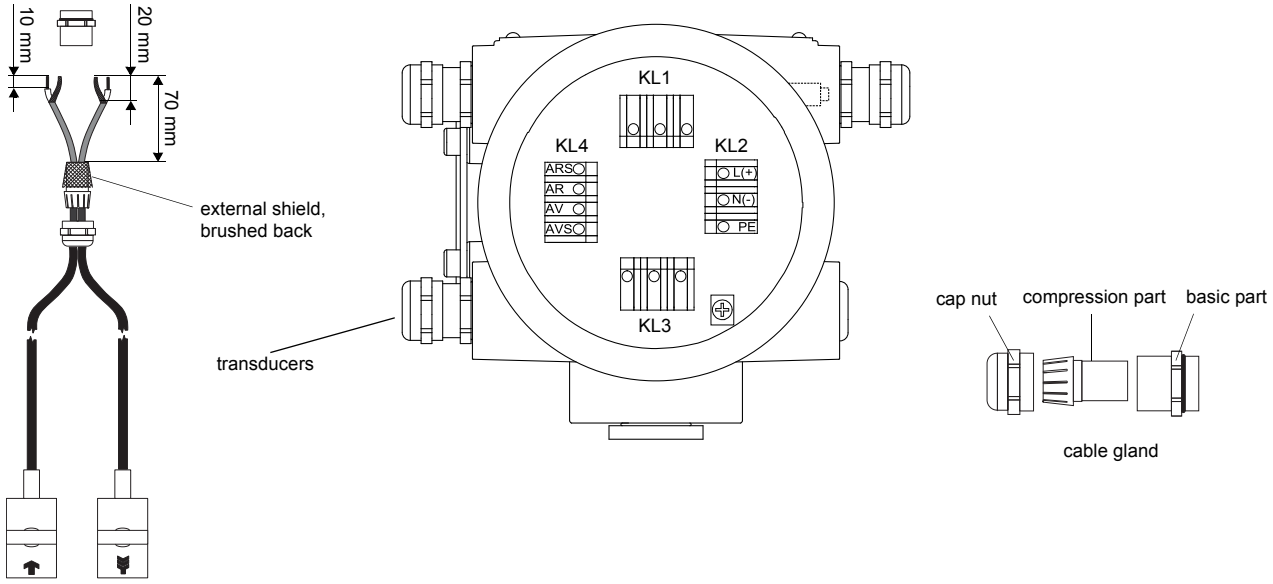


Fig. 6.6: Connection of the transducer cable

Tab. 6.2: Terminal assignment (transmitter, KL4)

terminal	connection (transducer cable)
AV	transducer ↑ (core)
AVS	transducer ↑ (inner shield)
ARS	transducer ↓ (inner shield)
AR	transducer ↓ (core)

6.5.2 Connection of the extension cable to the transmitter

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- The transmitter has 1 cable gland for the connection of the transducers.
- Remove the left blind plug for the connection of extension cable (see Fig. 6.7).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Prepare the extension cable.
- Press the cap nut with the compression part on the cable until the thin rim of the compression part is flush with the external cable jacket.
- Cut the external shield and brush it back over the compression part.
- Insert the extension cable into the housing.
- Tighten the gasket ring side of the basic part into the housing of the transmitter.

Attention!	For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and thus to 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. 6.7 and Tab. 6.3).

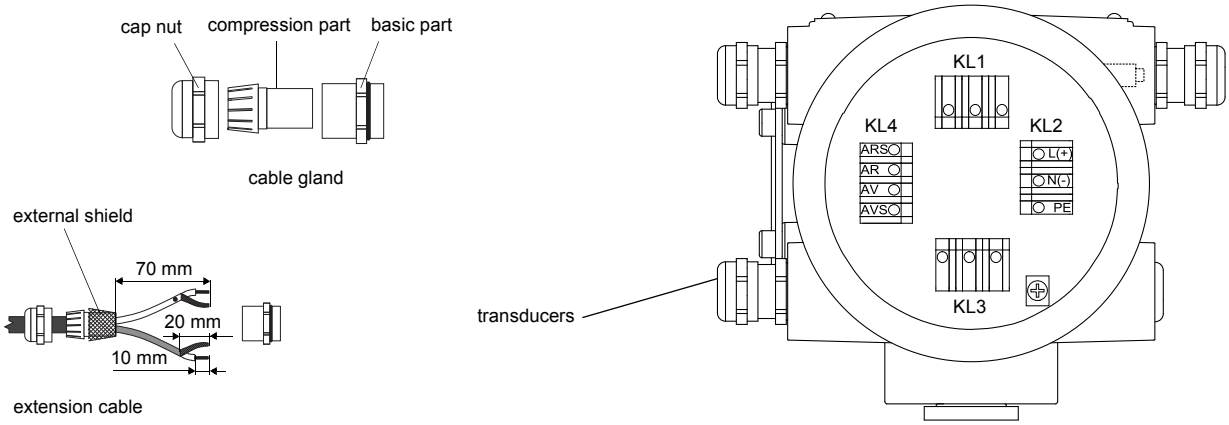


Fig. 6.7: Connection of the extension cable

Tab. 6.3: Terminal assignment (transmitter, KL4)

terminal	connection (extension cable)
AV	white or marked cable (core)
AVS	white or marked cable (internal shield)
ARS	brown cable (internal shield)
AR	brown cable (core)

6.5.3 Connection of the transducer cable to the junction box

6.5.3.1 Transducer cable with plastic cable jacket and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the right blind plug for the connection of the transducer cable (see Fig. 6.8).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Shorten the external shield and brush it back over the compression part.
- Tighten the gasket ring side of the basic part tightly into the junction box.
- Insert the transducer 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 thus to the junction box).

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the junction box (see Fig. 6.8 and Tab. 6.4).

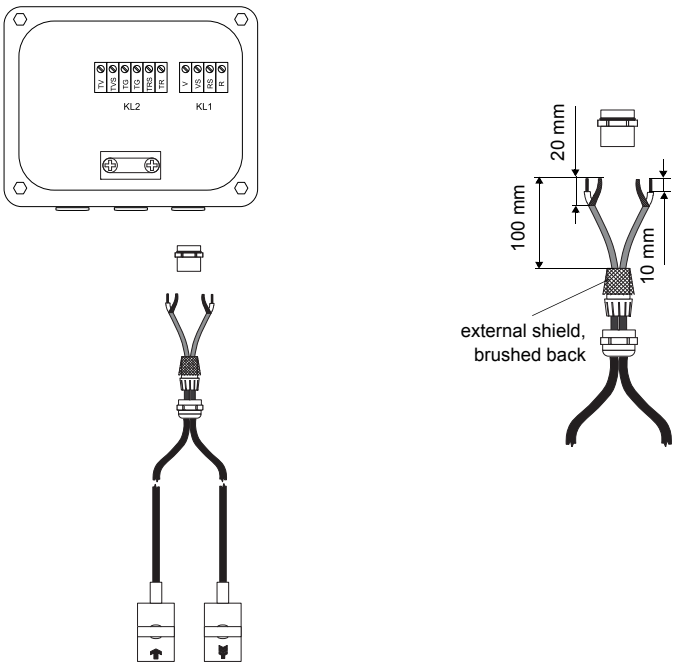


Fig. 6.8: Transducer cable with plastic cable jacket and stripped cable ends

Tab. 6.4: Terminal assignment (junction box, KL1)

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

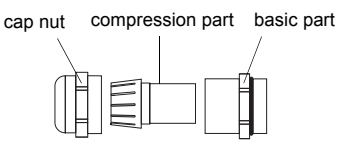


Fig. 6.9: Cable gland

6.5.3.2 Transducer cable with stainless steel conduit and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the right blind plug for the connection of the transducer cable (see Fig. 6.10).
- 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. 6.10 and Tab. 6.5).

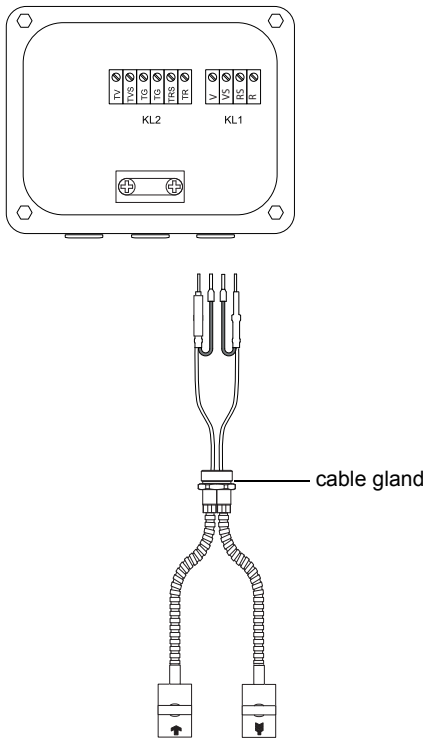


Fig. 6.10: Transducer cable with stainless steel conduit and stripped cable ends

Tab. 6.5: Terminal assignment (junction box, KL1)

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

6.5.4 Connection of the extension cable to the junction box

6.5.4.1 Without potential separation (standard)

The connection of an extension cables to a junction box without potential separation ensures that transducer, junction box and transmitter are on the same potential. The extension cable should always be connected that way especially if power cables are laid near the extension cable.

See section 6.5.4.2 if earthing on the same potential cannot be ensured.

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the blind plug for the connection of the extension cable (see Fig. 6.11).
- 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.
- Tighten 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 thus to 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. 6.11 and Tab. 6.6).

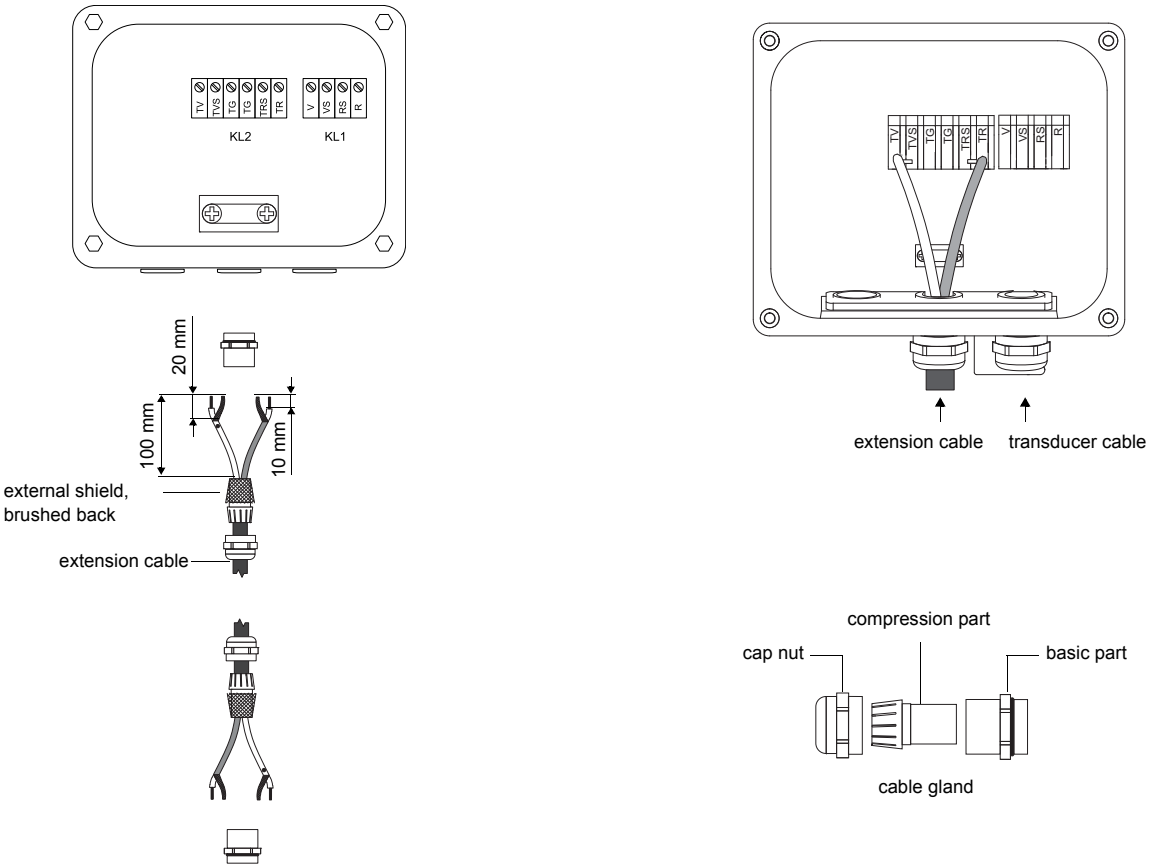


Fig. 6.11: Connection of the extension cable to the junction box

Tab. 6.6: Terminal assignment (junction box, KL2)

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

6.5.4.2 Connection with potential separation

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

Note!	For the installation of transducers to pipes with a cathodic corrosion protection see document TIFLUXUS_GalvSep.

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the blind plug for the connection of the extension cable (see Fig. 6.12).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut, the compression part and the basic part of the cable gland.
- Insert the extension cable into the junction box.
- Prepare the extension cable.
- Cut the outer shield and brush it back.
- Pull the extension cable back until the brushed back external shield is below the shield terminal (see Fig. 6.12). The extension cable must remain completely insulated up to the shield terminal.
- Tighten the gasket ring side of the basic part into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.

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

- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the transmitter (see Fig. 6.12 and Tab. 6.7).

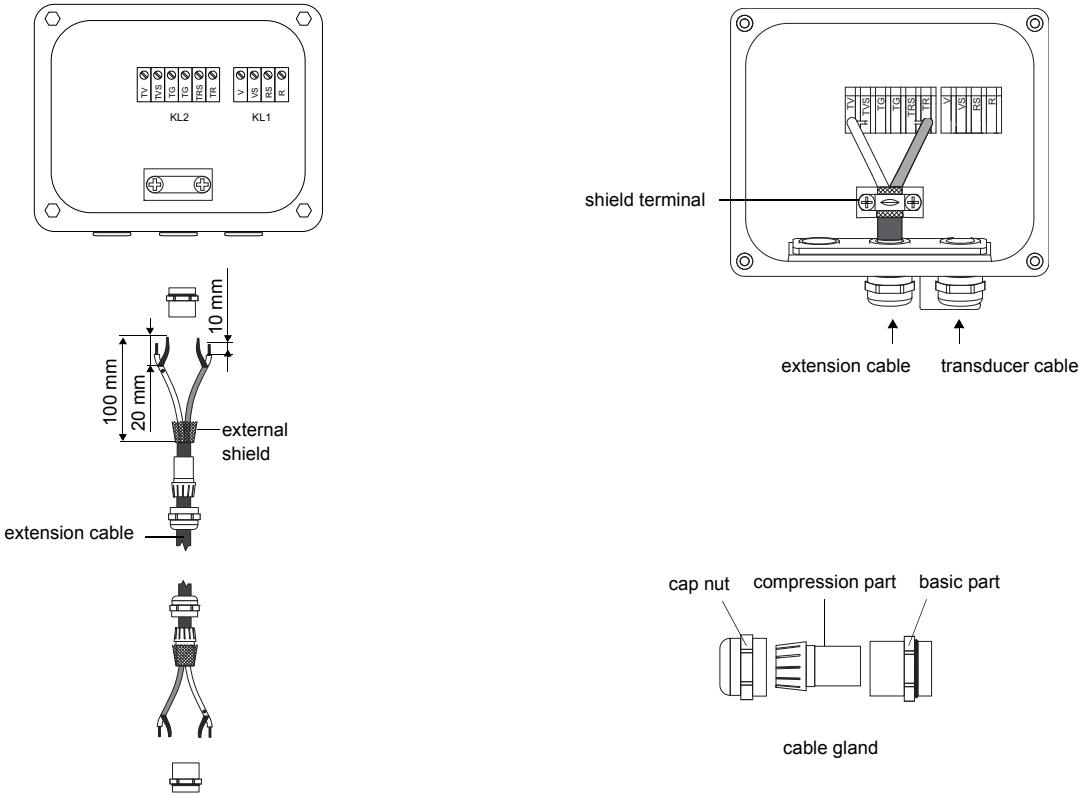


Fig. 6.12: Connection of the extension cable to the junction box

Tab. 6.7: Terminal assignment (junction box, KL2)

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

6.6 Connection of the transducers to the transmitter F808**-F1

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 6.11).

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 6.6.1.

For the connection of the extension cable to the transmitter see section 6.6.2.

For the connection to a junction box, see section 6.6.3.

6.6.1 Connection of the transducer cable to the transmitter

Attention!	Observe the safety and installation instructions for the use in explosive atmospheres (see documents SIFLUXUS_808_FM and SIFLUXUS_1N62).

- The transmitter has an opening for the connection of the transducers.
- Remove the blind plug for the connection of the transducer cable (see Fig. 6.13).
- Insert the transducer cable through the cable conduit (approved for FM Class I, Division 1) into the housing.
- Connect the transducer cable to the terminals of the transmitter (see Fig. 6.13 and Tab. 6.8).

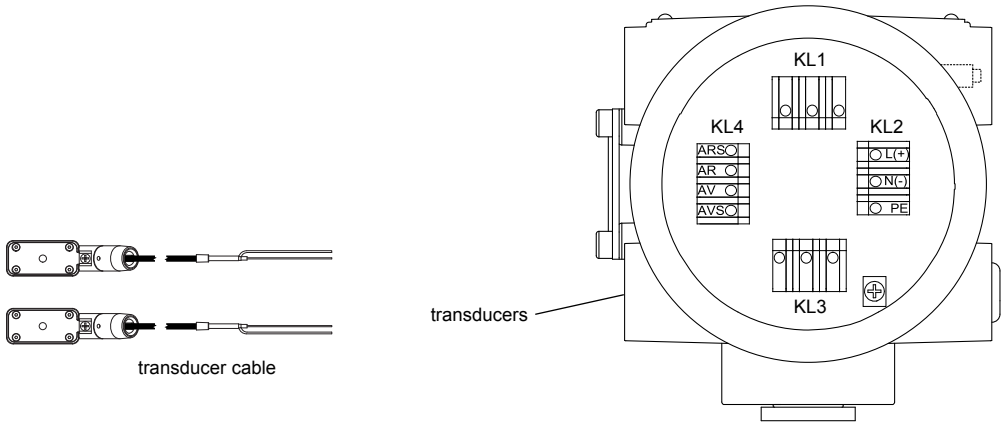


Fig. 6.13: Connection of the transducer cable

Tab. 6.8: Terminal assignment (transmitter, KL 4)

terminal	connection (transducer cable)
AR	transducer (signal)
ARS	transducer (inner shield)
AVS	transducer (inner shield)
AV	transducer (signal)

6.6.2 Connection of the extension cable to the transmitter

Attention!	Observe the safety and installation instructions for the use in explosive atmospheres (see documents SIFLUXUS_808_FM and SIFLUXUS_1N62).

- The extension cable is connected to the transmitter via the transducer connection.
- Remove the blind plug for the connection of the transducer cable (see Fig. 6.13).
- Insert the extension cable through the cable conduit (approved for FM Class I, Division 1) into the housing.
- Prepare the extension cable.
- Connect the extension cable to the terminals of the transmitter (see Fig. 6.14 and Tab. 6.9).

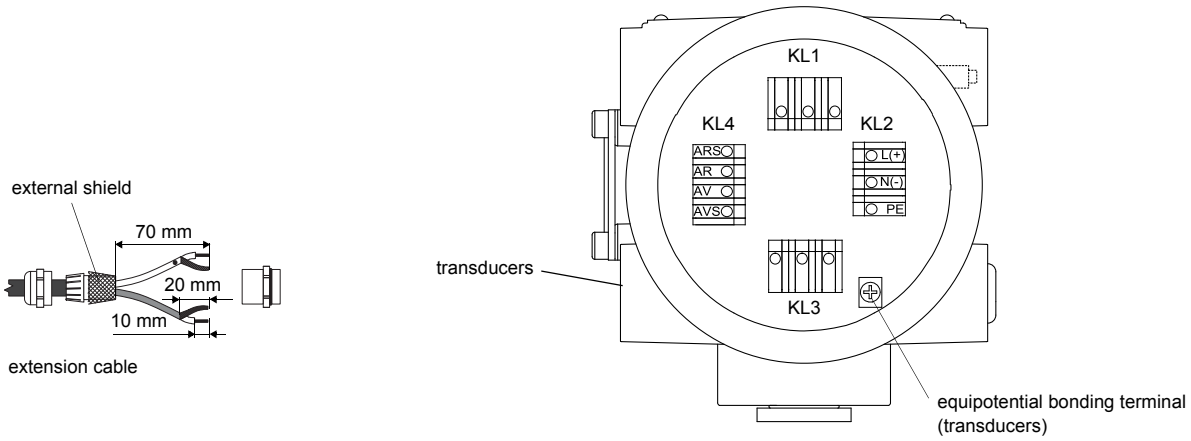


Fig. 6.14: Connection of the extension cable

Tab. 6.9: Terminal assignment (transmitter, KL 4)

terminal	**connection (extension cable)**
AV	white or marked cable (core)
AVS	white or marked cable (internal shield)
ARS	brown cable (internal shield)
AR	brown cable (core)
equipotential bonding terminal	external shield

6.6.3 Connection to the junction box

The transducers and the extension cable are connected via the terminal board KFM1. The terminal board has to be installed into a junction box (by the customer) approved for the use in explosive atmospheres.

• Connect the transducer cable to the terminals of the junction box (see Fig. 6.15, Tab. 6.10 and Tab. 6.11).

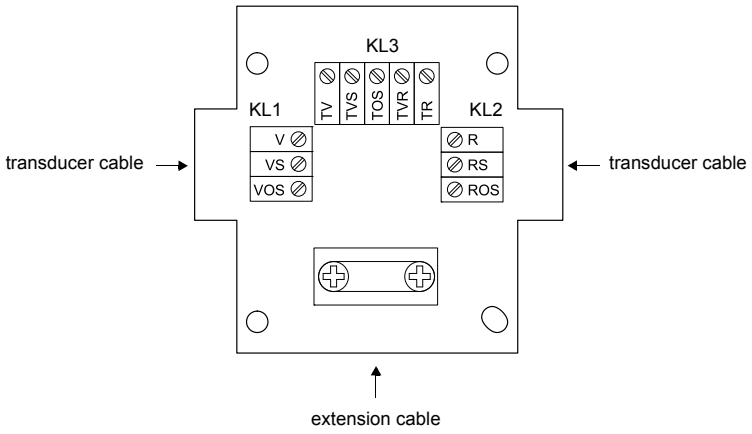


Fig. 6.15: Terminal board KFM1

Tab. 6.10: Terminal assignment (terminal board KFM1)

terminal	**connection (transducer cable)**
terminal strip KL1	
V	transducer ↑ (signal)
VS	transducer ↑ (inner shield)
VOS	transducer ↑ (external shield)

terminal	**connection (transducer cable)**
terminal strip KL2	
R	transducer ⇑ (signal)
RS	transducer ⇑ (inner shield)
ROS	transducer ⇑ (external shield)

Tab. 6.11: Terminal assignment (terminal board KFM1)

terminal	**connection (extension cable)**
terminal strip KL3	
TV	signal
TVS	internal shield
TOS	external shield
TRS	internal shield
TR	signal

6.7 Connection of the transducers to the transmitter F808**-F2

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 6.11).

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 6.7.1.

For the connection of the extension cable to the transmitter see section 6.7.2.

For the connection of the transducer cable to the junction box see section 6.7.3.

For the connection of the extension cable to the junction box see section 6.7.4.

6.7.1 Connection of the transducer cable to the transmitter

6.7.1.1 Transducer cable with stainless steel conduit and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_F2).

- The transmitter has 1 cable gland for the connection of the transducers.
- Remove the left blind plug for the connection of the transducer cable (see Fig. 6.16).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Press the cap nut with the compression part on the cable until the thin rim of the compression part is flush with the external cable jacket.
- Insert the transducer cable into the housing.
- Tighten the gasket ring side of the basic part into the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the transmitter (Fig. 6.16 and Tab. 6.12).

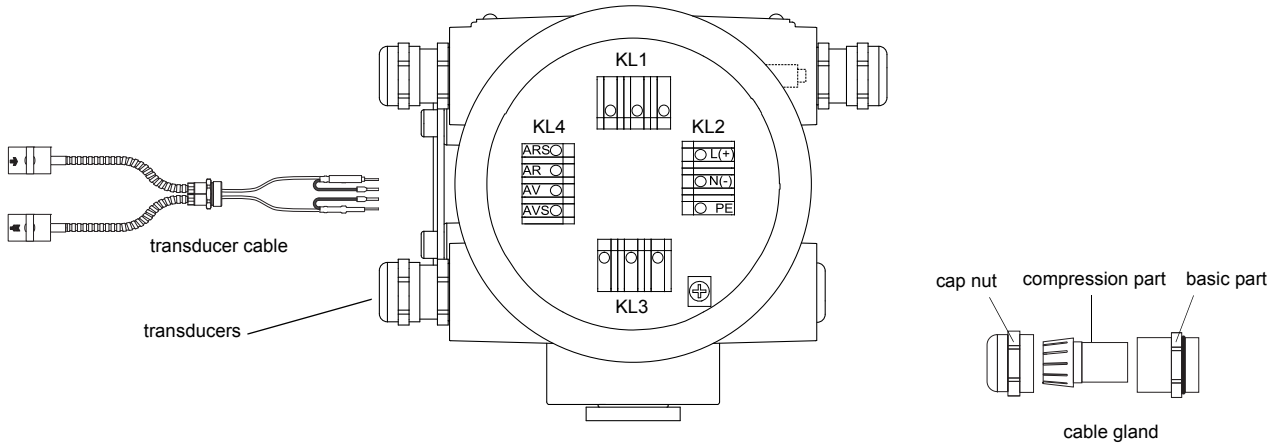


Fig. 6.16: Connection of the transducer cable

Tab. 6.12: Terminal assignment (transmitter, KL4)

terminal	connection (transducer cable)
AV	transducer ↑ (brown cable, marked white)
AVS	transducer ↑ (red cable)
ARS	transducer ↓ (red cable)
AR	transducer ↓ (brown cable)

6.7.1.2 Transducer cable with SMB connectors

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_F2).

For the installation of transducers with SMB connectors a SMB adapter is required.

- The transmitter has 1 cable gland for the connection of the transducers.
- Remove the left blind plug for the connection of the transducer cable (see Fig. 6.17).
- Connect the transducers with the SMB adapter.
- Insert the transducer cables with SMB connector into the housing.
- Tighten the gasket ring side of the basic part tightly into the housing of the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the transmitter (Fig. 6.17 and Tab. 6.13).

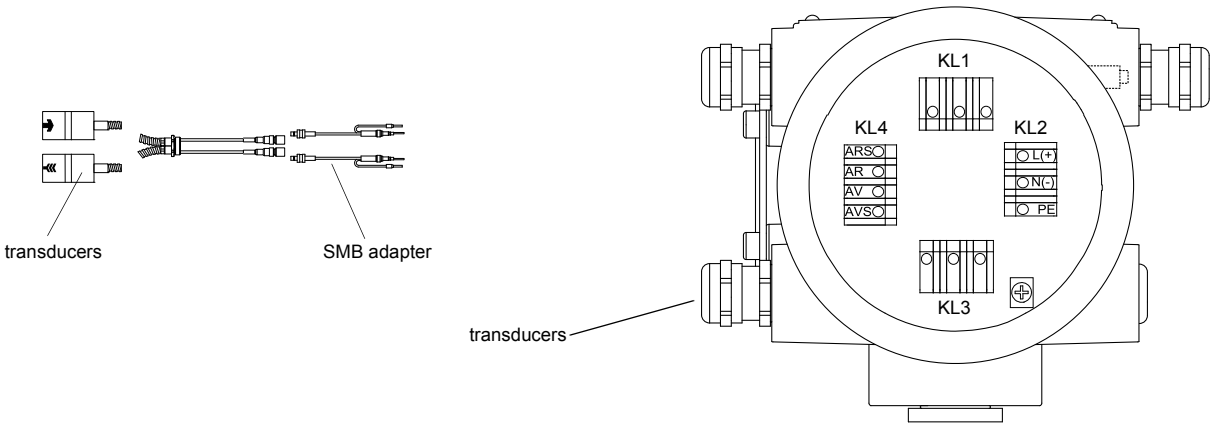


Fig. 6.17: Connection of the transducer cable with SMB adapter

Tab. 6.13: Terminal assignment (transmitter, KL4)

terminal	connection (SMB adapter)
AV	transducer ↑ (brown cable, marked white)
AVS	transducer ↑ (red cable)
ARS	transducer ↓ (red cable)
AR	transducer ↓ (brown cable)

6.7.2 Connection of the extension cable to the transmitter

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_F2).

- The transmitter has 1 cable gland for the connection of the transducers.
- Remove the left blind plug for the connection of extension cable (see Fig. 6.18).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer 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.
- Insert the extension cable into the housing.
- Tighten the gasket ring side of the basic part into the housing of the transmitter.

Attention!	For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and thus to 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. 6.18 and Tab. 6.14).

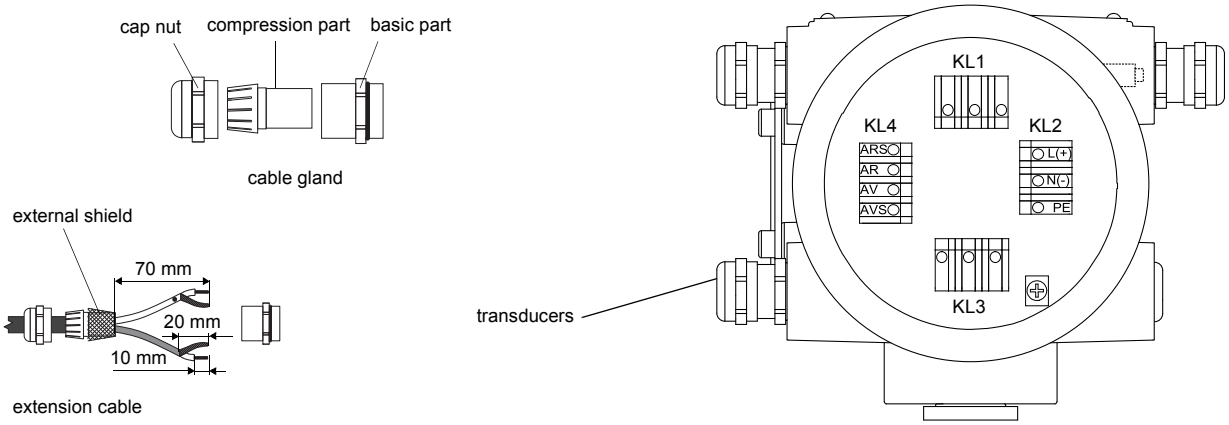


Fig. 6.18: Connection of the extension cable

Tab. 6.14: Terminal assignment (transmitter, KL4)

terminal	**connection (extension cable)**
AV	white or marked cable (core)
AVS	white or marked cable (internal shield)
ARS	brown cable (internal shield)
AR	brown cable (core)

6.7.3 Connection of the transducer cable to the junction box

6.7.3.1 Transducer cable with SMB connectors

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_F2).

The transducer cable with SMB connectors and the extension cable are connected via the junction box JB04.

- Remove the right blind plug for the connection of the transducer cable (see Fig. 6.19).
- Insert the transducer cable with the SMB connectors into the junction box.
- Connect the SMB connectors to the sockets of the junction box (see Fig. 6.19 and Tab. 6.15).

Tab. 6.15: Terminal assignment (junction box JB04, KL2)

terminal	connection (transducer cable)
XV	SMB connector (brown cable, marked white)
XR	SMB connector (brown cable, marked black)

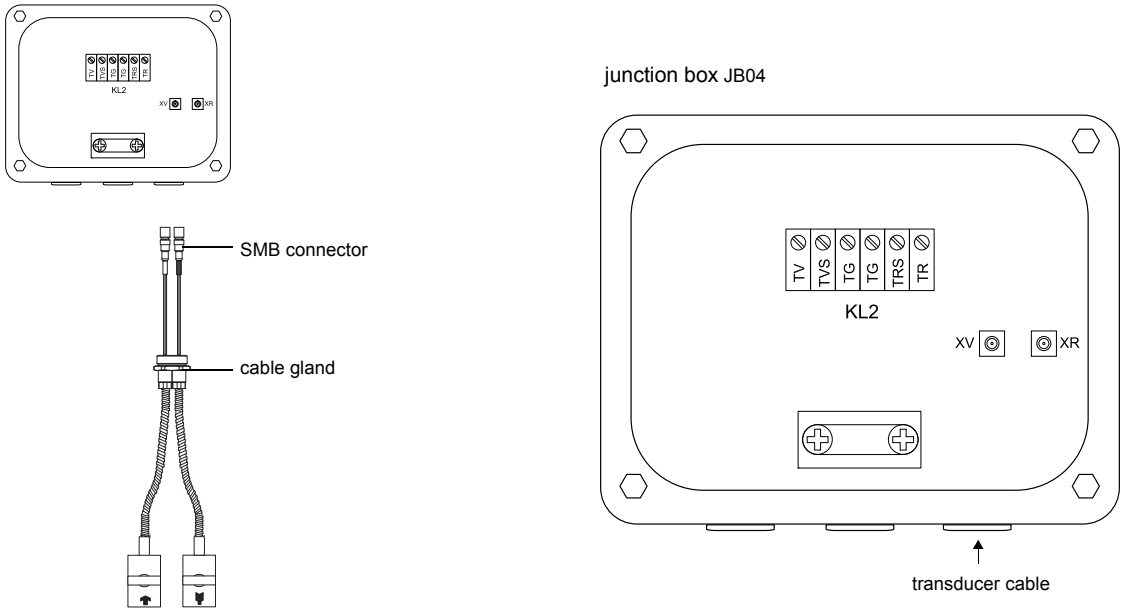


Fig. 6.19: Connection of the transducer cable with SMB connectors

6.7.4 Connection of the extension cable to the junction box

6.7.4.1 Connection without potential separation (standard)

The connection of an extension cables to a junction box without potential separation ensures that transducer, junction box and transmitter are on the same potential. The extension cable should always be connected that way especially if power cables are laid near the extension cable.

See section 6.7.4.2 if earthing on the same potential cannot be ensured.

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_F2).

- Remove the blind plug for the connection of the extension cable (see Fig. 6.20).
- 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.
- Tighten 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 thus to 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. 6.20 and Tab. 6.16).

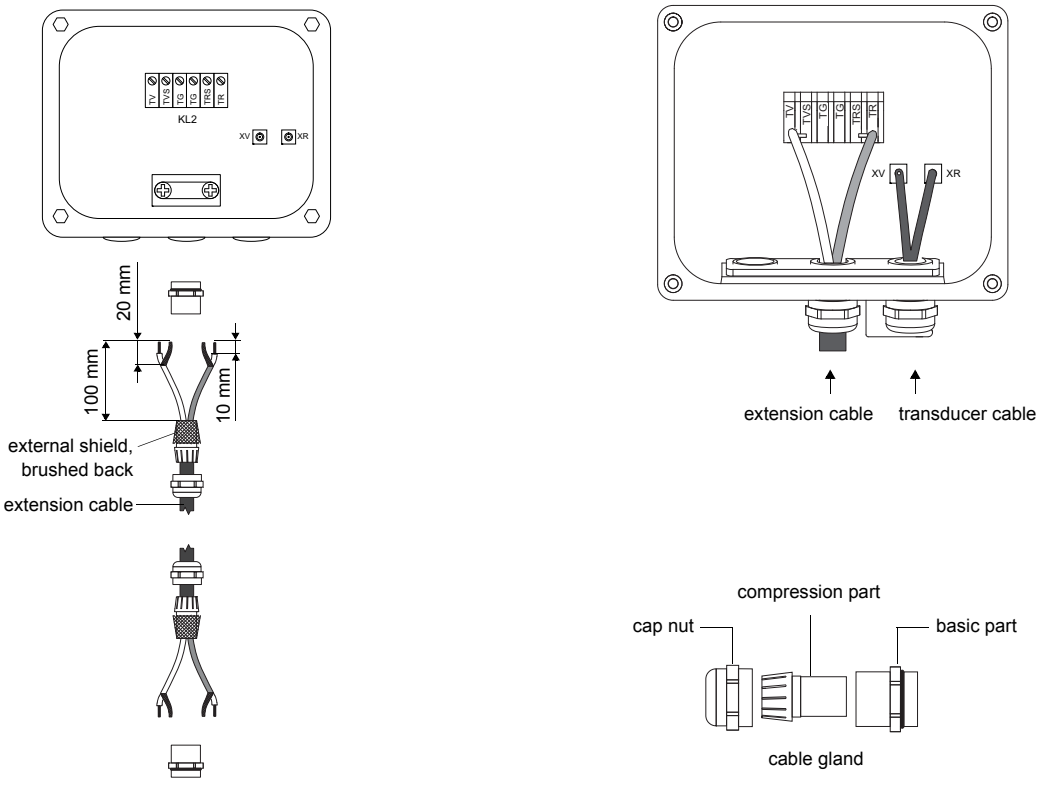


Fig. 6.20: Connection of the extension cable to the junction box

Tab. 6.16: Terminal assignment (junction box JB04, KL2)

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

6.7.4.2 Connection with potential separation

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

Note!	For the installation of transducers to pipes with a cathodic corrosion protection see document TIFLUXUS_GalvSep.

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the blind plug for the connection of the extension cable (see Fig. 6.21).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut, the compression part and the basic part of the cable gland.
- Insert the extension cable into the junction box.
- Prepare the extension cable.
- Cut the outer shield and brush it back.
- Pull the extension cable back until the brushed back external shield is below the shield terminal (see Fig. 6.21). The extension cable must remain completely insulated up to the shield terminal.
- Tighten the gasket ring side of the basic part into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.

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

- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the transmitter (see Fig. 6.21 and Tab. 6.17).

