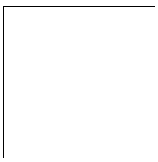
Operating Instruction
UMFLUXUS_F8V4-6-1-0EN
AN EN8X27

Flexim FLUXUS F801, ADM 8027, ADM 8127B Ultrasonic Flowmeter

FLEXIM

EMERSON



Die Sprache, in der die Anzeigen auf dem Messumformer erscheinen, kann eingestellt werden (siehe Abschnitt 10.5).

The transmitter can be operated in the language of your choice (see section 10.5).

Il est possible de sélectionner la langue utilisée par le transmetteur à l'écran (voir section 10.5).

El caudalímetro puede ser manejado en el idioma de su elección (ver sección 10.5).

De transmitter kan worden gebruikt in de taal van uw keuze (zie gedeelte 10.5).

Имеется возможность выбора языка информации, отображаемой на экране преобразователя (смотри подраздел 10.5).

Content

Annex

1 Introduction

1.1 Regarding this Manual

This user manual has been written for the 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 Atmosphere" (see document SIFLUXUS 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. If you however find some erroneous information, please inform us. We will be grateful for any suggestions and comments regarding the concept and your experience working with the measuring instrument.

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

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 an explosive atmosphere.

Observe these safety instruction!

1.3 Warranty

We warrant the reliability of the material and workmanship of FLUXUS for the term specified in the sales contract, provided the measuring instrument is used for the purpose for which it was designed, and operated according to the instructions given in this user manual. Improper use of the FLUXUS leads to the withdrawal of any warranties of any kind, explicit or implicit.

Incorrect use 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 injuries to the customer or third persons directly caused by material failure due to unpredictable defects in the product or for any indirect damages.

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

If any problem appears which cannot be solved with the help of this user manual (see chapter 19), contact our sales office and give a precise description of the problem. Specify the type, serial number and firmware version of the measuring instrument.

2 Handling

2.1 First Inspection

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

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

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

2.2 General Precautions

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

FLUXUS is a precision measuring instrument and has to be handled with care. In order to obtain good measurement results and not damage the measuring instrument, it is important to pay special attention 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 is only 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. Handle the cables with care. Avoid excessive cable bends.
- Make sure to work under correct ambient and operating temperatures. The ambient temperature at the measuring point has to be within the operating temperature range of the transmitter and the sensors (see Technical Specification).
- Observe the degree of protection (see Technical Specification).

3 General Principles

For the ultrasonic measurement of the flow rate, the flow velocity of the fluid 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.

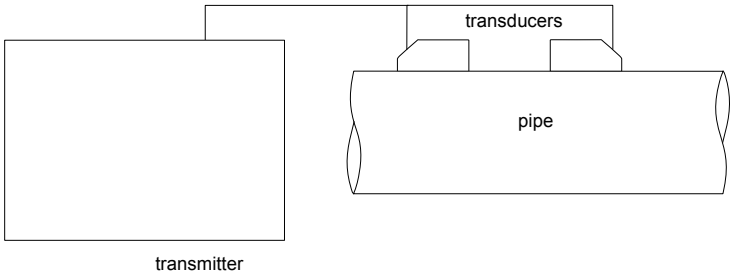


Fig. 3.1: Example of a measurement setup

3.2 Measurement Principle

The flow velocity of the fluid is measured in the TransitTime mode using the ultrasonic-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 flowing in the pipe is determined from the transit time difference (see Fig. 3.2, Fig. 3.5 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 all flow velocities of the fluid over the cross-sectional pipe area.

Acoustic calibration factor k_a

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

The acoustic calibration factor k_a is a parameter of the transducer which results from the sound speed c within the transducer and the angle of incidence (see Fig. 3.2). According to Snell's law of refraction, the angle of propagation in the adjoining 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 the 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 the flow direction is shorter than the transit time against the flow direction. This transit time difference is proportional to the average flow velocity.

The average 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 fluid

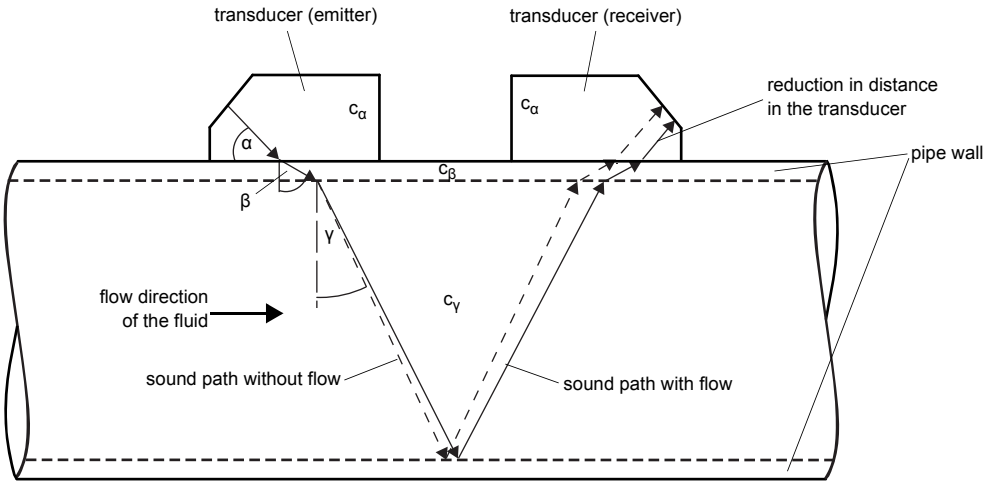


Fig. 3.2: Sound path of the signal in the flow direction.

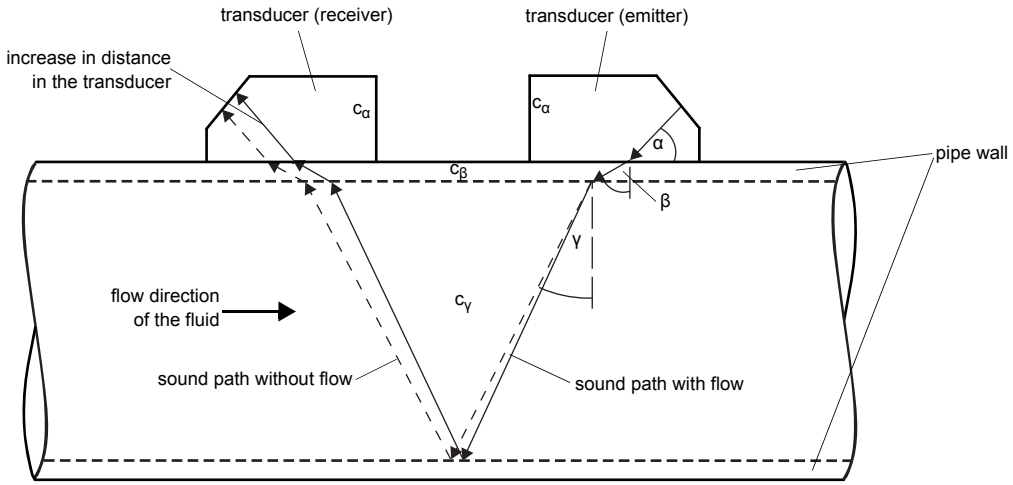


Fig. 3.3: Sound path of the signal against the flow direction

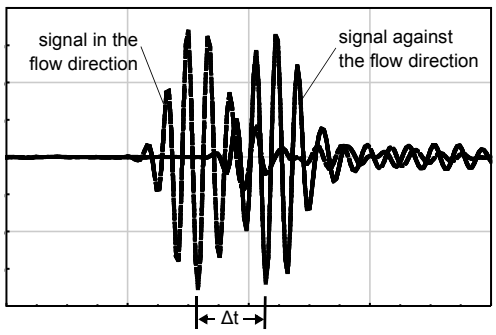


Fig. 3.4: Signals and transit time difference Δt

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 not possible anymore.

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

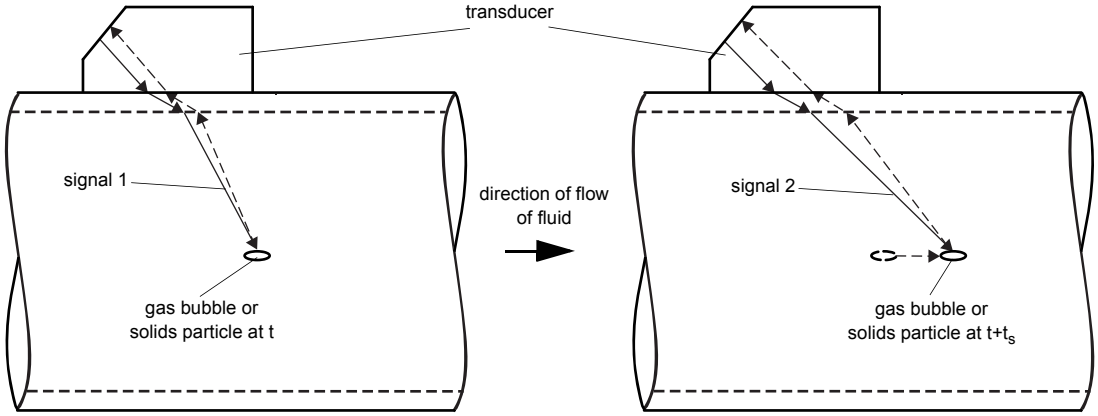


Fig. 3.5: Measurement of the flow velocity in the NoiseTrek mode

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

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

Diagonal arrangement

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

Reflection arrangement

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

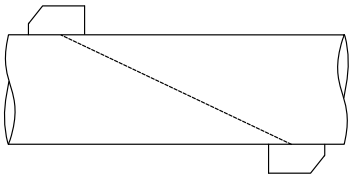


Fig. 3.6: Diagonal arrangement

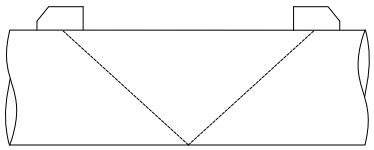


Fig. 3.7: Reflection arrangement

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

Beam

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

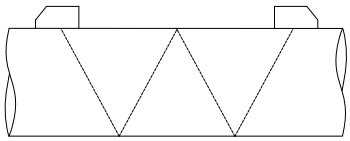


Fig. 3.8: 1 beam, 4 sound paths, reflection arrangement

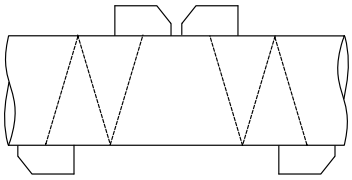
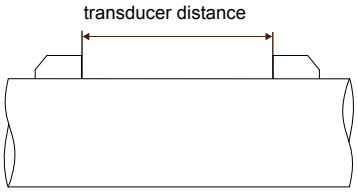


Fig. 3.9: 2 beams, 3 sound paths, diagonal arrangement

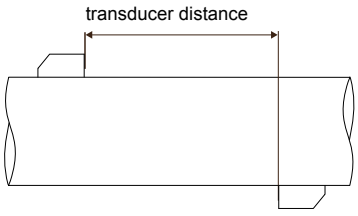
Transducer Distance

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

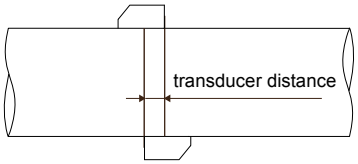
reflection arrangement



diagonal arrangement
(positive transducer distance)



diagonal arrangement
(negative transducer distance)



Sound beam plane

The plane containing one, two or more sound paths or beams (see Fig. 3.10).

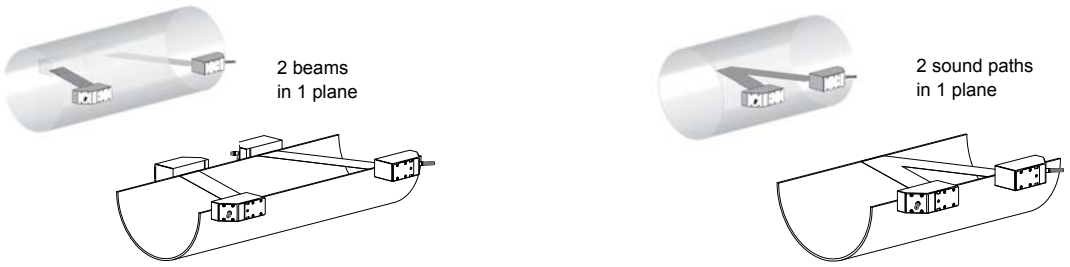
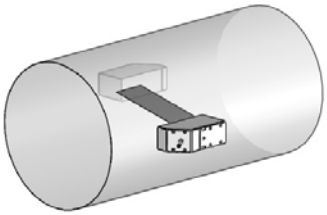
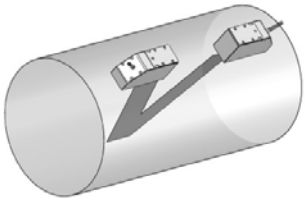
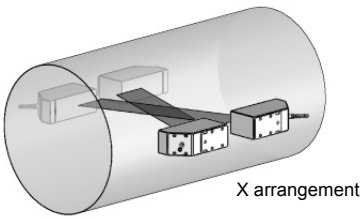
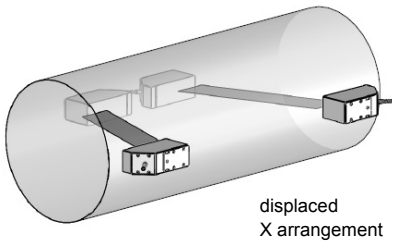
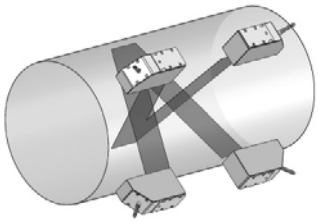


Fig. 3.10: Sound paths and beams in one plane

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 beam	**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 ADM 8027

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 when the housing is closed.