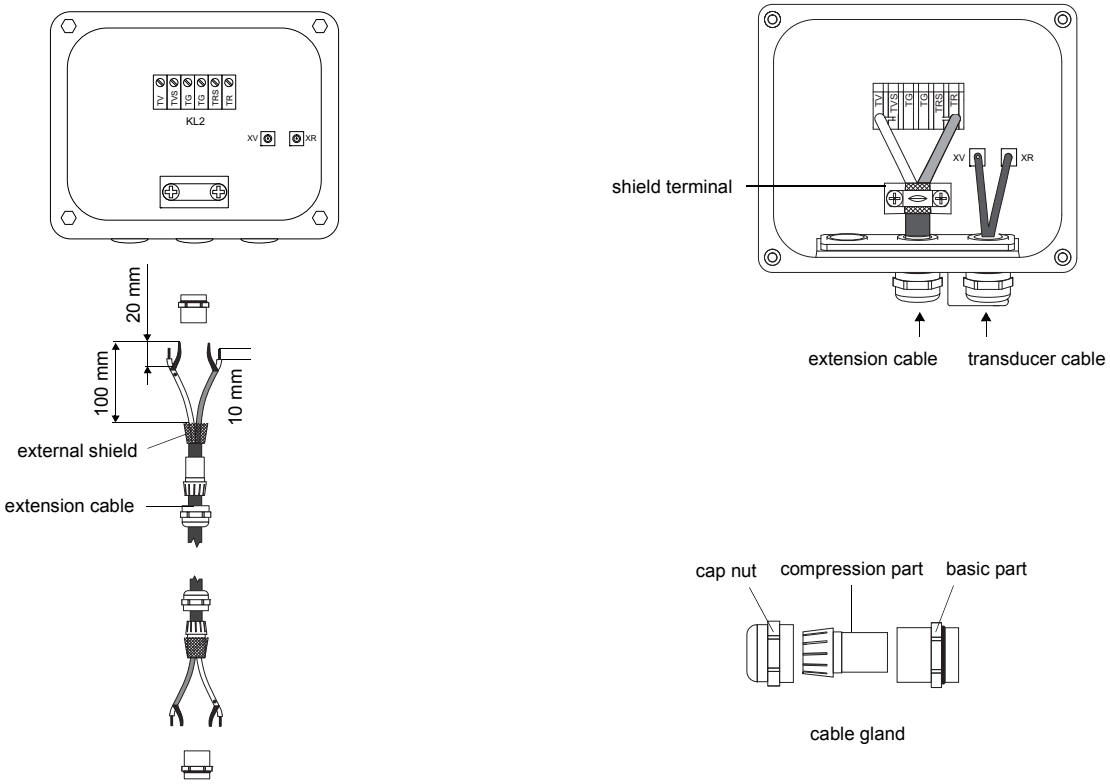


Fig. 6.21: Connection of the extension cable to the junction box

Tab. 6.17: Terminal assignment (junction box JB04, KL2)

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

6.8 Power supply

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 measuring instrument 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.

6.8.1 FLUXUS F808**-A1, FLUXUS F808**-F2

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS and SIFLUXUS_808_F2).

The external protective earth is connected to the equipotential bonding terminal on the transmitter housing. It always has to be connected (see Fig. 6.23).

For the connection of the power cable to the transmitter, see box "Cable connection", Fig. 6.23 and Tab. 6.18.

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.
- Tighten 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.

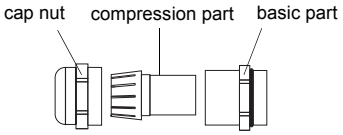


Fig. 6.22: Cable gland

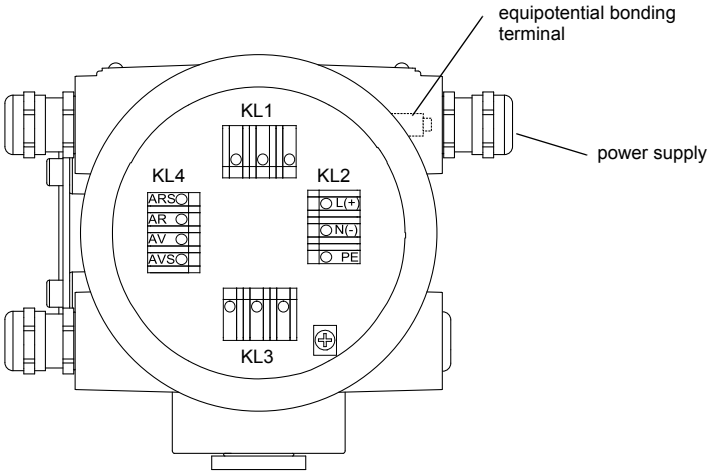


Fig. 6.23: Connection of the power supply

Tab. 6.18: Connection of the power supply (KL2)

AC		**DC**	
terminal	connection	terminal	connection
L	phase	L+	+
N	neutral	N-	-
PE	earth	PE	earth

6.8.2 FLUXUS F808**-F1

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_FM and SIFLUXUS_1N62).

The external protective earth is connected to the equipotential bonding terminal on the transmitter housing. It always has to be connected (see Fig. 6.24)

For the connection of the power cable to the transmitter, see Fig. 6.24 and Tab. 6.19.

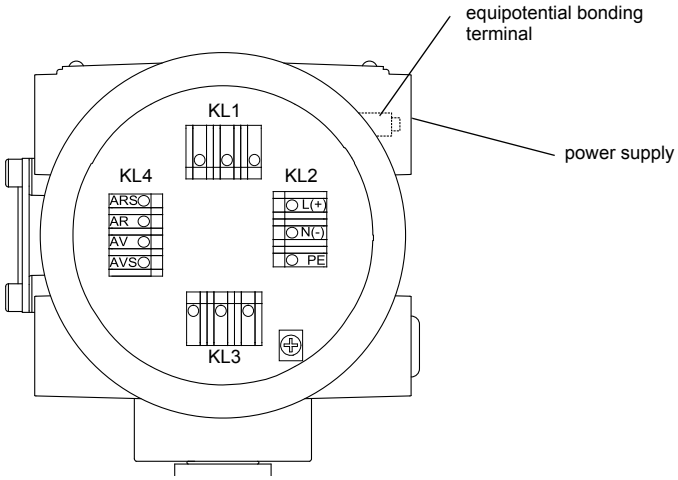


Fig. 6.24: Connection of the power supply

Tab. 6.19: Connection of the power supply (KL2)

AC		**DC**	
terminal	connection	terminal	connection
L	phase	L+	+
N	neutral	N-	-
PE	earth	PE	earth

6.9 Outputs

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

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

For the connection of the output cable to the transmitter, see box "Cable connection", p. 47, Fig. 6.25 and Tab. 6.20.

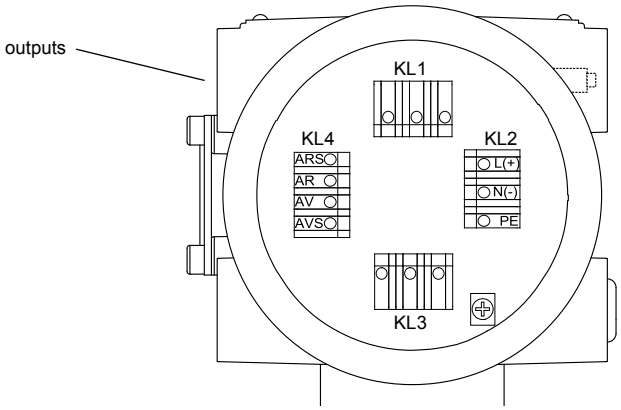
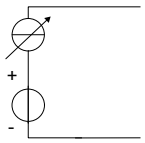
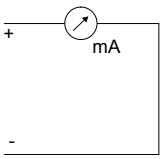
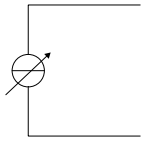
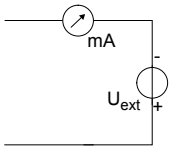


Fig. 6.25: Connection of the outputs

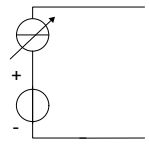
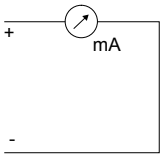
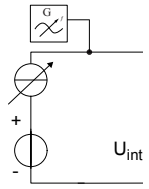
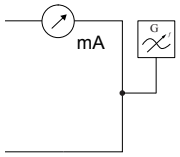
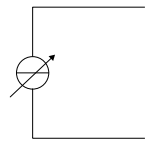
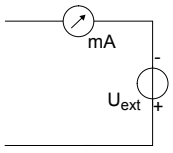
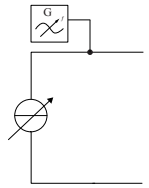
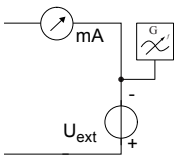
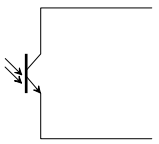
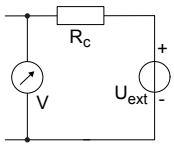
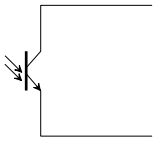
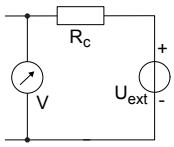
Tab. 6.20: Circuits of the outputs

output	**transmitter**			**remark**
	internal circuit	**connection**	**external circuit**	
active current loop		I1: 2 (+) KL3 I1: 1 (-)		R_{ext} < 500 Ω
passive current loop		I1: 1 (-) KL3 I1: 2 (+)		U_{ext} = 4…24 V U_{ext} > 0.021 A · R_{ext} [Ω] + 4 V example: U_{ext} = 12 V R_{ext} ≤ 380 Ω

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

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

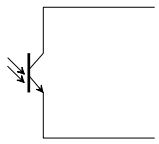
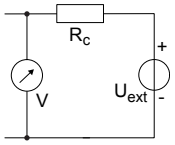
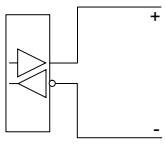
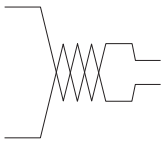
Tab. 6.20: Circuits of the outputs

output	transmitter			remark
	internal circuit	connection	external circuit	
active current loop/HART F808**-A1 F808**-F1	current loop			R_{ext} < 500 Ω U_{int} = 24 V
		I1: 2 (+) KL3 I1: 1 (-)		
	HART mode			
		I1: 2 (+) KL3 I1: 1 (-)		
passive current loop/HART F808**-A1 F808**-F1	current loop			U_{ext} = 7...30 V U_{ext} > 0.022 A · R_{ext} [Ω] + 7 V example: U_{ext} = 12 V R_{ext} ≤ 227 Ω current during transmitter error: I_{fault} = 3.2...3.5 mA
		I1: 1 (-) KL3 I1: 2 (+)		
	HART mode			
		I1: 1 (-) KL3 I1: 2 (+)		
binary output (open collector)		B1: 6 (+) KL1 B1: 5 (-)		U_{ext} = 5...24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA
binary output (open collector)		B1: 6 (+) KL1 B1: 5 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} ≤ 0.4 mA

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

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

Tab. 6.20: Circuits of the outputs

output	**transmitter**			**remark**
	internal circuit	**connection**	**external circuit**	
binary output (open collector) NAMUR		B1: 6 (+) KL1 B1: 5 (-)		U_{ext} = 8.2 V R_c = 1 kΩ DIN EN 60947-5-6 (NAMUR)
RS485	 shield	2 (A+) KL1 3 (B-) 1		120 Ω termination resistor

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

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

6.10 Serial interface

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

6.10.1 RS232 interface

The RS232 interface can only be connected outside of an explosive atmosphere because the housing has to be opened (see Fig. 6.26).

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

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

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

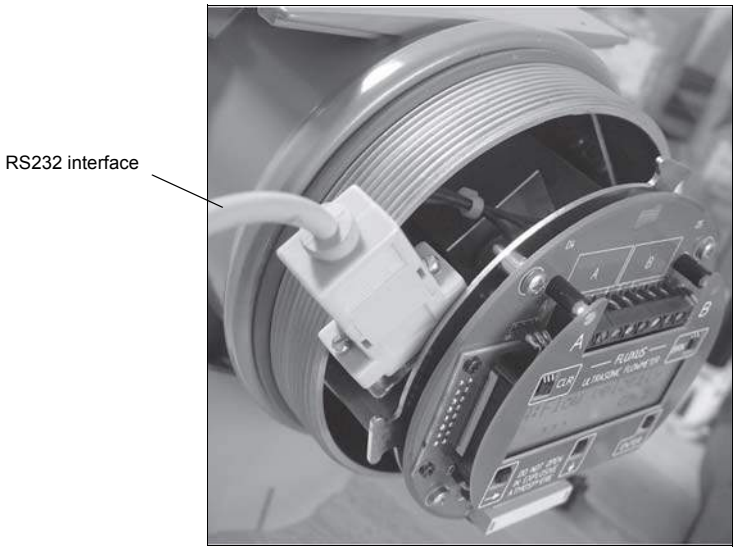


Fig. 6.26: Connection of the RS232 interface

6.10.2 RS485 interface

The transmitter can also be equipped with an RS485 interface (optional). For the connection of the serial interface see box "Cable connection", p. 47 (F808**-A1 only), Fig. 6.27 and Tab. 6.20.

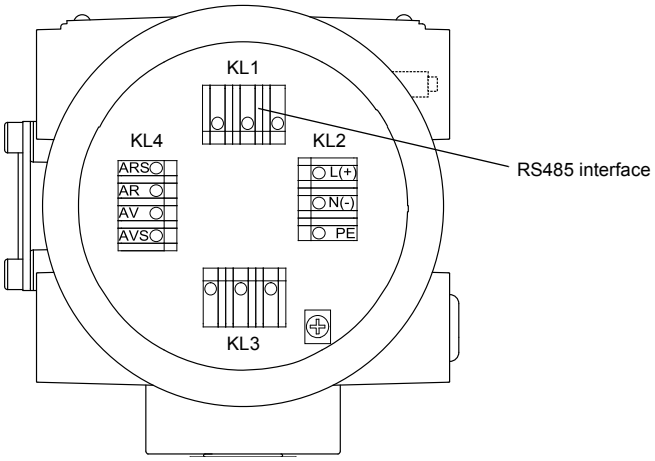


Fig. 6.27: Connection of the RS485 interface

For further information on the data transmission see chapter 13.

6.11 Sensor module (SENSPROM)

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

The sensor module contains important transducer data for the operation of the transmitter with the transducers. It is con-nected to the connector strips above the display of the transmitter.

If transducers are replaced or added, the sensor module also has to be replaced or added.

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

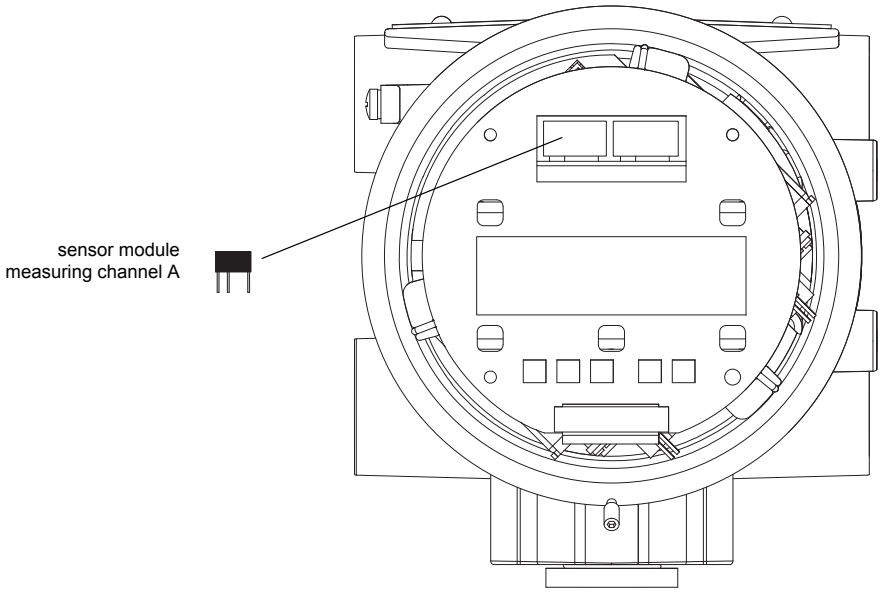


Fig. 6.28: Sensor module

7 Installation of FLUXUS F809

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM and SIFLUXUS_1N62).

7.1 Location

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

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.

7.2 Opening and closing the housing

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM and SIFLUXUS_1N62).

The transmitter has 3 set screws which have to be unscrewed before the housing can be opened. After the installation of the transmitter, make sure that the housing is closed correctly and that the set screws are tightened (see Fig. 7.1).

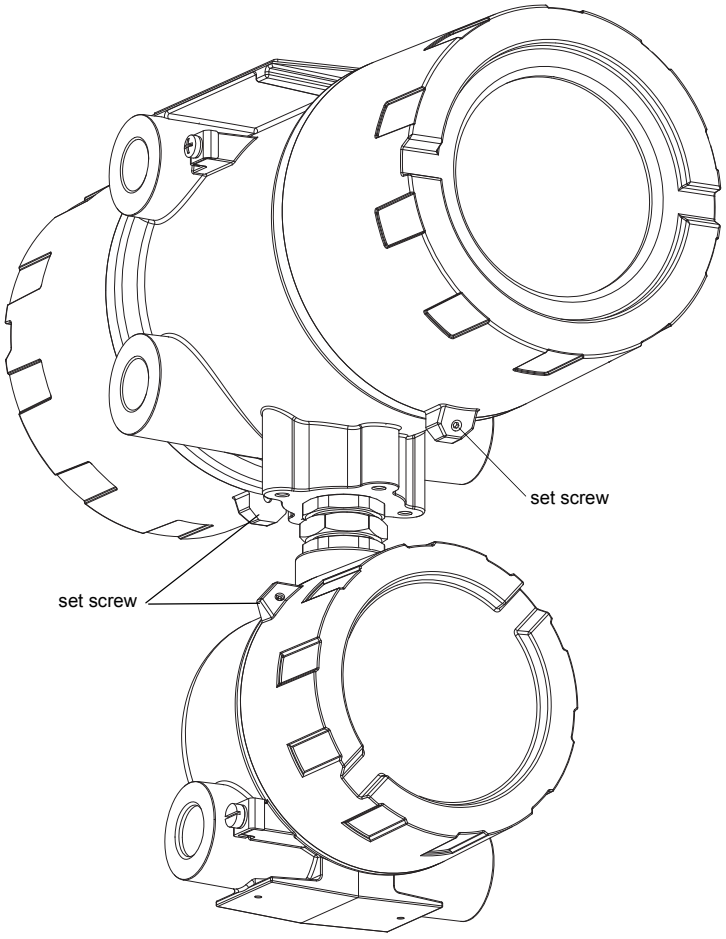


Fig. 7.1: Transmitter FLUXUS F809

7.3 Installation

7.3.1 Wall installation

- Fix the housing to the instrument mounting plate (2) (see Fig. 7.2).
- Fix the transmitter to the wall.

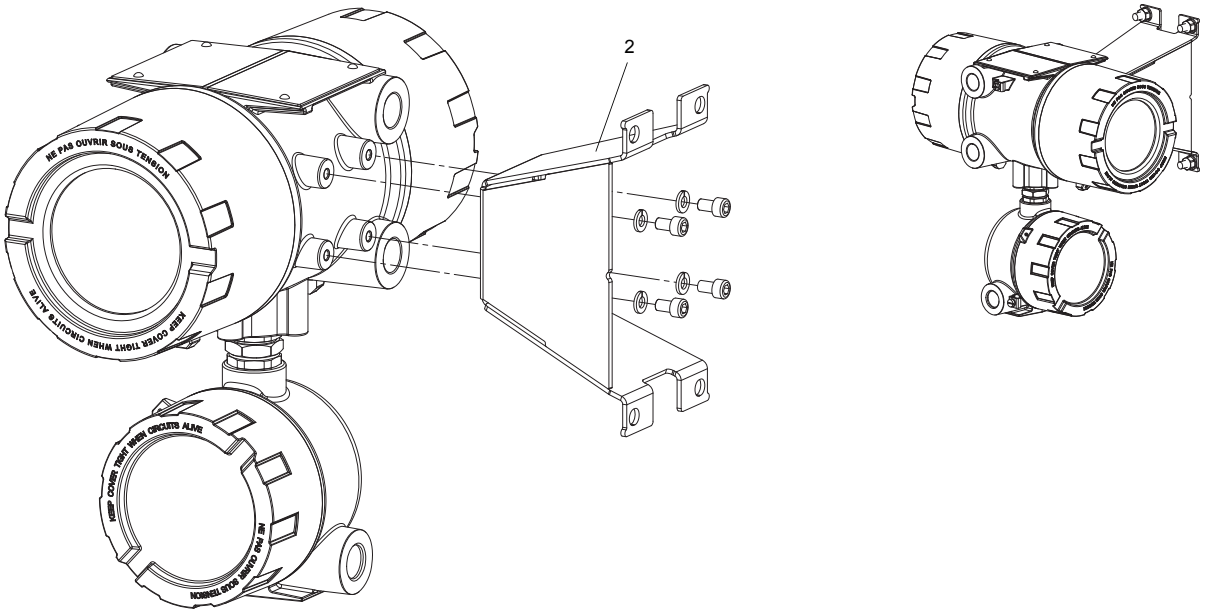


Fig. 7.2: Wall installation

7.3.2 Pipe Installation

Installation on a 2" pipe

The instrument mounting plate (2) is fixed to the pipe using a shackle (1) (see Fig. 7.3).

- Fix the transmitter to the instrument mounting plate.
- Tighten the nuts (3) to fix the transmitter with the shackle to the pipe.

Installation on a pipe > 2"

The instrument mounting plate (2) is fixed to the pipe using tension straps (see Fig. 7.3).

• Fix the transmitter to the instrument mounting plate.

• Fix the instrument mounting plate (2) to the pipe using tension straps (4) instead of shackles (1).

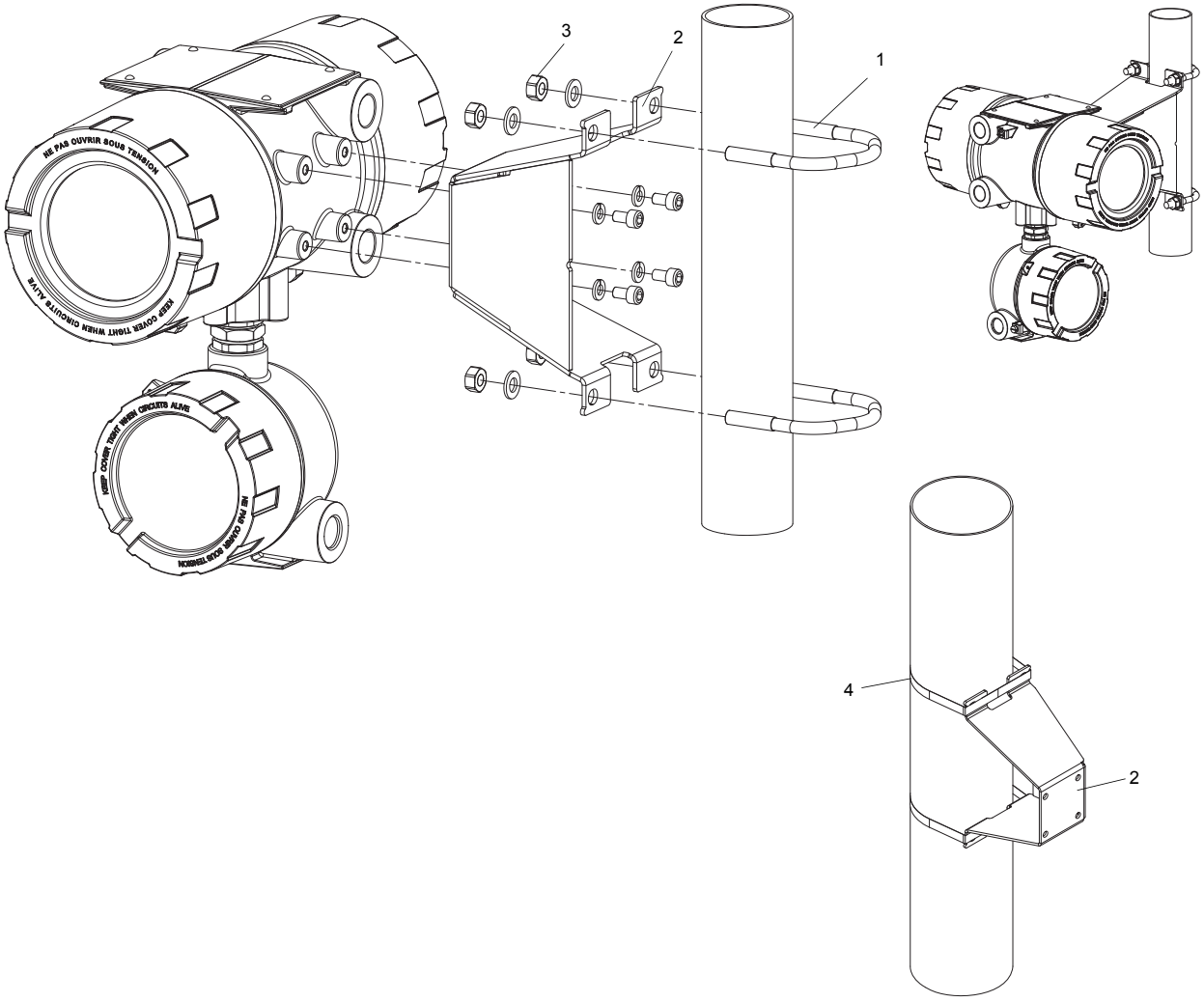


Fig. 7.3: Pipe installation

7.4 Connection of the transmitter

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM and SIFLUXUS_1N62).

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

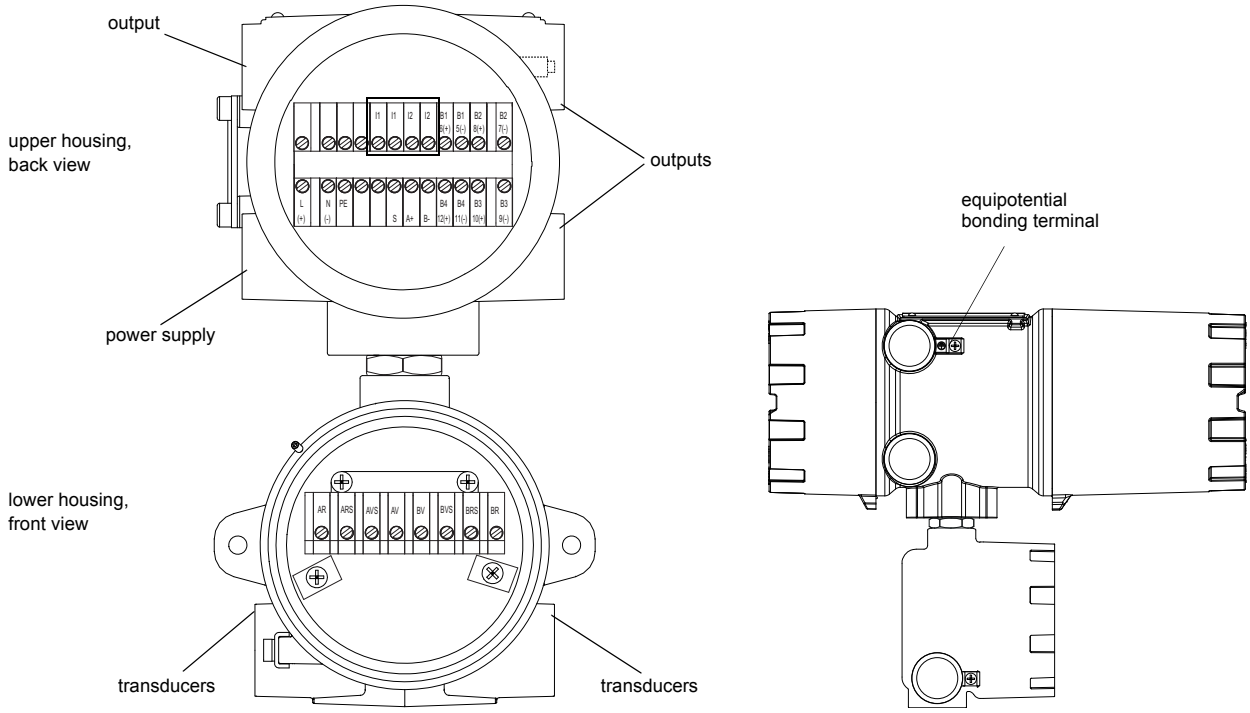


Fig. 7.4: Connections of the transmitter

7.5 Connection of the transducers to the transmitter F809**-A1

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 7.10).

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 7.5.1.

For the connection of the extension cable to the transmitter see section 7.5.2.

For the connection of the transducer cable to the junction box see section 7.5.4.

For the connection of the extension cable to the junction box see section 7.5.3.

7.5.1 Connection of the transducer cable to the transmitter

7.5.1.1 Transducer cable with stainless steel conduit and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- The transmitter has 2 cable glands for the connection of the transducers.
- Remove the blind plug for the connection of the transducer cable (see Fig. 7.5).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Press the cap nut with the compression part on the cable until the thin rim of the compression part is flush with the external cable jacket.
- Insert the transducer cable into the housing.
- Screw the gasket ring side of the basic part into the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the transmitter (Fig. 7.5, Tab. 7.1 and Tab. 7.2).

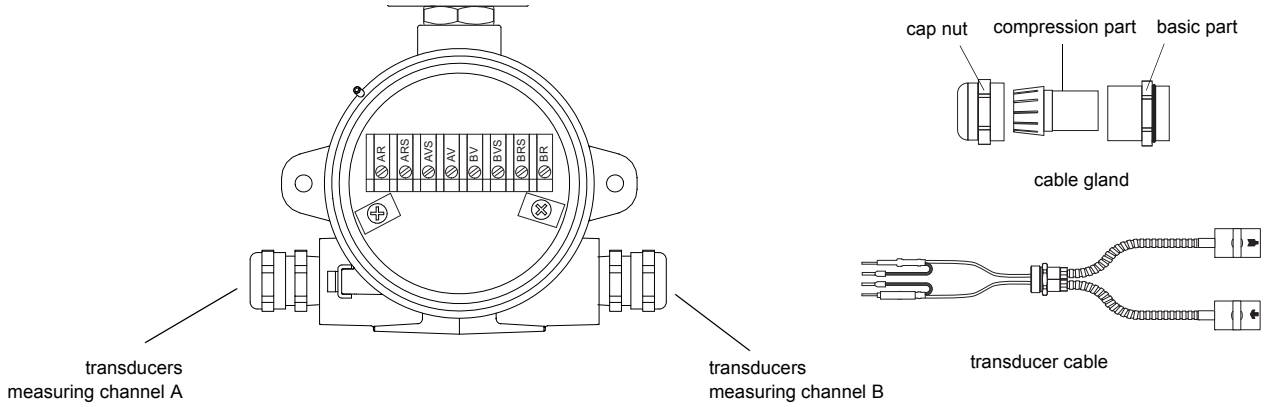


Fig. 7.5: Connection of the transducer cable

Tab. 7.1: Terminal assignment (transmitter)

terminal	connection (transducer cable)
AV	transducer ↑ (brown cable, marked white)
AVS	transducer ↑ (red cable)
ARS	transducer ↓ (red cable)
AR	transducer ↓ (brown cable)

7.5.1.2 Transducer cable with plastic cable jacket and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- The transmitter has 2 cable glands for the connection of the transducers.
- Remove the blind plug for the connection of the transducer cable (see Fig. 7.6).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Shorten the external shield and brush it back over the compression part.
- Screw the gasket ring side of the basic part tightly 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 thus to 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 (Fig. 7.5 and Tab. 7.1).

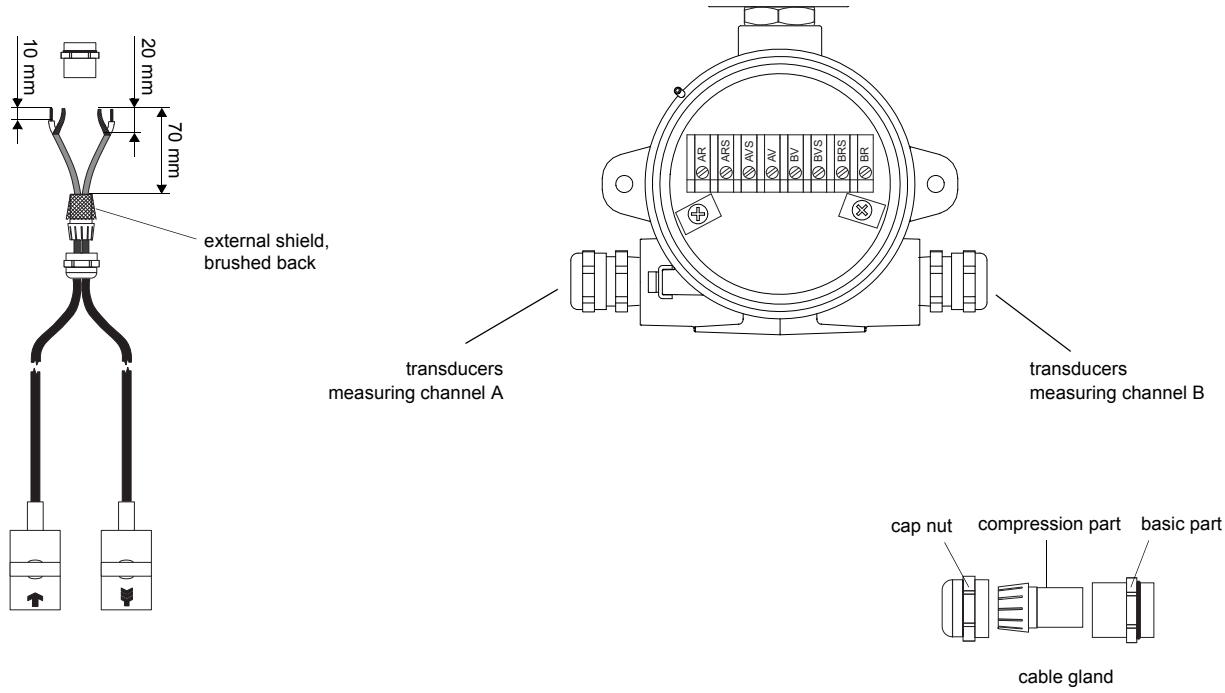


Fig. 7.6: Connection of the transducer cable

Tab. 7.2: Terminal assignment (transmitter)

terminal	connection (transducer cable)
AV	transducer ↑ (core)
AVS	transducer ↑ (inner shield)
ARS	transducer ↓ (inner shield)
AR	transducer ↓ (core)

7.5.2 Connection of the extension cable to the transmitter

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- The transmitter has 2 cable glands for the connection of the transducers.
- Remove the blind plug for the connection of extension cable (see Fig. 7.7).
- Open the cable gland. The compression part remains in the cap nut.
- Push the transducer 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.
- Insert the extension cable into the housing.
- Screw the gasket ring side of the basic part into the housing of the transmitter.

Attention!	For good high frequency shielding, it is important to ensure good electrical contact between the external shield and the cap nut (and thus to 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. 7.7 and Tab. 7.3).

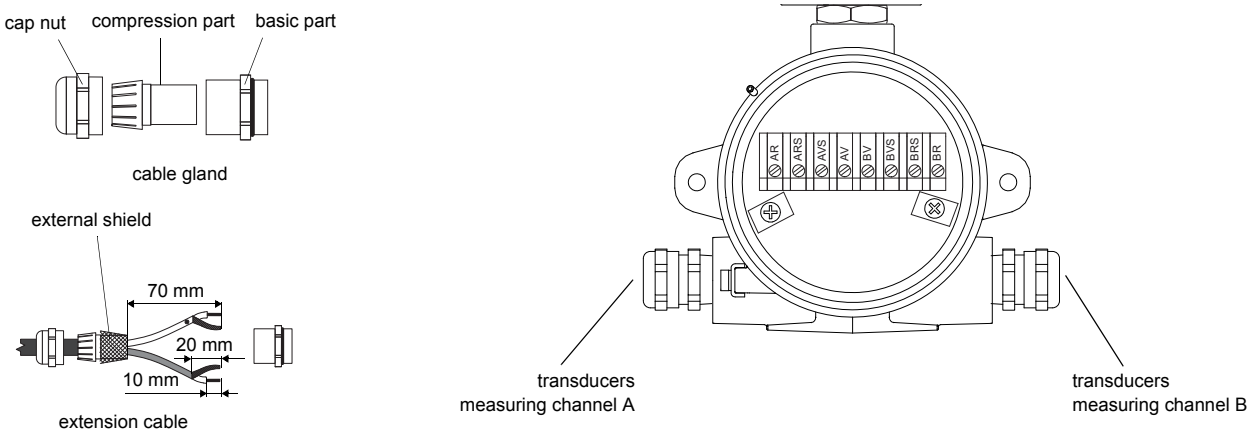


Fig. 7.7: Connection of the extension cable

Tab. 7.3: Terminal assignment (transmitter)

terminal	**connection (extension cable)**
AV	white or marked cable (core)
AVS	white or marked cable (internal shield)
ARS	brown cable (internal shield)
AR	brown cable (core)

7.5.3 Connection of the transducer cable to the junction box

7.5.3.1 Transducer cable with plastic cable jacket and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the right blind plug for the connection of the transducer cable (see Fig. 7.8).
- Open the cable gland of the transducer cable. The compression part remains in the cap nut (see Fig. 7.9).
- Push the transducer cable through the cap nut and the compression part.
- Prepare the transducer cable.
- Shorten the external shield and brush it back over the compression part.
- Screw the gasket ring side of the basic part tightly into the junction box.
- Insert the transducer 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 thus to the junction box).

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the transducer cable to the terminals of the junction box (see Fig. 7.8 and Tab. 7.4).

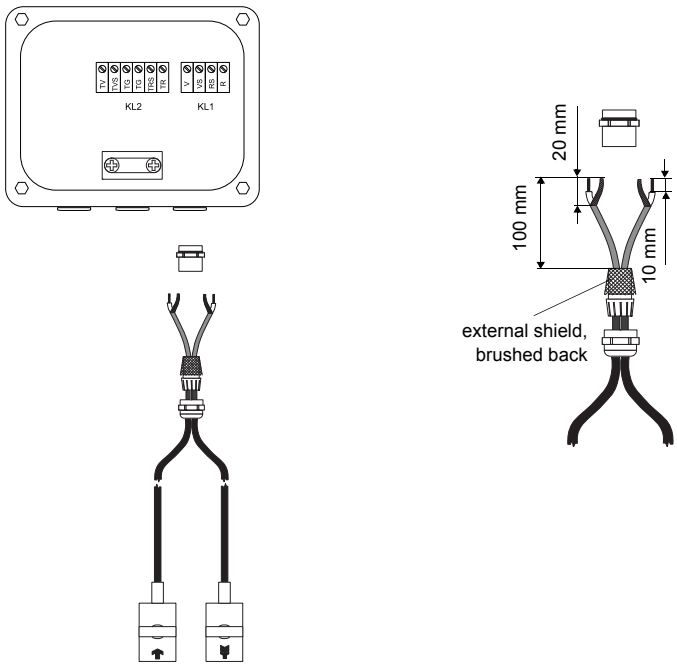


Fig. 7.8: Transducer cable with plastic cable jacket and stripped cable ends

Tab. 7.4: Terminal assignment (junction box, KL1)

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

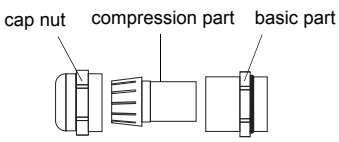


Fig. 7.9: Cable gland

7.5.3.2 Transducer cable with stainless steel conduit and stripped cable ends

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the right blind plug for the connection of the transducer cable (see Fig. 7.10).
- 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. 7.10 and Tab. 7.5).

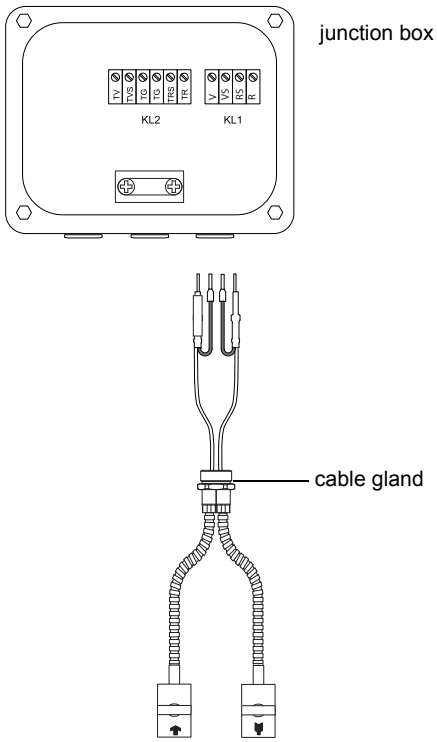


Fig. 7.10: Transducer cable with stainless steel conduit and stripped cable ends

Tab. 7.5: Terminal assignment (junction box, KL1)

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

7.5.4 Connection of the extension cable to the junction box

7.5.4.1 Connection without potential separation (standard)

The connection of the extension cable to a junction box without potential separation ensures that transducer, junction box and transmitter are on the same potential. The extension cable should always be connected that way especially if power cables are laid near the extension cable.

See section 7.5.4.2 if earthing on the same potential cannot be ensured.

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the blind plug for the connection of the extension cable (see Fig. 7.11).
- 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 thus to 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. 7.11 and Tab. 7.6).

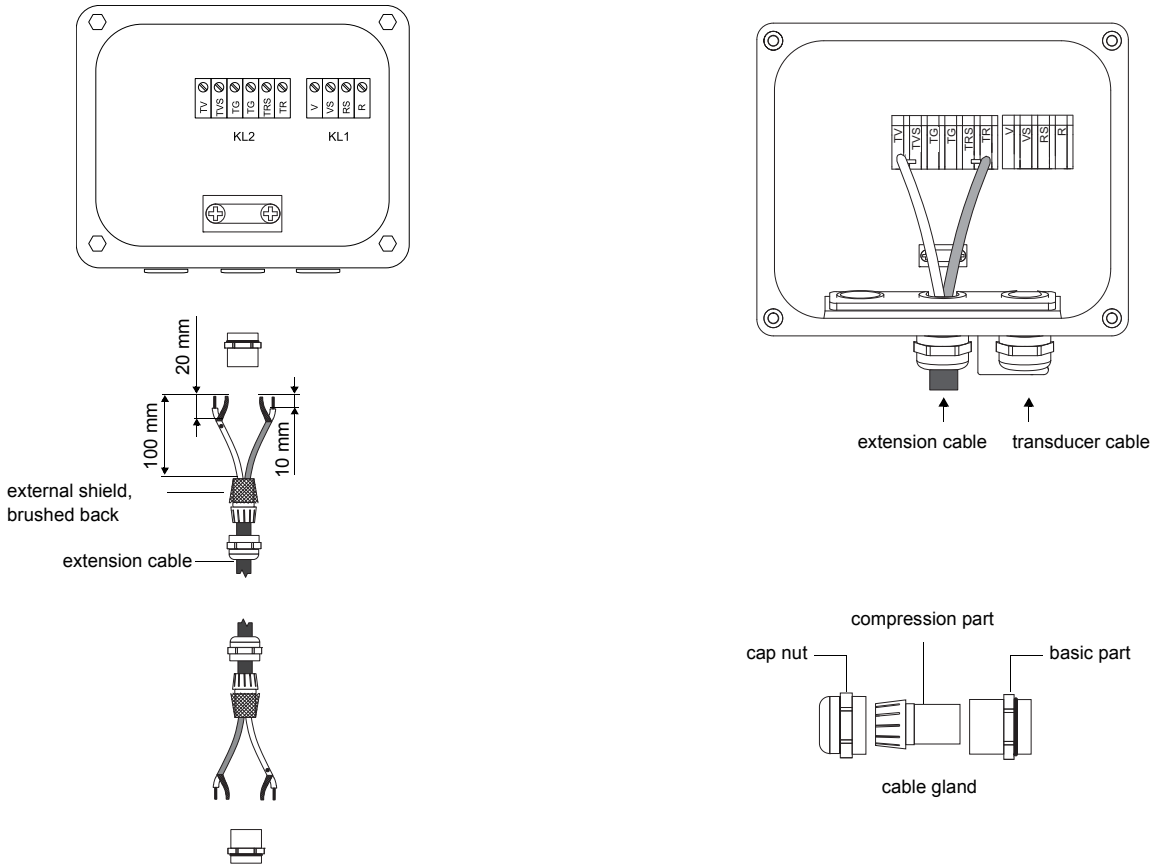


Fig. 7.11: Connection of the extension cable to the junction box

Tab. 7.6: Terminal assignment (junction box, KL2)

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

7.5.4.2 Connection with potential separation

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

Note!	For the installation of transducers to pipes with a cathodic corrosion protection see document TIFLUXUS_GalvSep.

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

- Remove the blind plug for the connection of the extension cable (see Fig. 7.12).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut, the compression part and the basic part.
- Insert the extension cable into the junction box.
- Prepare the extension cable.
- Cut the outer shield and brush it back.
- Pull the extension cable back until the brushed back external shield is below the shield terminal (see Fig. 7.12). The extension cable must remain completely insulated up to the shield terminal.
- Screw the gasket ring side of the basic part into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.

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

- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.12 and Tab. 7.7).

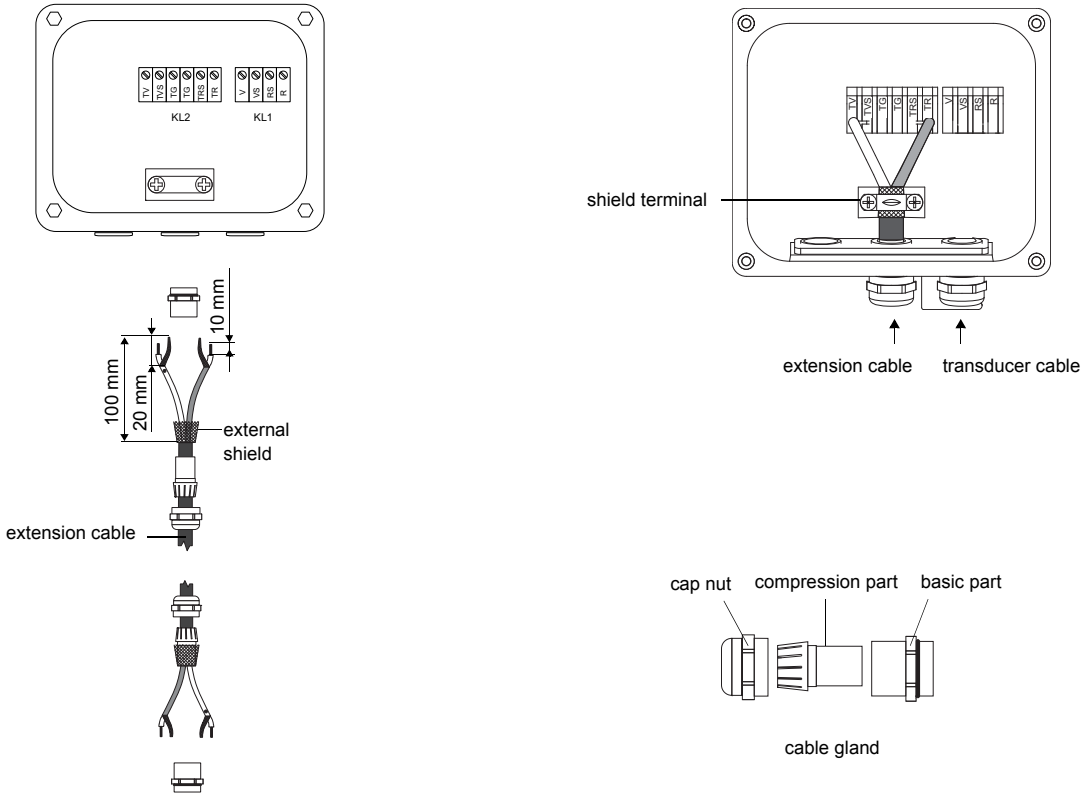


Fig. 7.12: Connection of the extension cable to the junction box

Tab. 7.7: Terminal assignment (junction box, KL2)

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

7.6 Connection of the transducers to the transmitter F809**-F1

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 7.10).

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 7.6.1.

For the connection of the extension cable to the transmitter see section 7.6.2.

For the connection to a junction box, see section 7.6.3.

7.6.1 Connection of the transducer cable to the transmitter

Attention!	Observe the safety and installation instructions for the use in explosive atmospheres (see documents SIFLUXUS_808_FM and SIFLUXUS_1N62).

- The transmitter has 2 cable glands for the connection of the transducers.
- Remove the blind plug for the connection of the transducer cable (see Fig. 7.13).
- Insert the transducer cable through the cable conduit (approved for FM Class I, Division 1) into the housing.
- Connect the transducer cable to the terminals of the transmitter (see Fig. 7.13 and Tab. 7.8).

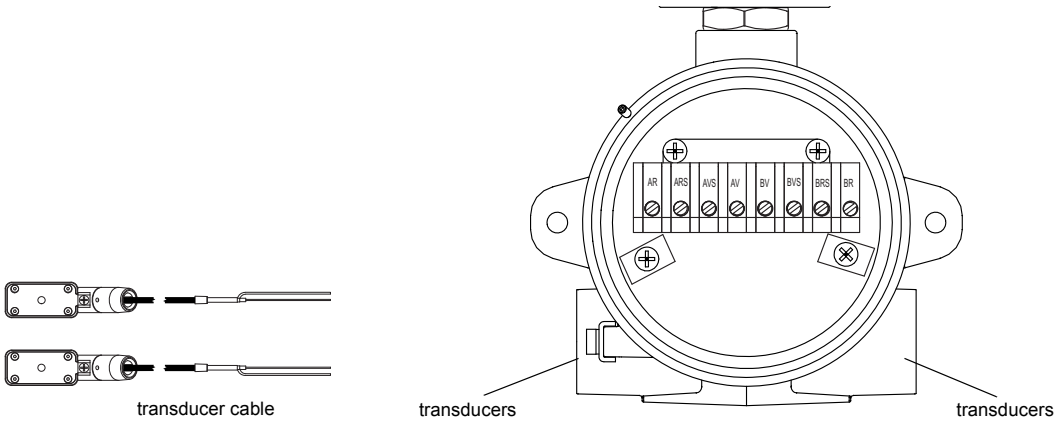


Fig. 7.13: Connection of the transducer cable

Tab. 7.8: Terminal assignment (transmitter)

terminal	connection (transducer cable)
AR	transducer (signal)
ARS	transducer (inner shield)
AVS	transducer (inner shield)
AV	transducer (signal)

7.6.2 Connection of the extension cable to the transmitter

Attention!	Observe the safety and installation instructions for the use in explosive atmospheres (see documents SIFLUXUS_808_FM and SIFLUXUS_1N62).

- The extension cable is connected to the transmitter via the transducer connection.
- Remove the blind plug for the connection of the transducer cable (see Fig. 7.13).
- Insert the extension cable through the cable conduit (approved for FM Class I, Division 1) into the housing.
- Prepare the extension cable.
- Connect the extension cable to the terminals of the transmitter (see Fig. 7.14 and Tab. 7.9).

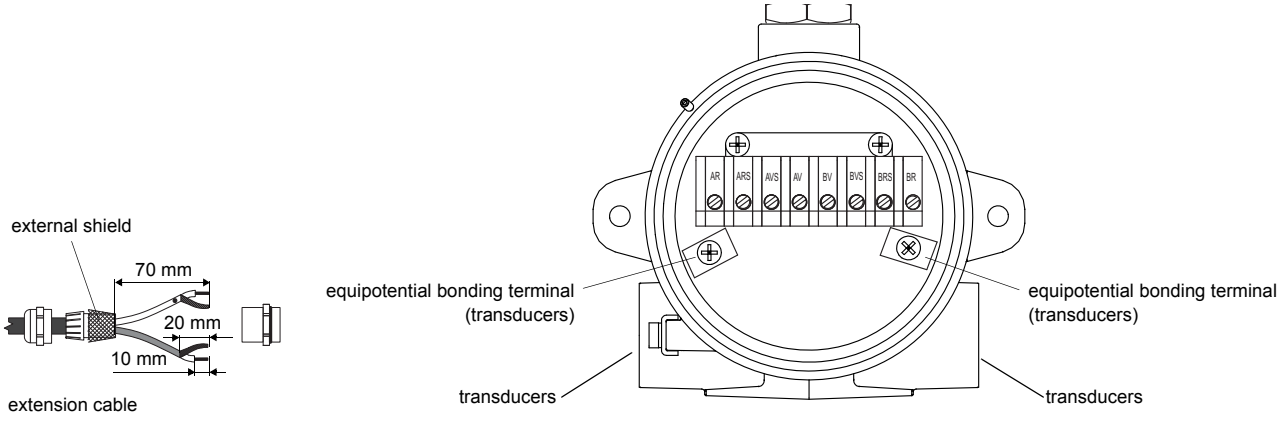


Fig. 7.14: Connection of the extension cable

Tab. 7.9: Terminal assignment (transmitter)

terminal	connection (extension cable)
AV	white or marked cable (core)
AVS	white or marked cable (internal shield)
ARS	brown cable (internal shield)
AR	brown cable (core)
equipotential bonding terminal	external shield

7.6.3 Connection to the junction box

The transducers and the extension cable are connected via the terminal board KFM1. The terminal board has to be installed into a junction box (by the customer) approved for the use in explosive atmospheres.

• Connect the transducer cable to the terminals of the junction box (see Fig. 7.15, Tab. 7.10 and Tab. 7.11).

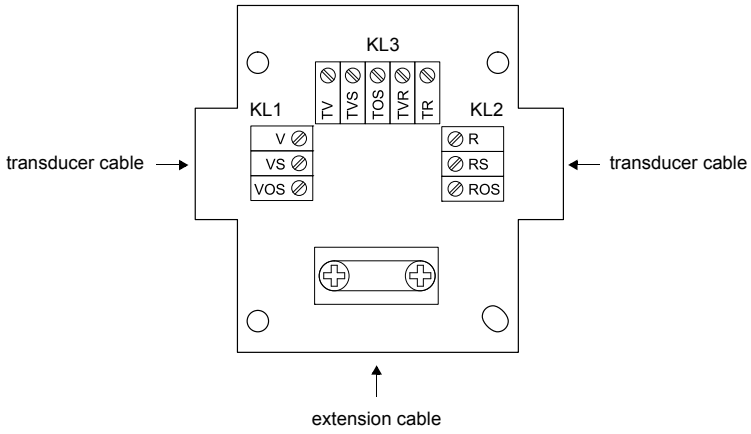


Fig. 7.15: Terminal board KFM1

Tab. 7.10: Terminal assignment (terminal board KFM1)

terminal	connection (transducer cable)
terminal strip KL1	
V	transducer (signal)
VS	transducer (inner shield)
VOS	transducer (external shield)

terminal	connection (transducer cable)
terminal strip KL2	
R	transducer (signal)
RS	transducer (inner shield)
ROS	transducer (external shield)

Tab. 7.11: Terminal assignment (terminal board KFM1, KL3)

terminal	**connection (extension cable)**
TV	signal
TVS	internal shield
TOS	external shield
TRS	internal shield
TR	signal

7.7 Power supply

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

7.7.1 FLUXUS F809**-A1, F809**-A1A

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS).

The external protective earth is connected to the equipotential bonding terminal on the housing of the transmitter. It must always be connected (see Fig. 7.17).

For the connection of the power cable to the transmitter, see box "Cable connection", Fig. 7.17 and Tab. 7.12.

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.

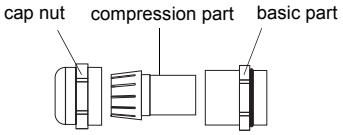


Fig. 7.16: Cable gland

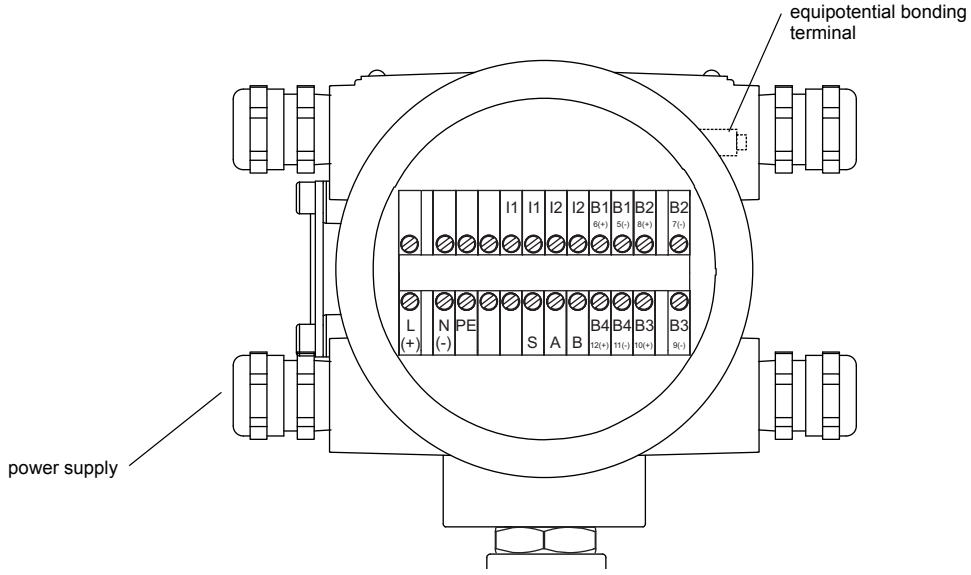


Fig. 7.17: Connection of the power supply

Tab. 7.12: Connection of the power supply

AC (F809-A1)**		**DC**	
terminal	connection	terminal	connection
L	phase	L+	+
N	neutral	N-	-
PE	earth	PE	earth

7.7.2 FLUXUS F809**-F1

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS_808_FM and SIFLUXUS_1N62).

The external protective earth is connected to the equipotential bonding terminal on the housing of the transmitter. It must always be connected (see Fig. 7.18).

For the connection of the power cable to the transmitter, see Fig. 7.18 and Tab. 7.12.

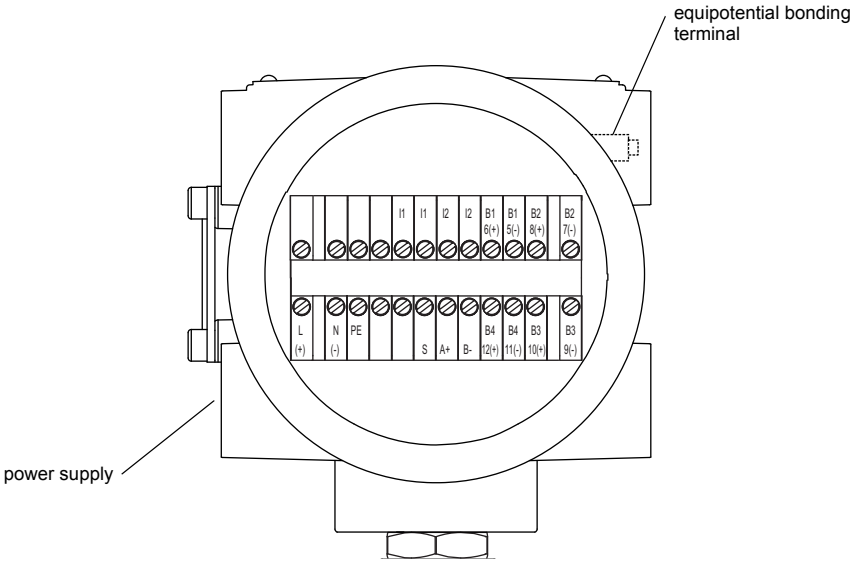


Fig. 7.18: Connection of the power supply

Tab. 7.13: Connection of the power supply (KL2)

AC		**DC**	
terminal	connection	terminal	connection
L	phase	L+	+
N	neutral	N-	-
PE	earth	PE	earth

7.8 Outputs

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM and SIFLUXUS_1N62).

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

For the connection of the output cable to the transmitter, see box "Cable connection", p. 69 and Tab. 7.14.

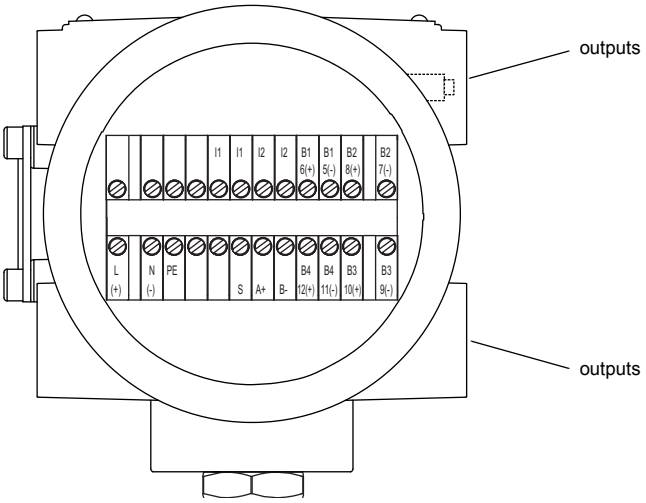
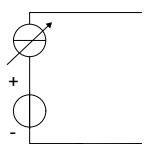
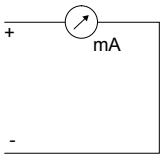
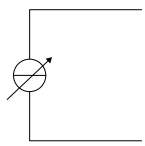
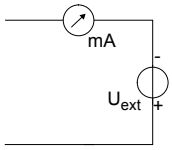


Fig. 7.19: Connection of the outputs

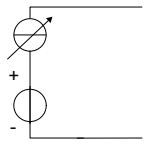
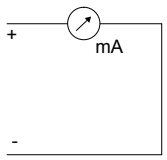
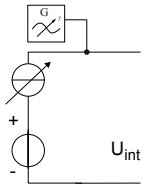
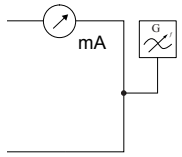
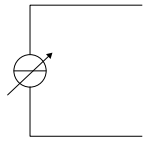
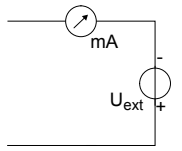
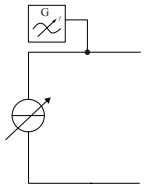
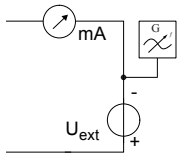
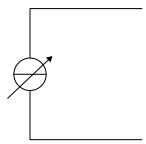
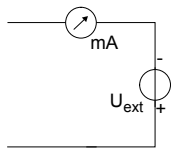
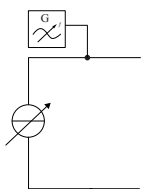
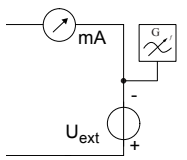
Tab. 7.14: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
active current loop F809**-A1 F809**-F1		I1/I2: 2/4 (+) I1/I2: 1/3 (-)		R_{ext} < 500 Ω
passive current loop F809**-A1 F809**-F1		I1/I2: 1/3 (-) I1/I2: 2/4 (+)		U_{ext} = 4…24 V U_{ext} > 0.021 A · R_{ext} [Ω] + 4 V example: U_{ext} = 12 V R_{ext} ≤ 380 Ω

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

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

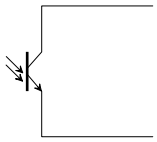
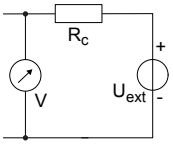
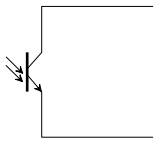
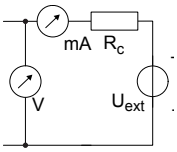
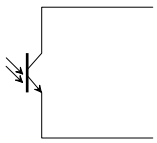
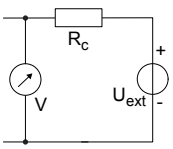
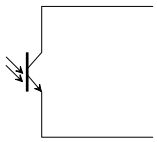
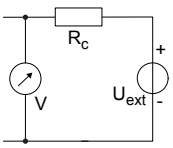
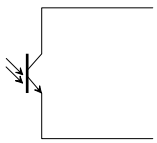
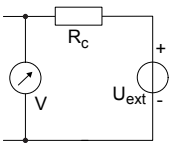
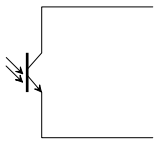
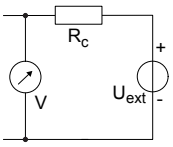
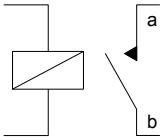
Tab. 7.14: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
active current loop/HART F809**-A1 F809**-F1	current loop			
		I1/I2: 2/4 (+) I1/I2: 1/3 (-)		R_{ext} < 500 Ω
	HART mode			
		I1/I2: 2/4 (+) I1/I2: 1/3 (-)		U_{int} = 24 V
passive current loop/HART F809**-A1 F809**-F1	current loop			U_{ext} = 7...30 V U_{ext} > 0.022 A · R_{ext} [Ω] + 7 V example: U_{ext} = 12 V R_{ext} ≤ 227 Ω current during transmitter error: I_{fault} = 3.2...3.5 mA
		I1/I2: 1/3 (-) I1/I2: 2/4 (+)		
	HART mode			
		I1/I2: 1/3 (-) I1/I2: 2/4 (+)		
intrinsically safe current loop/HART F809**-A1A	current loop			U_i = 30 V DC I_i = 100 mA P_i = 0.75 W U_{ext} ≤ U_i U_{ext} > 0.022 A · $R_{ext_{max}}$ [Ω] + 7 V $R_{ext_{min}}$ ≥ U_{ext}/I_i example: U_{ext} = 24 V 240 Ω ≤ R_{ext} ≤ 770 Ω current during transmitter error: I_{fault} = 3.2...3.5 mA
		I1/I2: 1 (-) I1/I2: 2 (+)		
	HART mode			
		I1/I2: 1 (-) I1/I2: 2 (+)		

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

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

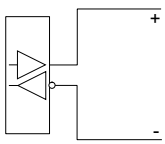
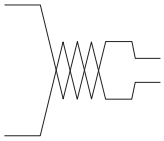
Tab. 7.14: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
frequency output (open collector) F809**-A1 F809**-F1		F1: 2 (+) F1: 1 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} ≤ 0.4 mA
frequency output (open collector) NAMUR F809**-A1 F809**-F1		F1: 2 (+) F1: 1 (-)		U_{ext} = 8.2 V R_c = 1 kΩ DIN EN 60947-5-6 (NAMUR)
frequency output (open collector) F809**-A1 F809**-F1		F1: 2 (+) F1: 1 (-)		U_{ext} = 5...24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA
binary output (open collector) F809**-A1 F809**-F1		B1...B4: 6/8 (+) B1...B4: 5/7 (-)		U_{ext} = 5...24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA
binary output (open collector) F809**-A1 F809**-F1		B1/B2: 6/8 (+) B1/B2: 5/7 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} ≤ 0.4 mA
binary output (open collector) NAMUR F809**-A1 F809**-F1		B1/B2: 6/8 (+) B1/B2: 5/7 (-)		U_{ext} = 8.2 V R_c = 1 kΩ DIN EN 60947-5-6 (NAMUR)
binary output (Reed relay) F809**-A1 F809**-F1		B3/B4: 10 B3/B4: 9		U_{max} = 48 V I_{max} = 100 mA

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

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

Tab. 7.14: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
RS485 F809**-A1 F809**-F1		A B S		120 Ω termination resistor

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

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

7.9 Serial interface

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM and SIFLUXUS_1N62).

7.9.1 RS232 interface

The RS232 interface can only be connected outside of an explosive atmosphere because the housing has to be opened (see Fig. 7.20).

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

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

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

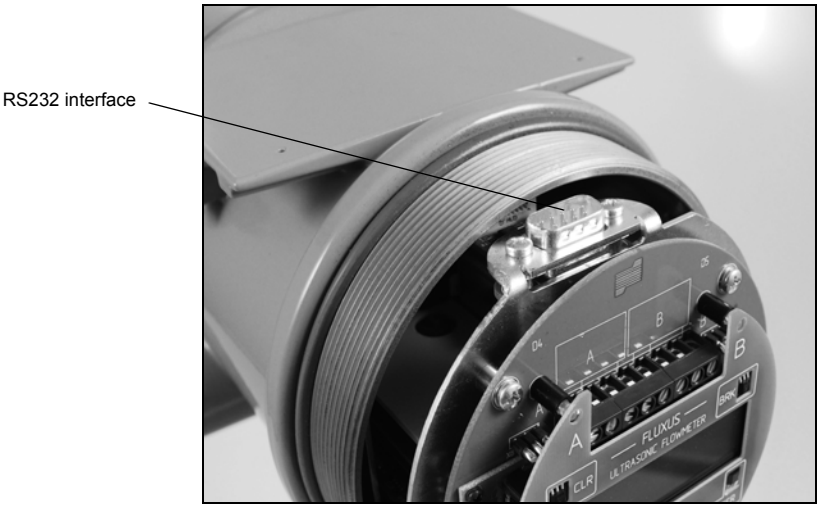


Fig. 7.20: Connection of the RS232 interface

7.9.2 RS485 interface

The transmitter can also be equipped with an RS485 interface (optional). For the connection of the serial interface see box "Cable connection", p. 69 (F809**A1 only), Fig. 7.21 and Tab. 7.14.

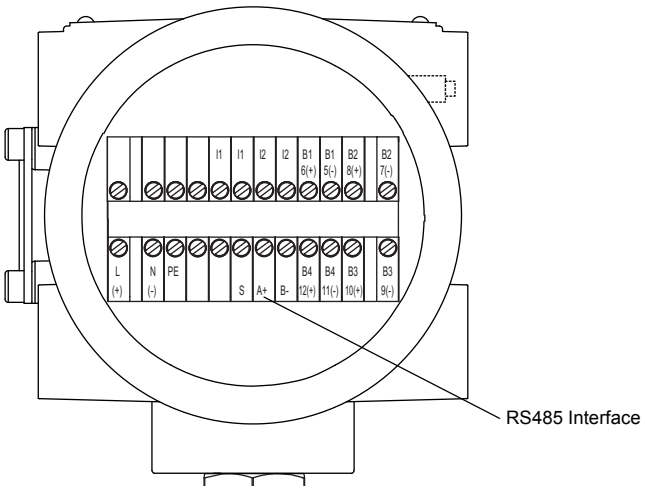


Fig. 7.21: Connection of the RS485 interface

For further information on the data transmission see chapter 13.

7.10 Sensor module (SENSPROM)

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM and SIFLUXUS_1N62).

The sensor module contains important transducer data for the operation of the transmitter with the transducers. It is connected to the connector strips above the display of the transmitter.

If transducers are replaced or added, the sensor module also 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.

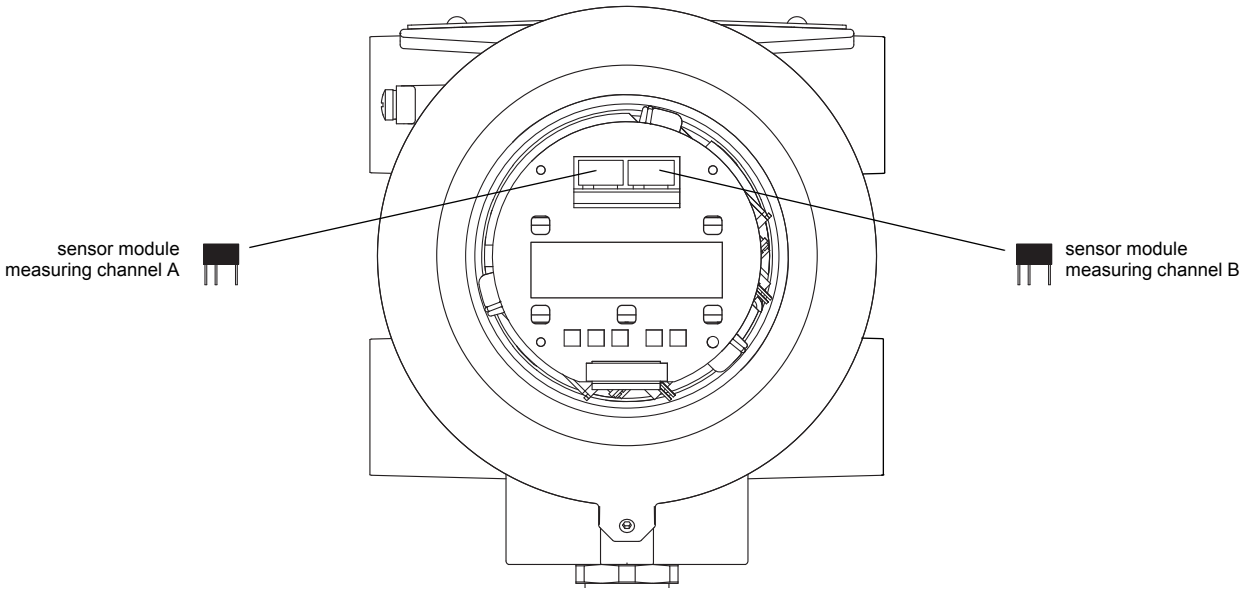


Fig. 7.22: Sensor module

8 Installation of the transducers

Attention!	Observe the Safety Instructions for the Use in Explosive Atmosphere (see document SIFLUXUS, SIFLUXUS_808_FM,SIFLUXUS_808_F2 and SIFLUXUS_1N62).

8.1 Pipe preparation

• The pipe has to be stable. It has to be able to withstand the pressure exerted by the transducer mounting fixture.

Rust, paint or 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.

8.2 Orientation of the transducers and transducer distance

Mount the transducers onto the pipe in such way that the engravings on the transducers form an arrow (see Fig. 8.1). The transducer cables show in opposite directions.

The transducer distance is the distance between the inner edges of the transducers (see section 3.3 and Fig. 8.1).

For the determination of the flow direction see section 10.8.

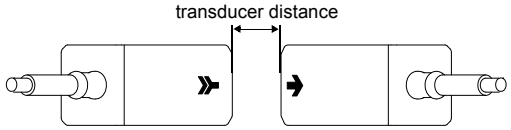


Fig. 8.1: Correct orientation of the transducers and transducer distance

Select the installation instructions that correspond to the supplied transducer mounting fixture:

• Variofix L: see section 8.3
• Variofix C: see section 8.4
• PermaFix: see section 8.5

8.3 Transducer mounting fixture Variofix L (PermaRail)

When measuring in reflection arrangement, the transducer mounting fixtures are mounted on the same side of the pipe (see Fig. 8.2).

When measuring in diagonal arrangement, the transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 8.3).

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

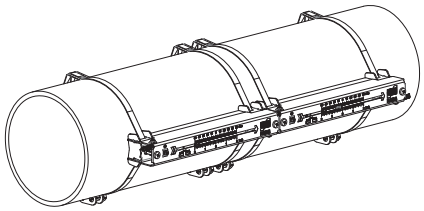


Fig. 8.2: Transducer mounting fixture Variofix L (reflection arrangement)

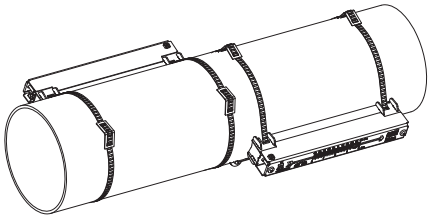


Fig. 8.3: Transducer mounting fixture Variofix L (diagonal arrangement)

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**
  screw the rail to the tension strap and fix it with the second tension strap
- **step 5**
  insert the transducer in the cover, screw the cover with the transducer to the rail

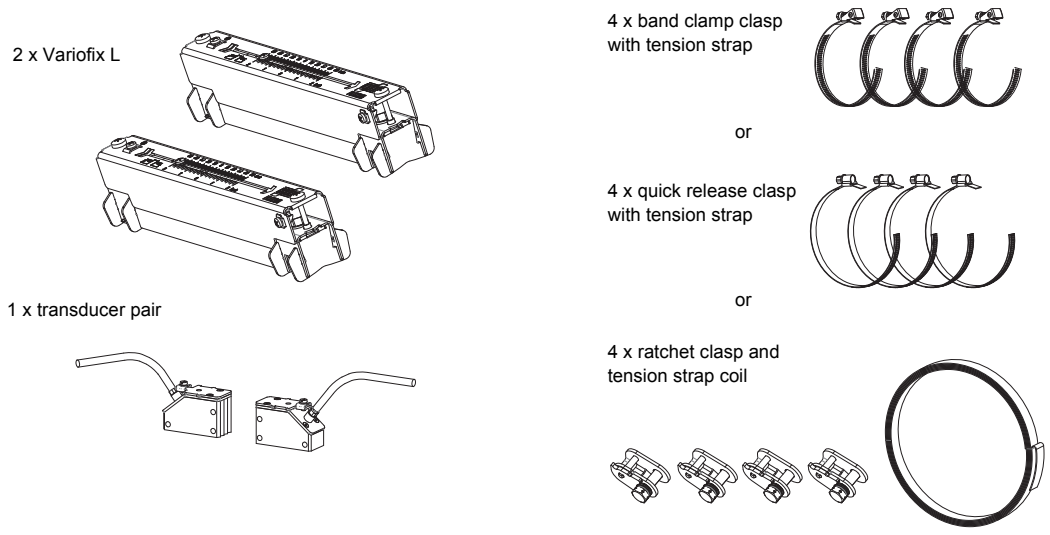


Fig. 8.4: Scope of delivery

If the transducer distance is small and when measuring in reflection arrangement, only one transducer mounting fixture has to be mounted (see Tab. 8.1).

Note!	When measuring in diagonal arrangement with 2 beams in X arrangement (see section 5.3), 4 transducer mounting fixtures have to be mounted.

Tab. 8.1: Approximate values for the mounting of a Variofix L

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

8.3.1 Disassembly of Variofix L

• Disassemble the transducer mounting fixture Variofix L (see Fig. 8.5).

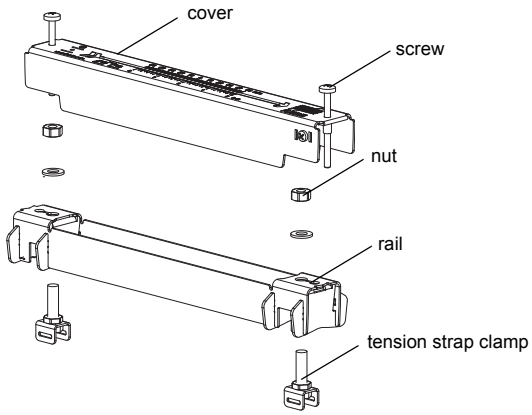


Fig. 8.5: Disassembly of Variofix L

8.3.2 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. 8.6).

Quick release clasp

The clasp is fixed to the tension strap (see Fig. 8.7).