The terminals for the connection of the transducers are in the lower housing, the terminals for the connection of the outputs and of the power supply on the back side of the upper housing (see Fig. 4.1).

4.2 FLUXUS F801, ADM 8127B

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

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

Fig. 4.1: FLUXUS ADM 8027

Fig. 4.2: FLUXUS F801, ADM 8127B

4.3 Keyboard

The keyboard consists of 5 keys.

Tab. 4.1: General functions

ENTER	confirmation of selection or entered value
BRK + CLR + ENTER	RESET: Press these three keys simultaneously to correct a malfunction. The reset has the same effect as restarting the transmitter. Stored data are not affected.
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 Atmosphere" (see document SIFLUXUS).

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

A measurement on a pipe is possible if

• the ultrasound propagates with a sufficiently high amplitude (see section 5.1)

• the flow profile is fully developed (see section 5.2)

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

Due to the variety of applications and the different factors that influence the measurement, there is no standard solution for the transducer positioning. The correct position of the transducers is influenced by the following factors:

• diameter, material, lining, wall thickness and shape of the pipe

• 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.

Avoid locations with deposit formation in the pipe.

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

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

The ambient temperature at the measuring point has to be within the operating temperature range of the transmitter and the sensor (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 penetratable 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 pockets when the fluid expands, e.g., before pumps and after great cross-section extensions.

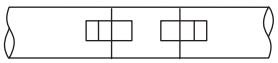
Observe the notes in the following table:

Tab. 5.1: Recommended transducer mounting position

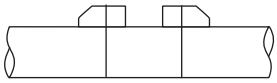
horizontal pipe

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. By doing this, the solid on the bottom of the pipe or gas bubbles in the pipe's upper part are prevented from influencing the propagation of the signal.

correct:



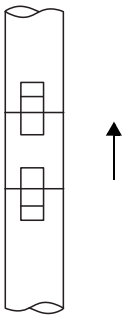
disadvantageous:



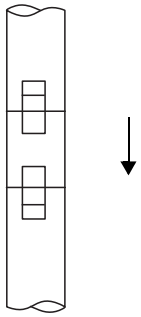
vertical pipe

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

correct:



disadvantageous:

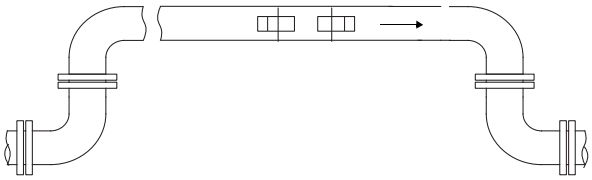


free inlet or outlet pipe section:

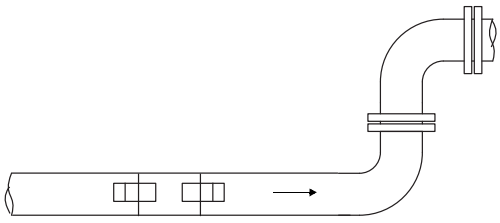
Select the measuring point at a pipe location where the pipe cannot run empty.

correct:

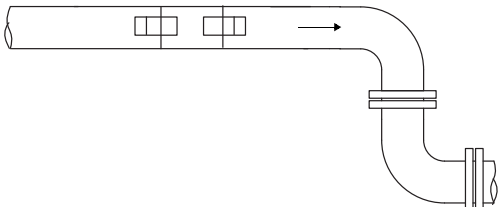
disadvantageous:



correct:



disadvantageous:



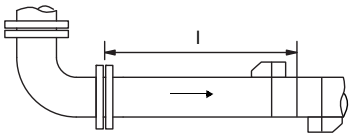
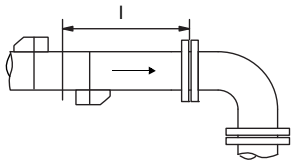
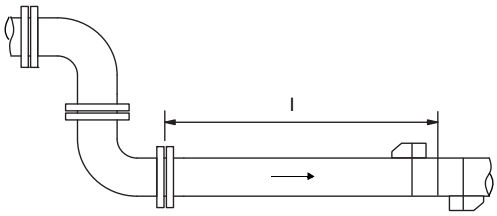
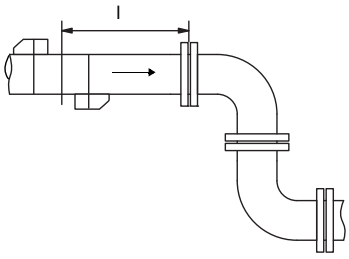
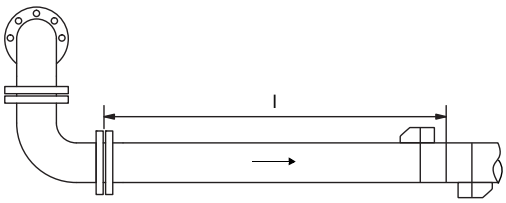
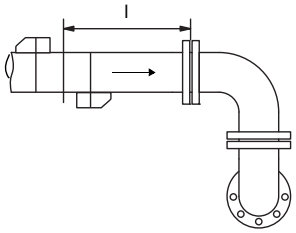
5.2 Undisturbed Flow Profile

Some flow elements (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.

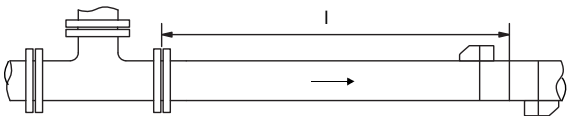
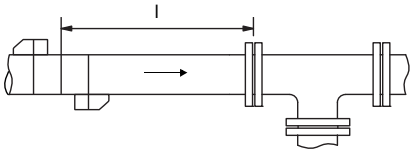
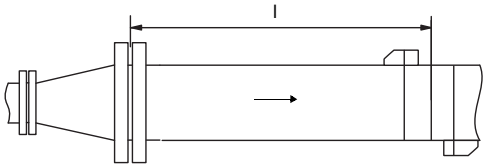
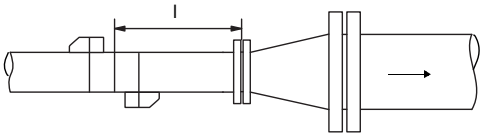
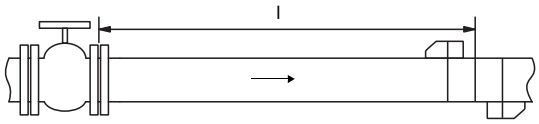
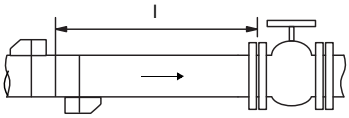
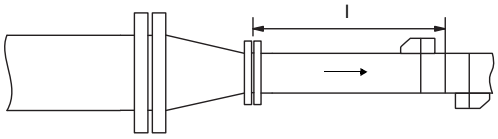
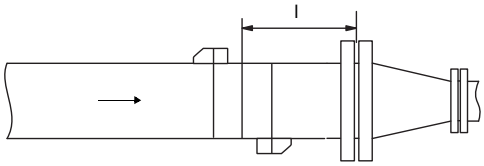
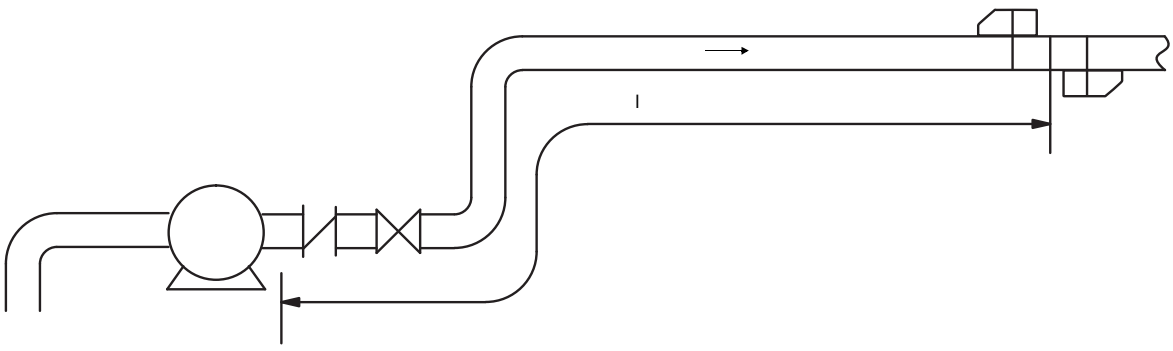
It is most important that the measuring point is chosen at a sufficient distance from any disturbance sources. Only then it can be assumed that the flow profile in the pipe is fully developed. However, measuring results can be obtained even if the recommended distance to disturbance sources cannot be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

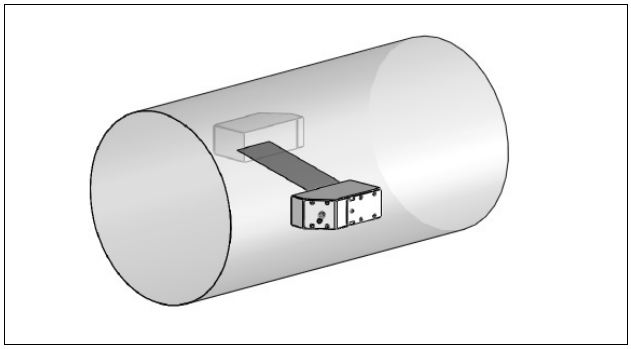
disturbance source: 90° elbow	
supply line: l ≥ 10 D	return line: l ≥ 5 D
	
disturbance source: 2x 90° elbows on same level	
supply line: l ≥ 25 D	return line: l ≥ 5 D
	
disturbance source: 2x 90° elbows on different level	
supply line: l ≥ 40 D	return line: l ≥ 5 D
	

Tab. 5.2: Recommended distance from disturbance sources; D = nominal pipe diameter at the measuring point, l = recommended distance

disturbance source: T piece	
supply line: l ≥ 50 D	return line: l ≥ 10 D
	
disturbance source: diffuser	
supply line: l ≥ 30 D	return line: l ≥ 5 D
	
disturbance source: valve	
supply line: l ≥ 40 D	return line: l ≥ 10 D
	
disturbance source: reducer	
supply line: l ≥ 10 D	return line: l ≥ 5 D
	
disturbance source: pump	
supply line: l ≥ 50 D	
	

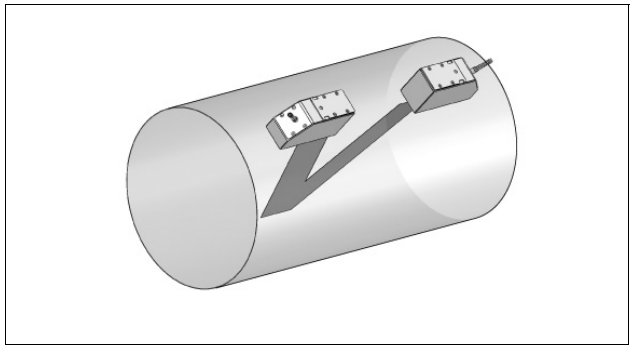
5.3 Selection of the Measurement Arrangement Taking into Account the Measuring Range and the Measuring Conditions

Diagonal arrangement with 1 beam



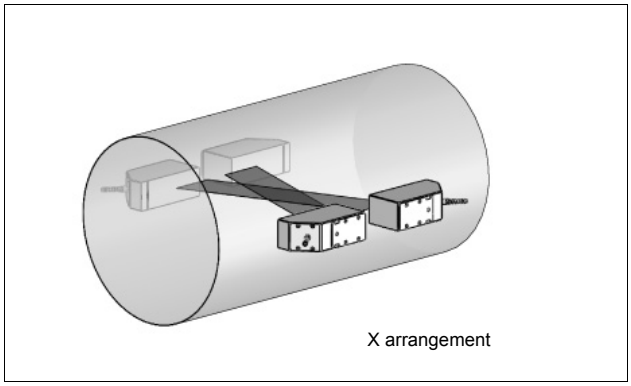
- wider flow velocity and sound speed range compared to the reflection arrangement
- use in the presence of deposits on the inner pipe wall or with strongly attenuating gases or liquids (due to 1 sound path)

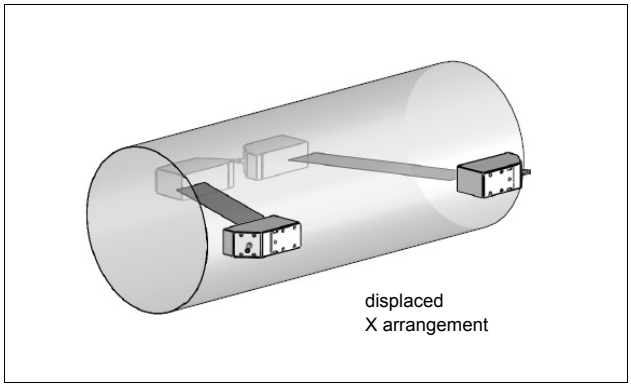
Reflection arrangement with 1 beam



- 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

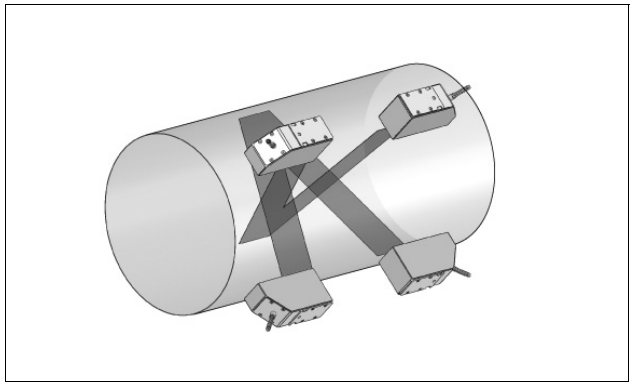
Diagonal arrangement with 2 beams





- same characteristics as diagonal arrangement with 1 beam
- additional characteristic:
  transverse flow effects are compensated due to measurement is conducted with 2 beams