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

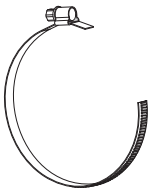


Fig. 8.6: Band clamp clasp with tension strap

Fig. 8.7: Quick release clasp with tension strap

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. Debur sharp edges.

• Insert approx. 100 mm of the tension strap into part 1 and 2 of the clasp (see Fig. 8.8 a).
• Bend the tension strap.
• Insert the tension strap into part 1 of the ratchet clasp (see Fig. 8.8 b).
• Tighten the tension strap.
• Repeat the steps for the second tension strap.

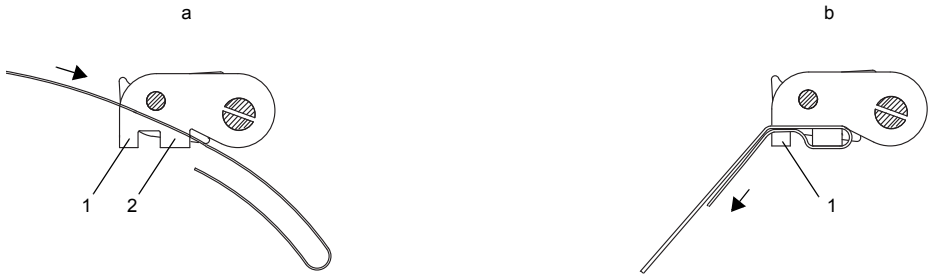


Fig. 8.8: Ratchet clasp with tension strap

8.3.3 Fixing the tension strap to the pipe

One tension strap is fixed to the pipe (see Fig. 8.9). The second tension strap is mounted later.

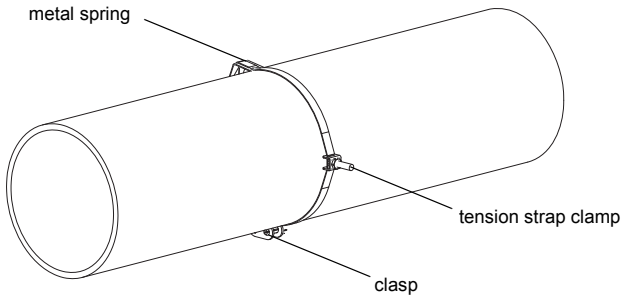


Fig. 8.9: Tension strap with tension strap clamp and metal spring on the pipe

Select the installation instructions that correspond to the supplied clasp:

Band clamp clasp

• Insert the tension strap into the tension strap clamp (see Fig. 8.10).
• Position the clasp and the tension strap clamp on the pipe (see Fig. 8.9). 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. 8.12).
• 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. 8.10 and Fig. 8.11).
• Position the clasp, the metal spring and the tension strap clamp on the pipe (see Fig. 8.9):
  – 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. 8.13).
• Tighten the tension strap.
• Tighten the screw of the clasp.

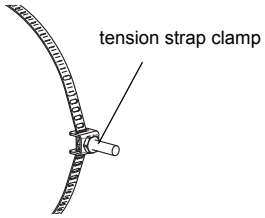


Fig. 8.10: Tension strap with tension strap clamp

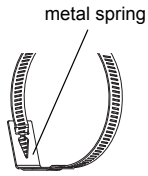


Fig. 8.11: Tension strap with metal spring

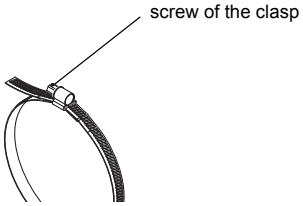


Fig. 8.12: Band clamp clasp with tension strap

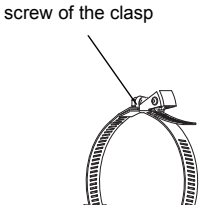


Fig. 8.13: Quick release clasp with tension strap

Ratchet clasp

- Insert the tension strap into the tension strap clamp and the metal spring (see Fig. 8.14). It is not necessary to mount the metal spring:
  - on steel pipes or
  - 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. 8.9):
  - 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. 8.15).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 8.15).

Attention!	The edge of the tension strap is very sharp, leading to risk of injury. Debur sharp edges.

- Tighten the screw of the clasp.

Fig. 8.14: Tension strap with metal spring and tension strap clamp

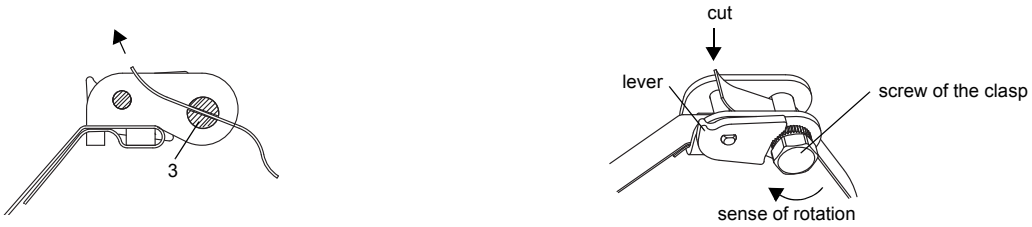


Fig. 8.15: Ratchet clasp with tension strap

Attention!	To release the screw and the tension strap press the lever down (see Fig. 8.15).

8.3.4 Fixing the rail to the pipe

- Place one tension strap clamp in the rail (see tension strap clamp 1 in Fig. 8.16). 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. 8.17).
- Tighten the nut of tension strap clamp 2, but not too firmly in order not to damage the tension strap.

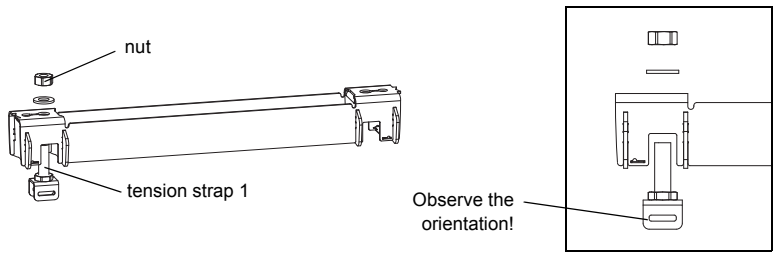


Fig. 8.16: Rail with tension strap clamp

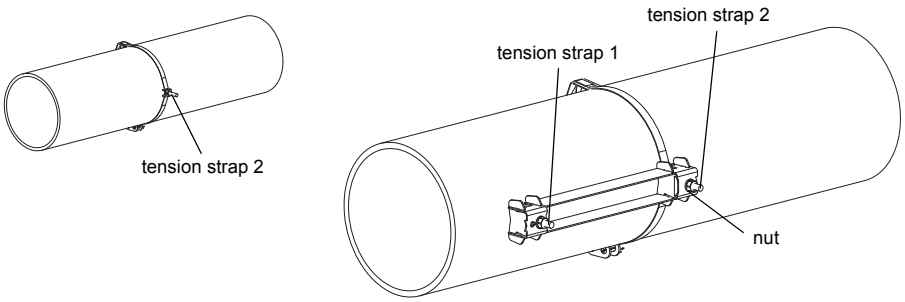


Fig. 8.17: Rail, mounted on one side of the pipe

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

Band clamp clasp

- Insert the tension strap into tension strap clamp 1 (see Fig. 8.18).
- Place the tension strap around the pipe and insert it into the clasp (see Fig. 8.19).
- 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. 8.18).

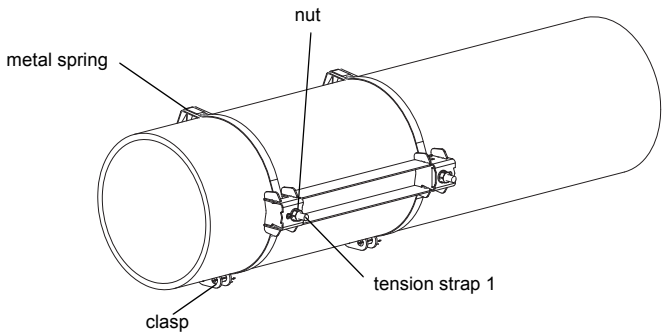


Fig. 8.18: Rail on the pipe

Quick release clasp

- Insert the tension strap into tension strap clamp 1 and the metal spring (see Fig. 8.20 and Fig. 8.18).
- 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. 8.18).

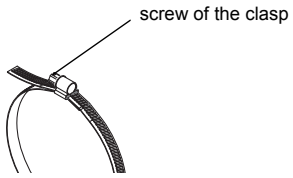


Fig. 8.19: Tension strap with band clamp clasp

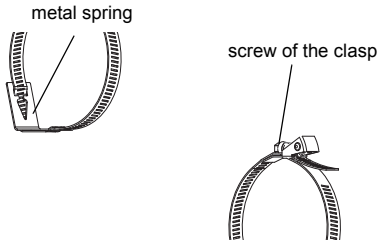


Fig. 8.20: Tension strap with quick release clasp and metal spring

Ratchet clasp

- Insert the tension strap into tension strap clamp 1 and the metal spring (see Fig. 8.18 and Fig. 8.21). It is not necessary to mount the metal spring:
  - on steel pipes or
  - 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. 8.22).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 8.22).

Attention!	The edge of the tension strap is very sharp, leading to risk of injury. Debur sharp edges.

- 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. 8.18).

Fig. 8.21: Tension strap with metal spring and tension strap clamp

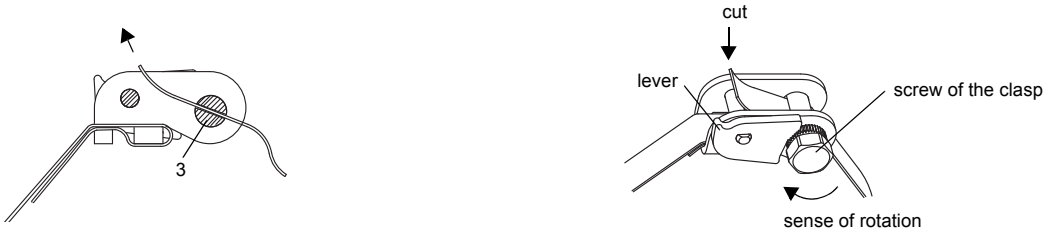


Fig. 8.22: Ratchet clasp with tension strap

Note!	To release the screw and the tension strap, press the lever down (see Fig. 8.21).

• Repeat the steps to fix the second rail (see Fig. 8.23).

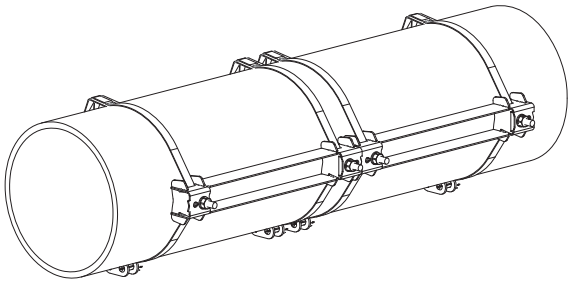


Fig. 8.23: Pipe with 2 rails

8.3.5 Installation of the transducers in Variofix L

• Press the transducers firmly into the transducer clamping fixtures of the covers until the transducers are tightly fixed (one transducer in each cover). The transducer cables show in opposite directions (see Fig. 8.24).

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

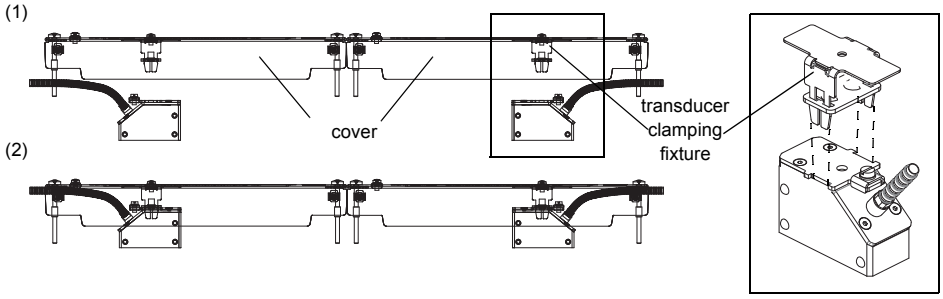


Fig. 8.24: Transducers in the covers

• Adjust the transducer distance displayed by the transmitter (see section 10.6 and Fig. 8.25).
• Fix the cables of the transducers with the strain relief clamp to protect them from mechanical strain (see Fig. 8.25).
• 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 coupling compound.

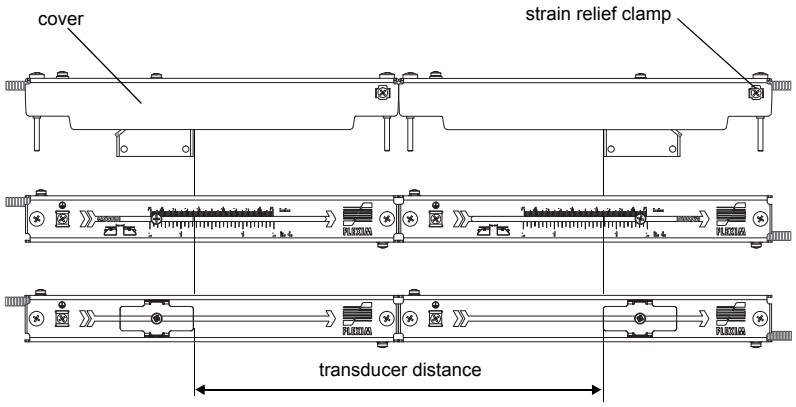


Fig. 8.25: Adjusting the transducer distance

• Put the covers with the transducers on the rail.
• Correct the transducer distance, if necessary (see section 10.6.1 and 10.6.2).

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

• Tighten the screws of the cover (see Fig. 8.26).

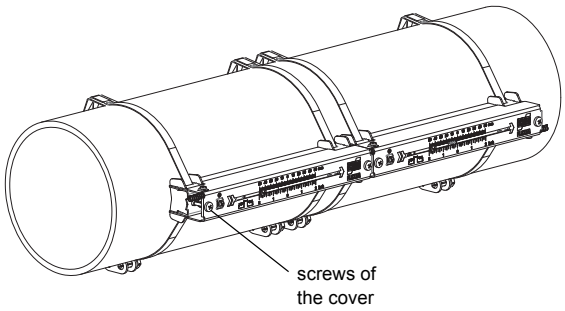


Fig. 8.26: Transducers with Variofix L on the pipe

8.4 Transducer mounting fixture Variofix C

When measuring in reflection arrangement, 1 transducer mounting fixture is mounted on the side of the pipe (see Fig. 8.27).

When measuring in diagonal arrangement, 2 transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 8.28).

In the following, the installation of a transducer mounting fixture is described (transducers in reflection arrangement).

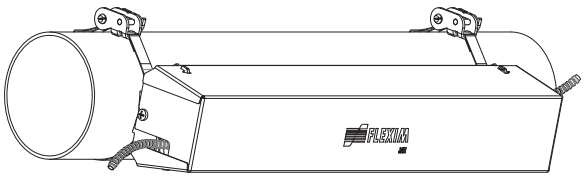


Fig. 8.27: Transducer mounting fixture Variofix C (reflection arrangement)

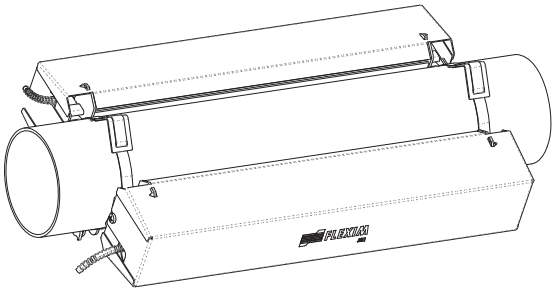


Fig. 8.28: Transducer mounting fixture Variofix C (diagonal arrangement)

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

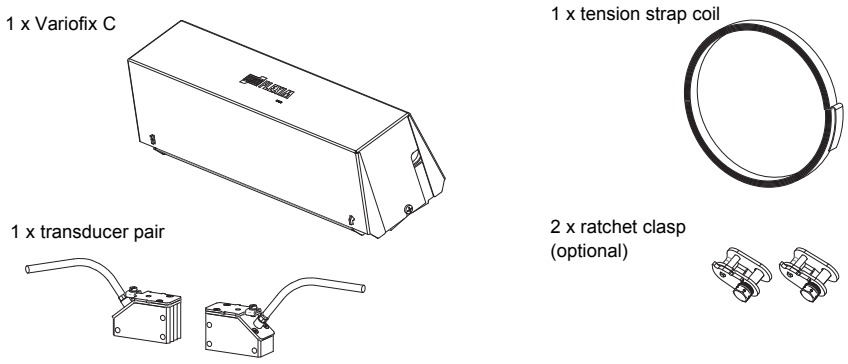


Fig. 8.29: Scope of delivery

8.4.1 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. 8.30).

In order to remove the spring clip from the rail, slide it over the indentation on the rail and lift it off (see Fig. 8.31).

Fig. 8.30: Removal of the cover

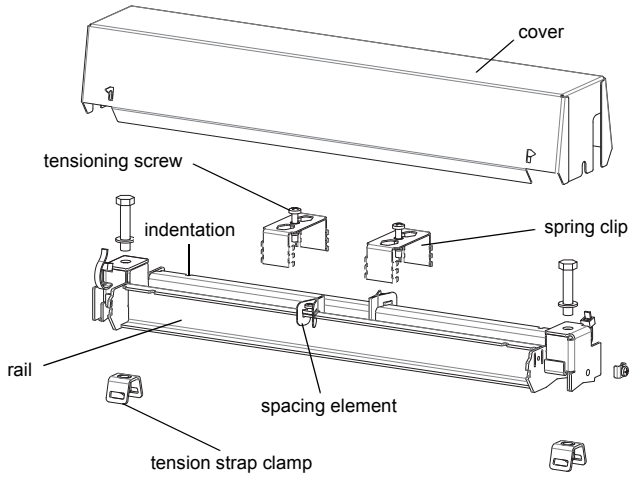


Fig. 8.31: Disassembly of Variofix C

8.4.2 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 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. Debur sharp edges.

• Insert approx. 100 mm of the tension strap into one of the slots of the tension strap clamp and bend it (see Fig. 8.32).

• If necessary, insert the long end of the tension strap into the metal spring (see Fig. 8.33). It is not necessary to mount the metal spring:

– on steel pipes or

– 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. 8.34).

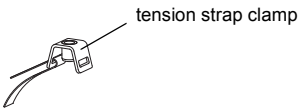


Fig. 8.32: Tension strap with tension strap clamp

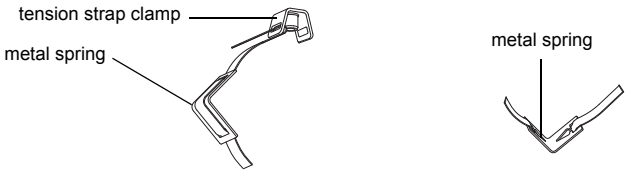
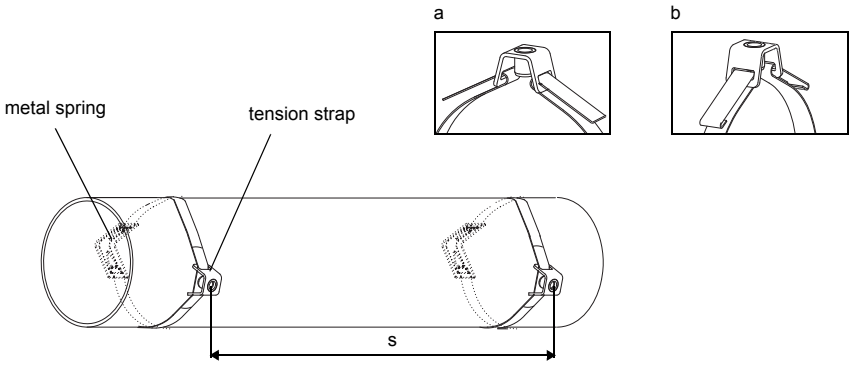


Fig. 8.33: Tension strap with metal spring and tension strap clamp

• Position the metal spring (if mounted) and the tension strap clamp (see Fig. 8.34):
  – 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



s = length of the rail – 33 mm

Fig. 8.34: Tension strap with metal spring and tension strap clamp on the pipe

• Insert the long end of the tension strap into the second slot of the tension strap clamp (see Fig. 8.34 a).
• Tighten the tension strap and bend it.
• Bend both ends of the tension strap (see Fig. 8.34 b).
• Repeat the steps for the second tension strap. Position the tension strap at the distance s (see Fig. 8.34).
• Put the rail on the tension strap clamps.
• Use the screws to fix the rail to the tension strap clamps (see Fig. 8.35).
• Tighten the screws.

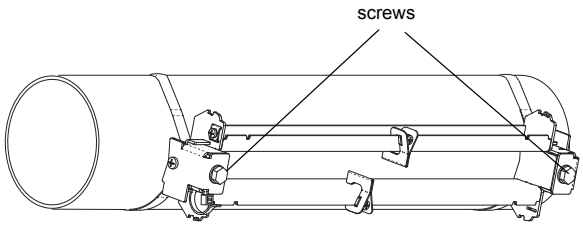


Fig. 8.35: Rail on the pipe

Installation of the rail with 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. Debur sharp edges.

• Insert approx. 100 mm of the tension strap the into part 1 and 2 of the ratchet clasp (see Fig. 8.36 a).

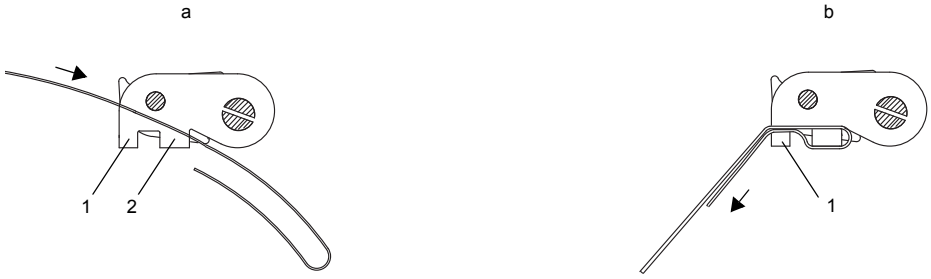


Fig. 8.36: Ratchet clasp with tension strap

• Bend the tension strap.
• Insert the tension strap into part 1 of the ratchet clasp (see Fig. 8.36 b).
• Tighten the tension strap.
• Insert the long end of the tension strap into the tension strap clamp and the metal spring (see Fig. 8.37). It is not necessary to mount the metal spring:
  – on steel pipes or
  – 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. 8.38).

Fig. 8.37: Tension strap with metal spring and 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. 8.39).
• Tighten the tension strap.
• Cut off the protruding tension strap (see Fig. 8.39).
• Tighten the screw of the ratchet clasp.

• Repeat the steps for the second tension strap.

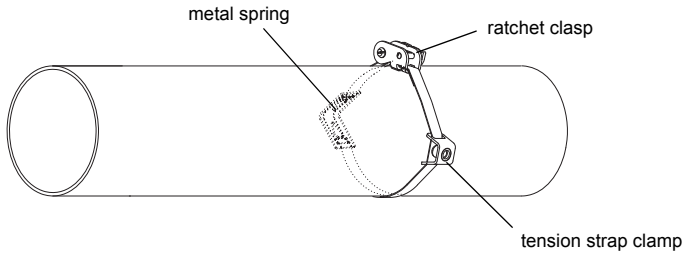


Fig. 8.38: Tension strap with metal spring, the ratchet clasp and tension strap clamp on the pipe

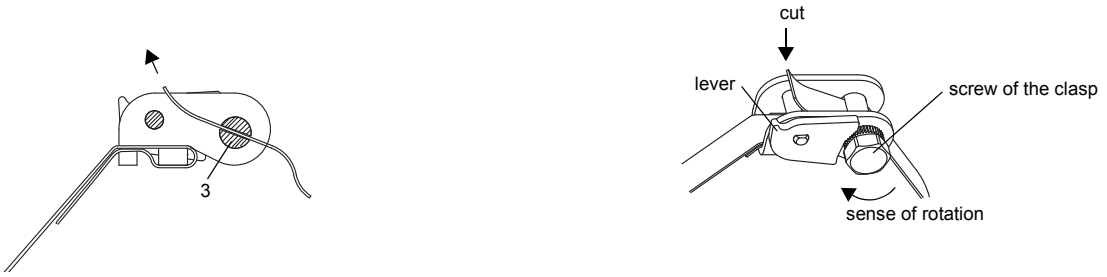


Fig. 8.39: Ratchet clasp with tension strap

Note!	To release the screw and the tension strap press the lever down (see Fig. 8.39).

• Put the rail on the tension strap clamps (see Fig. 8.40).
• Fix the rail to the tension strap clamps with the screws.
• Tighten the screws.

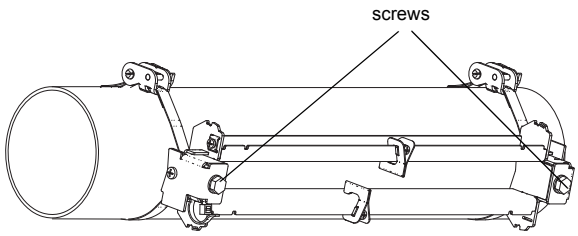


Fig. 8.40: Rail on the pipe

8.4.3 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 coupling compound.

Note!	If coupling foil is used: If the signal is not sufficient for the measurement, use coupling compound instead of 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. 8.41).
- Adjust the transducer distance displayed by the transmitter (see section 10.6 and Fig. 8.41).
- Slide the spring clips on the transducers (see Fig. 8.42).
- 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. 8.41).
- Correct the transducer distance, if necessary (see section 10.6.1 and section 10.6.2).
- Tighten the tensioning screws.
- Fix the spacing element on the rail to mark the transducer position (see Fig. 8.41).
- Use a cable tie to fix the transducer cables in order to protect them from mechanical strain (see Fig. 8.42).
- Put the cover on the rail (see Fig. 8.43).
- Tighten the screws on both sides of the cover.

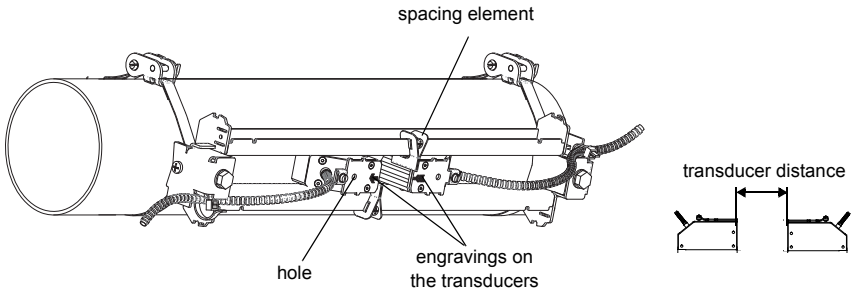


Fig. 8.41: Transducers in the rail (spring clip not shown)

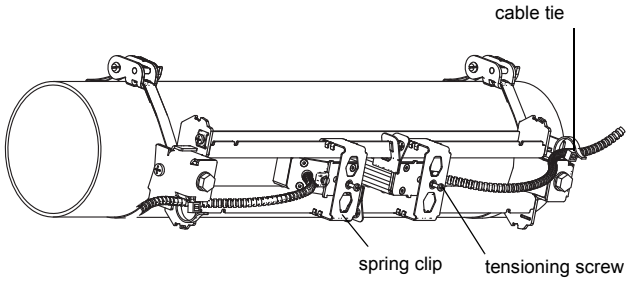


Fig. 8.42: Transducers in the rail

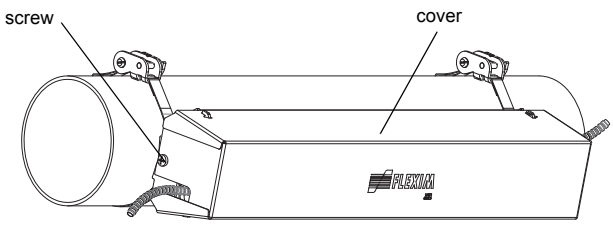


Fig. 8.43: Variofix C with transducer on the pipe

The cover can be removed from the mounted transducer mounting Variofix C fixture as follows:

- Use a lever tool to remove the cover.
- Insert the lever tool in one of the 4 openings of the cover (see Fig. 8.44).
- Press the lever tool against the fixture.
- Bend the cover outwards and release it from the anchoring.
- Repeat the steps for the other 3 openings.
- Remove the cover from the rail.

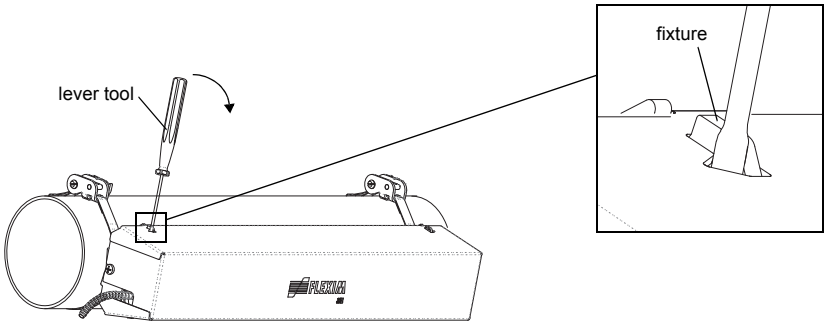


Fig. 8.44: Removal of the cover

8.5 Transducer mounting fixture PermaFiX

Attention!	Observe the "Safety and installation instructions for the use in hazardous (classified) locations" (see documents SIFLUXUS_808_FM and SIFLUXUS_1N62).

For measurements in Class I, Division 1 hazardous locations, the transducer mounting fixture PermaFiX (see Fig. 7.1) has to be used for the installation of the transducers.

Note!	Take great care in selecting the measuring point for the installation of the transducer mounting fixture PermaFiX. Observe the instructions in chapter 3 and 5.

When measuring in reflection arrangement, the transducers are installed on the same side of the pipe. If the transducer distance is small, both transducers are mounted into one rail. If the transducer distance is large, it can be necessary to mount two transducer mounting fixtures (one for each transducer) on the same side of the pipe.

When measuring in diagonal arrangement, the transducers are installed on opposite sides of the pipe.

The transducer mounting fixture PermaFiX can be installed on the pipe using bolts (see section 8.5.3) or tension straps (see section 8.5.4). Select the mounting instructions correspondingly. It is recommended to use bolts for the installation of PermaFiX on pipes with a diameter of max. 40 mm and tension straps for larger pipes.

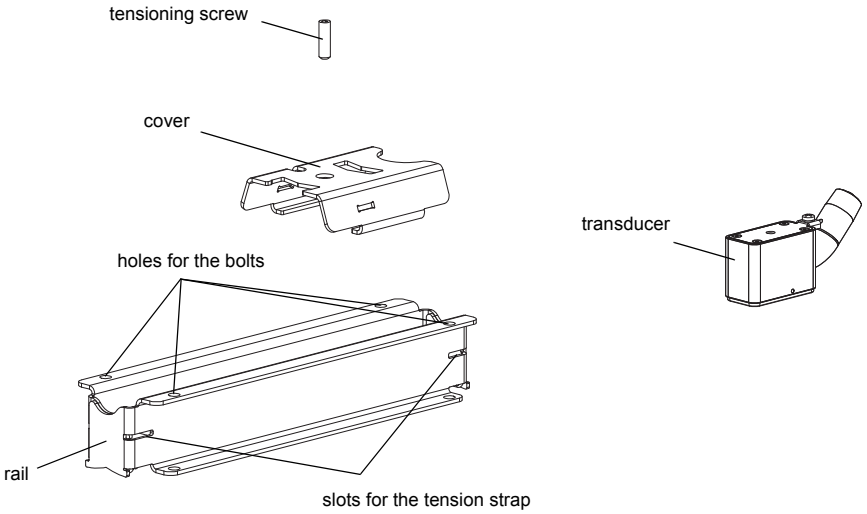


Fig. 8.45: Disassembly of PermaFiX

8.5.1 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.

8.5.2 Orientation of the transducers and transducer distance

Mount the transducers onto the pipe in such way that the engravings on the transducers form an arrow (see Fig. 8.46). The transducer cables show in opposite directions.

The transducer distance is the distance between the inner edges of the transducers (see section 3.3 and Fig. 8.46)

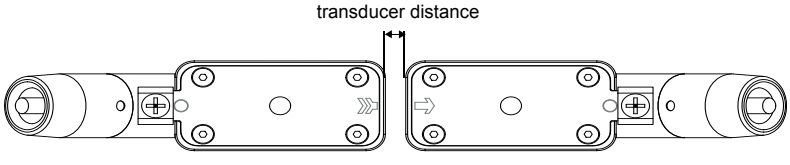


Fig. 8.46: Correct orientation of the transducers and transducer distance

8.5.3 Installation of the rail with bolts

The number and arrangement of PermaFiX rails depends on the required transducer arrangement and transducer distance. See Fig. 8.47 for an overview of possible arrangements.

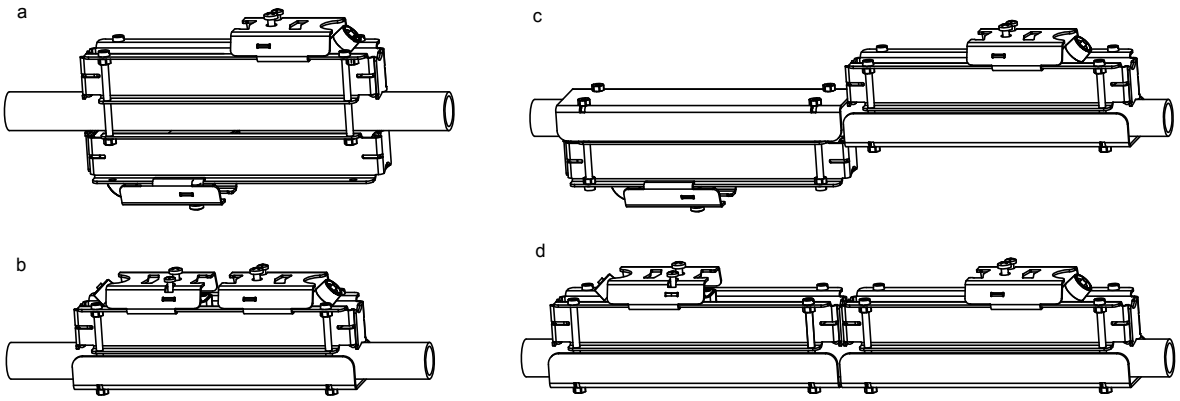


Fig. 8.47: Possible arrangements of PermaFiX (installation with bolts)

a – diagonal arrangement, small transducer distance
b – reflection arrangement, small transducer distance
c – diagonal arrangement, large transducer distance
d – reflection arrangement, large transducer distance

- Select the arrangement according to the measurement.
- Disassemble the transducer mounting fixture PermaFiX (see Fig. 8.45).
- Place one of the rails on the pipe.
- Insert the bolts (M6) into the holes of the rail and secure them with nuts.
- Slide the second rail (arrangement a) or the counter plate (arrangements b, c, d) onto the bolts on the opposite side of the pipe and secure it with nuts.
- Make sure not to tilt the rails when tightening the nuts.
- Repeat the steps for the second rail, if necessary.

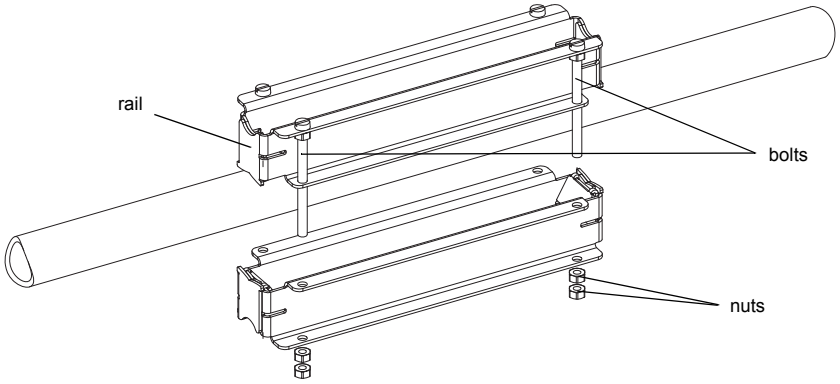


Fig. 8.48: Installation of the rail with bolts (diagonal arrangement, small transducer distance)

8.5.4 Installation of the rail with tension straps

The number and arrangement of PermaFiX rails depends on the required transducer arrangement and transducer distance. See Fig. 8.49 for an overview of possible arrangements.

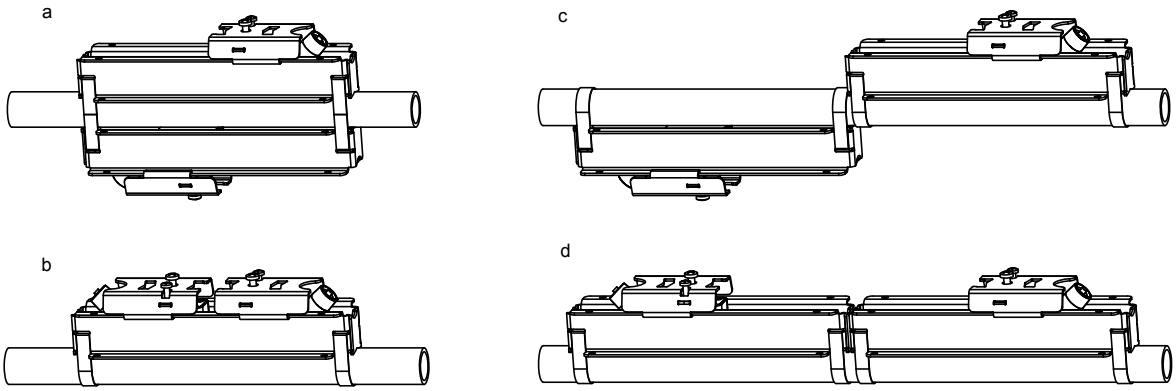


Fig. 8.49: Possible arrangements of PermaFiX (installation with tension straps)

a – diagonal arrangement, small transducer distance
b – reflection arrangement, small transducer distance
c – diagonal arrangement, large transducer distance
d – reflection arrangement, large transducer distance

- Select the arrangement according to the measurement.
- Disassemble the transducer mounting fixture PermaFiX (see Fig. 8.45).
- Cut the tension straps to length (pipe circumference + at least 120 mm).

Attention!	The edge of the tension strap is very sharp, leading to risk of injury. Debur sharp edges.

- Insert approx. 100 mm of the tension strap into part 1 and 2 of the clasp (see Fig. 8.50 a).
- Bend the tension strap.
- Insert the tension strap into part 1 of the ratchet clasp (see Fig. 8.50 b).
- Tighten the tension strap.
- Insert the tension strap into the slots of one rail (arrangements b, c, d) or both rails (arrangement a) (see Fig. 8.52).
- Place the rail with the tension strap on the pipe and the tension strap around the pipe (arrangements b, c, d) or place the two rails with the tension strap around the pipe (arrangement a).
- Insert the free end of the tension strap into part 3 of the ratchet clasp (see Fig. 8.51).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 8.50).
- Tighten the screw of the ratchet clasp.
- Repeat the steps for the second tension strap.
- Repeat the steps for the second rail, if necessary.

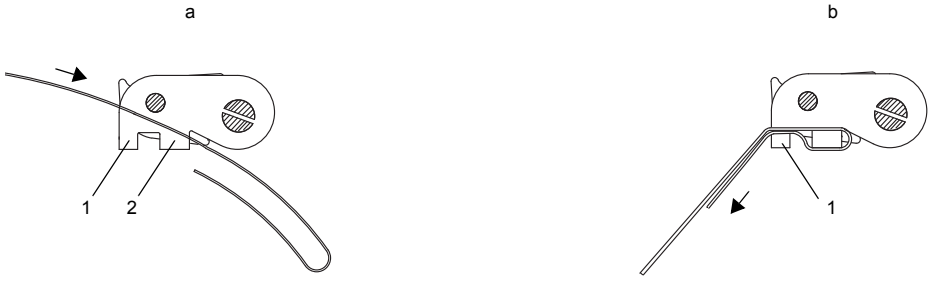


Fig. 8.50: Ratchet clasp with tension strap

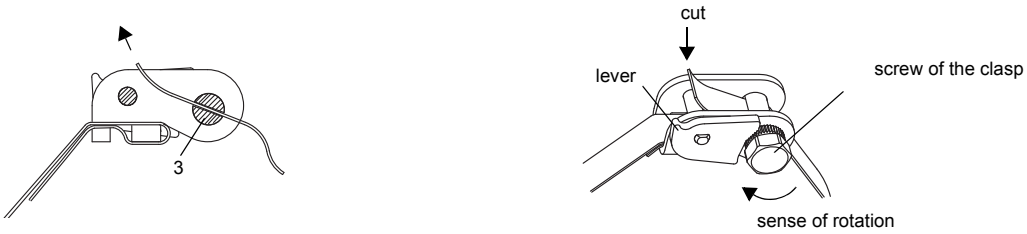


Fig. 8.51: Ratchet clasp with tension strap

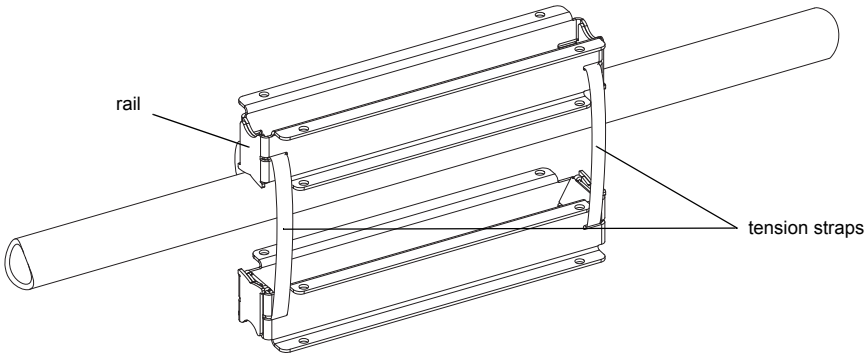


Fig. 8.52: Installation of the rail with tension straps (diagonal arrangement, small transducer distance)

8.5.5 Installation of the transducers

Mount the transducers into the rail in such way that the engravings on the transducers form an arrow (see Fig. 8.53). The transducer cables show in opposite directions.

- Slide the cover over the rail.
- Insert the transducer with the conduit sealing fitting into the rail. The round cutout of the cover faces the conduit sealing fitting.
- Observe that there must be no air pockets between the transducer contact surface and the pipe wall.
- Align the transducer with the cover in such way that the hole in the transducer is placed below the tensioning screw. Use the tensioning screw of the cover to press the transducer against the pipe.
- Screw the flexible conduit (approved for FM Class I, Division 1) onto the transducer with the conduit sealing fittings.
- Repeat the steps for the second transducer.
- Connect the flexible conduit to the conduit system of the facility in accordance with the local regulations.

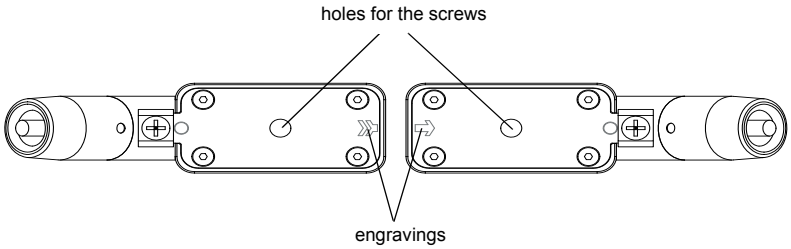


Fig. 8.53: Correct positioning of the transducers

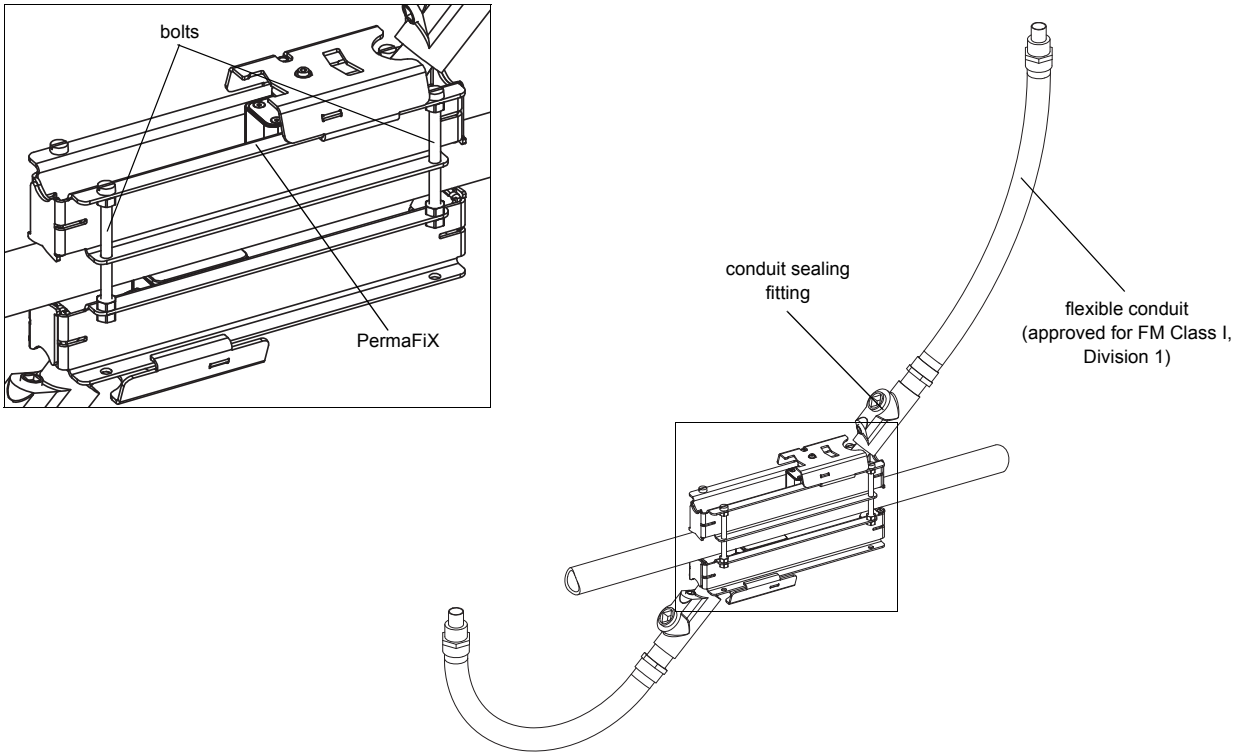


Fig. 8.54: PermaFiX on the pipe (example: diagonal arrangement with bolts)

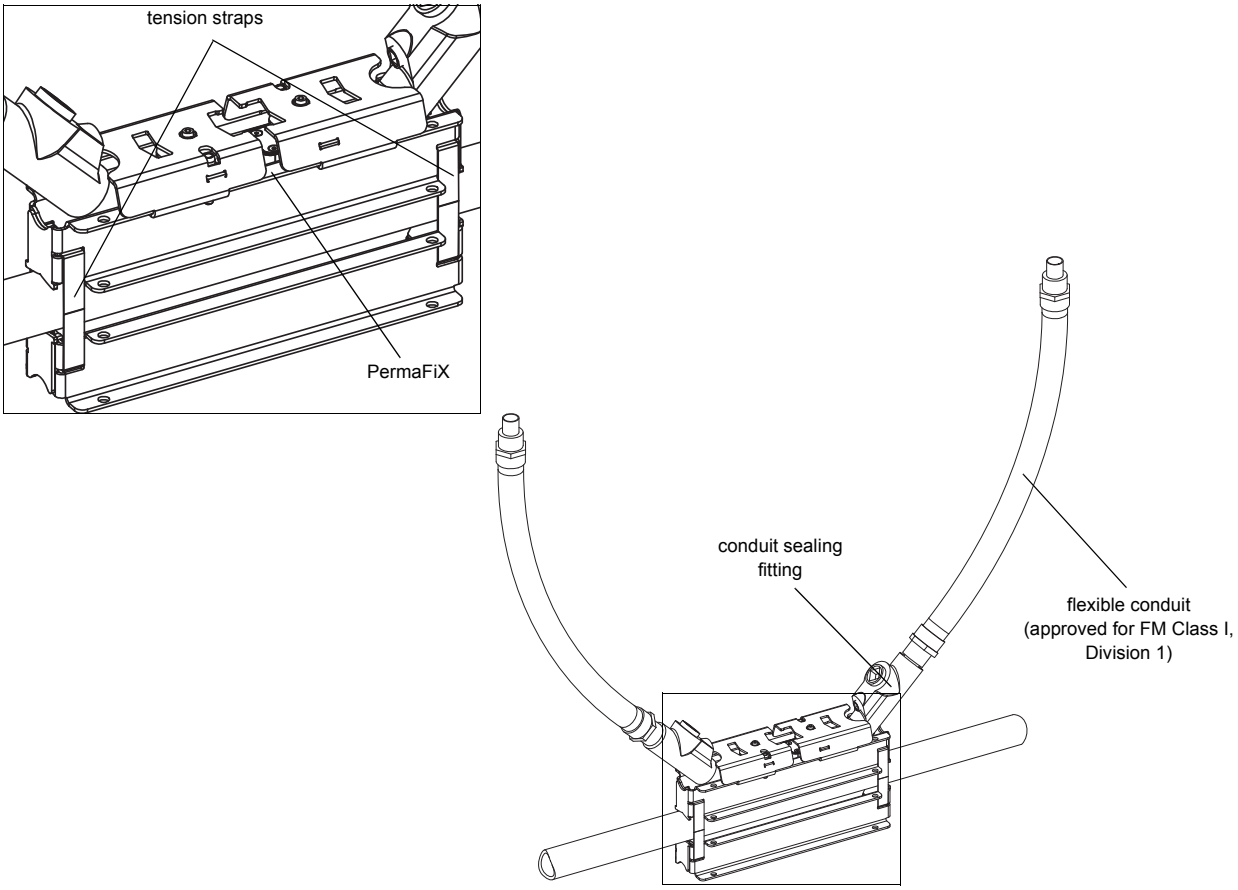


Fig. 8.55: PermaFiX on the pipe (example: reflection arrangement with tension straps)

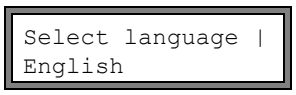
9 Start-up of the transmitter

9.1 Start-up settings

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

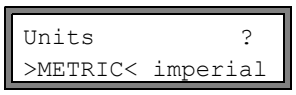
- language
- units of measurement
- time/date

These displays will be indicated only once when the transmitter is switched on for the first time.



The available languages of the transmitter are displayed in the relevant language. Select a language. Press ENTER.

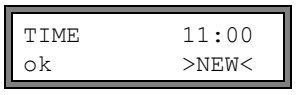
The menus are displayed in the selected language.



Select the units of measurement to be used. Press ENTER.

Select whether the transmitter is used in the region of Canada or not. Press ENTER.

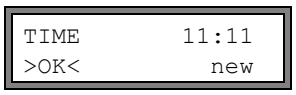
This display will only be indicated if `IMPERIAL` has been selected.



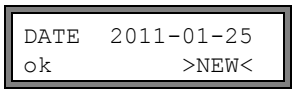
The current time is displayed. Select `ok` to confirm the time or `new` to adjust it. Press ENTER.

Select the character to be edited with key [→].

Edit the selected character with key [↓]. Press ENTER.



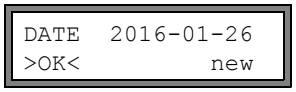
The new time is displayed. Select `ok` to confirm the time or `new` to adjust it again. Press ENTER.



The current date is displayed. Select `ok` to confirm the date or `new` to adjust it. Press ENTER.

Select the character to be edited with key [→].

Edit the selected character with key [↓]. Press ENTER.

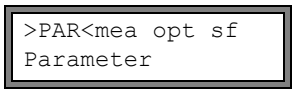


The new date is displayed. Select `ok` to confirm the date or `new` to adjust it again. Press ENTER.

9.2 Switching on

As soon as the transmitter is connected to the power supply, the serial number of the transmitter is displayed for a short time.

No data can 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 9.6).

9.3 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 CLR pressed.
- During the operation of the transmitter: press keys BRK, CLR and ENTER at the same time. A RESET is executed. Release key ENTER only. Keep keys BRK and CLR pressed.

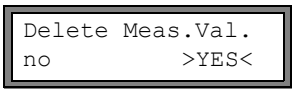
After the initialization has been executed, the message `INITIALISATION DONE` is displayed.

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.



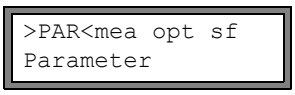
Select `yes` to delete the stored measured values or `no` to keep them stored.

Press ENTER.

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

9.4 Display

9.4.1 Main menu



The main menu contains the following program branches:

- `par` (Parameter)
- `mea` (Measuring)
- `opt` (Output options)
- `sf` (Special functions)

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 → and ↓. Press ENTER.

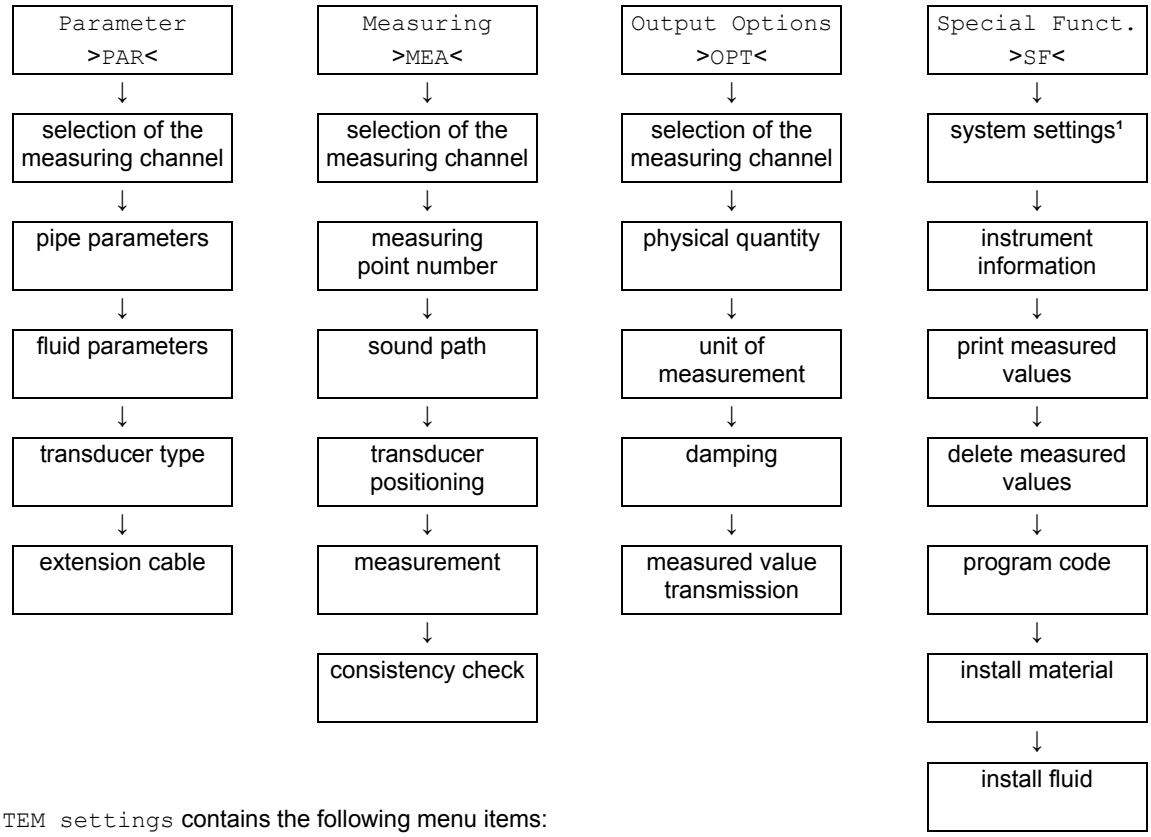
Note!	By pressing key BRK, the measurement will be stopped and the main menu is selected.

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 "\".

9.4.2 Program branches

- **Program branch `Parameter`**
  input of pipe and fluid parameters
- **Program branch `Measuring`**
  execution of measurement steps
- **Program branch `Output Options`**
  setting of the physical quantity, the unit of measurement and the parameters for the measured values 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.



¹ `SYSTEM settings` contains the following menu items:

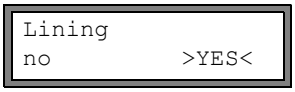
- set clock
- libraries
- dialogs and menus
- measuring
- outputs
- storing
- signal snap
- network
- serial transmission
- miscellaneous

9.4.3 Navigation

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

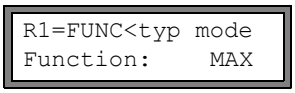
Use key → and ↓ to select a list item in the lower line. Press ENTER.

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.



Press key → and ↓ 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.

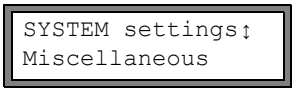


Press key → to scroll through the upper line and select a list item.
Press key ↓ to scroll through the lower line and select a value for the selected list item.
Press ENTER.

9.5 HotCodes

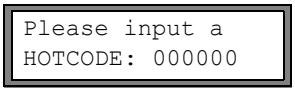
A HotCode is a key sequence that activates certain functions and settings:

function	HotCode	see section	deactivation
language selection	**9090xx**	9.6	
enabling of the FastFood mode	**007022**	12.9.1	HotCode **007022**
manual input of the lower limit for the inner pipe diameter	**071001**	12.11	
activation of the SuperUser mode	**071049**	16.1	HotCode **071049**
change of the transmission parameters of the RS232 interface	**232-0-**	13.2.4	
resetting the contrast of the display to medium	**555000**	15.4	

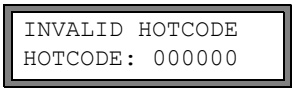


Select `Special Funct.\SYSTEM settings\Miscellaneous`.

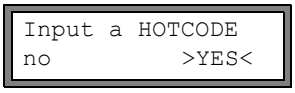
Select `yes` to enter a HotCode.



Enter the HotCode. Press ENTER.



An error message will be displayed if an invalid HotCode has been entered. Press ENTER.



Select `yes` to enter the HotCode again or `no` to return to the menu item `Miscellaneous`.

9.6 Language selection

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

Tab. 9.1: Language HotCodes

909031	Dutch
909033	French
909034	Spanish
909044	English
909049	German

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.

9.7 Operation state indication

The operation state is indicated by 2 LEDs.

Tab. 9.2: Operation state indication

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

9.8 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.

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.

10 Basic measurement

Attention!	Observe the "Safety instructions for the use in explosive atmospheres" (see document SIFLUXUS, SIFLUXUS_808_FM, SIFLUXUS_808_F2 and SIFLUXUS_1N62).

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

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.

10.1 Input of pipe parameters

```
>PAR<mea opt sf
Parameter
```

Select the program branch `Parameter`. Press ENTER.

```
Parameter       ↕
for Channel   A:
```

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.

10.1.1 Outer pipe diameter/pipe circumference

```
Outer Diameter
    100.0      mm
```

Enter the outer pipe diameter. Press ENTER.

```
Outer Diameter
1100.0   MAXIMAL
```

An error message will be displayed if the entered parameter is outside 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 15.2.1).

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.

10.1.2 Pipe wall thickness

```
Wall Thickness
      3.0      mm
```

Enter the pipe wall thickness. Press ENTER.

Note!	The inner pipe diameter (= outer pipe diameter – 2 x 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 12.11).

10.1.3 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.

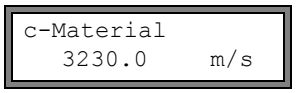
```
Pipe Material   ↕
Carbon Steel
```

Select the pipe material.

If the fluid 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 14.5).

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.

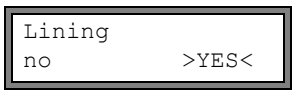


Enter the sound speed of the pipe material. Press ENTER.

Note!	A distinction is made between the longitudinal and transversal sound speed. 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.

10.1.4 Pipe lining



If the pipe has an inner lining, select `yes`. Press ENTER.

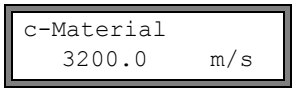
If `no` is selected, the next parameter will be displayed (see section 10.1.5).

Select the lining material.

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

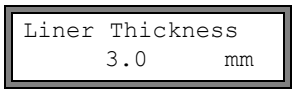
It can be specified which materials will be displayed in the scroll list (see section 14.5).

If `Other Material` is selected, the sound speed has to be entered.



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 – 2 x pipe wall thickness – 2 x 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 12.11).

10.1.5 Pipe roughness

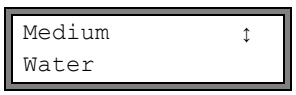
The flow profile of the fluid is influenced by the roughness of the inner pipe wall. The roughness is used for the calculation of the profile correction factor. As, in most cases, the pipe roughness cannot be determined exactly, it has to be estimated.

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

Enter the roughness of the selected pipe or lining material.

Change the value according to the condition of the inner pipe wall. Press ENTER.

10.2 Input of fluid parameters



Select the fluid from the scroll list.

If the fluid is not in the scroll list, select `Other Medium`. Press ENTER.

It is possible to specify which fluids will be displayed in the scroll list (see section 14.5).

For the programmed parameters of common fluids see annex C.3.

If a fluid is selected from the scroll list, the menu item for the input of the fluid temperature is displayed directly (see section 10.2.4).

If `Other Medium` is selected or no data set for the selected fluid is stored in the transmitter, the fluid parameters have to be entered first:

- average sound speed of the fluid
- range around the average sound speed of the fluid
- kinematic viscosity
- density

10.2.1 Sound speed

The sound speed of the fluid is used for the calculation of the transducer distance at the beginning of the measurement. However, the sound speed has no direct influence on the measuring result. Often, the exact value of the sound speed for a fluid is unknown. Therefore, a range of possible values for the sound speed has to be entered.

```
c-Medium
   1500.0     m/s
```

Enter the average sound speed of the fluid. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

```
c-Medium range
 auto      >USER<
```

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.

```
c-Medium=1500m/s
range +-150m/s
```

Enter the area around the average sound speed of the fluid. Press ENTER.
This display will only be indicated if `user` is selected.

10.2.2 Kinematic viscosity

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

```
Kinem.Viscosity
     1.00   mm2/s
```

Enter the kinematic viscosity of the fluid. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

10.2.3 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.

```
Density
     1.00   g/cm3
```

Enter the operating density of the fluid. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

10.2.4 Fluid temperature

At the beginning of the measurement, the fluid temperature is used for the interpolation of the sound speed and thus, for the calculation of the recommended transducer distance.

During the measurement, the fluid temperature is used for the interpolation of the density and the viscosity of the fluid.

```
Medium Temperat.
     20.0       C
```

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

10.2.5 Fluid pressure

The fluid pressure is used for the interpolation of the sound speed and the gas compressibility coefficient.

```
Fluid pressure
     1.00     bar
```

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

10.3 Other parameters

10.3.1 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.

```
Transducer Type↕
Standard
```

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!	When `Special Version` is selected and standard transducer parameters are used, FLEXIM cannot guarantee for the precision of the measured values. A measurement might even be impossible.

```
Transd. Data   1
    35.99
```

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

10.3.2 Extension cable

```
Additional cable
     65.0       m
```

If the transducer cable has to be extended, enter the additional cable length (e.g., between the junction box and the transmitter). Press ENTER.

10.4 Selection of channels

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

```
par>MEA<opt sf
Measuring
```

Select program branch `Measuring`. Press ENTER.

```
par>MEA<opt sf
NO DATA!
```

If this error message is displayed, the parameters are not complete. Enter the missing parameters in the program branch `Parameter`.

```
CHANN: >A< B Y Z
MEASUR  ✓  ✓ - .
```

The channels for the measurement can be activated and deactivated:

✓: the channel is active

–: the channel is not active

•: the channel cannot be activated

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

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.

• Press key [→] to select a channel.

• Press key [↓] 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:

```
A:Meas.Point No.:
     xxx (↑↓← →)
```

Enter the measuring point number. Press ENTER.

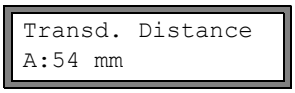
If arrows are displayed in the lower line on the right, ASCII text can be entered. If no arrows are displayed, only digits, point and hyphen can be entered.

10.5 Input of the sound path number

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

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

10.6 Transducer distance



A value for the transducer distance is recommended. Fix the transducers (see chapter 10). Adjust the transducer distance.

Press ENTER.

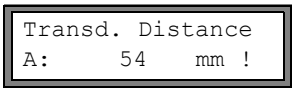
`A` – measuring channel
`Reflec` – reflection arrangement
`Diagon` – diagonal arrangement

The transducer distance is the distance between the inner edges of the transducers (see section 3.3 and Fig. 10.1)

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

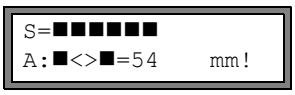
Note!	The accuracy of the recommended transducer distance depends on the accuracy of the entered pipe and fluid parameters.

10.6.1 Fine adjustment of the transducer distance



If the displayed transducer distance is adjusted, press ENTER.

The measuring run for the positioning of the transducers is started.

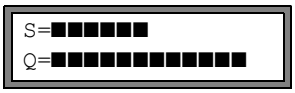


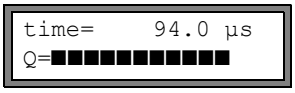
The amplitude of the received signal is displayed by the bar graph `S=`.

If the LED of the measuring channel lights green, the signal is sufficient for a measurement.

If the LED of the measuring channel lights red, the signal is not sufficient for a measurement.

• Shift a transducer slightly within the range of the recommended transducer distance.



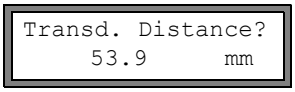


The following quantities can be displayed in the upper line by pressing key [→] and in the lower line by pressing key [↓]:

• ■<>■=: transducer distance
• `time`: transit time of the measuring signal in µs
• `S=`: signal amplitude
• `Q=`: signal quality, bar graph has to have max. length

If the signal is not sufficient for measurement, `Q= 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 transducer positioning, the recommended transducer distance is displayed again.

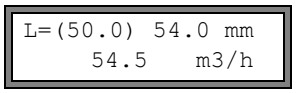
Enter the actual (precise) transducer distance. Press ENTER.

Repeat the steps for all channels on which a measurement is made. The measurement will be started automatically afterwards.

10.6.2 Consistency check

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

The transducer distance can be displayed during measurement by pressing key [→].



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.

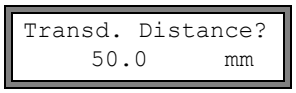
The optimum transducer distance is calculated on the basis of the measured sound speed. It is therefore a better approximation than the first recommended value which had been calculated on the basis of the sound speed range entered in the program branch `Parameter`.

If the difference between the optimum and the entered transducer distance is less than specified in Tab. 10.1, the measurement is consistent and the measured values are valid. The measurement can be continued.

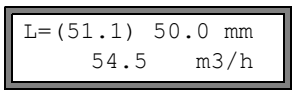
If the difference is greater, adjust the transducer distance to the displayed optimum value. Afterwards, check the signal quality and the signal amplitude bar graph (see section 10.6.1). Press ENTER.

Tab. 10.1: Standard values for signal optimization

transducer frequency (third character of the technical type)	**difference between the optimum and the entered transducer distance [mm]**	
	shear wave transducer	**lamb wave transducer**
F	-	-70...+120
G	20	-50...+100
H	-	-35...+60
K	15	-25...+40
M	10	-10...+20
P	8	-6...+10
Q	6	-3...+5
S	3	-



Enter the new adjusted transducer distance. Press ENTER.



Press key [→] 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.

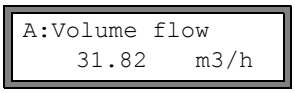
10.6.3 Value of sound speed

The sound speed of the fluid 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 10.6.2, 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 fluid temperature because the sound speed depends on the temperature. The value can be entered in the program branch `Parameter` or a user defined fluid can be created for this sound speed (see section 14.2 and 14.3).

10.7 Start of measurement



The measured values are displayed in the lower line. Press ENTER to return to the fine adjustment of the transducer distance (see section 10.6.1).

If more than one measuring channel is available/activated, the transmitter works with an integrated 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 the setting of the output options see chapter 11. For further measuring functions see chapter 12.

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

10.9 Interruption of the measurement

The measurement is interrupted by pressing key BRK if it is not protected by a program code (see section 12.13).

Note!	Be careful not to stop a current measurement by inadvertently pressing key BRK!

11 Displaying measured values

The physical quantity is set in the program branch `Output Options` (see section 11.1).

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 11.3).

11.1 Selection of the physical quantity and the unit of measurement

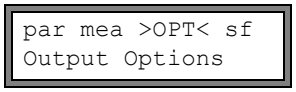
The following physical quantities can be measured:

• **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 fluid

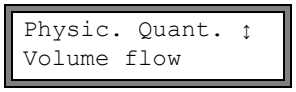
The physical quantity is selected as follows:



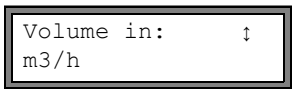
Select the program branch `Output Options`. Press ENTER.

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, 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 17).

11.2 Toggling between 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

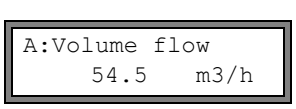
• HumanMux mode

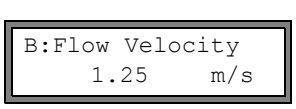
The command →`Mux:Auto/Human` toggles between the modes (see section 12.1).

11.2.1 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 11.1). When the multiplexer switches to the next channel, the display is updated.





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.

11.2.2 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.

The selected channel is displayed left in the upper line.

Select the command →Mux:Nextchan. 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 11.1).

11.3 Adjustment of the display

During the measurement, the display can be adapted in order to display 2 measured values simultaneously (one in each line of the display). This does not affect totalizing, storing of measured values, transmission of measured values, etc.

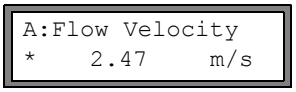
The following information can be displayed in the upper line:

display	explanation
Mass Flow=	designation of the physical quantity
A: +8.879 m3	values of the totalizers
full=	date and time at which the data logger will be full, if activated
Mode=	measuring mode
L=	transducer distance
Compress=	compressibility coefficient of the gas
Rx=	alarm state indication if it is activated (see section 17.7.5) and if alarm outputs are activated (see section 17.6).
δc=	difference between the measured sound speed and the sound speed of a selected reference fluid, if activated (see section 15.3)
	status line (see section 11.4)

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

display	explanation
12.3 m/s	flow velocity
1423 m/s	sound speed
124 kg/h	mass flow rate
15 m3/h	volumetric flow rate

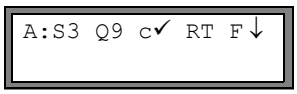
Press key → during the measurement to change the display in the upper line, press key ↓ to change the display in the lower line.



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

11.4 Status line

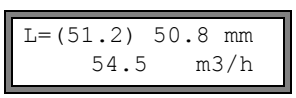
Important data concerning the ongoing measurement are displayed in the status line. The quality and precision of the ongoing measurement can be estimated.



Press key [→] during the measurement to scroll through the upper line to the status line.

	value	explanation
S		**signal amplitude**
	0 … 9	< 5 % … ≥ 90 % Values ≥ 3 are sufficient for the measurement.
Q		**signal quality**
	0 … 9	< 5 % … ≥ 90 %
c		**sound speed** Comparison of the measured and the expected sound speed of the fluid. The expected sound speed is calculated on the basis of the fluid parameters (fluid selected in the program branch `Parameter`, temperature dependence).
	√	ok, is equal to the expected value
	↑	> 20 % of the expected value
	↓	< 20 % of the expected value
	?	unknown, cannot be measured
R		**flow profile** information about the flow profile based on the Reynolds number
	T	fully turbulent flow profile
	L	fully laminar flow profile
	↕	the flow is in the transition range between laminar and turbulent flow
	?	unknown, cannot be calculated
F		**flow velocity** comparison of the measured flow velocity with the flow limits of the system
	√	ok, the flow velocity is not in the critical range
	↑	the flow velocity is higher than the current limit
	↓	the flow velocity is lower than the current cut-off flow (even if it is not set to zero)
	0	the flow velocity is in the limit range of the measuring method
	?	unknown, cannot be measured

11.5 Transducer distance



By pressing key [→] 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!

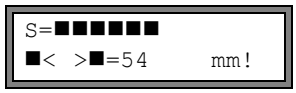
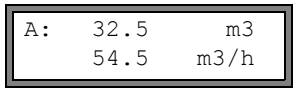
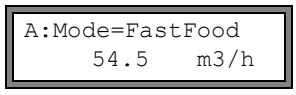
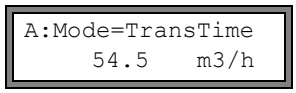
12 Advanced measuring functions

12.1 Command execution during measurement

Commands that can be executed during a measurement are displayed in the upper line. A command begins with an arrow →. If programmed, a program code has to be entered first (see section 12.13).

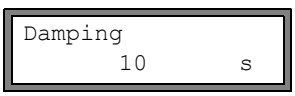
Press key [→] until the command is displayed. Press ENTER. The following commands are available:

Tab. 12.1: Commands that can be executed during the measurement

command	explanation
→Adjust transd.	 Select transducer positioning. If a program code is active, the measurement will be continued 8 s after the last keyboard entry.
→Clear totalizer	 All totalizers will be reset to zero.
→Mux:Auto/Human	Toggle between the AutoMux and the HumanMux mode of the display (see section 11.2). This display will not be indicated if the transmitter has only one measuring channel or only one measuring channel is active.
→Mux:Nextchan.	display the next channel This display will not be indicated if the transmitter has only one measuring channel or only one measuring channel is active.
→Break measure	stop the measurement and return to the main menu
→Toggle FastFood	 

12.2 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. Values which fluctuate strongly due to a higher flow dynamics require a higher damping factor. Select the program branch `Output Options`. 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.

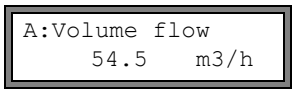
12.3 Totalizers

The total volume or total mass of the fluid at the measuring point can be determined.

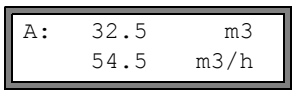
There are two totalizers, one for the positive flow direction, one for the negative flow direction.

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

The values of the totalizers can be displayed with up to 11 places, e.g., 74890046.03. For the adjustment of the number of decimal places (max. 4 places) see section 16.7.



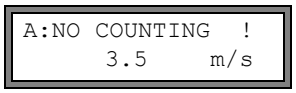
Press key → to scroll through the upper line to the display of the totalizers.



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

Press ENTER while a totalizer is displayed to toggle between the displays of the totalizers for the two flow directions.

Select the command →Clear totalizer in the upper line to reset the totalizers to zero. Press ENTER.



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

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.

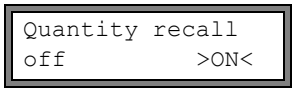
If one is selected, only the value of the totalizer that is currently displayed will be stored.

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.



If on is selected, the values of the totalizers will be stored and used for the next measurement.

If off is selected, the totalizers will be reset to zero.

12.3.1 Overflow of the totalizers

The overflow behavior of the totalizers can be set:

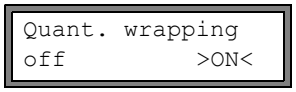
Without overflow

- The value of the totalizer increases to the internal limit of 10^{38}.
- If necessary, the values will be displayed as exponential numbers (±1.00000E10). The totalizer can only be reset to zero manually.

With overflow

- The totalizer will be reset to zero automatically when ±9999999999 is reached.

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



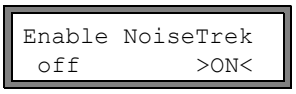
Select on to work with overflow. Select off to work without overflow. Press ENTER.

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 ΣQ) via an output is no longer 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.

12.4 Settings of the NoiseTrek parallel beam mode

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



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

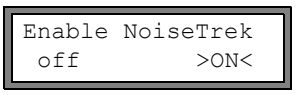
Select `on` to enable the NoiseTrek parallel beam mode, `off` to disable it. Press ENTER.

This display will only be indicated if the NoiseTrek mode is enabled.

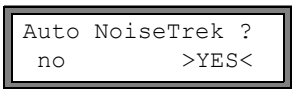
12.5 Settings of the HybridTrek mode

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.

Note!	Due to its higher measuring accuracy, the TransitTime mode should be used preferentially over the NoiseTrek mode.



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.

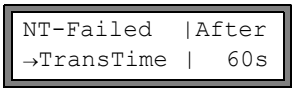
Select `yes` to activate the automatic toggling between the TransitTime and the NoiseTrek mode. If `yes` the NoiseTrek mode can also be activated and deactivated manually during the measurement.

Press ENTER.

This display will only be indicated if the NoiseTrek mode is enabled and the NoiseTrek parallel beam mode has not been activated.

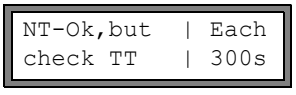
If the automatic toggling between the TransitTime and the NoiseTrek mode is activated, the toggling parameters have to be configured.

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.

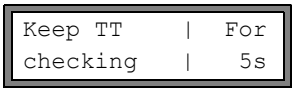


Enter the time after which the transmitter has to toggle to the TransitTime mode if there are no valid measured values in the NoiseTrek mode. If `0` (zero) is entered, the transmitter does not toggle to the TransitTime mode.

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 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 ENTER when the measuring mode is displayed.

12.6 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`.

```
Velocity limit
     0.0    m/s
```

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.
- an exclamation point (`!`) will be displayed after the unit of measurement, in case of a normal error, an interrogation point (`?`).