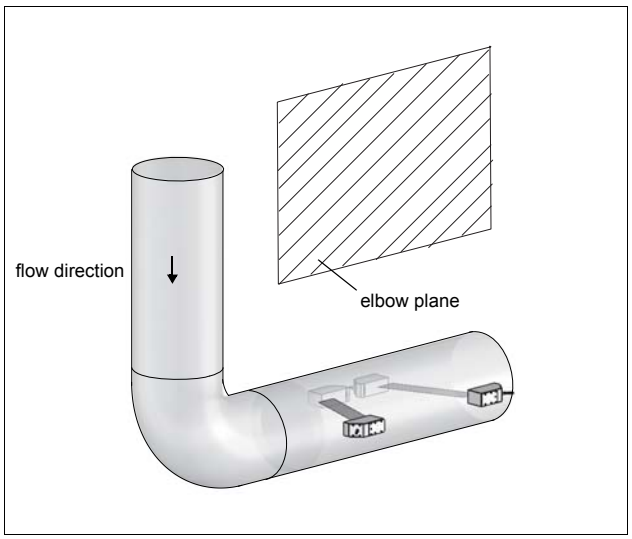
Reflection arrangement with 2 beams and 2 planes



- same characteristics as reflection arrangement with 2 beams
- additional characteristic:
  influences of the flow profile are compensated due to measurement takes place in 2 planes

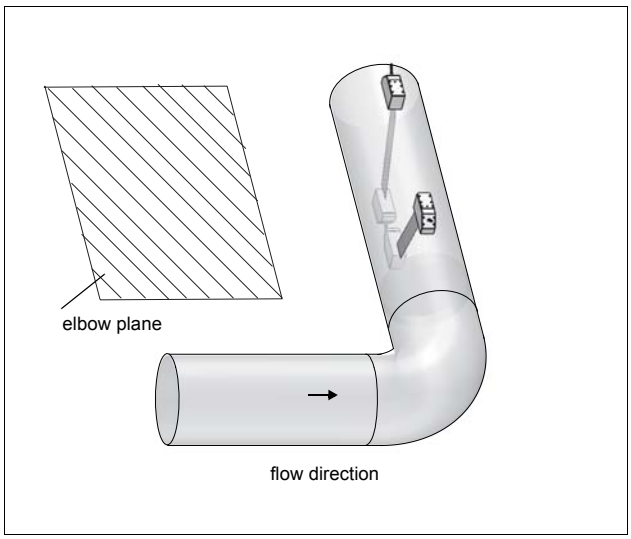
5.4 Selection of the Sound Beam Plane near an Elbow

With vertical pipe orientation



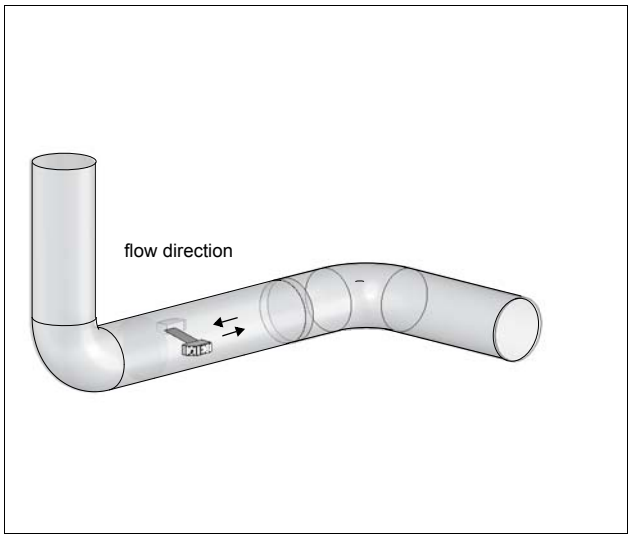
- The sound beam plane (see section 3.3.1) has an angle of 90° to the elbow plane. The elbow is upstream of the measuring point.

With horizontal pipe



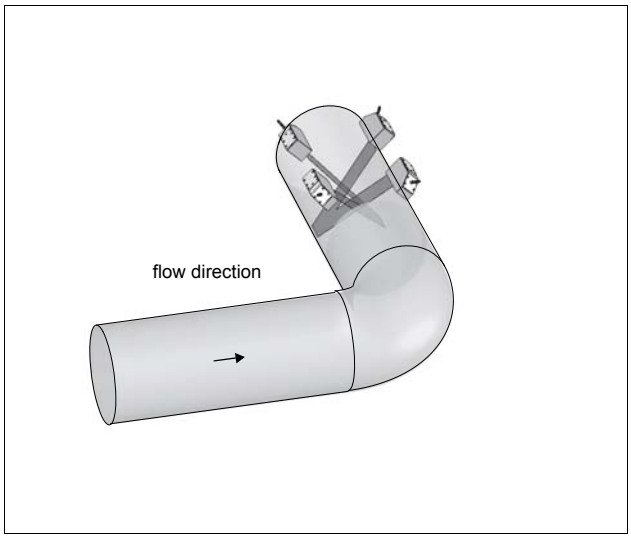
- The sound beam plane (see section 3.3.1) has an angle of 90° ± 45°to the elbow plane.

With measurements in both directions



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

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



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

6 Installation of FLUXUS ADM 8027

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

6.1 Location

• Select the measuring point according to the recommendations in chapter 3 and 5.

• Select the location of the transmitter within the range of the cable 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 Atmosphere" (see document SIFLUXUS).

The transmitter has a set screw which has to be unscrewed before the housing can be opened.

After the installation of the transmitter, make sure that the housings are closed correctly and that the set screw is tigh-tened.

6.3 Installation

6.3.1 Wall Installation

• Fix the bottom side of the upper housing to the instrument mounting plate (3) (see Fig. 6.1).

• Fix the transmitter to the wall.

6.3.2 Pipe Installation

Installation on a 2" pipe

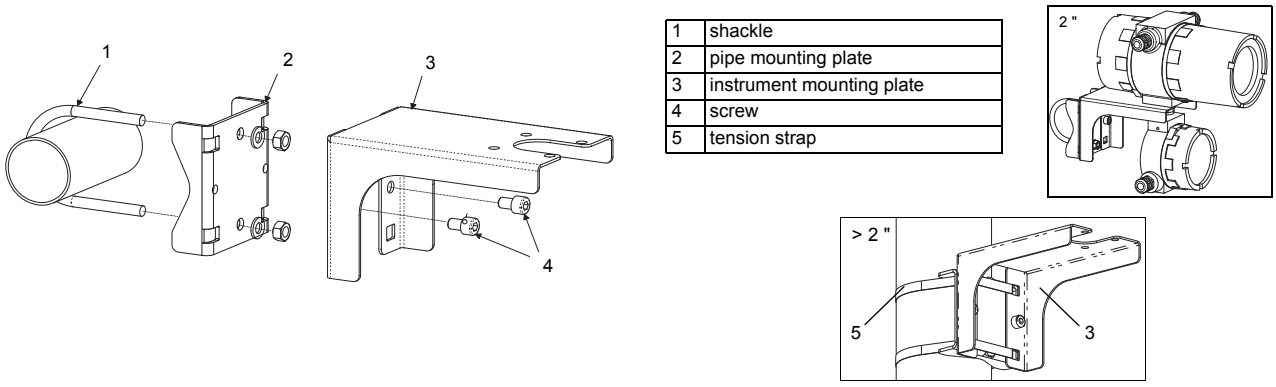
• Fix the pipe mounting plate (2) to the pipe (see Fig. 6.1).

• Fix the instrument mounting plate (3) to the pipe mounting plate (2) with the screws (4).

• Fix the bottom side of the upper housing to the instrument mounting plate (3).

Installation on a pipe > 2"

The pipe mounting kit is fixed to the pipe with tension straps instead of the shackle (see Fig. 6.1). Push the tension straps (5) through the holes in the instrument mounting plate (3).



1	shackle
2	pipe mounting plate
3	instrument mounting plate
4	screw
5	tension strap

Fig. 6.1: Pipe mounting kit

6.4 Connection of the Transmitter

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

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.

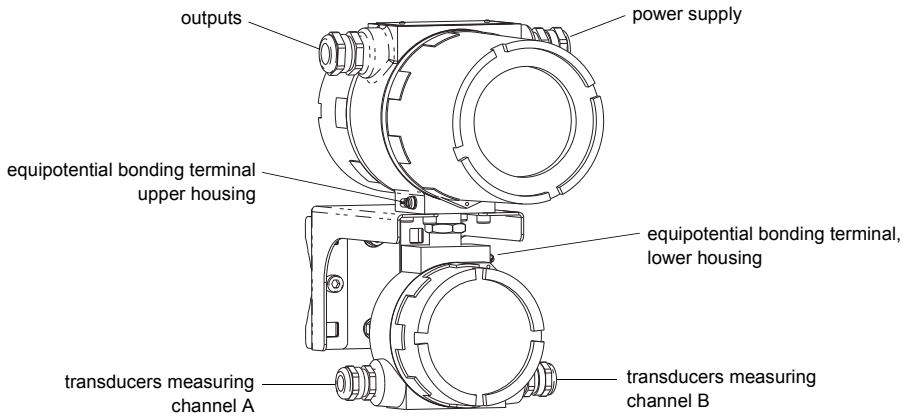
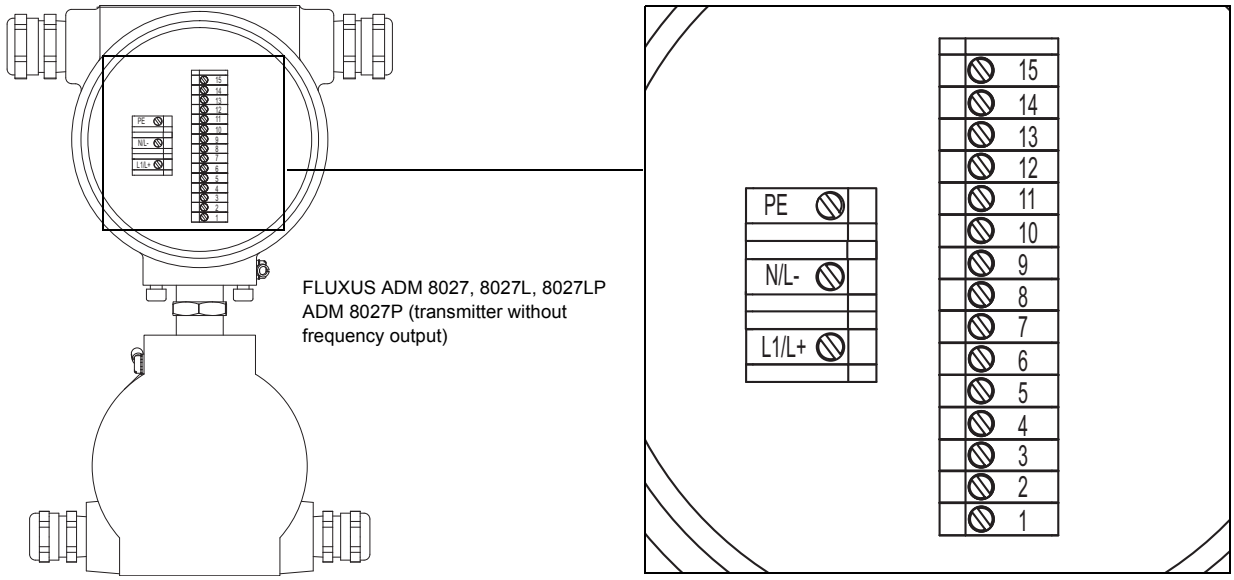


Fig. 6.2: Connections of the Transmitter



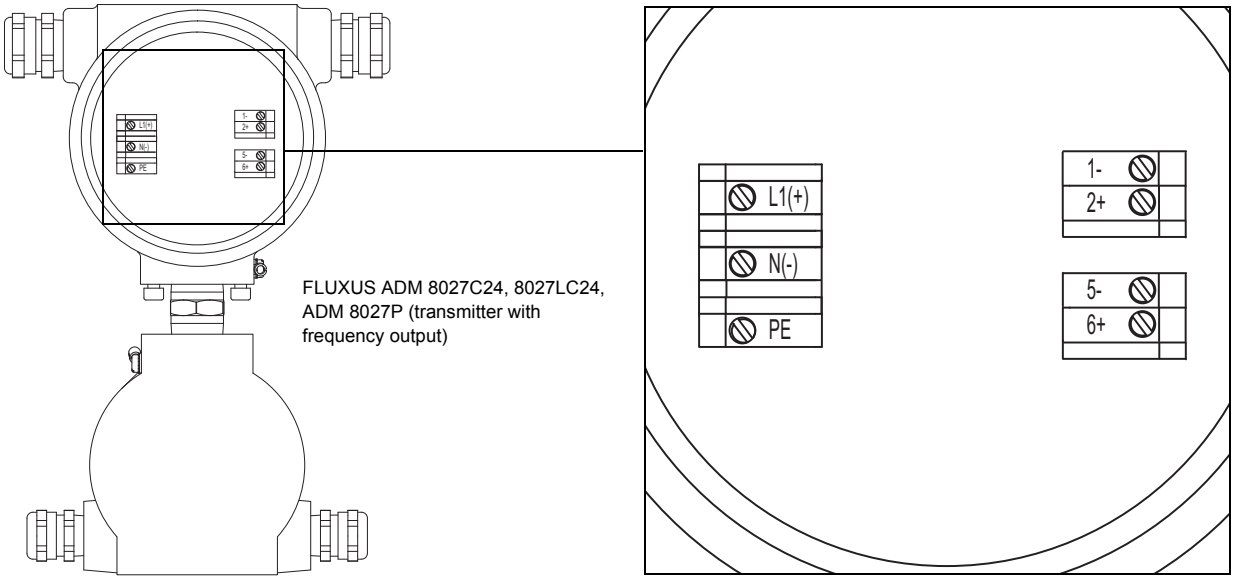


Fig. 6.3: Terminal designation of the transmitter (power supply, outputs)

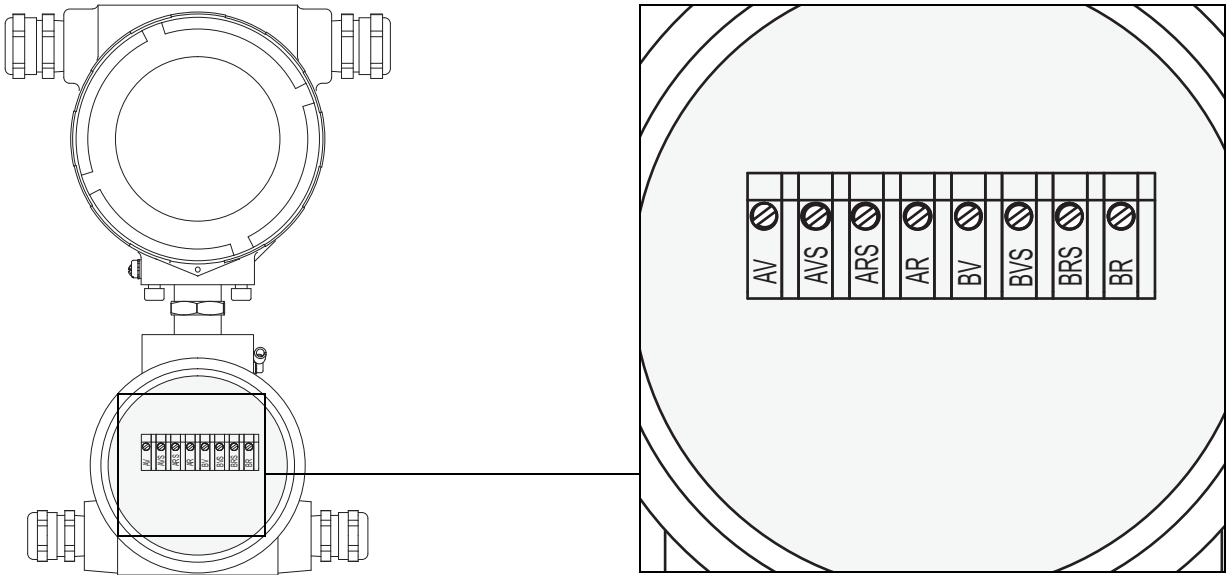


Fig. 6.4: Terminal designation of the transmitter (transducers)

6.5 Connection of the Transducers

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 6.9).

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

Transducers with direct connection are already connected to the transmitter.

6.5.1 Connection of the Extension Cable to the Transmitter

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

The transmitter has 2 cable glands for the connection of the transducers. If the transmitter has only one measuring channel, one of the openings is closed with a blind plug.

- Remove the cable gland for the connection of the transducers (see Fig. 6.2).
- Open the cable gland. The compression part remains in the cap nut (see Fig. 6.5).
- Push the extension cable through the cap nut, the compression part and the basic part of the cable gland.
- 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 of the transducer cable and brush it back.
- Insert the end of the extension cable into the lower housing.
- Screw the gasket ring side of the basic part into the lower housing.

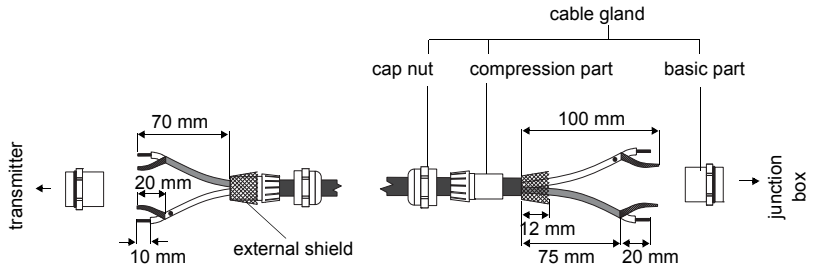


Fig. 6.5: Preparation of the extension cable

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

• Fix the cable gland by screwing the cap nut onto the basic part (see Fig. 6.5).

• Connect the core and the shield correctly to the terminals of the transmitter (see Fig. 6.6, Fig. 6.4 and Tab. 6.1).

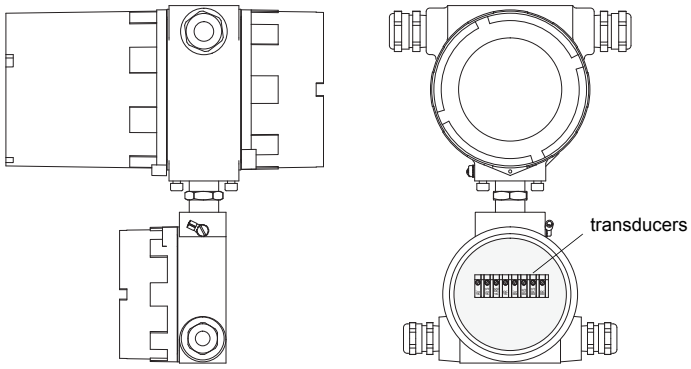


Fig. 6.6: Terminals for the connection of the transducers (extension cable)

Tab. 6.1: Terminal assignment (extension cable)

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

6.5.2 Connection of the Extension Cable to the Junction Box

6.5.2.1 Connection without potential separation (standard)

The connection of the extension cable to the junction box without potential separation ensures that transducer, junction box and transmitter are on the same potential. The extension cable should always be connected in this manner, especially if there are power current cables nearby the extension cable.

If earthing on the same potential cannot be ensured, see section 6.5.2.2.

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

• Remove the left blind plug for the connection of extension cable (see Fig. 6.7).

• 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.

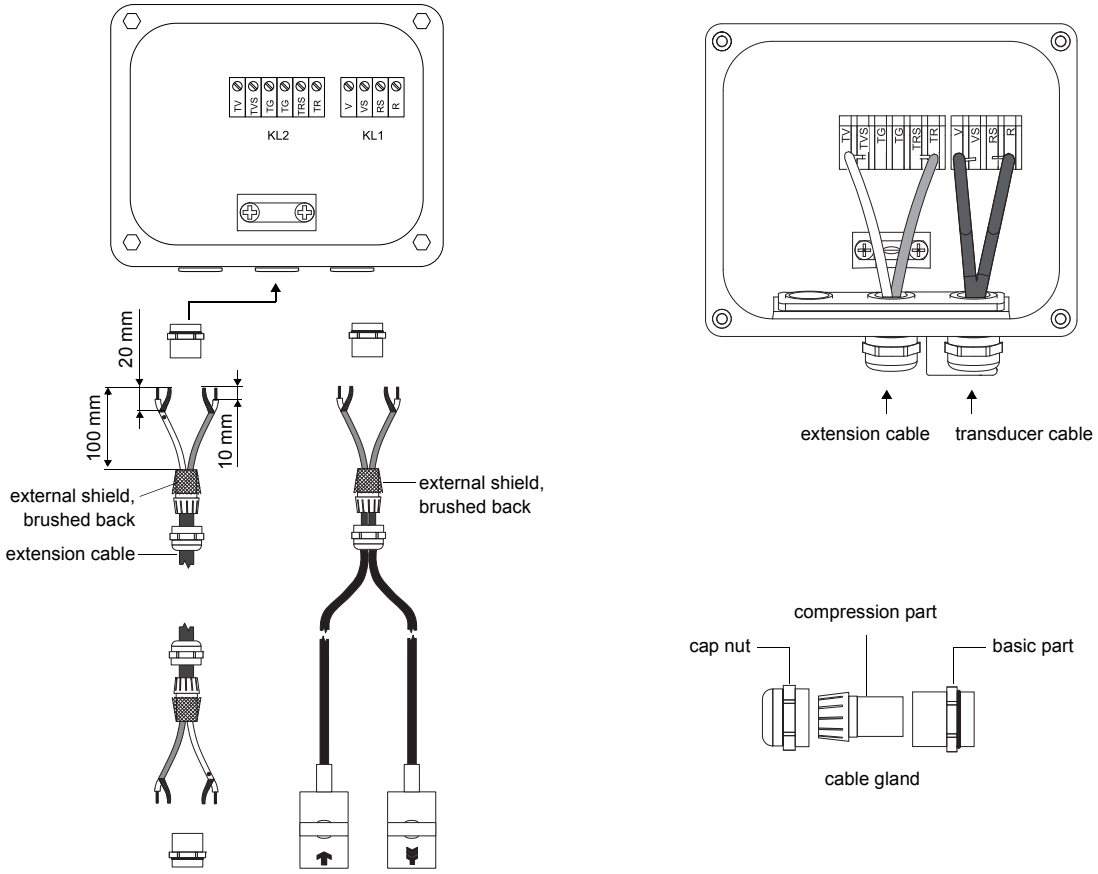


Fig. 6.7: Connection of the extension and transducer cable to the junction box JB01

- Prepare the extension cable.
- Cut the external shield and brush it back over the compression part.
- Screw the gasket ring side of the basic part into the junction box.
- Insert the extension cable into the junction box.

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

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the extension cable to the terminals of the transmitter (see Fig. 6.7 and Tab. 6.2).

Tab. 6.2: Terminal assignment (extension cable, KL2)

terminal	**connection**
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

For the terminal assignment of the transducer cable see Fig. 6.7 and Tab. 6.5.

Tab. 6.3: Terminal assignment (transducer cable)

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

6.5.2.2 Connection with potential separation

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

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

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

- Remove the left blind plug for the connection of extension cable (see Fig. 6.8).
- 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.

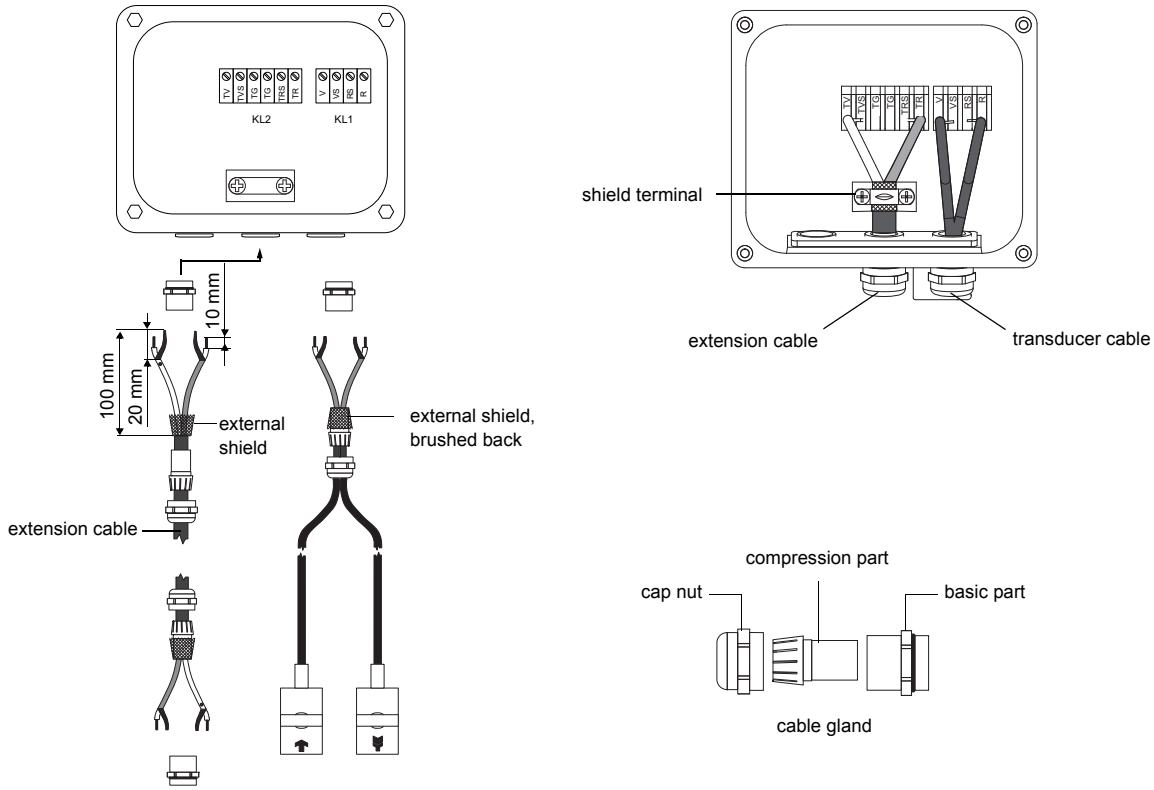


Fig. 6.8: Connection of the extension and transducer cable to the junction box JB01

- Insert the extension cable into the junction box.
- Prepare the extension cable.
- Cut the outer shield to length and brush it back.
- Pull the extension cable back until the brushed back external shield is below the shield terminal (see Fig. 6.8). The extension cable has to remain completely insulated up to the shield terminal.
- Screw the gasket ring side of the basic part into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.