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

12.7 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. The cut-off flow is set in `Special Funct.\SYSTEM settings\Measuring\Cut-off Flow`.

```
Cut-off Flow
absolut   >SIGN<
```

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

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

Press ENTER.

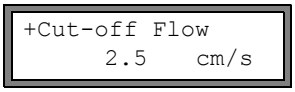
```
Cut-off Flow
factory   >USER<
```

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.

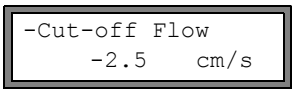
Press ENTER.

If `Cut-off Flow\sign` and `user` are selected, 2 values will have to be entered:



Enter the cut-off flow. Press ENTER.

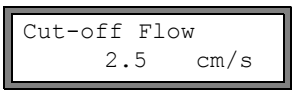
All positive values of the flow velocity that are lower than this limit will be set to zero.



Enter the cut-off flow. Press ENTER.

All negative values of the flow velocity greater than this limit will be set to zero.

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



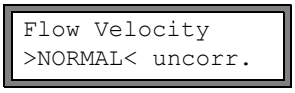
Enter the cut-off flow. Press ENTER.

The absolute value of all flow velocity values that are lower than this limit will be set to zero.

12.8 Uncorrected flow velocity

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

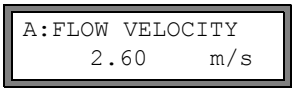
The profile correction for the flow velocity is activated in `Special Funct.\SYSTEM settings\Measuring\Flow Velocity`.



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 whether 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.

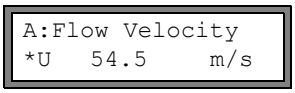
Press ENTER.

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 ↓ 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.`

12.9 Measurement of highly dynamic flows (FastFood mode)

The FastFood mode allows to measure flows with high dynamics.

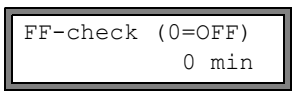
A continuous adaptation to changing measuring conditions is only partially realized in the FastFood mode.

- The sound speed of the fluid is not updated. The last measured value of the sound speed before toggling to the FastFood mode is used.
- It is not possible to change the measuring channel. The measurement takes place on one channel only. During the activation of the FastFood mode no measurement is carried out on the other channels.
- The outputs of the FastFood mode activated channel can still be used.
- The outputs for further channels (multi-channel measurement) transmit an error value.
- The measured values are stored with the storage rate of the FastFood mode (see section 12.9.2).
- The FastFood mode has to be enabled and activated.

12.9.1 Enabling/disabling the FastFood mode

Enter HotCode **007022** (see section 9.5).

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

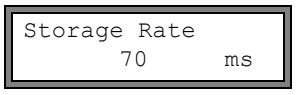


If the FastFood mode is enabled, a time t has to be entered. When the FastFood mode is started a search run will always be started after expiration of time t.

The search run is used to optimize the amplification settings.

Enter `0` if no search run is to be carried out.

12.9.2 Storage rate of the FastFood mode

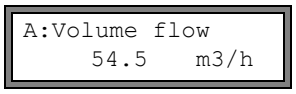


If the FastFood mode is enabled, a `Storage Rate` in ms has to be entered in the program branch `Output Options`.

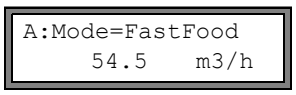
Press ENTER.

12.9.3 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.



During the measurement, select the command →`Toggle FastFood` in the upper line to activate/deactivate the FastFood mode on the channel whose values are currently displayed. Press ENTER.



The activated measuring mode can be displayed in the upper line.

If the data logger is activated, a new data set will be created and the storing of measured values will be started. If the FastFood mode is deactivated or 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.

12.10 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 2 virtual calculation channels Y and Z. The measured values of the measuring channels A and B 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 which are possible 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.

12.10.1 Characteristics of the calculation channels

The measuring channels to be used for the calculation and the calculation function have to be entered in the program branch `Parameter`.

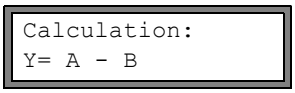
A calculation channel cannot be attenuated. The damping factor has to be set separately for each of the two measuring channels.

Two cut-off flow values for each calculation channel can be defined. The cut-off flow is not based on the flow velocity as is the case with 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.

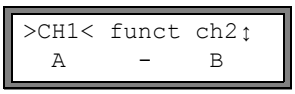
A calculation channel provides valid measured values if at least one measuring channel provides valid measured values.

12.10.2 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 [→].

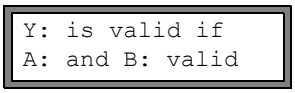
The list items are displayed in the lower line.

Scroll with key [↓] through the scroll list. All measuring channels and their absolute values can be used as input channels for the calculation.

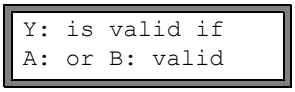
The following calculation functions are available:

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

Press ENTER.



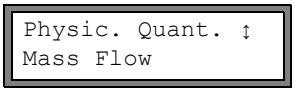
This message will be displayed after the parametrization of the calculation channel if the calculation function `(+)/2` is selected. The measured values of the calculation channel (here: `Y`) will be valid if the measured values of both measuring channels (here: `A` and `B`) are valid. If only one measuring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

12.10.3 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.

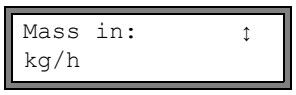
Make sure that the physical quantity selected for the calculation channel can be calculated from the physical quantities of the selected measuring channels. Possible combinations are shown in Tab. 12.2.

Tab. 12.2: Physical quantity of the calculation channel

physical quantity of the calculation channel	**possible physical quantity of the first measuring channel (ch1)**				**possible physical quantity of the second measuring channel (ch2)**			
	flow velocity	volumetric flow rate	mass flow rate		flow velocity	volumetric flow rate	mass flow rate	
flow velocity	x	x	x		x	x	x	
volumetric flow rate		x	x			x	x	
mass flow rate		x	x			x	x	

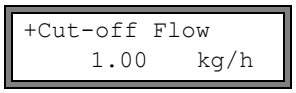
example: The difference of the volume flow rates of the channels A and B is to be calculated.

The physical quantity of the measuring channel A and B can be the volumetric flow rate or the mass flow rate, but not the flow velocity. The physical quantities of both measuring channels do not need to be identical (channel A = mass flow rate, channel B = volumetric flow rate).

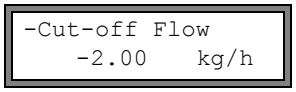


Select the unit of measurement. Press ENTER.

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.



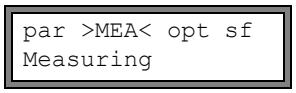
All positive calculated values that are lower than the limit will be set to `0`.



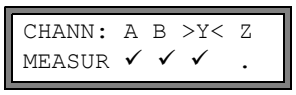
All negative calculated values that are greater than the limit will be set to `0`.

The data logger can be activated/deactivated. Press ENTER.

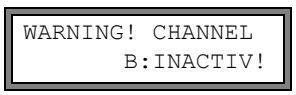
12.10.4 Measuring with calculation channels



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.

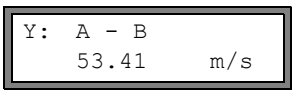


If a measuring channel that is needed for an activated calculation channel has not been activated, a warning will be displayed. Press ENTER.

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 11.2.2) 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.



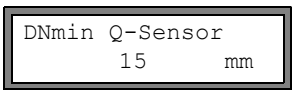
Press key → to display the calculation function.

Press key ↓ to display the measured values of the different channels.

12.11 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.

Enter the HotCode **071001** (see section 9.5).



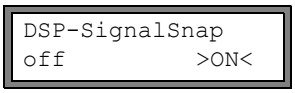
Enter the lower limit of the inner pipe diameter of the displayed transducer type. Press ENTER to select the next transducer type.

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

12.12 Diagnosis by means of the snap function

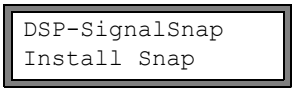
By means of the snap function it is possible to store measuring parameters which are useful for the evaluation of measuring results or diagnostic purposes.

The snap function is activated in `Special Funct.\SYSTEM settings\Signal snap\DSP-SignalSnap`.

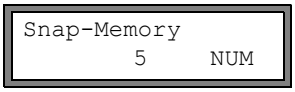


Select `on` to activate the snap function. Select `off` to deactivate the snap function. Press ENTER.

Snap memory settings

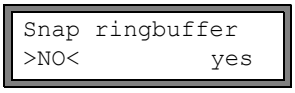


Select `Install Snap`. Press ENTER.



Enter the number of the snap memory storage spaces. Press ENTER.

Activate or deactivate the auto-snap function. Press ENTER.

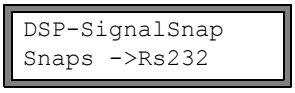


Activate or deactivate the snap ringbuffer. Press ENTER.

Delete snaps

Select `Clear Snaps`. Press ENTER.

Read Snaps



Select `Snaps ->Rs232`. Press ENTER.

Activation of the snap function

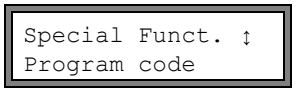
In order to activate a snap function, press key → during the measurement until `DSP-SignalSnap/Voltage` is displayed in the upper line. Press ENTER.

12.13 Program code

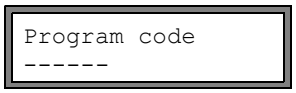
An ongoing measurement can be protected from an inadvertent intervention by means of a program code.

If a program code has been defined, it will be requested when there is an intervention in the measurement (by means of a command or key BRK).

12.13.1 Defining a program code



Select `Special Funct.\Program code`.



Enter a program code with max. 6 digits. Press ENTER.

An error message will be displayed if a reserved number has been entered (e.g., a HotCode for language selection).

A program code will remain valid as long as:

- no other valid program code is entered or
- the program code is not deactivated.

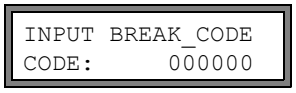
Note!	Do not forget the program code!

12.13.2 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.

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

If key BRK is pressed:



To stop an ongoing measurement, the complete program code has to be entered (= break code).

Enter the program code with the keys → and ↓. Press ENTER.

If the entered program code is invalid, an error message will be displayed for a few seconds.

If the entered program code is valid, the measurement will be stopped.

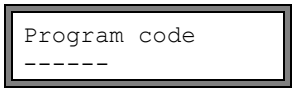
If a command is selected:

To execute a command, it is sufficient to enter the first three digits of the program code (= access code).

Enter the first 3 digits of the program code with the keys → and ↓. Press ENTER.

At first, `000000` is displayed. If the program code starts with `000`, ENTER can be pressed immediately.

12.13.3 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.

13 Data logger and transmission of data

The transmitter has a data logger in which the measured values are stored during the measurement (see section 13.1).

In addition, the measured values can be transmitted to a PC (see section 13.2). For the connection of the serial interface see section 6.10 (FLUXUS F808) or 7.9 (FLUXUS F809).

13.1 Data logger

The following data will be stored:

- date
- time
- measuring point number
- pipe parameters
- fluid 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 (in case the totalizers are activated)
- diagnostic values (in case the storing of diagnostic values is activated)

In order to store the measured data, the data logger has to be activated (see section 13.1.1).

The available data logger capacity can be displayed (see section 13.1.6).

13.1.1 Activation/deactivation of the data logger

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

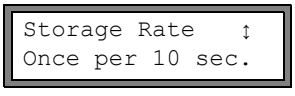
Select `yes` to activate the data logger, `no` to deactivate it. Press ENTER.

13.1.2 Setting the storage rate

The storage rate is the frequency to transmit or store measured values. 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 with 2 activated measuring channels: min. 2 s, 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.

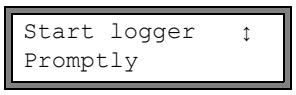
13.1.3 Settings of the data logger

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

- start of the storing
- ringbuffer
- storage mode
- storing of the totalizers
- storing of the signal amplitude
- storing of the fluid sound speed
- storing of the diagnostic values

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.

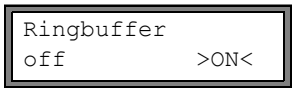
`Promptly`: Storing will be started immediately.
`On full 5 min.`: Storing will be started on the next full 5 minutes.
`On full 10 min.`: Storing will be started on the next full 10 minutes.
`On quarter hour`: Storing will be started on the next full 15 minutes.
`On half hour`: Storing will be started on the next full 30 minutes.
`On full hour`: Storing will be started on the next full hour.

example:	current time: 9:06 o'clock setting: `On full 10 min.` Storing will be started at 9:10 o'clock.

Ringbuffer

The setting of the ringbuffer influences 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 capacity that was free during the activation will be used by the ringbuffer. If more data logger capacity is necessary, the 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 undamped values measured during a storage interval will be used for storing and online transmission of data.

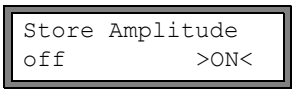
Note!	The storage mode does not affect the outputs.

Note!	`Storage mode` = `average` The average of the selected physical quantity and other physical quantities assigned to the measuring channel will be calculated. If the storage rate < 5 s (see section 13.1.2) 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 of the stored measurement data will contain (`???`) for invalid average values of the measured value.

Storing of the totalizers

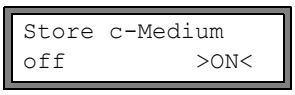
see section 12.3

Storing of the signal amplitude



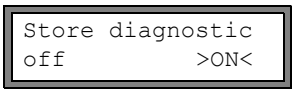
If `on` is selected and the data logger is activated, the amplitude of the measured signal will be stored together with the measured values. Press ENTER.

Storing of the sound speed



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

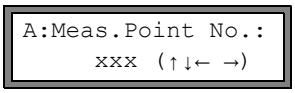
Storing of the diagnostic values



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

13.1.4 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 15.2.3.

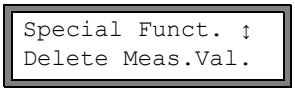
If `Output Options\Store Meas.Data` has been activated and `Special Funct.\SYSTEM settings\Ringbuffer` is deactivated, an error message will be displayed as soon as the data logger is full.

Press ENTER.

The error message will be displayed periodically.

The storing will be stopped.

13.1.5 Deleting measured values

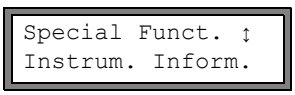


Select `Special Funct.\Delete Meas.Val.` Press ENTER.

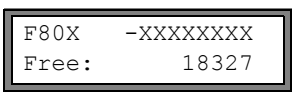
Select `yes` or `no`. Press ENTER.

13.1.6 Available data logger capacity

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



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

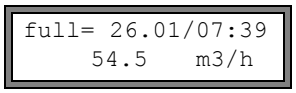


The type and the serial number of the transmitter will be displayed in the upper line.

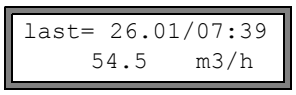
The max. available data logger capacity will be displayed in the lower line (here: 18 327 additional measured values can be stored). Press key BRK twice to return to the main menu.

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 will be full can be displayed during the measurement. All activated channels, totalizers and other values will be considered.



Press key → 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.

13.2 Transmission of data

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

13.2.1 Online transmission of data

The measurement data are transmitted during the measurement. The measurement data can be transmitted to a terminal program.

Tab. 13.1: Overview of online transmission of data

serial interface	transmission of data	see
RS232	terminal program	section 13.2.5
RS485 (sender)	terminal program	section 13.2.5

The data logger works independently of the online transmission.

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.

13.2.2 Offline transmission of data

The measurement data of the data logger are transmitted.

Tab. 13.2: Overview offline transmission of data

serial interface	transmission of data	see
RS232	terminal program	section 13.2.6
RS232	FluxData	section 13.2.7
RS485 (sender)	terminal program	section 13.2.6

Selection of the serial interface for the offline transmission of data

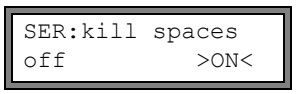
Select `Special Funct.\SYSTEM settings\serial transmis.` Press ENTER until `Send Offline via` is displayed.

Select the serial interface for the offline transmission of data.

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

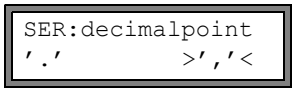
13.2.3 Format of the measurement data

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



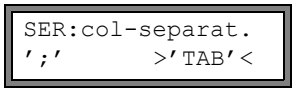
Select `on` if the space characters are not to be transmitted. Press ENTER.

The file size will be considerably smaller (shorter transmission time).



Select the decimal marker to be used for floating-point numbers (point or comma). Press ENTER.

This setting depends on the setting of the operating system of the PC.



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

13.2.4 Transmission parameters

• the transmitter sends CRLF-terminated ASCII

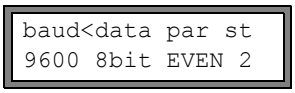
• max. line length: 255 digits

RS232

• default: 9 600 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:

Enter HotCode **232-0-** (see section 9.5).



Set the transmission parameters in the 4 scroll lists. Press ENTER.

• `baud`: baud rate

• `data`: number of data bits

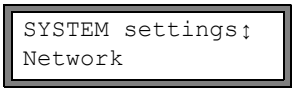
• `par`: parity

• `st`: number of stop bits

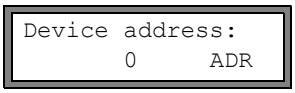
RS485

• default: 9 600 bits/s, 8 data bits, even parity, 1 stop bit

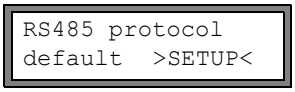
The transmission parameters of the RS485 interface can be changed in the program branch `Special Funct.\SYSTEM settings\Network`. This display will only be indicated if the transmitter has an RS485 interface.



Select `Special Funct.\SYSTEM settings\Network` to change the settings of the transmission parameters.



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.

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.

13.2.5 Online transmission of data to a terminal program

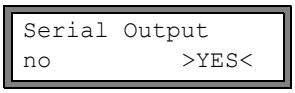
• Start the terminal program.

• Enter the transmission parameters into the terminal program (see section 13.2.4). The transmission parameters of the terminal program and the transmitter have to be identical.

Transmitter settings

• Select the program branch `Output Options`. Press ENTER.

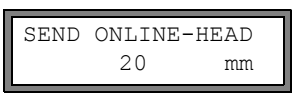
• Select the channel for which the online transmission of data is to be activated. Press ENTER until the menu item `Serial Output` is displayed.



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

• Set the storage rate (see section 13.1.2).

• Start the measurement. The measuring point number will be requested (see section 13.1.4).



The measured values are transmitted during the measurement.

13.2.6 Offline transmission of data to a terminal program

- Start the terminal program.
- Enter the transmission parameters into the terminal program (see section 13.2.4). The transmission parameters of the terminal program and the transmitter have to be identical.

```
Special Funct. ↕
Print Meas.Val.
```

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

```
NO VALUES      !
Print Meas.Val.
```

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

```
Send Header   01
..............
```

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

```
■■■■■■
..............
```

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

```
SERIAL ERROR   !
Print Meas.Val.
```

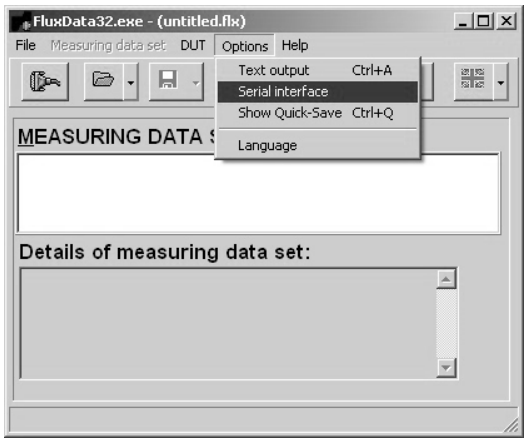
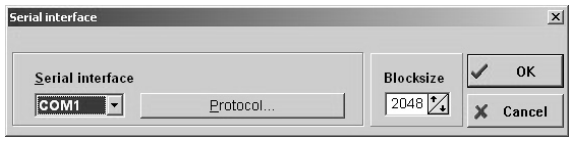
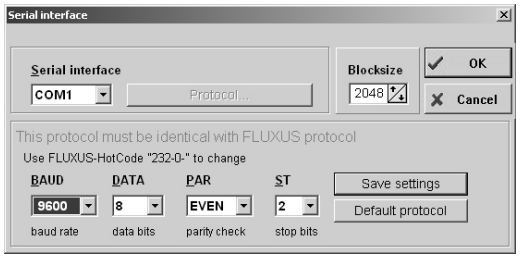
This error message will be displayed if an error has occurred during the serial transmission. Press ENTER. Check the connections and make sure that the PC is ready to receive data.

13.2.7 Offline transmission of data with the program FluxData

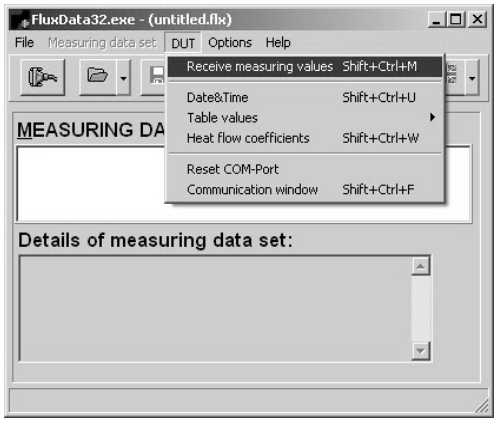
The measurement data in the data logger are transmitted to a PC via the serial interface RS232 with the FLEXIM program FluxData.

Program settings

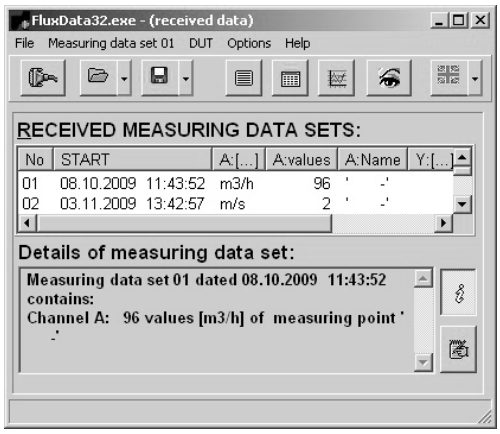
Start the program FluxData V3.0 or higher on the PC.

<table>
<tr><td> 
</td><td>Select the menu:
Options > Serial interface.</td></tr>
<tr><td> 
</td><td>Select the serial interface used by the PC (e.g., COM1).
Click on Protocol.
Click on OK.</td></tr>
<tr><td> 
</td><td>Enter the transmission parameters (see section 13.2.4). If the default settings of the transmission parameters are to be used, click on Default protocol.
The transmission parameters of the program FluxData and the transmitter have to be identical.
Click on OK.</td></tr>
</table>

transmission of data

	Select the menu: DUT > Receive measuring values. Wait until the data is transmitted.

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.

13.2.8 Structure of the data

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

example:

```
\DEVICE            : F80X-XXXXXXXX
\MODE              : ONLINE
DATE               : 2014-01-09
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
```

Next, the line `\DATA` will be transmitted next. Followed by the column titles for the respective channel (see Tab. 13.3). The measured values are transmitted afterwards.

example:

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

Depending on the 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 transducer positioning.

The following data columns can be transmitted:

Tab. 13.3: Columns of data

column title	column format	contents
`\*MEASURE`	`###000000.00`	physical quantity selected in `Output Options`
`Q_POS`	`+00000000.00`	totalizer value for the positive flow direction
`Q_NEG`	`-00000000.00`	totalizer value for the negative flow direction
`SSPEED`		sound speed of the fluid
`AMP`		signal amplitude

Online transmission of data

Columns will be created for all quantities that appear during the measurement.

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.

14 Libraries

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

User defined materials and fluids can be stored in an integrated coefficient memory (user memory area). The coefficient memory has to be partitioned first (see section 14.1).

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

• as constants without extended library (see section 14.2)

• as constants or as temperature and pressure dependent functions with extended library (see section 14.3)

The material and fluids scroll lists displayed in the program branch `Parameter` can be arranged (see section 14.5). Shorter scroll lists make work more effective.

14.1 Partitioning of the coefficient memory

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

• material parameters:
  – transversal and longitudinal sound speed
  – typical roughness
• fluid parameters:
  – min. and max. sound speed
  – kinematic viscosity
  – density

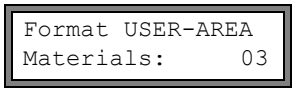
For the max. number of data sets for each category of these material data see Tab. 14.1.

Tab. 14.1: Capacity of the coefficient memory

	max. number of data sets	occupancy of the coefficient memory in %
materials	13	97
fluids	13	97

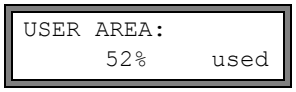
Select `Special Funct.\SYSTEM settings\Libraries\Format USER-AREA`. Press ENTER.

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.

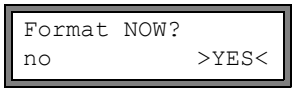


Enter the number of the user defined materials. Press ENTER.

Enter the number of the user defined fluids. Press ENTER.



The occupancy of the coefficient memory is displayed for a few seconds.



Select `yes` to start the partitioning. Press ENTER.

The coefficient memory is partitioned accordingly. This procedure takes a few seconds.

After the partitioning, `Format USER-AREA` is displayed again.

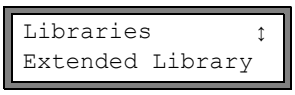
14.1.1 Data retention during the partitioning of the coefficient memory

When the coefficient memory is repartitioned, max. 8 data sets of each type can be retained.

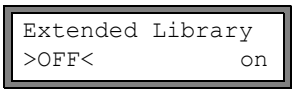
example 1:	The number of user defined materials is reduced from 5 to 3. The data sets #01...#03 are retained. The data sets #04 and #05 are deleted.
example 2:	The number of user defined materials is increased from 5 to 6. All 5 data sets are kept.

14.2 Input of material/fluid parameters without extended library

In order to enter the material/fluid parameters as constants, the extended library has to be deactivated.



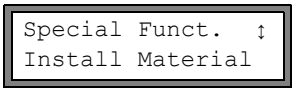
Select `Special Funct.\SYSTEM settings\Libraries\Extended Library`. Press ENTER.



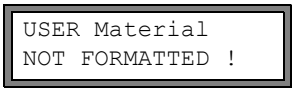
Select `off` to deactivate the extended library. Press ENTER.

The parameters of a user defined material/fluid can be entered now.

The input of a material or a fluid is almost identical. Therefore, displays for a fluid will only be shown and described in case of differences.



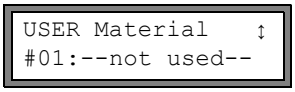
Select `Special Funct.\Install Material` or `Install Medium`. Press ENTER.



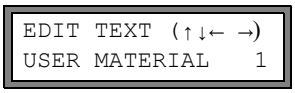
This error message will be displayed if the coefficient memory does not contain an area for user defined materials/fluids.

Partition the coefficient memory accordingly (see section 14.1).

Select `edit`. Press ENTER.



Select a user defined material/fluid. Press ENTER.

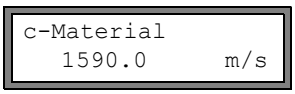


Change the designation of the material/fluid.

The default name for a user defined material/fluid is `USER MATERIAL N` or `USER MEDIUM N` with `N` being an integer.

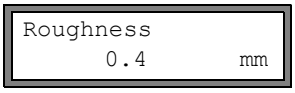
Note!	There are 95 ASCII characters (letters, capital letters, numbers, special characters [!? " + - ( ) > < % *]) available for the designation of materials/fluids. A designation can have max. 16 characters. The input of text is described in section 4.3.

Material parameters



Enter the sound speed of the material. Press ENTER.

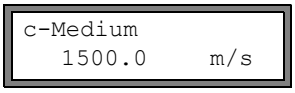
For the sound speed of some materials annex C.1.



Enter the roughness of the material. Press ENTER.

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

Fluid parameters



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

```
c-Medium range
 auto     >USER<
```

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.

```
c-Medium=1500m/s
range   +-150m/s
```

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

This display will only be indicated if `user` has been selected.

```
Kinem.Viscosity
     1.01    mm2/s
```

Enter the kinematic viscosity of the fluid. Press ENTER.

```
Density
     1.00    g/cm3
```

Enter the density of the fluid. Press ENTER.

14.3 Extended library

14.3.1 Introduction

If the extended library is activated, it is possible to enter material and fluid parameters as a function of the temperature or the pressure. These data can be entered into the transmitter directly or by means of the program FluxKoef.

Tab. 14.2: Material and fluid parameters that can be stored

parameter	**parameter necessary for...**
material parameter	
transversal sound speed	flow measurement
longitudinal sound speed	flow measurement
type of sound wave	flow measurement
typical roughness	profile correction of the flow velocity
fluid parameter	
sound speed	start of measurement
viscosity	profile correction of the flow velocity
density	calculation of mass flow rate

Enter only the parameters needed for the measuring task.

example: The density of a fluid 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 the volumetric flow rate will not be affected. However, the value of the mass flow rate will be wrong.

The dependence of the material/fluid parameters on the temperature and pressure can be described

- as constants
- as linear function
- with polynomials of 1^{st} to 4^{th} grade or
- with customized interpolation functions.

In most cases, constants or a linear function are sufficient.

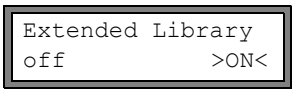
If, e.g., the temperature fluctuations at the measuring point are low compared to the temperature dependence of the material parameters, the linearization or the complete neglect of the temperature dependence will not result in a considerable additional measuring error.

If, however, the process conditions fluctuate strongly and the fluid 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.

Special interpolation functions

Some dependencies are only approximated insufficiently by polynomials. A number of special interpolation functions `Basics: Y=F(X,Z)` are available to interpolate multidimensional dependencies `y = f(T, p)`. Contact FLEXIM for more information.

14.3.2 Activation of the extended library



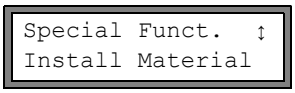
Select `Special Funct.\SYSTEM settings\Libraries\Extended Library`. Press ENTER.

Select `on` to activate the extended library. Press ENTER.

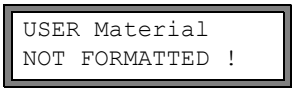
14.3.3 Input of material/fluid parameters

The parameters of a user defined material/fluid can be entered now.

The input of a material or a fluid is almost identical. Therefore, the displays for a fluid will only be shown and described in case of differences.

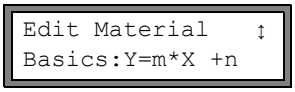


Select `Special Funct.\Install Material` or `Install Medium`. Press ENTER.



An error message will be displayed if the coefficient memory does not contain an area for user defined materials/fluids.

Partition the coefficient memory accordingly (see section 14.1).



Select the function for the temperature or pressure dependence of the material/fluid parameters:

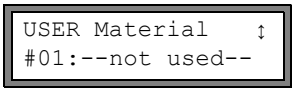
`Y=const.`: constants

`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)`: special interpolation function (only for experienced users or after consultation with FLEXIM)

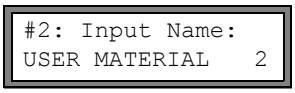
`go back`: return to the previous menu item



Select a user defined material/fluid.

Select `edit` to edit the material/fluid parameters or `delete` to delete the material/fluid and to return to the scroll list `Edit Material` or `Edit Medium`.

This display will only be indicated if an already existing material/fluid has been selected.



Enter the designation of the material/fluid. Press ENTER.

The default name for a user defined material/fluid is `USER MATERIAL N` or `USER MEDIUM N` with `N` being an integer.

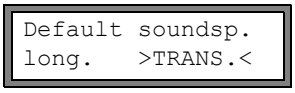
Material parameters

Enter the material's:

- transversal sound speed
- longitudinal sound speed

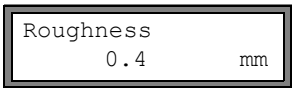
Depending on the selected function, 1...5 values have to be entered. Press ENTER after each input.

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.

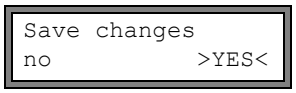


Select the type of sound wave to be used for the flow measurement. Press ENTER.

For most materials, a transversal sound wave has to be selected.



Enter the typical roughness of the material. Press ENTER.



Select `yes` to store the entered parameters or `no` to quit the menu item without storing. Press ENTER.

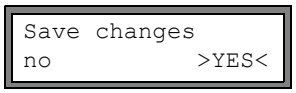
Fluid parameters

Enter the fluid'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 fluid 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.



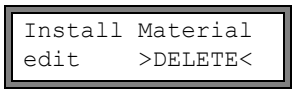
Select `yes` to store the entered parameters, `no` to quit the menu item without storing. Press ENTER.

14.4 Deleting a user defined material/fluid

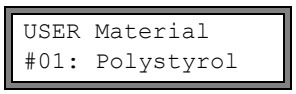
To delete a user defined material/fluid, proceed as follows:

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.



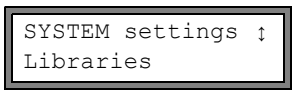
Select the material/fluid to be deleted. Press ENTER.

Select `yes` or `no`. Press ENTER.

14.5 Arrangement of the material/fluid scroll list

The materials and fluids to be displayed in the program branch `Parameter` are arranged in the material scroll list and in the fluid scroll list.

Note!	User defined materials/fluids 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 fluid scroll list.

Select `go back` to return to `SYSTEM settings`. Press ENTER.

Select `factory` if all materials/fluids of the internal database are to be displayed in the scroll list. An already existing user defined 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 fluid scroll list can be edited (see section 14.5.1...14.5.3).

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/fluid scroll list is quit by pressing key BRK before storing, all changes will be lost.

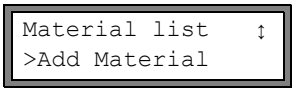
14.5.1 Displaying a scroll list

Select `Show list`. Press ENTER to display the scroll list as in the program branch `Parameter`.

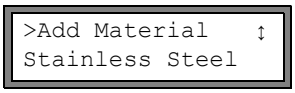
The current scroll list is displayed in the lower line.

Press ENTER to return to the scroll list `Material list` or `Medium list`.

14.5.2 Adding a material/fluid to the scroll list



Select `Add Material` or `Add Medium` to add a material/fluid to the scroll list. Press ENTER.

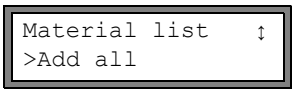


All materials/fluids that are not contained in the current scroll list will be displayed in the lower line.

Select the material/fluid. Press ENTER. The material/fluid will be added to the scroll list.

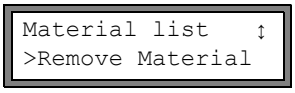
Note!	The materials/fluids are displayed in the order in which they have been added.

14.5.3 Adding all materials/fluids to the scroll list

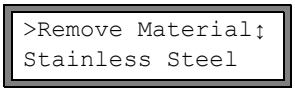


Select `Add all` to add all materials/fluids of the database to the current scroll list. Press ENTER.

14.5.4 Removing a material/fluid from the scroll list



Select `Remove Material` or `Remove Medium` to remove a material/fluid from the scroll list. Press ENTER.

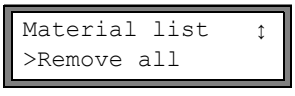


All materials/fluids of the current scroll list will be displayed in the lower line.

Select the material/fluid. Press ENTER. The material/fluid will be removed from the scroll list.

Note!	User defined materials/fluids will always be displayed in the scroll lists of the program branch `Parameter`. They cannot be removed.

14.5.5 Removing all materials/fluid from the scroll list



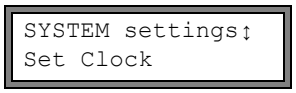
Select `Remove all` to remove all materials/fluids from the scroll list. Press ENTER. User defined materials/fluids will not be removed.

15 Settings

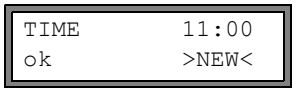
15.1 Time and date

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

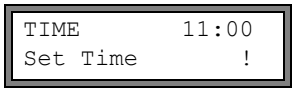
15.1.1 Time



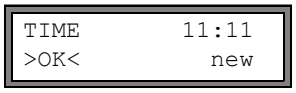
Select `Special Funct.\SYSTEM settings\Set Clock`. Press ENTER.



The current time is displayed. Select `ok` to confirm the time or `new` to set the time. Press ENTER.



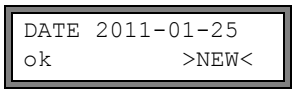
Press key → to select the digit to be edited.
Press key ↓ to edit the selected digit. Press ENTER.



The new time is displayed. Select `ok` to confirm the time or `new` to set the time again. Press ENTER.

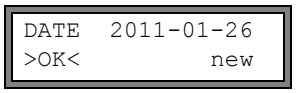
15.1.2 Date

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 → to select the digit to be edited.
Press key ↓ to edit the selected digit. Press ENTER.



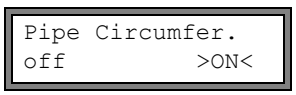
The new date is displayed. Select `ok` to confirm the date or `new` to set the date again. Press ENTER.

15.2 Dialogs and menus

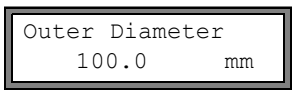
Select `Special Funct.\SYSTEM settings\Dialogs/Menus`. Press ENTER.

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 stored.

15.2.1 Pipe circumference

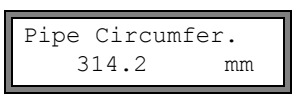


Select `on` if the pipe circumference is to be entered instead of the pipe diameter in the program branch `Parameter`. Press ENTER.



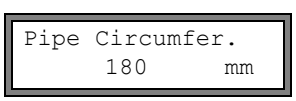
If `on` has been selected for `Pipe Circumfer.`, the outer pipe diameter will nevertheless be requested in the program branch `Parameter`.

To select the menu item `Pipe Circumfer.`, enter `0` (zero). Press ENTER.

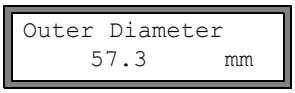


The value displayed in `Pipe Circumfer.` is calculated on the basis of the last displayed value of the outer pipe diameter.

example: 100 mm · π = 314.2 mm



Enter the pipe circumference. The limits for the pipe circumference are calculated on the basis of the limits for the outer pipe diameter.



During the next scroll through the program branch `Parameter`, the outer pipe diameter that corresponds to the entered pipe circumference will be displayed.

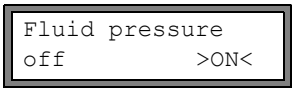
example: 180 mm : π = 57.3 mm

Note!	The pipe circumference is only edited temporarily. When the transmitter switches back to the display of the pipe circumference (internal recalculation), slight rounding errors may occur.

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.

15.2.2 Fluid pressure

The dependence of the fluid parameters on the pressure can be taken into account.

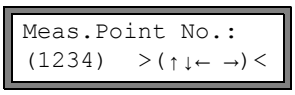


If `on` has been selected, the fluid pressure will be requested in the program branch `Parameter`.