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

- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the transmitter (see Fig. 6.8 and Tab. 6.4).

Tab. 6.4: Terminal assignment (extension cable, KL2)

terminal	**connection**
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

For the terminal assignment of the transducer cable see Fig. 6.8 and Tab. 6.5.

Tab. 6.5: Terminal assignment (transducer cable)

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

6.6 Connection of the Power Supply

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

The external protective earth is connected to the equipotential bonding terminals of the upper and lower housing of the transmitter (see Fig. 6.2).

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.

- Remove the cable gland for the connection of the power supply (see Fig. 6.2).
- Prepare the power cable with an M20 cable gland.
- Push the power cable through the cap nut, the compression part and the basic part of the cable gland (see Fig. 6.9).
- Insert the power cable into the upper housing.
- Screw the gasket ring side of the basic part into the upper housing of the transmitter.
- Fix the cable gland by screwing the cap nut onto the basic part (see Fig. 6.9).
- Connect the leads to the terminals of the transmitter according to the voltage printed on the nameplate below the terminal strip KL1 (see Fig. 6.10, Fig. 6.3 and Tab. 6.6).

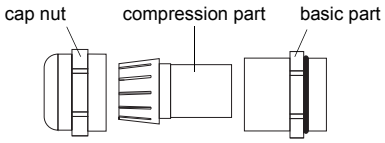


Fig. 6.9: Cable gland

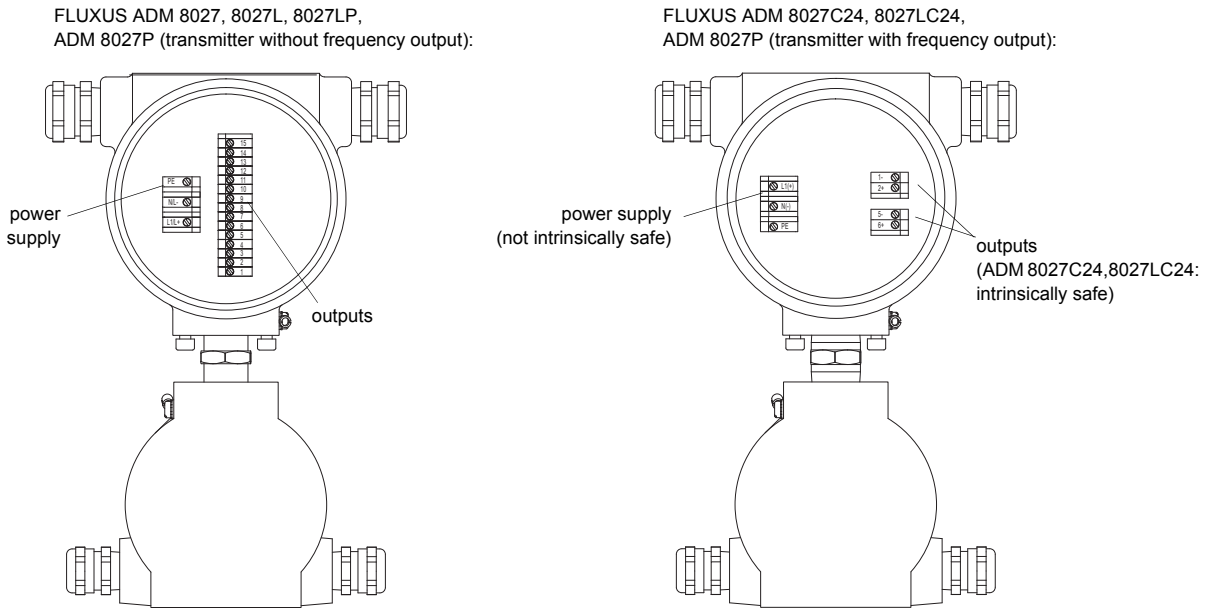


Fig. 6.10: Terminals for the connection of the power supply and the outputs

Tab. 6.6: Connection of the power supply

AC		DC	
terminal	**connection**	**terminal**	**connection**
PE	earth	PE	earth
N	neutral	L+	+
L1	phase 100…240 V	L-	-

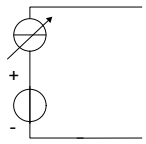
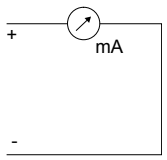
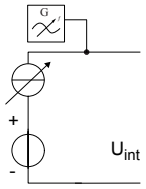
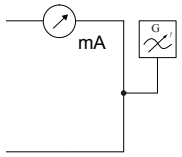
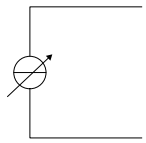
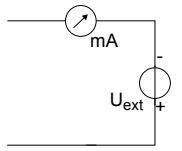
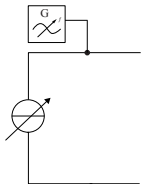
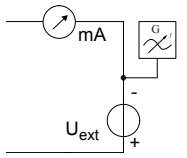
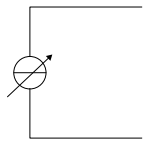
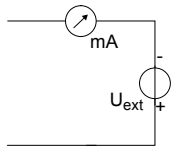
6.7 Connection of the Outputs

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

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

- Remove the cable gland for the connection of the outputs (see Fig. 6.2).
- Prepare the output cable with an M20 cable gland.
- Push the output cable through the cap nut, the compression part and the basic part of the cable gland (see Fig. 6.9).
- Insert the output cable into the upper housing.
- Screw the gasket ring side of the basic part into the upper housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the leads of the output cable to the terminals of the transmitter (see Fig. 6.10, Fig. 6.3 and Tab. 6.7).

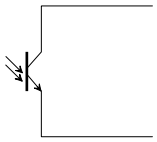
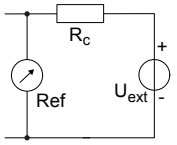
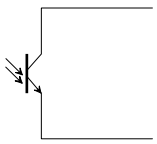
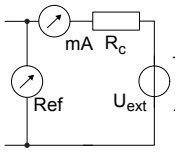
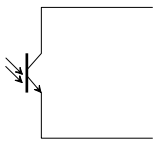
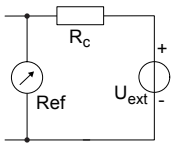
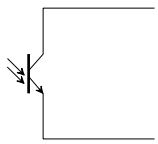
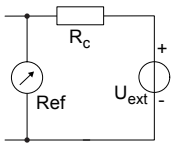
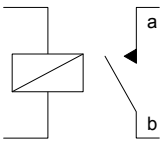
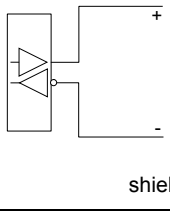
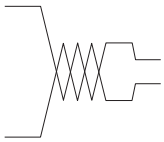
Tab. 6.7: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
active current loop/ HART ADM 8027 ADM 8027L	current loop			
		I1/I2: 2/4 (+) I1/I2: 1/3 (-)		R_{ext} < 500 Ω current during transmitter error: I_{fault} ≈ 0 mA
	HART mode			
		I1: 2 (+) I1: 1 (-)		U_{int} = 24 V current during transmitter error: I_{fault} ≈ 0 mA
passive current loop/HART ADM 8027P ADM 8027LP	current loop			
		I1/I2: 1/3 (-) I1/I2: 2/4 (+)		U_{ext} = 4...26.4 V U_{ext} > 0.021 A · R_{ext} [Ω] + 4 V example: U_{ext} = 12 V R_{ext} = 0…380 Ω current during transmitter error: I_{fault} ≈ 0 mA
	HART mode			
		I1: 1 (-) I1: 2 (+)		U_{ext} = 10...24 V current during transmitter error: I_{fault} ≈ 0 mA
passive current loop Ex ia ADM 8027C24a ADM 8027LC24a		I1: 2 (+) I1: 1 (-)		U_{i} = 30 V DC I_{i} = 56 mA P_{i} = 0.42 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 430 Ω ≤ R_{ext} ≤ 770 Ω current during transmitter error: I_{fault} = 3.2…3.5 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. 6.7: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
frequency output (open collector) ADM 8027P		F1: 2 (+) F1: 1 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} = 0.8 mA
frequency output (open collector) ADM 8027P		F1: 2 (+) F1: 1 (-)		U_{ext} = 8.2 V R_c = 1 kΩ DIN EN 60947-5-6 (NAMUR)
binary output (open collector) (only with frequency output) ADM 8027P		B1: 6 (+) B1: 5 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} = 0.8 mA
binary output (open collector) ADM 8027 ADM 8027L ADM 8027P ADM 8027LP		B1...B4: 6/8/10/12 (+) B1...B4: 5/7/9/11 (-)		U_{ext} = 5...24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA
binary output (Reed relay) ADM 8027 ADM 8027L ADM 8027P ADM 8027LP		B3/B4: 9/11 B3/B4: 10/12		U_{max} = 48 V I_{max} = 100 mA
RS485 ADM 8027 ADM 8027L ADM 8027P ADM 8027LP		14 (A+) 13 (B-) 15		120 Ω termination resistor

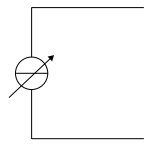
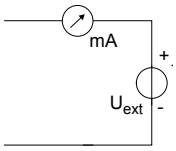
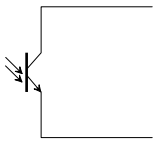
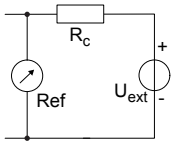
The number, type and connections of the outputs are customized.

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

6.7.1 Intrinsically Safe Current Output Ex ib

The current output may be fed with max. 28.2 V DC/0.76 W.

Tab. 7: Circuit of the current output Ex ib

output	transmitter		external circuit	remark
	internal circuit	connection		
Ex ib ADM 8027C24 ADM 8027LC24		I1: 2 (+) I1: 1 (-)		U_i = 28.2 V, P_i = 0.76 W U_{ext} = 4...28.2 V U_{ext} > 0.021 A · R_{ext} [Ω] + 4 V example: U_{ext} = 12 V R_{ext} ≤ 380 Ω
binary output (open collector) ADM 8027C24 ADM 8027LC24		B1: 6 (+) B1: 5 (-)		U_i = 28.2 V, P_i = 0.76 W U_{ext} = 5...28.2 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA

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

If the transmitter is disconnected from the power supply during the measurement:
- the passive current output continues being powered thanks to an external power supply
- the last measured value is output.

In order to check the function of the transmitter:
- the binary output is installed and activated
- the binary output is used as an alarm output.

For the installation and activation of the binary output see chapter 18.

Recommended configuration of the alarm output

`func` (switching condition)	`ERROR`
`type` (holding behavior)	`HOLD (NON-HOLD)`
`mode` (switching function)	`NC CONT.`

If the transmitter is disconnected from the power supply, the binary output indicates an alarm state.

6.8 Connection of the Serial Interface

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

Because the upper housing has to be opened, the RS232 interface can only be connected outside of an explosive atmosphere (see Fig. 6.1).

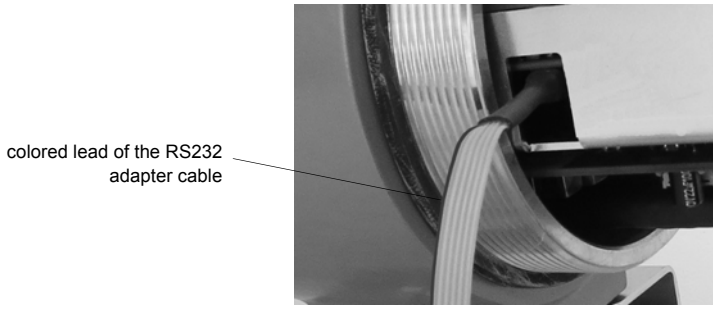


Fig. 6.1: RS232 interface of FLUXUS ADM 8027

- Insert the RS232 adapter into the socket in such way that the colored lead of the cable is on the marked side of the socket.
- Connect the RS232 cable to the RS232 adapter.
- Connect the RS232 cable to 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 the RS232/USB adapter is used for the connection, contact your system administrator.

The transmitter can also be equipped with an RS485 interface (optional). For the connection see section 6.7.

For further information on the data transmission see chapter 14.

6.9 Sensor Module (SENSPROM)

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

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

- Insert the sensor module into the socket of the measuring channel to which new transducers have to be connected.

7 Installation of FLUXUS F801

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

7.1 Location

• Select the measuring point according to the recommendations in chapter 3 and 5.

• Select the location of the transmitter within the range of the cable 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 Atmosphere" (see document SIFLUXUS).

The transmitter has a countersunk screw which has to be unscrewed before the housing can be opened.

After the installation, make sure that the housing is closed correctly and that the countersunk screw is tightened.

7.3 Installation

7.3.1 Wall Installation

• Fix the instrument mounting plate (2) to the wall with the 4 screws (4) (see Fig. 7.1).

• Fix the transmitter to the instrument mounting plate (2) with the 2 screws (3).

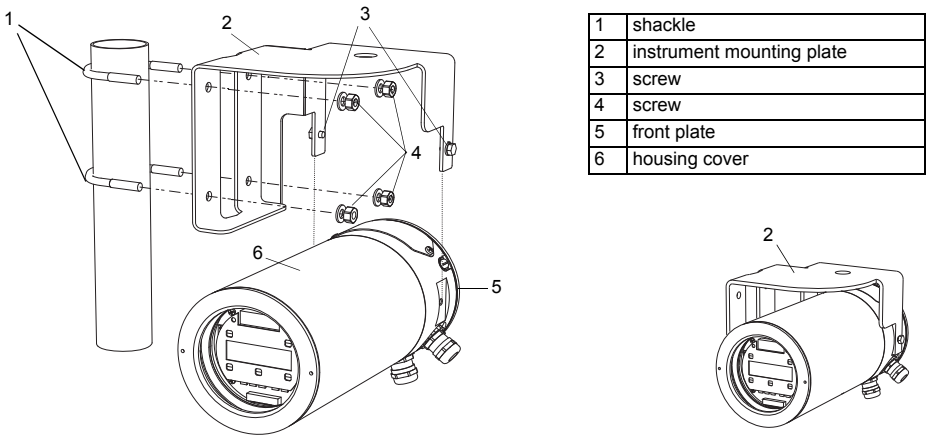
7.3.2 Pipe Installation

Installation on a 2" pipe

• Position the shackles (1) at the pipe (see Fig. 7.1).

• Fix the instrument mounting plate (2) to the shackles with the 4 screws (4).

• Fix the transmitter to the instrument mounting plate (2) with the 2 screws (3).



1	shackle
2	instrument mounting plate
3	screw
4	screw
5	front plate
6	housing cover

Fig. 7.1: Pipe mounting kit

7.4 Connection of the Transmitter

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

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

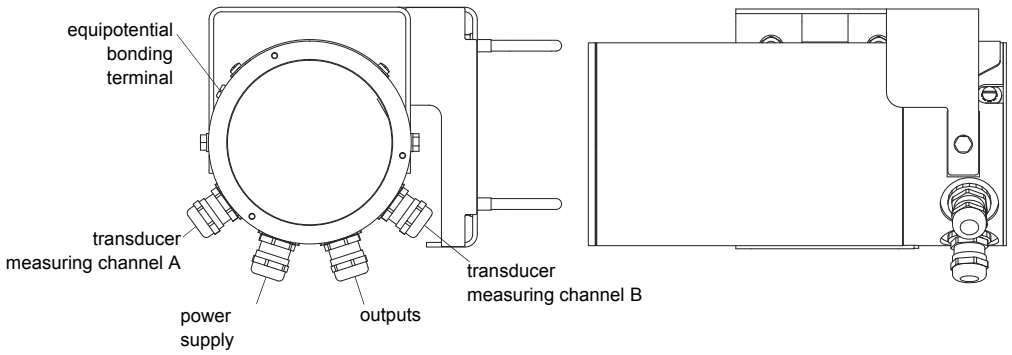
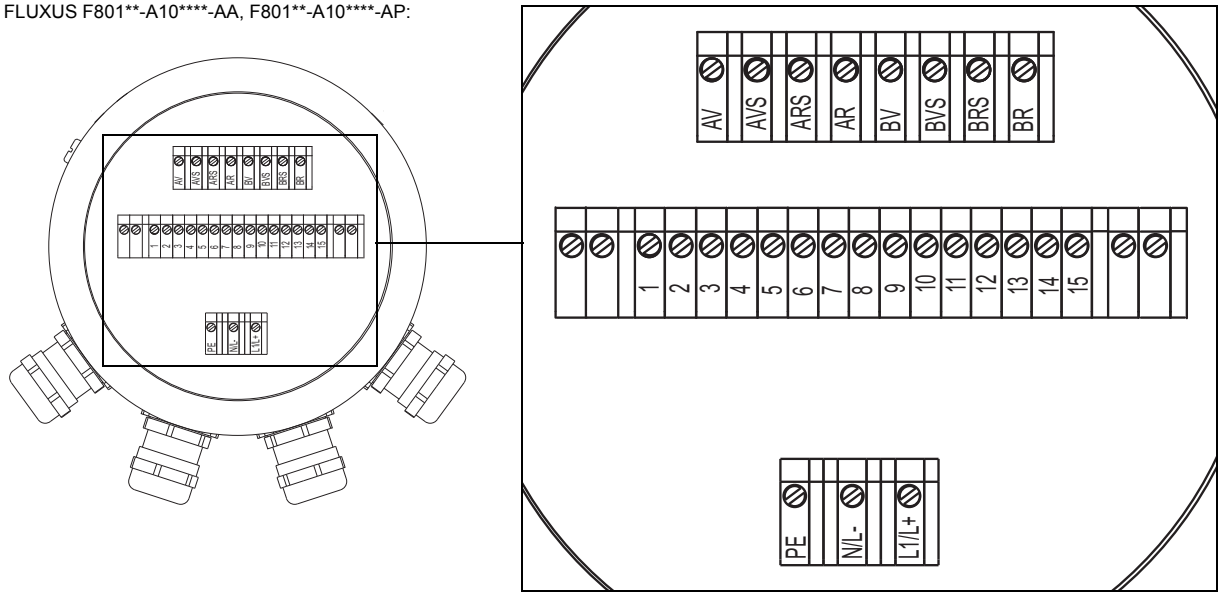


Fig. 7.2: Connections of the Transmitter

FLUXUS F801**-A10****-AA, F801**-A10****-AP:



FLUXUS F801C24, F801**-A10****-FF:

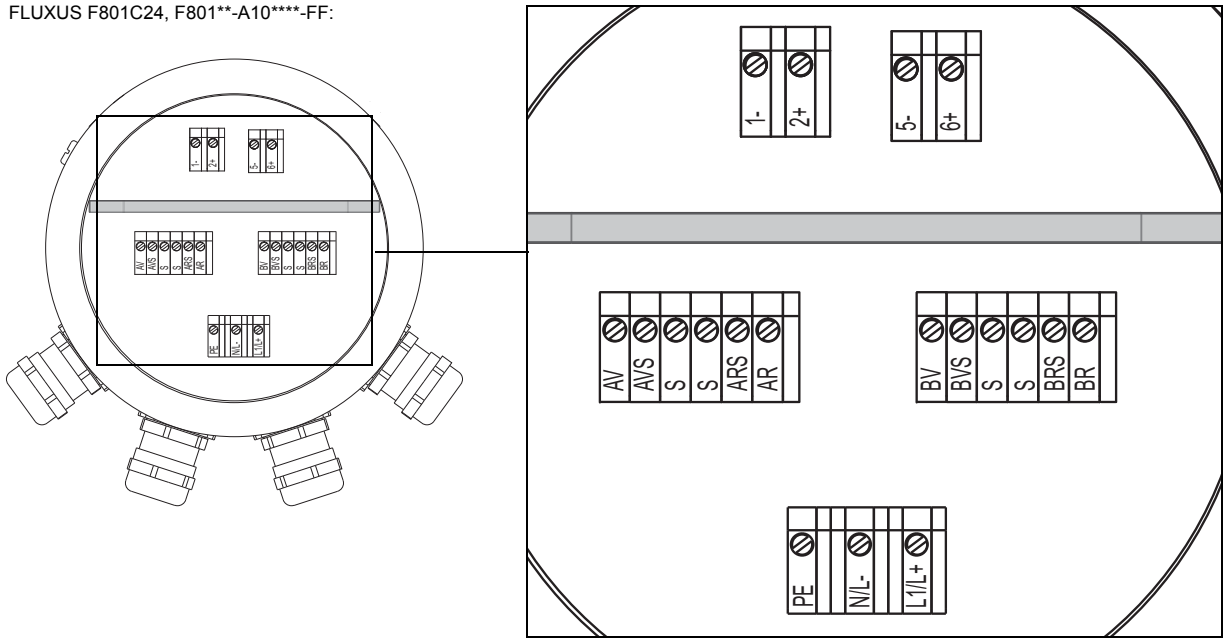


Fig. 7.3: Terminal designation of the transmitter

7.5 Connection of the Transducers

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 7.9).

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

Transducers with direct connection are already connected to the transmitter.

7.5.1 Connection of the Extension Cable to the Transmitter

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

The transmitter has 2 cable glands for the connection of the transducers. If the transmitter has only one measuring channel, one of the openings is closed with a blind plug.

- Remove the cable gland for the connection of the transducers (see Fig. 7.2).
- Open the cable gland. The compression part remains in the cap nut (see Fig. 7.4).

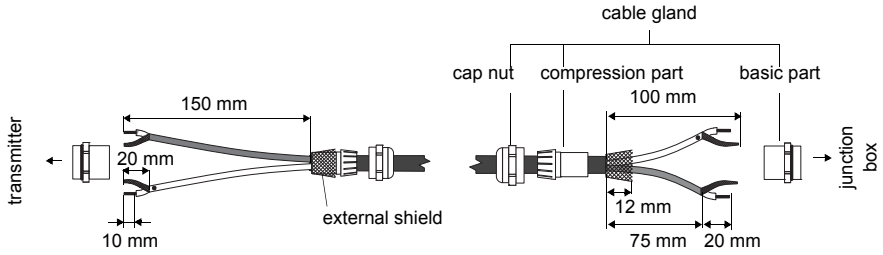


Fig. 7.4: Preparation of the extension cable

- Push the extension cable through the cap nut, the compression part and the basic part of the cable gland.
- 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 (see Fig. 7.4).
- Cut the external shield of the transducer cable and brush it back.
- Insert the end of the extension cable into the housing.
- Screw the gasket ring side of the basic part into the housing.

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

- Fix the cable gland by screwing the cap nut onto the basic part (see Fig. 7.4).
- Connect the core and the shield correctly to the terminals of the transmitter (see Fig. 7.3, Fig. 7.5 and Tab. 7.1).

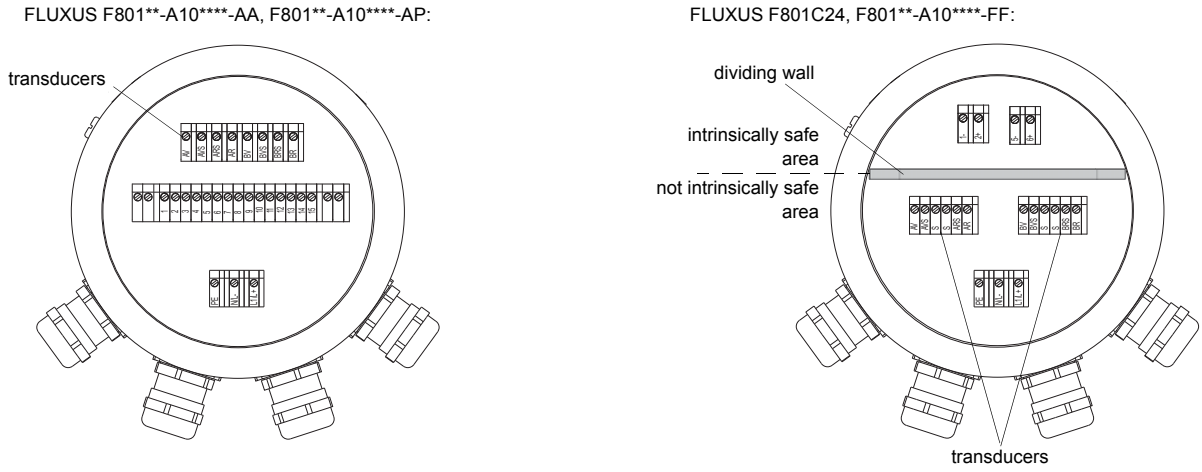


Fig. 7.5: Terminals for the connection of the transducers (extension cable)

Tab. 7.1: Terminal assignment (extension cable)

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

7.5.2 Connection of the Extension Cable to the Junction Box

7.5.2.1 Connection without potential separation (standard)

The connection of the extension cable to the junction box without potential separation ensures that transducer, junction box and transmitter are on the same potential. The extension cable should always be connected in this manner especially if there are power current cables nearby the extension cable.

If earthing on the same potential cannot be ensured, see section 7.5.2.2.

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

- Remove the left blind plug for the connection of extension cable (see Fig. 7.6).
- 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.