If `off` has been selected, 1 bar will be used for all calculations.

Note!	For documentation purposes, it is useful to enter the fluid pressure, even if the transmitter contains no pressure-dependent characteristic curves.

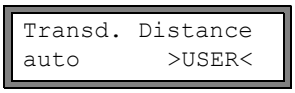
15.2.3 Measuring point number



Select `(1234)` if the measuring point is to be identified only by numbers, point and hyphen.

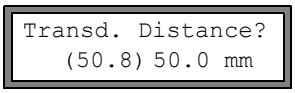
Select `(↑↓← →)` if the measuring point is to be designated with ASCII characters.

15.2.4 Transducer distance

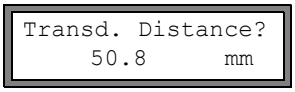


recommended setting: `user`

- `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.

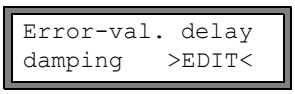


During transducer positioning in the program branch `Measuring`

- 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.

15.2.5 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.



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 in case of missing measured values see section 17.1.2 and 17.2.

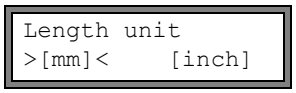
15.2.6 Alarm state indication

Select `on` to display the alarm state during the measurement.

Fur further information on the alarm outputs see section 17.6.

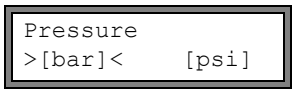
15.2.7 Units of measurement

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

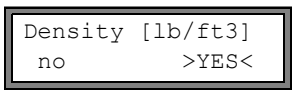


Select `mm` or `inch` as the unit of measurement for the length. Press ENTER.

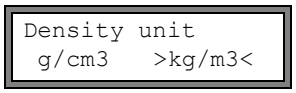
Select `°C` or `°F` as the unit of measurement for the temperature. Press ENTER.



Select `bar` or `psi` as the unit of measurement for the pressure. Press ENTER.

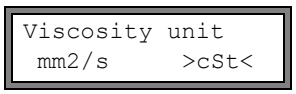


Select `yes` if `lb/ft3` is to be used as the unit of measurement for the density. Press ENTER.

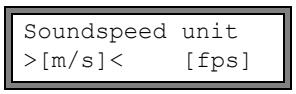


Select `g/cm3` or `kg/m3` as the unit of measurement for the density. Press ENTER.

This display will only be indicated if `lb/ft3` has not been selected as the unit of measurement for the density.



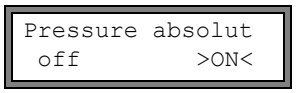
Select `mm2/s` or `cSt` as the unit of measurement for the kinematic viscosity. Press ENTER.



Select `m/s` or `fps` as the unit of measurement for the sound speed. Press ENTER.

15.2.8 Setting for the fluid pressure

It is possible to set whether the absolute or the relative pressure will be used:

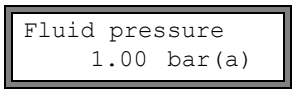


Select `on` or `off`. Press ENTER.

If `on` has been selected, the absolute pressure p_a will be displayed/input/output.

If `off` has been selected, the relative pressure p_g will be displayed/input/output.

$p_g = p_a - 1.01$ bar

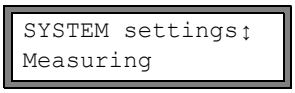


The pressure and its unit of measurement will, e.g., be displayed in the program branch `Parameter`. It will be followed by the selected pressure, indicated in parentheses:

a – absolute pressure
g – relative pressure

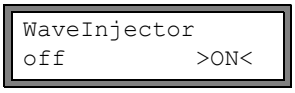
Note!	All changes will be stored at the end of the dialog.

15.3 Measurement settings

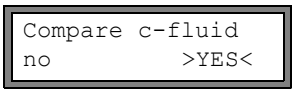


Select `Special Funct.\SYSTEM settings\Measuring`. Press ENTER.

Note!	The settings 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 stored.



This menu item will only be displayed if a WaveInjector is in the scope of supply (see user manual of the WaveInjector).

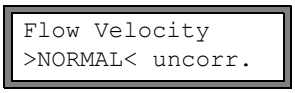


Select `yes` if the measured sound speed is to be compared to the theoretical or expected value. The difference

$\delta c = c_{mea} - c_{stored}$

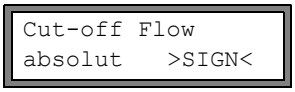
between the two sound speeds will be displayed in the upper line during the measurement. c_{stored} is the sound speed stored in the database.

Press key [→] during the measurement to scroll to the display of δc.

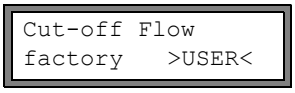


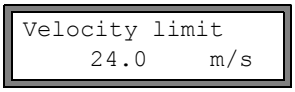
Select `normal` to display and transmit the profile corrected flow values, `uncorr.` to display and transmit the flow values without flow profile correction. Press ENTER.

For further information see section 12.8.



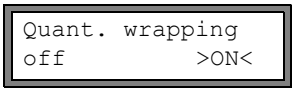
A lower limit for the flow velocity can be entered (see section 12.7).





An upper limit for the flow velocity can be entered (see section 12.6).

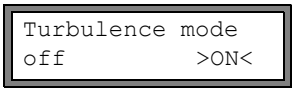
Enter `0` (zero) to deactivate the flow velocity check.



Select the overflow behavior of the totalizers (see section 12.3.1).

Select `on` to keep the 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.

15.4 Contrast settings

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:

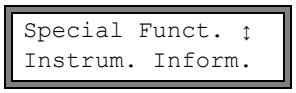
→ increases the contrast

↓ reduces the contrast

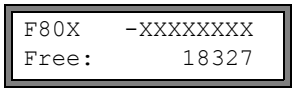
It is possible to reset the display to medium contrast. Enter HotCode **555000** (see section 9.5).

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

15.5 Instrument information



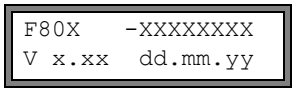
Select `Special Funct.\Instrum. Inform.` to display information about the transmitter. Press ENTER.



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

The max. available data logger capacity 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 13.1.6.

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.

16 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 for experimental work. Features of the SuperUser mode are:

- Defaults will not be used.
- 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.

16.1 Activation/deactivation

Enter HotCode **071049** (see section 9.5).

It is displayed that the SuperUser mode is activated. Press ENTER. The main menu will be displayed.

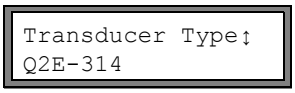
Enter HotCode **071049** again to deactivate the SuperUser mode.

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.

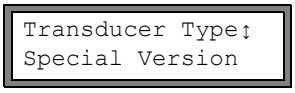
16.2 Transducer parameters

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



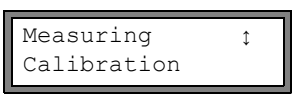
Select `Special Version` to enter the transducer parameters. Press ENTER.

If `Special Version` has been selected, the transducer parameters have to be entered.

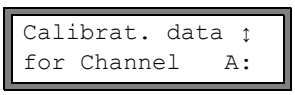
The transducer parameters have to be provided by the transducer manufacturer. Press ENTER after each input.

16.3 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.

16.3.1 Profile bounds

```
A:Profile bounds
 factory  >USER<
```

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 16.3.2).

Press ENTER.

```
Laminar flow
if R*<          0
```

Enter the max. Reynolds number at which the flow is laminar. The entered number will be rounded to hundreds. Enter `0` (zero) to use the default value 1 000.

Press ENTER.

```
Turbulent flow
if R*>          0
```

Enter the min. Reynolds number at which the flow is turbulent. The entered number will be rounded to hundreds. Enter `0` (zero) to use the default value 3 000.

Press ENTER.

```
A:Calibration ?
>OFF<          on
```

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 16.3.2.

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.

16.3.2 Correction of the flow velocity

After the profile bounds have been defined (see section 16.3.1), it is possible to define a correction of the flow velocity:

$v_{cor} = m \cdot v + n$

with

v – measured flow velocity

m – slope, range: -2.000…+2.000

n – offset, range: -12.7…+12.7 cm/s

v_{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.

```
A:Calibration ?
off           >ON<
```

Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.

```
A:Slope=
     1.00
```

If `on` has been selected, enter the slope. If `0.0` is entered, the correction will be deactivated.

Press ENTER.

```
A:Offset=
      0.0    cm/s
```

Enter the offset. Enter `0` (zero) to work without offset.

Press ENTER.

example 1:	`Slope`: 1.1 `Offset`: -10.0 cm/s = -0.1 m/s If a flow velocity v = 5 m/s is measured it will be corrected as follows: v_{cor} = 1.1 · 5 m/s – 0.1 m/s = 5.4 m/s, before the calculation of the derived quantities.
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.

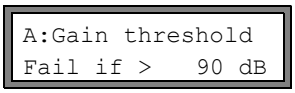
Attention!	The correction of the flow velocity is still active after the deactivation of the SuperUser mode.

16.4 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,

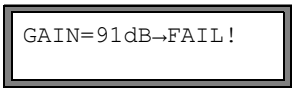
- the flow velocity will be marked as invalid. The physical quantity cannot be determined.
- the LED of the measuring channel will light red.
- a hash symbol (`#`) will be displayed after the unit of measurement, in case of a normal error an interrogation point (`?`).

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `Gain threshold` is displayed.



Enter for each measuring channel the max. signal amplification. Enter `0` (zero) if no limit of the signal amplification is to be used.

Press ENTER.



The current value of the signal amplification (`GAIN=`) can be displayed in the upper line in the program branch `Measuring`. If the current value of the signal amplification is higher than the max. signal amplification, `→FAIL!` will be displayed after the current value.

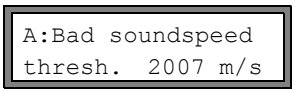
Attention!	The limit of the signal amplification is still active after the deactivation of the SuperUser mode.

16.5 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 of the flow velocity for the fluid is calculated from the greatest of the following values:

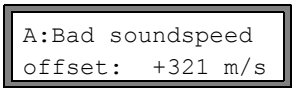
- fixed upper value, default: 1 848 m/s
- value of the sound speed curve of the fluid at the operating point plus offset, default offset: 300 m/s

In the SuperUser mode, the values can be defined for fluids 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 the fixed upper limit of the sound speed for each measuring channel. Enter `0` (zero) to use the default value of 1 848 m/s.

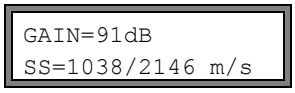
Press ENTER.



Enter the offset for each measuring channel. Enter `0` (zero) to use the default value of 300 m/s.

Press ENTER.

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 of 2 007, this value will be used as the upper limit of the sound speed when the plausibility of the signal is evaluated.



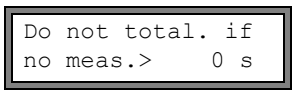
It is possible to display the valid range for the sound speed (`SS=`) in the lower line during the measurement. The second value (here: 2 146 m/s) corresponds to the upper limit at the operating point.

Attention!	The defined upper limit of the sound speed is still active after the deactivation of the SuperUser mode.

16.6 Detection of long measurement failures

If there are no valid measured values 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.

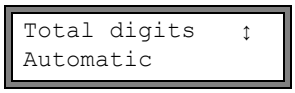


Enter the time. If `0` (zero) is entered, the default value of 30 s will be used.

16.7 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.

`Total digits = Automatic`

The number of decimal places will be adjusted dynamically. Low values will initially be displayed with 3 decimal places. If the values of the totalizers are higher, the number of decimal places will be reduced.

max. value	display		
< 10^6	±0.00	...	±999999.999
< 10^7	±1000000.00	...	±9999999.99
< 10^8	±10000000.0	...	±99999999.9
< 10^{10}	±1000000000	...	±9999999999

`Total digits = Fixed to x digit`

The number of decimal points is constant. The max value of the totalizers is reduced with each additional decimal place.

decimal places	max. value	max. display
0	< 10^{10}	±9999999999
1	< 10^8	±99999999.9
2	< 10^7	±9999999.99
3	< 10^6	±999999.999
4	< 10^5	±99999.9999

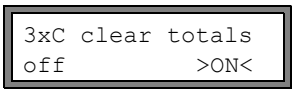
Note!	The number of decimal places and the max. value defined here only affect the display of the totalizers.

For setting the behavior of the totalizers when the max. value is reached see section 12.3.1.

16.8 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 3 times key CLR, 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.

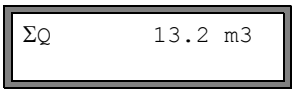
Note!	The manual reset of the totalizers is still active after the deactivation of the SuperUser mode.

16.9 Display of the totalizer sum

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 totalizer sum is activated, the sum `ΣQ` can be displayed in the upper line during the measurement.

16.10 Display of the last valid measured value

If the signal is not sufficient for a measurement, `UNDEF` is normally displayed. Instead of `UNDEF`, it is also possible to display the last valid measured value.

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `Keep display val` is displayed.

Select `on` to activate the display of the last valid measured value, `off` to deactivate it. Press ENTER.

16.11 Display during the measurement

In the SuperUser mode, the following information can be displayed during the measurement besides the normal information (see section 11.3):

display	**explanation**
`t=`	transit time of the measuring signal
`c=`	sound speed
`REYNOLD=`	Reynolds number
`VARI A=`	standard deviation of the signal amplitude
`VARI V=`	standard deviation of the transit time of the measuring signal
`dt-norm=`	transit time difference standardized to the transducer frequency
	density of the fluid

17 Outputs

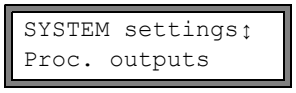
If the transmitter is equipped with outputs, they have to be installed and activated before they can be used:

- assignment of a measuring channel (source channel) to the output (if the transmitter has more than one measuring channel)
- assignment of the physical quantity (source item) to be transmitted to the output by the source channel, and of the properties of the signal
- definition of the behavior of the output in case no valid measured values are available
- activation of the installed output in the program branch `Output Options`

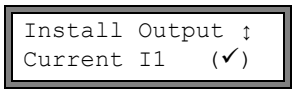
17.1 Installation of an output

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.

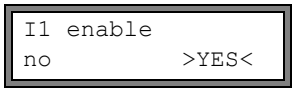


Select `Special Funct.\SYSTEM settings\Proc. outputs`. Press ENTER.



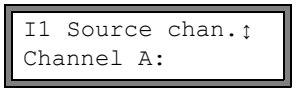
Select the output to be installed. Press ENTER.

The scroll list contains all available outputs. A tick ✓ after a list item indicates that this output has already been installed.



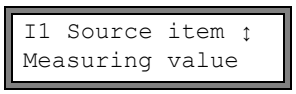
Select `yes` to install or reconfigure the output. Press ENTER.

Select `no` to uninstall the output and to return to the previous menu item in order 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. 17.1.

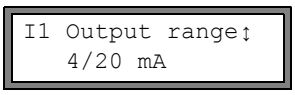
Tab. 17.1: Configuration of the outputs

source item	list item	output
`Measuring value`	`actual measure`	physical quantity selected in the program branch `Output Options`
	`flow`	flow, independent of the physical quantity selected in the program branch `Output Options`
`Quantity`	`Q+`	totalizer for the positive flow direction
	`Q-`	totalizer for the negative flow direction
	`ΣQ`	sum of the totalizers (positive and negative flow direction)
`Limit`	`R1`	limit message (alarm output R1)
	`R2`	limit message (alarm output R2)
	`R3`	limit message (alarm output R3)
`Impuls`	`from abs(x)`	pulse without sign consideration
	`from x > 0`	pulse for positive measured values
	`from x < 0`	pulse for negative measured values

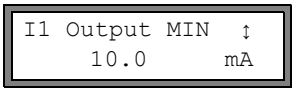
Tab. 17.1: Configuration of the outputs

source item	list item	output
Miscellaneous	c-Medium	sound speed of the fluid
	SCNR	ratio useful signal to correlated disturbance signal
	Signal	signal amplitude of a measuring channel
	VariAmp	standard deviation of the signal amplitude
	Density	density of the fluid
	Pressure	pressure of the fluid

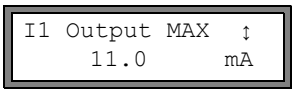
17.1.1 Output range

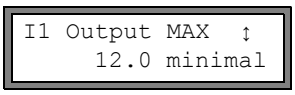


During the configuration of an analog output, the output range is defined. Select a list item or other range... to enter the output range manually.



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: $I_{MAX} - I_{MIN} \geq 2$ mA for a 4…20 mA current output

17.1.2 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 fluid.

Tab. 17.2: Error output

error value	result
Minimum	The lower limit of the output range is transmitted.
Hold last value	The last measured value is transmitted.
Maximum	The upper limit of the output range is transmitted.
Other value...	The value has to be entered manually. It has to be within the limits of the output.

example: source item: volumetric flow rate
output: current output
output range: 4…20 mA
error value delay t_d (see section 17.2): > 0

The volumetric flow rate cannot be measured during the time interval t_0...t_1 (see Fig. 17.1). The error value will be output.

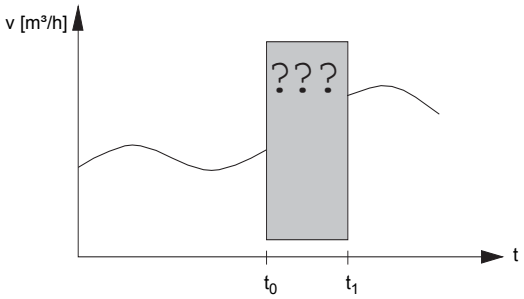
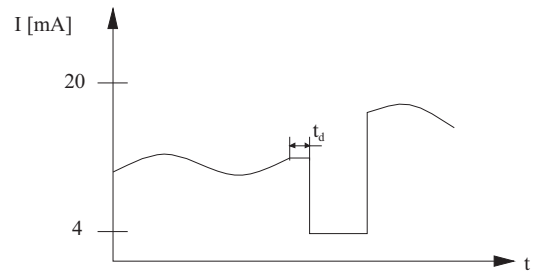
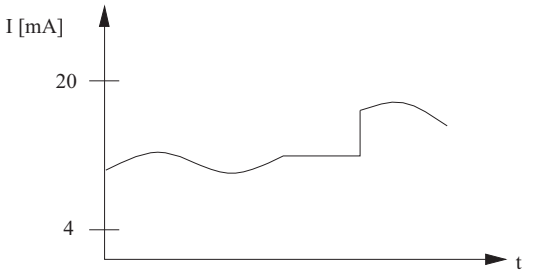
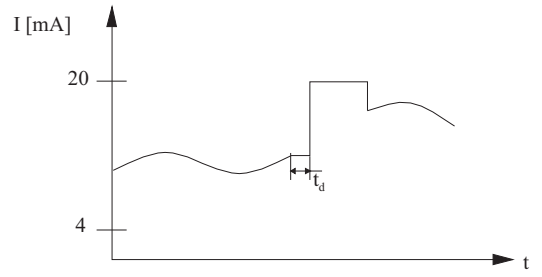
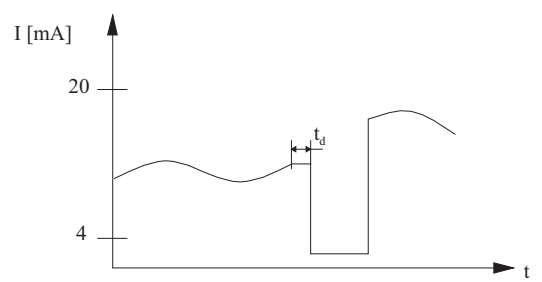
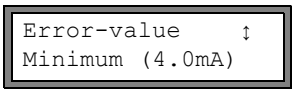


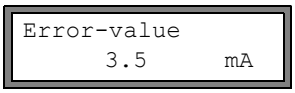
Fig. 17.1: Error output

Tab. 17.3: Examples for the error output

list item for the error output	output signal
Error-value ↕ Minimum (4.0mA)	
Error-value ↕ Hold last value	
Error-value ↕ Maximum (20.0mA)	
Error-value ↕ Other value... error output = 2 mA	



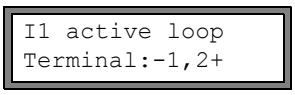
Select a list item for the error output. Press ENTER.



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.



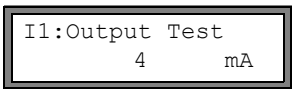
The terminals for the connection of the output are displayed (here: `-1` and `2+` for the active current loop).

Press ENTER.

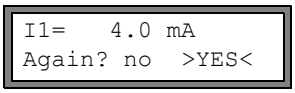
17.1.3 Function test

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

Test of the analog output



The current output is tested. Enter a test value. It has to be within the output range. Press ENTER.

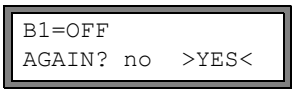


If the multimeter displays the entered value, the output functions correctly.

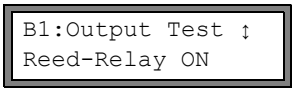
Press `yes` to repeat the test, `no` to return to `SYSTEM settings`. Press ENTER.

Test of the binary outputs

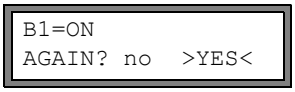
Select `Reed-Relay OFF` or `Open collect OFF` in the scroll list `Output Test` to test the de-energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be high ohmic.



Select `yes`. Press ENTER.



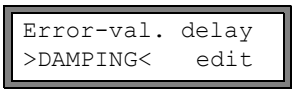
Select `Reed-Relay ON` or `Open collect. ON` in the scroll list `Output Test` to test the energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be low ohmic.



Select `yes` to repeat the test, `no` to return to `SYSTEM settings`. Press ENTER.

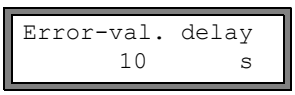
17.2 Error value delay

The error value delay is the time interval after which the entered error value is 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`.



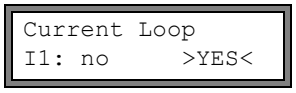
From now on, the error value delay can be entered in the program branch `Output Options`.

17.3 Activation of an analog output

Note!	An output can only be activated in the program branch `Output Options` if it has previously been installed.

Select the channel for which an output is to be activated in the program branch `Output Options`. Press ENTER.

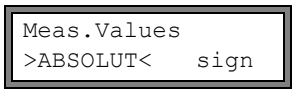
This display will not be indicated, if the transmitter has only one measuring channel.



Press ENTER until `Current Loop` is displayed. Select `yes` to activate the output. Press ENTER.

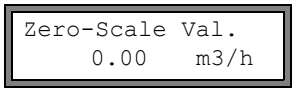
17.3.1 Measuring range of the analog outputs

After an analog output has been activated in the program branch `Output Options`, the measuring range of the source item has to be entered.



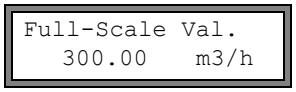
Select `sign` if the sign of the measured values is to be considered for the output.

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 17.1.1.



Enter the highest expected measured value.

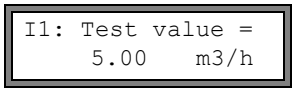
`Full-Scale Val.` is the measured value that corresponds to the upper limit of the output range as defined in section 17.1.1.

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

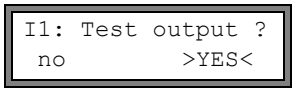
17.3.2 Function test

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

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.



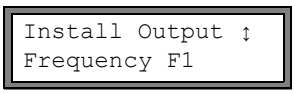
Select `yes` to repeat the test. Press ENTER.

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 (middle of the measuring range corresponds to 12 mA) If the multimeter indicates 12 mA, the current output functions correctly.

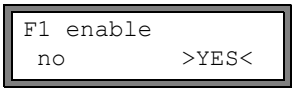
17.4 Configuration of a frequency output as a pulse output

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.

17.4.1 Installation of a frequency output (optional)

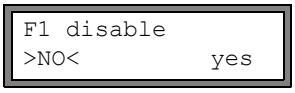


Select `Frequency F1` in `Special Funct.\SYSTEM settings\Proc. outputs`. Press ENTER.

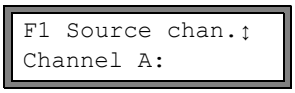


Select `yes` if the output has not been installed. Press ENTER.

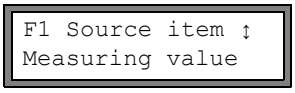
or



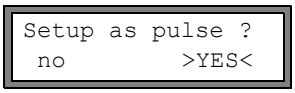
Select `no` if the output has already been installed. Press ENTER.



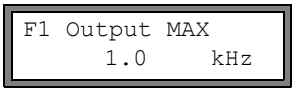
Select the measuring channel to be assigned to the output as the source channel in the scroll list. Press ENTER.



Select in the scroll list `Measuring value` (but not `Impuls`!). Press ENTER.



If `Measuring value` has been selected and the source item can be totalized, a request will be indicated whether the frequency output is to be configured as a pulse output. Select `yes`. Press ENTER.



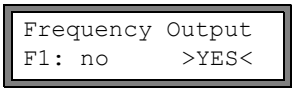
Enter the upper limit of the frequency. Press ENTER.

The lower limit of the frequency and the error value will be set automatically to 0.5 Hz.

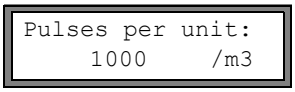
17.4.2 Activation of the output

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

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

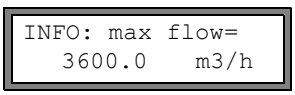


Select `yes` to activate the output. Press ENTER.



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 fluid.



The max. flow depending on the upper limit of the frequency and pulse value is indicated. Press ENTER.

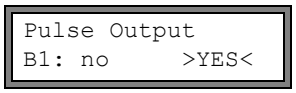
17.5 Activation of a binary output as a pulse output

A pulse output is an integrating output which emits a pulse when the volume or the mass of the fluid 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 the channel for which a pulse output is be activated in the program branch `Output Options`. Press ENTER.

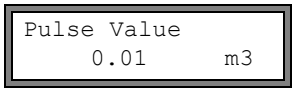
This display will not be indicated if the transmitter has only one measuring channel.



Press ENTER until the menu item `Pulse Output` is displayed. Select `yes` to activate the output. Press ENTER.

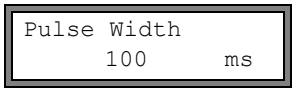
This error message will be displayed if the flow velocity has been selected as the physical quantity.

The use of the pulse output is not possible in this case because the integration of 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 entered pulse value, a pulse will be transmitted.



Enter the pulse width.

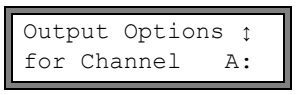
The range of possible pulse widths depends on the specification of the measuring instrument (e.g., counter, PLC) that is to be connected to the output.

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.

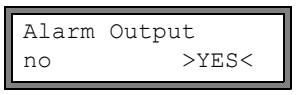
17.6 Activation of a binary output as an alarm output

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.

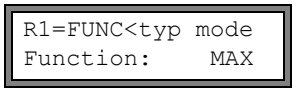


Select `yes` to activate the alarm output. Press ENTER.

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.

17.6.1 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 → to select a scroll list in the upper line. Press key ↓ to select a list item in the lower line.

Press ENTER to store the settings.

Tab. 17.4: Alarm properties

alarm property	setting	description
func (switching condition)	MAX	The alarm will switch if the measured value exceeds the upper limit.
	MIN	The alarm will switch if the measured value falls below the lower limit.
	+→- -→+	The alarm will switch if the flow direction changes (sign change of measured value).
	QUANT.	The alarm will switch if totalizing is activated and the totalizer reaches the limit.
	ERROR	The alarm will switch if a measurement is not possible.
	OFF	The alarm is switched off.
typ (holding behavior)	NON-HOLD	If the switching condition is not true anymore, the alarm will return to the idle state after approx. 1 s.
	HOLD	The alarm remains activated even if the switching condition is not true anymore.
mode (switching function)	NO Cont.	The alarm is energized if the switching condition is true and de-energized if idle.
	NC Cont.	The alarm is de-energized if the switching condition is true and energized if idle.

Note!	If no measurement is made, all alarms will be de-energized, independently of the programmed switching function.

17.6.2 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:

```
R1 Input:       ↕
Volume flow
```

Select the physical quantity to be used for the comparison in the scroll list Input. The following list items are available for the alarm output R1:

- selected physical quantity
- signal amplitude
- sound speed of the fluid

Press ENTER.

For the alarm outputs R2 and R3, the current physical quantity is selected automatically.

```
High Limit:
   -10.00    m3/h
```

switching condition: MAX

Enter the upper limit. Press ENTER.

The alarm will switch if the measured value exceeds the limit.

```
Low Limit:
   -10.00    m3/h
```

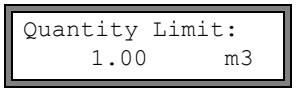
switching condition: MIN

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:



switching condition: QUANT.
Enter the limit of the totalizer. Press ENTER.
The alarm will switch when the measured value reaches the limit.

A positive limit will be compared to the totalizer value for the positive flow direction.
A negative limit will be compared to the totalizer value for the negative flow direction.
The comparison will also take place if the totalizer of the other flow direction is displayed.

Note!	The unit of measurement of the limit corresponds to the unit of measurement of the selected physical quantity. If the unit of measurement of the physical quantity is changed, the limit has to be converted and entered again.

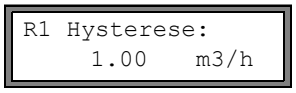
example 1:	physical quantity: volumetric flow rate in m³/h Quantity Limit: 1 m³
example 2:	physical quantity: volumetric flow rate in m³/h Low Limit: 60 m³/h The unit of measurement of the physical quantity is changed to m³/min. The new limit to be entered is 1 m³/min.

17.6.3 Defining the hysteresis

A hysteresis can be defined for the alarm output R1. This prevents a constant triggering of the alarm when measured values fluctuate marginally 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 Hysterese: 1 m³/h The alarm will be triggered at values > 30.5 m³/h and deactivated at values < 29.5 m³/h.



switching condition: MIN or MAX
Enter the value for Hysterese.
or
Enter 0 (zero) to work without a hysteresis.
Press ENTER.

17.7 Behavior of the alarm outputs

17.7.1 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.

17.7.2 Reset and initialization of the alarms

After an initialization, all alarm outputs will be initialized as follows:

Tab. 17.5: Alarm state after an initialization

func	OFF
typ	NON-HOLD
mode	NO Cont.
Limit	0.00

Press key CLR 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.

17.7.3 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.

The switching of the alarm outputs into the idle state will not be displayed.

17.7.4 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 for at least 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 the type NON-HOLD will be activated with each change of the flow direction for approx. 1 s (see Fig. 17.2).

Alarm outputs with the switching condition +→− −→+ and the type HOLD will be active after the first change of the flow direction. They can be switched back by pressing 3 times key CLR (see Fig. 17.2).

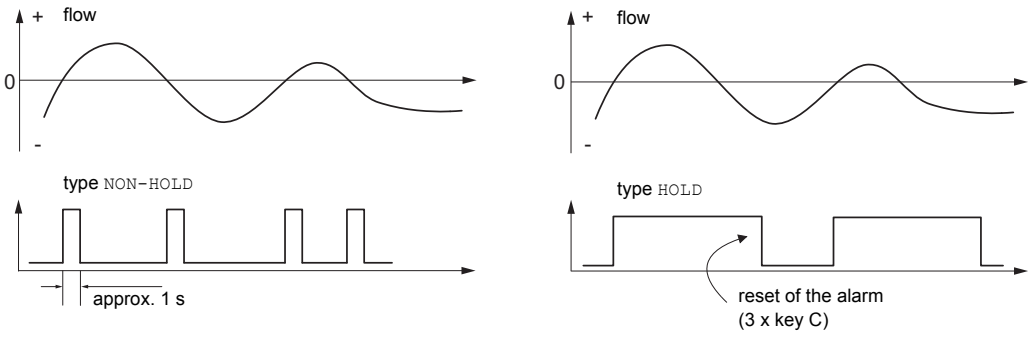


Fig. 17.2: Behavior of a relay when the flow direction changes

When adjusting to changed measurement conditions, e.g, a substantial increase of the fluid temperature, the alarm will not be switched. Alarm outputs with the switching condition OFF will be set automatically to the switching function NO Cont.

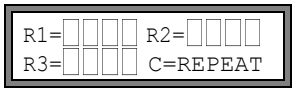
17.7.5 Alarm state indication

Note!	There is neither a visual nor an acoustic indication of alarm output switching.

The alarm state can be displayed after the configuration of the alarm outputs and during the measurement. 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:

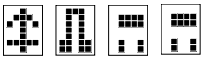
RX = □ □ □ □, with X being the number of the alarm output and □ a pictogram according to Tab. 17.1.

It is possible to repeat the configuration of the alarm outputs by pressing key C. When the configuration of the alarm outputs is finished, 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 → to scroll through the upper line and ↓ to scroll through the lower line until the alarm state is indicated.

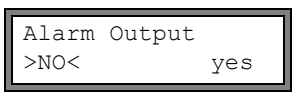
Tab. 17.1: Pictograms for the alarm state indication

	no.		`func` **(switching condition)**	`typ` **(holding behavior)**	`mode` **(switching function)**	**current state**
R	□	=	□	□	□	□
	1		OFF	NON-HOLD	NO Cont.	closed
	2		MAX	HOLD	NC Cont.	open
	3		MIN			
			+→− −→+			
			QUANT.			
			ERROR			

example: R1 = 

17.8 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.



Select `no` in `Output Options\Alarm Output` to deactivate an output. Press ENTER.

18 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 serviced conscientiously, no troubles should appear. The transmitter has been calibrated at 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 15.4).

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 okay, 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 displayed 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 CLR 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.

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 17.1.3. If the output is defective, contact FLEXIM.

A measurement is impossible or the measured values substantially differ from the expected values

see section 18.1.

The values of the totalizer are wrong

see section 18.6.

18.1 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 fluid. (Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.)
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point has been selected (see section 18.2).
- Try to establish better acoustic contact between the pipe and the transducers (see section 18.3).
- Enter a lower value for the number of sound paths. The signal attenuation might be too high due to a high fluid viscosity or deposits on the inner pipe wall (see section 18.4).

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

- An exclamation point (!) 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 12.6).
- If no exclamation point (!) is displayed, a measurement at the selected measuring point is not possible.

Loss of signal during the measurement

- If there is no measuring signal after the pipe had been run empty and refilled, 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 fluid.

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 18.5 for the description of typical situations in which wrong measured values are obtained.

18.2 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 fluid should flow upward.
- No gas bubbles should form (even bubble-free fluids can form gas bubbles when the fluid expands, e.g., upstream of pumps and downstream of great cross-section enlargements).

18.3 Maximum acoustic contact

Observe the instructions in chapter 8.

18.4 Application specific problems

The entered sound speed of the fluid 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 fluids strongly attenuate the ultrasonic signal

Measurements on fluids with a viscosity > 1000 mm²/s are only possible under certain conditions.

A higher proportion of gas bubbles or solids in the fluid 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.

18.5 Large deviations of the measured values

The entered sound speed of the fluid 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 fluid. 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 defined upper limit of the flow velocity is too low

All measured flow velocities that are greater than the upper limit will be ignored and marked as invalid. All quantities 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 fluid 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.

18.6 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 totalizers will be stored. The totalizers 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.

18.7 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 13.2.4) and of the terminal program.

19 Maintenance

The transmitter and the transducers are practically maintenance-free.

19.1 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.

19.2 Examination of the O-ring

Attention!	O-rings on increased safety housings may only be replaced by trained FLEXIM personnel.

• Check the O-ring when opening the housing (FLUXUS F808, see Fig. 19.1, FLUXUS F809, see Fig. 19.2).

Flameproof enclosure housing

• If the O-ring is defective or the housing does not seal anymore, change it (see Tab. 19.1).

Housing with increased safety

• If the O-ring is defective or the housing does not seal anymore, it has to be replaced.

Note!	Store the O-ring replacement in a hermetically sealed and dark place.