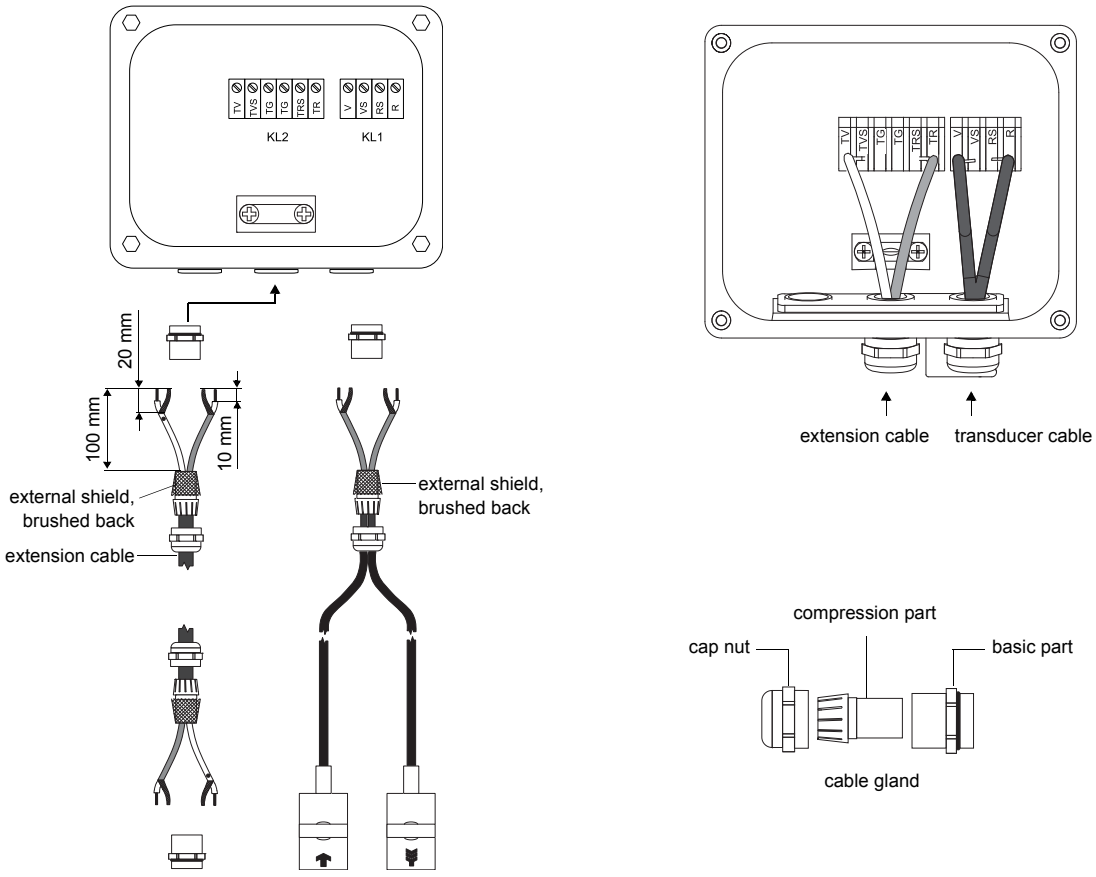


Fig. 7.6: Connection of the extension and transducer cable to the junction box JB01

• Prepare the extension cable.
• Cut the external shield and brush it back over the compression part.
• Screw the gasket ring side of the basic part into the junction box.
• Insert the extension cable into the junction box.

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

• Fix the cable gland by screwing the cap nut onto the basic part.
• Connect the extension cable to the terminals of the transmitter (see Fig. 7.6 and Tab. 7.2).

Tab. 7.2: Terminal assignment (extension cable, KL2)

terminal	**connection**
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

For the terminal assignment of the transducer cable see Fig. 7.6 and Tab. 7.5.

Tab. 7.3: Terminal assignment (transducer cable)

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

7.5.2.2 Connection with potential separation

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

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

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

- Remove the left blind plug for the connection of extension cable (see Fig. 7.7).
- 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.

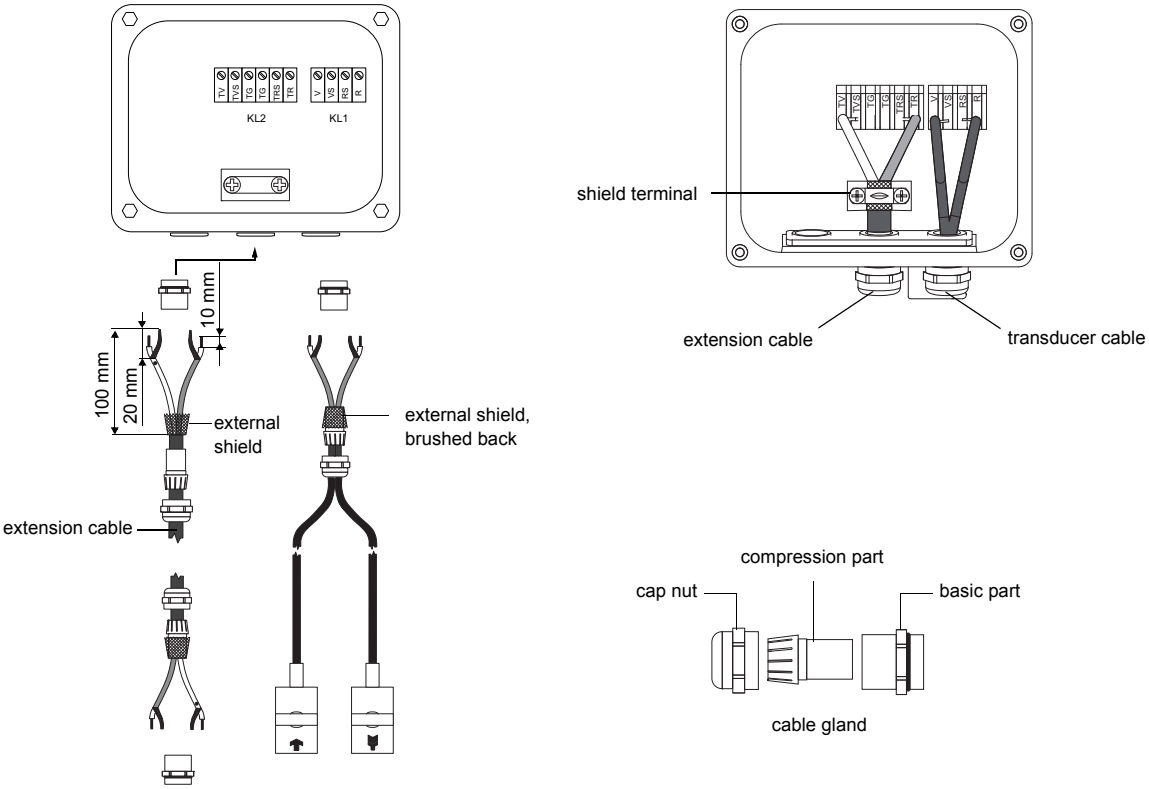


Fig. 7.7: Connection of the extension and transducer cable to the junction box JB01

• Insert the extension cable into the junction box.
• Prepare the extension cable.
• Cut the outer shield to length and brush it back.
• Pull the extension cable back until the brushed back external shield is below the shield terminal (see Fig. 7.7). The extension cable has to remain completely insulated up to the shield terminal.
• Screw the gasket ring side of the basic part into the junction box.
• Fix the cable gland by screwing the cap nut onto the basic part.

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

• Fix the extension cable and the external shield to the shield terminal.
• Connect the extension cable to the terminals of the transmitter (see Fig. 7.7 and Tab. 7.4).

Tab. 7.4: Terminal assignment (extension cable, KL2)

terminal	**connection**
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

For the terminal assignment of the transducer cable see Fig. 7.7 and Tab. 7.5.

Tab. 7.5: Terminal assignment (transducer cable)

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

7.6 Connection of the Power Supply

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

The external protective earth is connected to the equipotential bonding terminal on the housing of the transmitter (see Fig. 7.2).

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.

- Remove the cable gland for the connection of the power supply (see Fig. 7.2).
- Prepare the power cable with an M20 cable gland.
- Push the power cable through the cap nut, the compression part and the basic part of the cable gland (see Fig. 7.8).

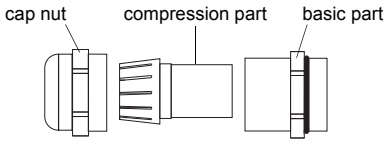


Fig. 7.8: Cable gland

- Insert the power cable into the housing (see Fig. 7.2).
- 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 leads to the terminals of the transmitter according to the voltage printed on the nameplate below the terminal strip KL1 (see Fig. 7.3, Fig. 7.9 and Tab. 7.6).

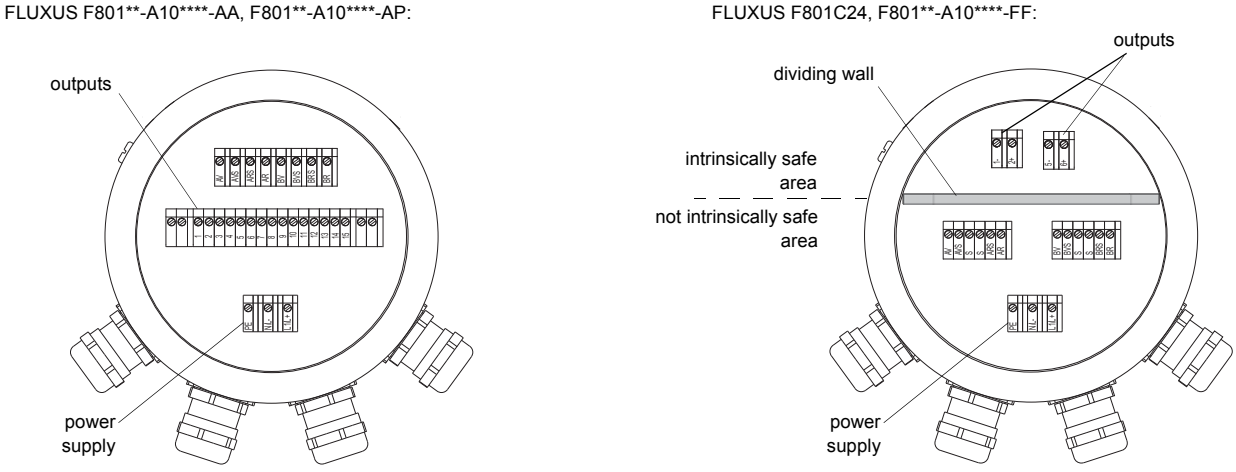


Fig. 7.9: Terminals for the connection of the power supply and the outputs

Tab. 7.6: Connection of the power supply

AC		DC	
terminal	**connection**	**terminal**	**connection**
PE	earth	PE	earth
N	neutral	L+	+ DC
L1	Phase 100…240 V AC	L-	- DC

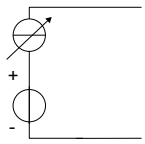
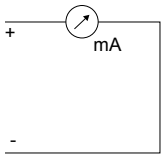
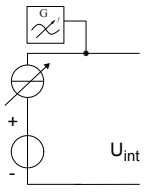
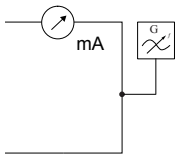
7.7 Connection of the Outputs

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

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

- Remove the cable gland for the connection of the outputs (see Fig. 7.2).
- Prepare the output cable with an M20 cable gland.
- Push the output cable through the cap nut, the compression part and the basic part of the cable gland (see Fig. 7.8).
- Insert the output cable into the housing.
- Screw the gasket ring side of the basic part into the housing.
- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the leads of the output cable to the terminals of the transmitter (see Fig. 7.3, Fig. 7.9 and Tab. 7.7).

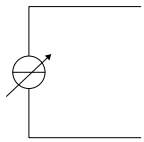
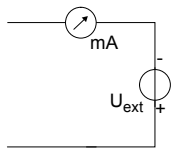
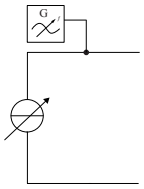
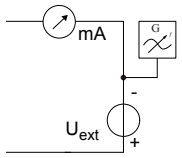
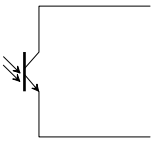
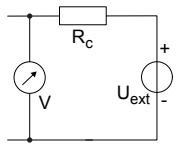
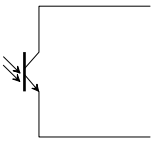
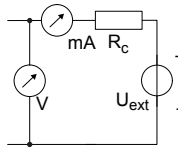
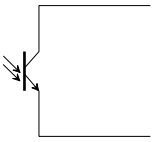
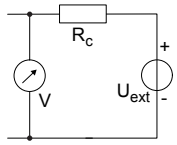
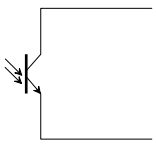
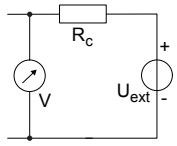
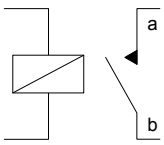
Tab. 7.7: Circuits of the outputs

output	**transmitter**		**external circuit**	**remark**
	internal circuit	**connection**		
active current loop/HART F801**-A10****-*A	current loop			
		I1/I2: 2/4 (+) I1/I2: 1/3 (-)		R_{ext} < 500 Ω current during transmitter error: I_{fault} ≈ 0 mA
	HART mode			
		I1: 2 (+) I1: 1 (-)		U_{int} = 24 V current during transmitter error: I_{fault} ≈ 0 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).