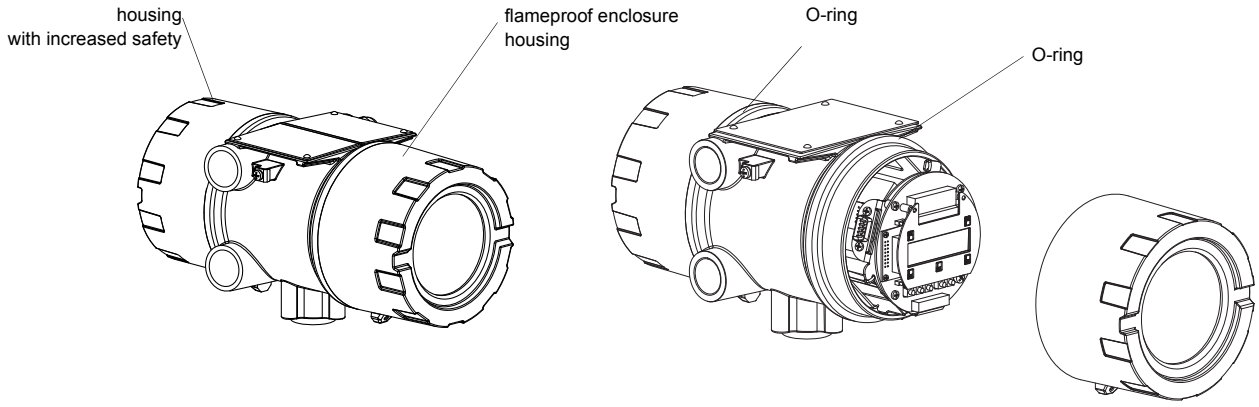


Fig. 19.1: FLUXUS F808

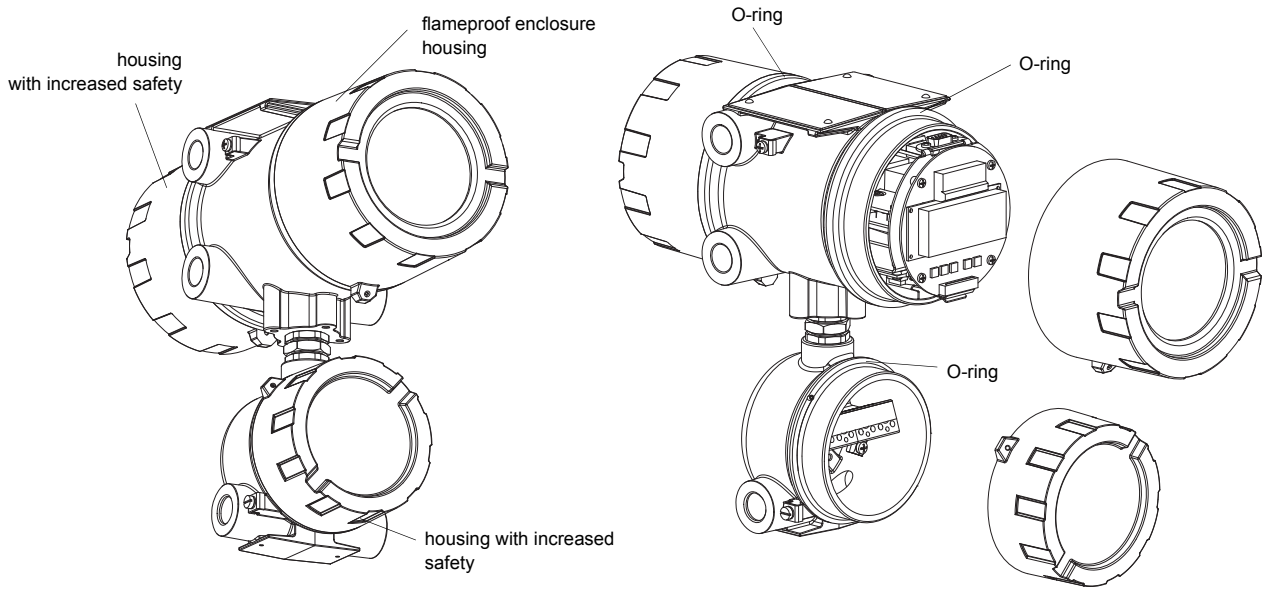
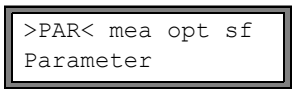
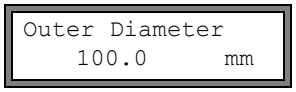
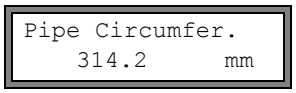
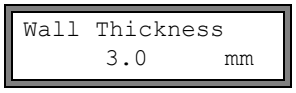
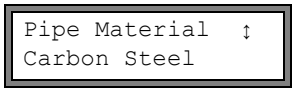
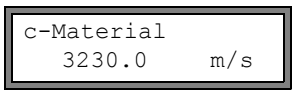
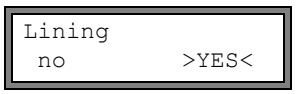
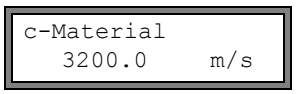
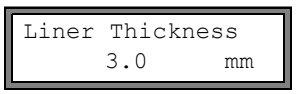
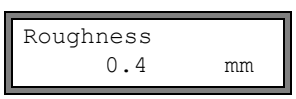
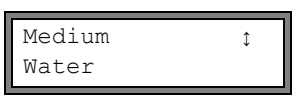
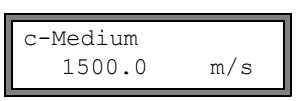


Fig. 19.2: FLUXUS F809

Tab. 19.1

transmitter	**O-ring**
FLUXUS F808	O-ring-116x4 mm
FLUXUS F809, upper housing	O-ring-116x4 mm
FLUXUS F809, lower housing	O-ring-97x3.5 mm

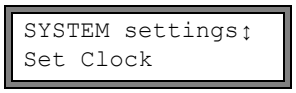
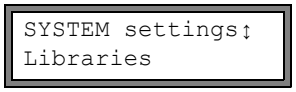
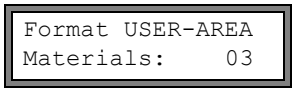
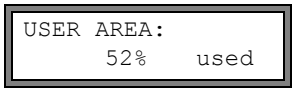
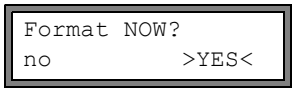
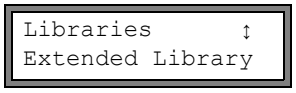
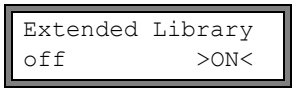
A Menu structure

	INIT-resistant
Program branch `Parameter`	
 main menu: selection of the program branch `Parameter`	
 selection of a measuring channel (A, B) or a calculation channel (Y, Z) This display will not be indicated if the transmitter has only one measuring channel.	
When a measuring channel is selected (A, B)	
 input of the outer pipe diameter	
 input of the pipe circumference This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Pipe Circumfer.` is activated and `Outer Diameter` = `0` has been entered.	
 input of the pipe wall thickness range: depends on the connected transducers default: 3 mm	
 selection of the pipe material	
 input of the sound speed of the pipe material range: 600...6553.5 m/s This display will only be indicated if `Other Material` has been selected.	
 selection whether the pipe is lined	
 selection of the lining material This display will only be indicated if `Lining` = `yes` has been selected.	
 input of the sound speed of the lining material range: 600...6553.5 m/s This display will only be indicated if `Other Material` has been selected.	
 input of the liner thickness range: 0...50 mm default: 3 mm	
 input of the roughness of the inner pipe wall range: 0...5 mm default: 0.1 mm (for steel as pipe material)	
 selection of the fluid	
 input of the average sound speed of the fluid range: 500...3500 m/s This display will only be indicated if `Other Medium` has been selected.	

		INIT-resistant
`c-Medium range` ` auto >USER<`	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.	
`c-Medium=1500m/s` `range +-150m/s`	input of the range around the average sound speed of the fluid This display will only be indicated if `user` has been selected.	
`Kinem.Viscosity` `1.00 mm2/s`	input of the kinematic viscosity of the fluid range: 0.01...30 000 mm²/s This display will only be indicated if `Other Medium` has been selected.	
`Density` `1.00 g/cm3`	input of the operating density of the fluid range: 0.01...20 g/cm³ This display will only be indicated if `Other Medium` has been selected.	
`Medium Temperat.` `20.0 C`	input of the fluid temperature default: 20 °C	
`Fluid pressure` `1.00 bar`	input of the fluid pressure range: 1...600 bar This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Fluid pressure` are activated.	
`Transducer Type↕` `Standard`	selection of the transducer type This display will only be indicated if no or special transducers are connected.	
`Additional cable` `65.0 m`	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.		
`Calculation:` `Y= A - B`	display of the current calculation function	
`>CH1< funct ch2↕` `A - B`	selection of the calculation function	
Program branch `Measuring`		
`par >MEA< opt sf` `Measuring`	main menu: selection of the program branch `Measuring`	
`CHANN: >A< B Y Z` `MEASUR ✓ ✓ - .`	activation of the channels This display will not be indicated if the transmitter has only one measuring channel.	
`A:Meas.Point No.:` `xxx (↑↓← →)`	input of the measuring point number This display will only be indicated if `Output Options\Store Meas.Data` and/or `Serial Output` are activated.	
`A:PROFILE CORR.` `>NO< yes`	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.	

		INIT-resistant
A:Sound Path (6) 2 NUM	input of the number of sound paths	
Transd. Distance A:54 mm Reflex	display of the transducer distance to be adjusted between the inner edges of the transducers	
Program branch `Output Options`		
par mea >OPT< sf Output Options	main menu: selection of the program branch `Output Options`	
Output Options ↕ for Channel A:	selection of the channel whose output options are to be defined	
Physic. Quant. ↕ Volume flow	selection of the physical quantity	
Volume in: ↕ m3/h	selection of the unit of measurement for the physical quantity	
Damping 10 s	input of the duration over which a floating average of the measured values has to be determined range: 1...600 s	
Store Meas.Data no >YES<	activation of the data logger	
Serial Output no >YES<	activation of the measured value transmission to a PC or a printer via the serial interface	
Storage Rate ↕ Once per 10 sec.	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.	
Storage Rate 1 s	input of the storage rate if `Storage Rate` = `EXTRA` has been selected range: 1...43 200 s (= 12 h)	
Current loop		
Current Loop I1: no >YES<	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`.	
Meas.Values >ABSOLUT< sign	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.	
Zero-Scale Val. 0.00 m3/h	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.	
Full-Scale Val. 300.00 m3/h		

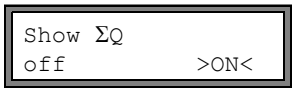
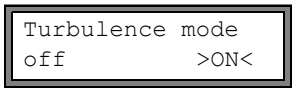
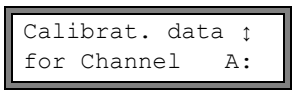
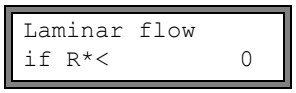
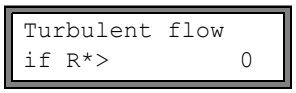
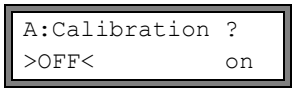
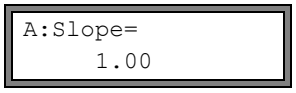
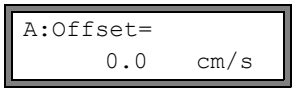
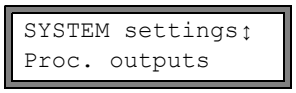
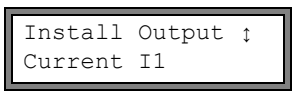
		INIT-resistant
Error-val. delay 10 s	input of the error value delay, i.e. of the time interval after which the value entered for the error output will be transmitted to the output if no valid measured values are available This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay` = `EDIT` has been selected.	
Pulse output		
Pulse Output B1: no >YES<	activation of a pulse output This display will only be indicated if a pulse output has been installed in `Special Funct.\SYSTEM settings\Proc. outputs`.	
Pulse Value 0.01 m3	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.	
Pulse Width 100 ms	input of the pulse width range: 1...1000 ms This display will only be indicated if `Pulse Output` is activated.	
Alarm output		
Alarm Output no >YES<	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`.	
R1=FUNC<typ mode Function: MAX	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.	
R1 Input: ↕ Volume flow	selection of the physical quantity to be monitored This display will only be indicated for R1 if `Alarm Output` is activated.	
High Limit: -10.00 m3/h	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.	
Low Limit: -10.00 m3/h	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.	
Quantity Limit: 1.00 m3	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.	
R1 Hysterese: 1.00 m3/h	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.`		
par mea opt >SF< Special Funct.	main menu: selection of the program branch `Special Funct.`	
`SYSTEM settings`		
Special Funct. ↕ SYSTEM settings	selection of `Special Funct.\SYSTEM settings`	

	INIT-resistant
SYSTEM settings\Set Clock	
 selection of the displays for the input of the date and the time	
SYSTEM settings\Libraries	
 selection of the displays for the management of the material and fluid scroll lists	
SYSTEM settings\Libraries\Material list	
 selection of the displays for the arrangement of the material scroll list (pipe and lining materials)	
SYSTEM settings\Libraries\Medium list	
 selection of the displays for the arrangement of the fluid scroll list	
SYSTEM settings\Libraries\Format USER-AREA	
 selection of the displays for the partitioning of the coefficient memory for the storing of user defined material and fluid properties	
 input of the number of user defined materials	
 input of the number of user defined fluids	
 display of the occupancy of the coefficient memory	
 confirmation of the selected partition	
 the coefficient memory is being partitioned	
SYSTEM settings\Libraries\Extended Library	
 selection of the displays for the activation of the extended library	
 activation of the extended library	x
SYSTEM settings\Dialogs/Menus	
 selection of the displays for the activation/deactivation or setting of the menu items in the other program branches	

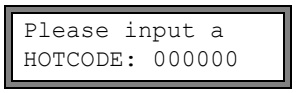
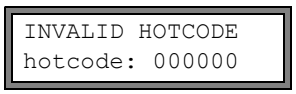
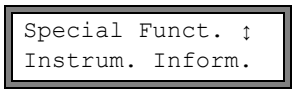
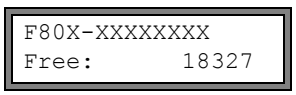
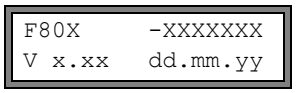
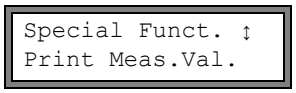
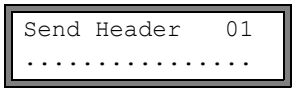
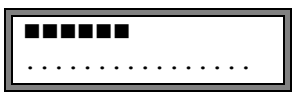
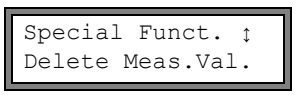
		INIT-resistant
Pipe Circumfer. off >ON<	activation of the menu item for the input of the pipe circumference in the program branch `Parameter`	x
Fluid pressure off >ON<	activation of the menu item for the input of the fluid pressure in the program branch `Parameter`	x
Meas.Point No.: (1234) >(↑↓← →)<	selection of the input mode for the measuring point number in the program branch `Measuring`: `(1234)`: digits, point, hyphen `(↑↓← →)`: ASCII editor	x
Transd. Distance auto >USER<	setting for the display for the input of the transducer distance 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`	x
Error-val. delay damping >EDIT<	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.	x
SHOW RELAIS STAT off >ON<	activation of the display of the alarm state during the measurement	x
Length unit >[mm]< [inch]	selection of the unit of measurement for the length	x
Temperature >[°C]< [°F]	selection of the unit of measurement for the temperature	x
Pressure absolut off >ON<	selection if the absolute pressure p_a or the relative pressure p_g is to be used	x
Pressure >[bar]< [psi]	selection of the unit of measurement for the pressure	x
Density [lb/ft3] no >YES<	selection if `lb/ft`^{3} is to be used as the unit of measurement for the density	x
Density unit g/cm3 >kg/m3<	selection of the unit of measurement for the density This display will only be indicated if `lb/ft`^{3} has not been selected as the unit of measurement for the density.	x
Viscosity unit mm2/s >cSt<	selection of the unit of measurement for the kinematic viscosity	x
Soundspeed unit >[m/s]< [fps]	selection of the unit of measurement for the sound speed	x

		INIT-resistant
SYSTEM settings\Measuring		
SYSTEM settings↕ Measuring	selection of the displays for the settings of the measurement	
WaveInjector off >ON<	activation of the WaveInjector (optional)	x
Enable NoiseTrek off >ON<	enabling of the NoiseTrek mode	x
Auto NoiseTrek ? no >YES<	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.	x
TT-Failed |After →NoiseTrek | 40s	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 TransitTime and the NoiseTrek mode is activated.	x
NT-Failed |After →TransTime | 60s	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 TransitTime and the NoiseTrek mode is activated.	x
NT-Ok,but | Each check TT | 300s	input of the time after which the transmitter has to toggle to the TransitTime mode range: 0...9999 s 0: no toggling to the TranitTime mode This display will only be indicated if the automatic toggling between the TransitTime and the NoiseTrek mode is activated.	x
Keep TT | For checking | 5s	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 This display will only be indicated if the automatic toggling between the TransitTime and the NoiseTrek mode is activated.	x
Compare c-fluid no >YES<	activation of the display for the difference between the measured and the expected sound speed of a selected reference fluid during the measurement	x
Flow Velocity normal >UNCORR.<	selection whether the flow velocity is displayed and transmitted with or without profile correction	x
Velocity limit 0.0 m/s	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.	x
Cut-off Flow absolut >SIGN<	selection of the input of a lower limit for the flow velocity: • absolut: independent of the flow direction • sign: dependent on the flow direction	x

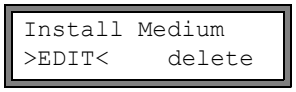
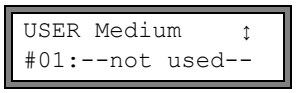
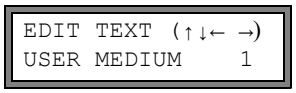
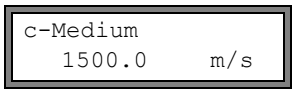
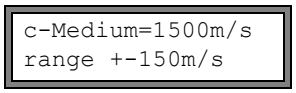
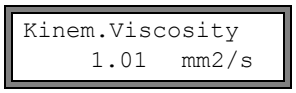
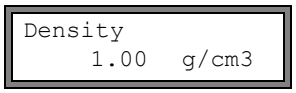
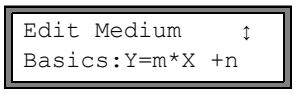
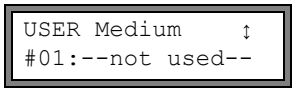
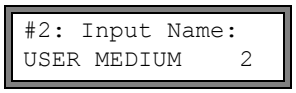
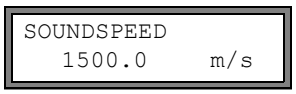
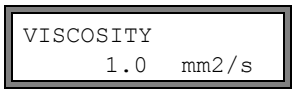
		INIT-resistant
Cut-off Flow factory >USER<	activation of the input of a lower limit of the flow velocity: • factory: the default limit of 2.5 cm/s will be used • user: input of a limit	x
+Cut-off Flow 2.5 cm/s	input of the cut-off flow for positive measured values range: 0...12.7 cm/s default: 2.5 cm/s This display will only be indicated if Cut-off Flow = sign and Cut-off Flow = user has been selected.	x
-Cut-off Flow -2.5 cm/s	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.	x
Cut-off Flow 2.5 cm/s	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.	x
A:Gain threshold Fail if > 90 dB	input of the max. signal amplification range: 0...255 0: no limit of the signal amplification This display will only be indicated if the SuperUser mode is activated.	x
A:Bad soundspeed thresh. 2007 m/s	input of the fixed upper limit of the sound speed range: 0...3 000 m/s 0: the default value 1 848 m/s is used This display will only be indicated if the SuperUser mode is activated.	x
A:Bad soundspeed offset: +321 m/s	input of the offset range: 0...900 m/s 0: the default value 300 m/s is used This display will only be indicated if the SuperUser mode is activated.	x
Quant. wrapping off >ON<	activation of the overflow of the totalizers	x
Quantity recall off >ON<	activation of the taking-over of the totalizer values after a restart of the measurement	x
Do not total. if no meas.> 0 s	input of the time interval without any valid measured values after which the transmitter recognizes a long measurement failure 0: the default value 30 s is used This display will only be indicated if the SuperUser mode is activated.	x
Total digits ↕ Automatic	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.	x
3xC clear totals off >ON<	activation of the manual reset of the totalizers. This display will only be indicated if the SuperUser mode is activated.	x

		INIT-resistant
	activation of the display of the sum of the totalizers This display will only be indicated if the SuperUser mode is activated.	x
	activation of the display of the last valid measured value This display will only be indicated if the SuperUser mode is activated.	x
	activation of the turbulence mode	x
`Special Funct.\SYSTEM settings\Measuring\Calibration`		
	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.	
	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.	
	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.	
	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.	
	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.	
	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.	
	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	

		INIT-resistant
SYSTEM settings\Storing		
SYSTEM settings↕ Storing	selection of the displays for the storing of measured values in the data logger	
Ringbuffer off >ON<	setting of the overflow behavior of the data logger	x
Storage mode sample >AVERAGE<	selection of the storage 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	x
Quantity Storage one >BOTH<	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	x
Store Amplitude off >ON<	activation of the storing of the signal amplitude The value will only be stored if the data logger is activated.	x
Store c-Medium off >ON<	activation of the storing of the sound speed of the fluid The value will only be stored if the data logger is activated.	x
Store diagnostic off >ON<	activation of the storing of diagnostic values	x
SYSTEM settings\serial transmis.		
SYSTEM settings↕ serial transmis.	selection of the displays for the formatting of the serial transmission of measured values	
SER:kill spaces off >ON<	activation of the serial transmission of data with/without blanks	x
SER:decimalpoint '.' >',<	selection of the decimal marker for floating point numbers	x
SER:col-separat. ';' >'TAB'<	selection of the character for column separation	x
Send Offline via RS232 >RS485<	selection of the serial interface default: RS232 This display will only be indicated if the transmitter has an RS485 interface.	x
SYSTEM settings\Network		
SYSTEM settings↕ Network	change of the settings of the transmission parameters of the RS485 interface	
Device address: 0 ADR	input of the address of the measuring instrument	x
RS485 protocol default >SETUP<	confirmation or change of the transmission parameters	x

		INIT-resistant
	change of the baud rate, parity or number of stop bits	x
SYSTEM settings\Miscellaneous		
	selection of the display for the setting of the contrast	
	setting of the contrast of the display	
	confirmation that a HotCode has to be entered	
	input of a HotCode	
	error message that an invalid HotCode has been entered	
Instrum. Inform.		
	selection of the displays for information about the transmitter	
	display of the type, serial number and max. available data logger memory	x
	display of the type, serial number and firmware version with the date (dd - day, mm - month, yy - year)	x
Print Meas.Val.		
	selection of the displays for the transmission of stored measured values to a PC	
	start of the transmission of measured values 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.	
	display of the data transmission progress	
Delete Meas.Val.		
	selection of the displays for the deleting of stored measured values	
	confirmation for the deleting of measured values This display will only be indicated if measured values are stored in the data logger.	

	INIT-resistant
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`	
`Install Material` `>EDIT<  delete` — selection whether a user defined material is to be edited or deleted	
`USER Material ↕` `#01:--not used--` — selection of a user defined material	
`EDIT TEXT (↑↓← →)` `USER MATERIAL 1` — input of a designation for the selected material	
`c-Material` `1590.0 m/s` — input of the sound speed of the material range: 600...6553.5 m/s	
`Roughness` `0.4 mm` — input of the roughness of the material	
`Install Material` **with** `Special Funct.\SYSTEM settings\Libraries\Extended Library = on`	
`Edit Material ↕` `Basics:Y=m*X +n` — selection of the function for the temperature and pressure dependence of the material properties	
`USER Material ↕` `#01:--not used--` — selection of a user defined material	
`USER Material 2` `>EDIT<  delete` — selection whether the user defined material is to be edited or deleted This display will only be indicated if the selected material already exists.	
`#2: Input Name:` `USER MATERIAL 2` — input of a designation for the selected material	
`T-SOUNDSP.` `1500.0 m/s` — input of the constants for the transversal sound speed of the material The number of constants depends on the function selected above.	
`L-SOUNDSP.` `1500.0 m/s` — input of the constants for the longitudinal sound speed of the material The number of constants depends on the function selected above.	
`Default soundsp.` `long. >TRANS.<` — selection of the sound wave type for the flow measurement	
`Roughness` `0.4 mm` — input of the roughness of the material	
`Save changes` `no >YES<` — 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.	

	INIT-resistant
Install Medium	
 selection of the displays for the input of fluids	
`Install Medium` **with** `Special Funct.\SYSTEM settings\Libraries\Extended Library = off`	
 selection whether a user defined fluid is to be edited or deleted	
 selection of a user defined fluid	
 input of a designation for the selected fluid	
 input of the sound speed of the fluid range: 500.0...3500.0 m/s	
 input of the range around the average sound speed of the fluid range: 50...999 m/s	
 input of the kinematic viscosity of the fluid range: 0.01...30 000.00 mm²/s	
 input of the operating density of the fluid	
`Install Medium` **with** `Special Funct.\SYSTEM settings\Libraries\Extended Library = on`	
 selection of the function for the temperature and pressure dependence of the fluid properties	
 selection of a user defined fluid	
 selection whether the user defined fluid is to be edited or deleted This display will only be indicated if the selected fluid already exists.	
 input of a designation for the selected fluid	
 input of the constants for the longitudinal sound speed of the fluid The number of constants depends on the function selected above.	
 input of the kinematic viscosity of the fluid	
 input of the operating density of the fluid	

		INIT-resistant
Save changes no >YES<	confirmation that the changes are to be stored This display will only be indicated if a new fluid has been entered or the properties of an existing fluid have been changed.	
Program Code		
Special Funct. ↕ set program code	selection of the displays for the input of a program code	
set program code ------	defining a program code	
INPUT BREAK_CODE CODE: 000000	input of the break code (= program code)	
INP. ACCESS CODE CODE: 000000	input of the access code (= the first three digits of the program code)	
After the input of HotCode 071001		
DNmin Q-Sensor 15 mm	input of the lower limit of the inner pipe diameter for the displayed transducer type range: 3...63 mm	x

B Units of measurement

length/roughness	
unit of measurement	description
mm	millimeter
inch	inch

temperature	
unit of measurement	description
°C	degree Celsius
°F	degree Fahrenheit

pressure	
unit of measurement	description
bar(a)	bar (absolute)
bar(g)	bar (relative)
psi(a)	pound per square inch (absolute)
psi(g)	pound per square inch (relative)

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

sound speed	
unit of measurement	description
m/s	meter per second

kinematic viscosity	
unit of measurement	description
mm2/s	square millimeter per second

1 mm²/s = 1 cSt

flow velocity	
unit of measurement	description
m/s	meter per second
cm/s	centimeter per second
in/s	inch per second
fps (ft/s)	foot per second

volumetric flow rate		**volume (totalized)**
unit of measurement	description	unit of measurement
m3/d	cubic meter per day	m3
m3/h	cubic meter per hour	m3
m3/min	cubic meter per minute	m3
m3/s	cubic meter per second	m3
km3/h	1000 cubic meters per hour	km3
ml/min	milliliter per minute	`l` or `m3`*
l/h	liter per hour	`l` or `m3`*
l/min	liter per minute	`l` or `m3`*
l/s	liter per second	`l` or `m3`*
hl/h	hectoliter per hour	`hl` or `m3`*
hl/min	hectoliter per minute	`hl` or `m3`*
hl/s	hectoliter per second	`hl` or `m3`*
Ml/d (Megalit/d)	megaliter per day	`Ml` or `m3`*
bbl/d	barrel per day	bbl
bbl/h	barrel per hour	bbl
bbl/m	barrel per minute	bbl
USgpd (US-gal/d)	gallon per day	gal
USgph (US-gal/h)	gallon per hour	gal
USgpm (US-gal/m)	gallon per minute	gal
USgps (US-gal/s)	gallon per second	gal
KGPM (US-Kgal/m)	kilogallon per minute	kgal
MGD (US-Mgal/d)	million gallons per day	Mg
CFD	cubic foot per day	cft**
CFH	cubic foot per hour	cft
CFM	cubic foot per minute	cft
CFS	cubic foot per second	aft***
MMCFD	million cubic feet per day	MMCF
MMCFH	million cubic feet per hour	MMCF

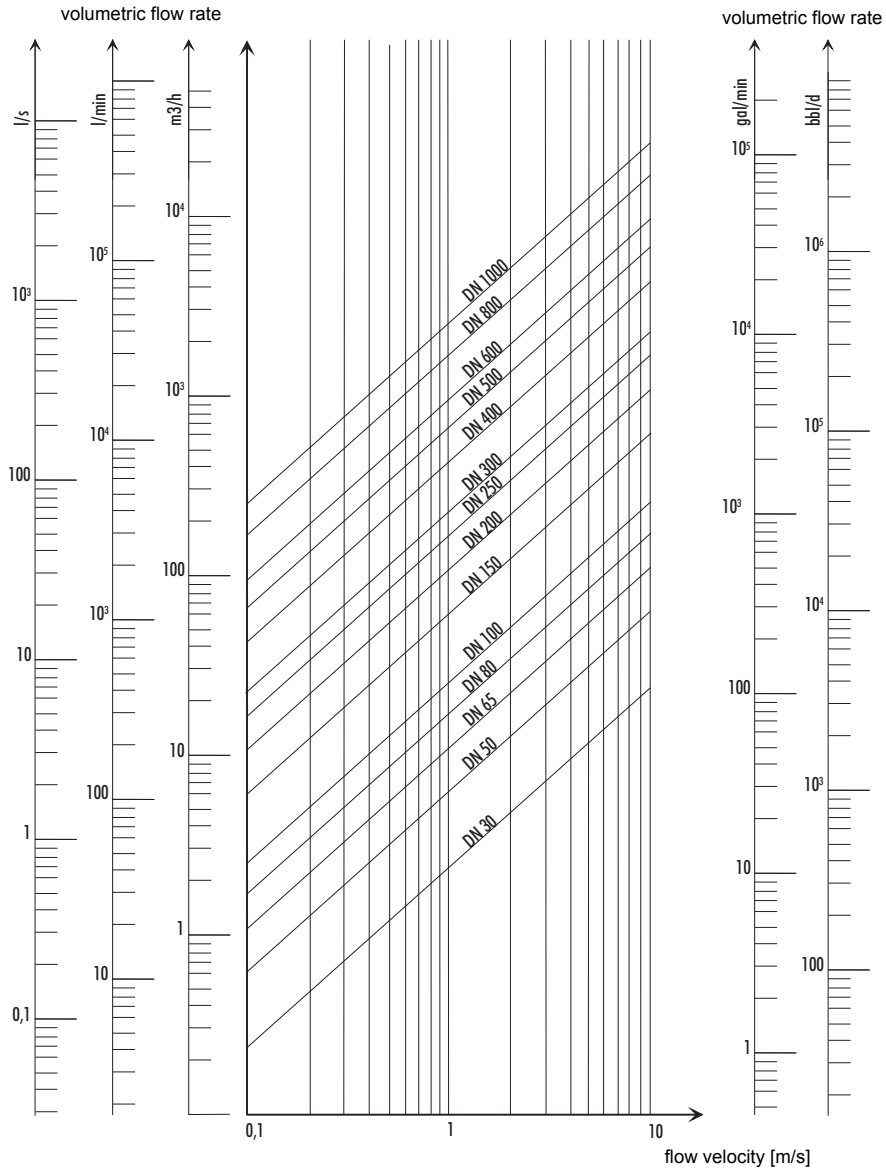
* selection with HotCode 007027, firmware version V5.91 or higher
** cft: cubic foot
*** aft: acre foot

1 US-gal = 3.78541 l
1 bbl = 42 US-gal = 158.9873 l

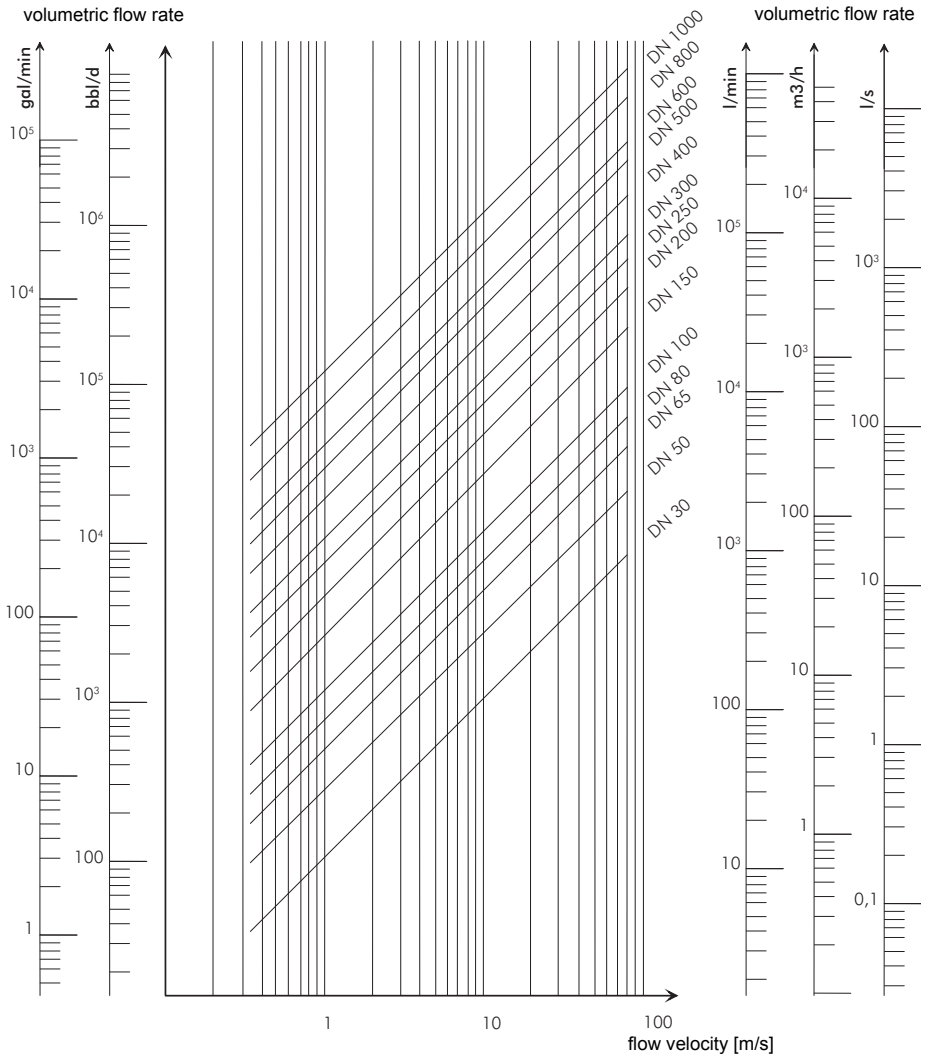
mass flow rate		**mass (totalized)**
unit of measurement	description	unit of measurement
t/h	metric ton per hour	t
t/d	metric ton per day	t
kg/h	kilogram per hour	kg
kg/min	kilogram per minute	kg
kg/s	kilogram per second	kg
g/s	gram per second	g
lb/d	pound per day	lb
lb/h	pound per hour	lb
lb/m	pound per minute	lb
lb/s	pound per second	lb
klb/h	kilopound per hour	klb
klb/m	kilopound per minute	klb

1 lb = 453.59237 g
1 t = 1000 kg

Flow nomogram (metrical)



Flow nomogram (imperial)



C Reference

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

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

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

material (display)	explanation	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
Carbon Steel	carbon steel	3 230	5 930	trans
Stainless Steel	stainless steel	3 100	5 790	trans
DUPLEX	duplex steel	3 272	5 720	trans
Ductile Iron	ductile cast iron	2 650	-	trans
Asbestos Cement	asbestos cement	2 200	-	trans
Titanium	titanium	3 067	5 955	trans
Copper	copper	2 260	4 700	trans
Aluminium	aluminum	3 100	6 300	trans
Brass	brass	2 100	4 300	trans
Plastic	plastic	1 120	2 000	long
GRP	glass-reinforced plastic	-	2 650	long
PVC	polyvinyl chloride	-	2 395	long
PE	polyethylene	540	1 950	long
PP	polypropylene	2 600	2 550	trans
Bitumen	bitumen	2 500	-	trans
Acrylic	acrylic glass	1 250	2 730	long
Lead	lead	700	2 200	long
Cu-Ni-Fe	alloy of copper, nickel, and iron	2 510	4 900	trans
Grey Cast Iron	gray cast iron	2 200	4 600	trans
Rubber	rubber	1 900	2 400	trans
Glass	glass	3 400	5 600	trans
PFA	perfluoroalkoxy	500	1 185	long
PVDF	polyvinylidene fluoride	760	2 050	long
Sintimid	Sintimid	-	2 472	long
Teka PEEK	Teka PEEK	-	2 534	long
Tekason	Tekason	-	2 230	long

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.

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

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

fluid (display)	explanation	sound speed [m/s]	kinematic viscosity [mm²/s]	density [g/cm³]
Acetone	acetone	1 190	0.4	0.73
Ammonia(NH3)	ammonia (NH_3)	1 386	0.2	0.6130
Gasoline	gasoline	1 295	0.7	0.8800
Beer	beer	1 482	1.0	0.9980
BP Transcal LT	BP Transcal LT	1 365	20.1	0.8760
BP Transcal N	BP Transcal N	1 365	94.3	0.8760
Diesel	diesel fuel	1 210	7.1	0.8260
Std. natural gas	natural gas, standard composition	433	12.42	0.0010
Ethanol	ethanol	1 402	1.5	0.7950
HF acid 50%	hydrofluoric acid, 50 %	1 221	1.0	0.9980
HF acid 80%	hydrofluoric acid, 80 %	777	1.0	0.9980
Glycol	glycol	1 665	18.6	1.1100
20% Glycol / H2O	glycol/H_2O, 20 %	1 655	1.7	1.0280
30% Glycol / H2O	glycol/H_2O, 30 %	1 672	2.2	1.0440
40% Glycol / H2O	glycol/H_2O, 40 %	1 688	3.3	1.0600
50% Glycol / H2O	glycol/H_2O, 50 %	1 705	4.1	1.0750
ISO VG 100	ISO VG 100	1 487	314.2	0.8690
ISO VG 150	ISO VG 150	1 487	539.0	0.8690
ISO VG 22	ISO VG 22	1 487	50.2	0.8690

fluid (display)	explanation	sound speed [m/s]	kinematic viscosity [mm²/s]	density [g/cm³]
ISO VG 220	ISO VG 220	1 487	811.1	0.8690
ISO VG 32	ISO VG 32	1 487	78.0	0.8690
ISO VG 46	ISO VG 46	1 487	126.7	0.8730
ISO VG 68	ISO VG 68	1 487	201.8	0.8750
Methanol	methanol	1 119	0.7	0.7930
Milk	milk	1 482	5.0	1.0000
Mobiltherm 594	Mobiltherm 594	1 365	7.5	0.8730
Mobiltherm 603	Mobiltherm 603	1 365	55.2	0.8590
caustic soda 10%	caustic soda, 10 %	1 762	2.5	1.1140
caustic soda 20%	caustic soda, 20 %	2 061	4.5	1.2230
Paraffin 248	paraffin 248	1 468	195.1	0.8450
R134 Freon	R134 Freon	522	0.2	1.2400
R22 Freon	R22 Freon	558	0.1	1.2130
Crudeoil hi-API	crude oil, light	1 163	14.0	0.8130
Crudeoil low API	crude oil, heavy	1 370	639.5	0.9220
30% H2SO4	sulphuric acid, 30 %	1 526	1.4	1.1770
80% H2SO4	sulphuric acid, 80 %	1 538	13.0	1.7950
96% H2SO4	sulphuric acid, 96 %	1 366	11.5	1.8350
Juice	juice	1 482	1.0	0.9980
HCl 25%	hydrochloric acid, 25 %	1 504	1.0	1.1180
HCl 37%	hydrochloric acid, 37 %	1 511	1.0	1.1880
Seawater	sea water	1 522	1.0	1.0240
Shell Thermina B	Shell Thermina B	1 365	89.3	0.8630
Silicon oil	silicone oil	1 019	14 746.6	0.9660
SKYDROL 500-B4	SKYDROL 500-B4	1 387	21.9	1.0570
SKYDROL 500-LD4	SKYDROL 500-LD4	1 387	21.9	1.0570
Water	water	1 482	1.0	0.9990

C.4 Properties of water at 1 bar and at saturation pressure

fluid temperature [°C]	fluid pressure [bar]	density [kg/m^3]	specific heat* [kJ/kg/K^{-1}]
0	1	999.8	4.218
10	1	999.7	4.192
20	1	998.3	4.182
30	1	995.7	4.178
40	1	992.3	4.178
50	1	988.0	4.181
60	1	983.2	4.184
70	1	977.7	4.190
80	1	971.6	4.196
90	1	965.2	4.205
100	1.013	958.1	4.216
120	1.985	942.9	4.245
140	3.614	925.8	4.285
160	6.181	907.3	4.339
180	10.027	886.9	4.408
200	15.55	864.7	4.497
220	23.20	840.3	4.613
240	33.48	813.6	4.769
260	46.94	784.0	4.983
280	64.20	750.5	5.290
300	85.93	712.2	5.762
320	112.89	666.9	6.565
340	146.05	610.2	8.233
360	186.75	527.5	14.58
374.15	221.20	315.5	∞

* at constant pressure