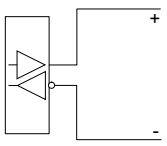
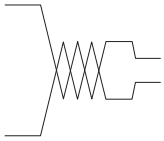
Tab. 7.7: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
passive current loop/HART F801**-A10****-*P	current loop			
		I1/I2: 1/3 (-) I1/I2: 2/4 (+)		U_{ext} = 4...26.4 V U_{ext} > 0.021 A · R_{ext} [Ω] + 4 V example: U_{ext} = 12 V R_{ext} = 0…380 Ω current during transmitter error: I_{fault} ≈ 0 mA
	HART mode			
		I1: 1 (-) I1: 2 (+)		U_{ext} = 10...24 V current during transmitter error: I_{fault} ≈ 0 mA
frequency output (open collector) F801**-A10****-FF		F1: 2 (+) F1: 1 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} = 0.8 mA
frequency output (open collector) F801**-A10****-FF		F1: 2 (+) F1: 1 (-)		U_{ext} = 8.2 V R_c = 1 kΩ DIN EN 60947-5-6 (NAMUR)
binary output (open collector) F801**-A10****-FF		B1: 6 (+) B1: 5 (-)		U_{ext} = 5...30 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 2...100 mA I_{off} = 0.8 mA
binary output (open collector) F801**-A10****-*A F801**-A10****-*P		B1...B4: 6/8/10/12 (+) B1...B4: 5/7/9/11 (-)		U_{ext} = 5...24 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA
binary output (Reed relay) F801**-A10****-*A F801**-A10****-*P		B3/B4: 9/11 B3/B4: 10/12		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. 7.7: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
RS485 F801**-A10****-*A F801**-A10****-*P		14 (A+) 13 (B-) 15		120 Ω termination resistor

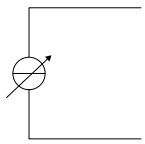
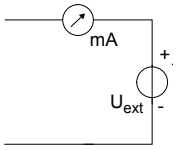
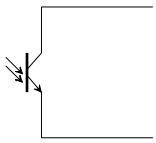
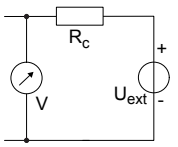
The number, type and connections of the outputs are customized.

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

7.7.1 Intrinsically Safe Current Output Ex ib

The current output may be fed with max. 28.2 V DC/0.76 W.

Tab. 8: Circuit of the current output Ex ib

output	transmitter		external circuit	remark
	internal circuit	connection		
passive current loop Ex ib F801C24		I1: 2 (+) I1: 1 (-)		U_i = 28.2 V, P_i = 0.76 W U_{ext} = 4...28.2 V U_{ext} > 0.021 A . R_{ext} [Ω] + 4 V example: U_{ext} = 12 V R_{ext} ≤ 380 Ω
binary output (open collector) F801C24		B1: 6 (+) B1: 5 (-)		U_i = 28.2 V, P_i = 0.76 W U_{ext} = 5...28.2 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA

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

If the transmitter is disconnected from the power supply during the measurement:
- the passive current output continues being powered thanks to an external power supply
- the last measured value is output.

In order to check the function of the transmitter:
- the binary output is installed and activated
- the binary output is used as an alarm output.

For the installation and activation of the binary output see chapter 18.

Recommended configuration of the alarm output

`func` (switching condition)	`ERROR`
`type` (holding behavior)	`HOLD (NON-HOLD)`
`mode` (switching function)	`NC CONT.`

If the transmitter is disconnected from the power supply, the binary output indicates an alarm state.

7.8 Connection of the Serial Interface

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

The RS232 interface can only be connected outside of an explosive atmosphere because the housing has to be opened (see Fig. 7.1).

- Insert the RS232 adapter into the socket in such way that the colored lead of the cable is on the marked side of the socket.
- Connect the RS232 cable to the RS232 adapter.
- Connect the RS232 cable to the transmitter and to the serial interface of the PC. If the RS232 cable cannot be connected to the PC, use the RS232/USB adapter.

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

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

The transmitter can also be equipped with an RS485 interface (optional). For the connection see section 7.7.

For further information on the data transmission see chapter 14.

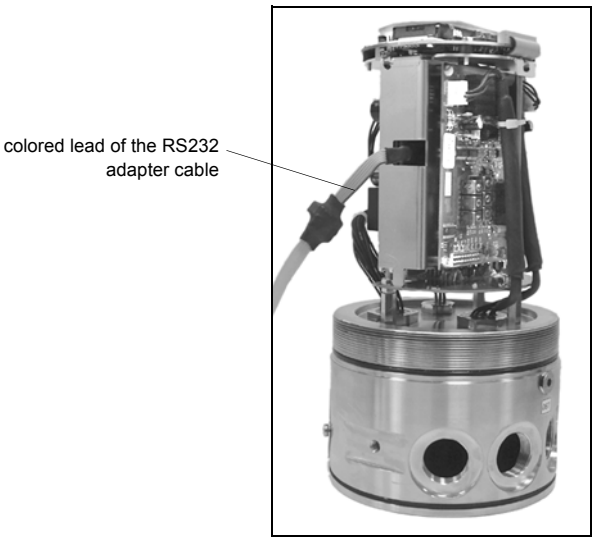


Fig. 7.1: RS232 interface of FLUXUSF801

7.9 Sensor Module (SENSPROM)

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

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

• Insert the sensor module into the socket of the measuring channel to which new transducers have to be connected.

8 Installation of FLUXUS ADM 8127B

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

8.1 Location

• Select the measuring point according to the recommendations in chapter 3 and 5.

• Select the location of the transmitter within the range of the cable 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.

8.2 Opening and Closing the Housing

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

The transmitter has a countersunk screw which has to be unscrewed before the housing can be opened.

After the installation, make sure that the housing is closed correctly and that the countersunk screw is tightened.

8.3 Installation

8.3.1 Wall Installation

• Fix the instrument mounting plate (2) to the wall with the 4 screws (4) (see Fig. 8.1).

• Fix the transmitter to the instrument mounting plate (2) with the 2 screws (3).

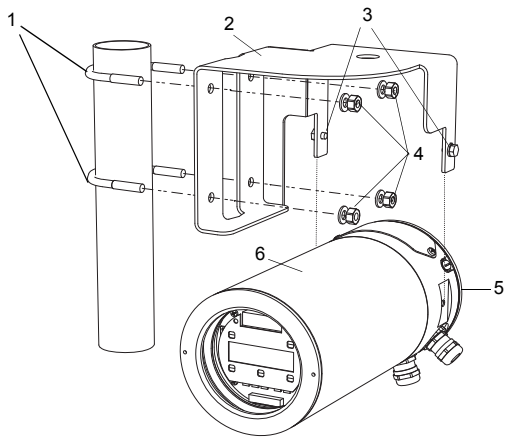
8.3.2 Pipe Installation

Installation on a 2" pipe

• Position the shackles (1) at the pipe (see Fig. 8.1).

• Fix the instrument mounting plate (2) to the shackles with the 4 screws (4).

• Fix the transmitter to the instrument mounting plate (2) with the 2 screws (3).



1	shackle
2	instrument mounting plate
3	screw
4	screw
5	front plate
6	housing cover

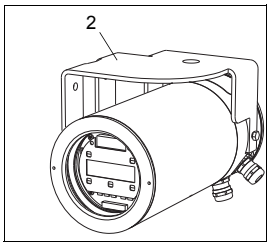


Fig. 8.1: Pipe mounting kit

8.4 Connection of the Transmitter

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

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

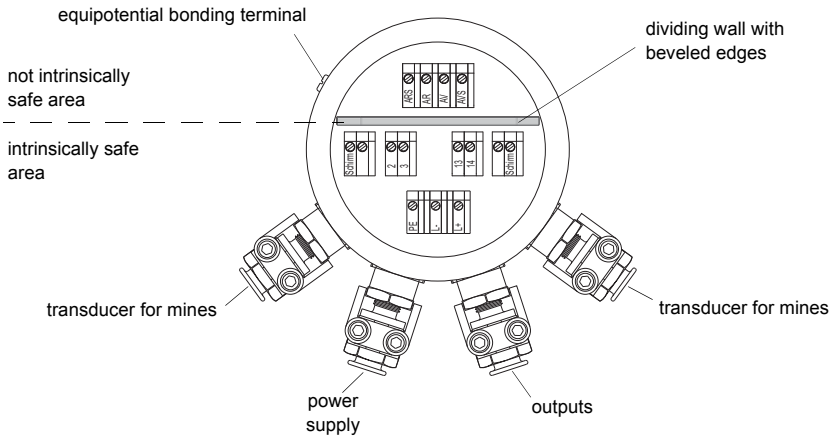


Fig. 8.2: Connections of the Transmitter

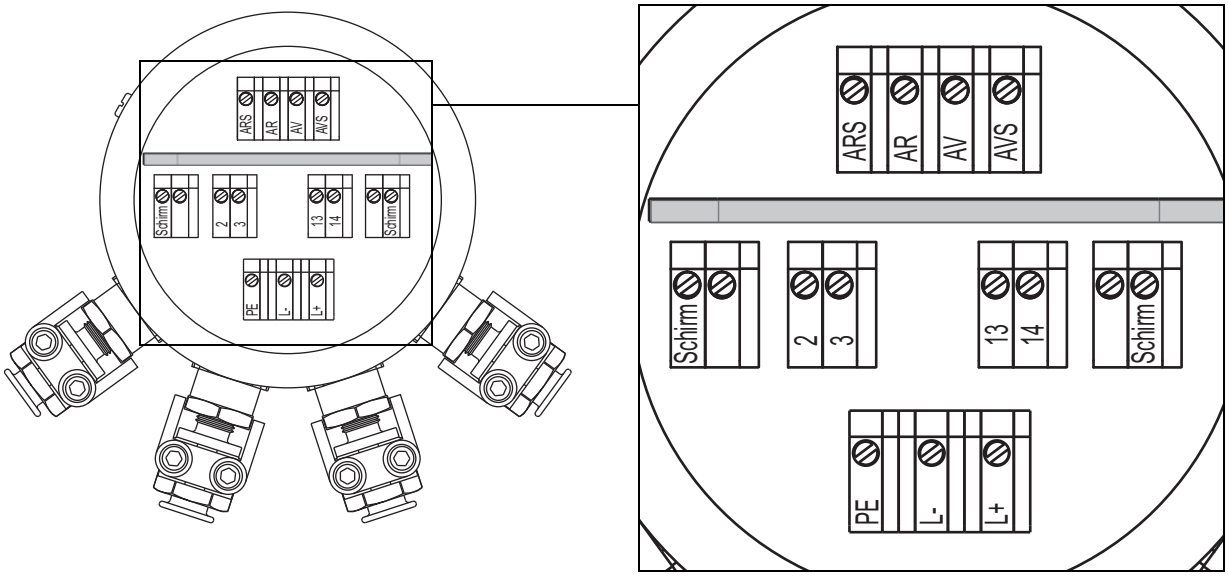


Fig. 8.3: Terminal designation of the transmitter

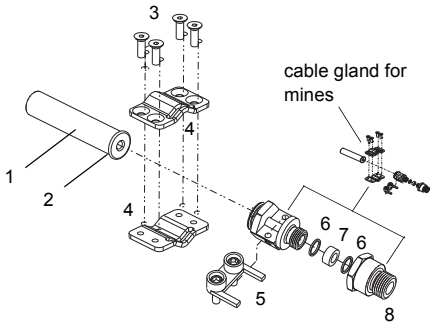
8.5 Connection of the Transducers for Mines

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

Note!	If transducers are replaced or added, the sensor module also has to be replaced or added (see section 8.8).

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

- Remove the cable gland for mines M16 for the connection of the transducers (see Fig. 8.2).
- Open the cable gland for mines (see Fig. 8.4).
- Prepare the transducer cable if necessary.
- Remove as little of the insulation as possible when stripping the cable. After the connection has been established, the insulation has to cover the lead up to the terminal.
- Push the end of the transducer cable with the stripped leads through the hose flange (2), screwed socket (5), compression rings (6), sealing ring (7) and gland body (8) into the housing (see Fig. 8.4).
- Push the hose flange (2) into the cable protection hose (1).
- Screw the gland body (8) into the housing.
- Fix the screwed socket (5) and the gland body (8) with the clamp by firmly tightening the screws of the clamp.
- Fix the cable protection hose (1) at the cable gland for mines with the hose clamp (4) by tightening the screws firmly (see Fig. 8.4).



1	cable protection hose
2	hose flange
3	screw
4	hose clamp

cable gland for mines consisting of:

5	screwed socket with clamp
6	compression ring
7	sealing ring
8	gland body

Fig. 8.4: Cable gland for mines M16

- Insert the cables via the beveled edges of the dividing wall into the not intrinsically safe area of the connection compartment (see Fig. 8.5).

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

- Connect the leads to the terminals of the transmitter. The stripped twisted end of the external shield that is to be connected to the terminal has to be as short as possible (see Fig. 8.3, Fig. 8.5 and Tab. 8.1).

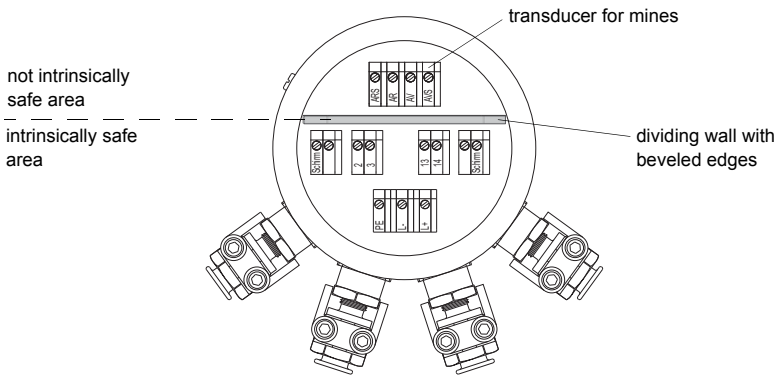


Fig. 8.5: Terminals for the connection of the transducer for mines

Tab. 8.1: Terminal assignment (transducer cable)

terminal	connection
AVS	marked cable (internal shield)
AV	marked cable (core)
AR	unmarked cable (core)
ARS	unmarked cable (internal shield)
shield	marked cable and unmarked shield (external shield)

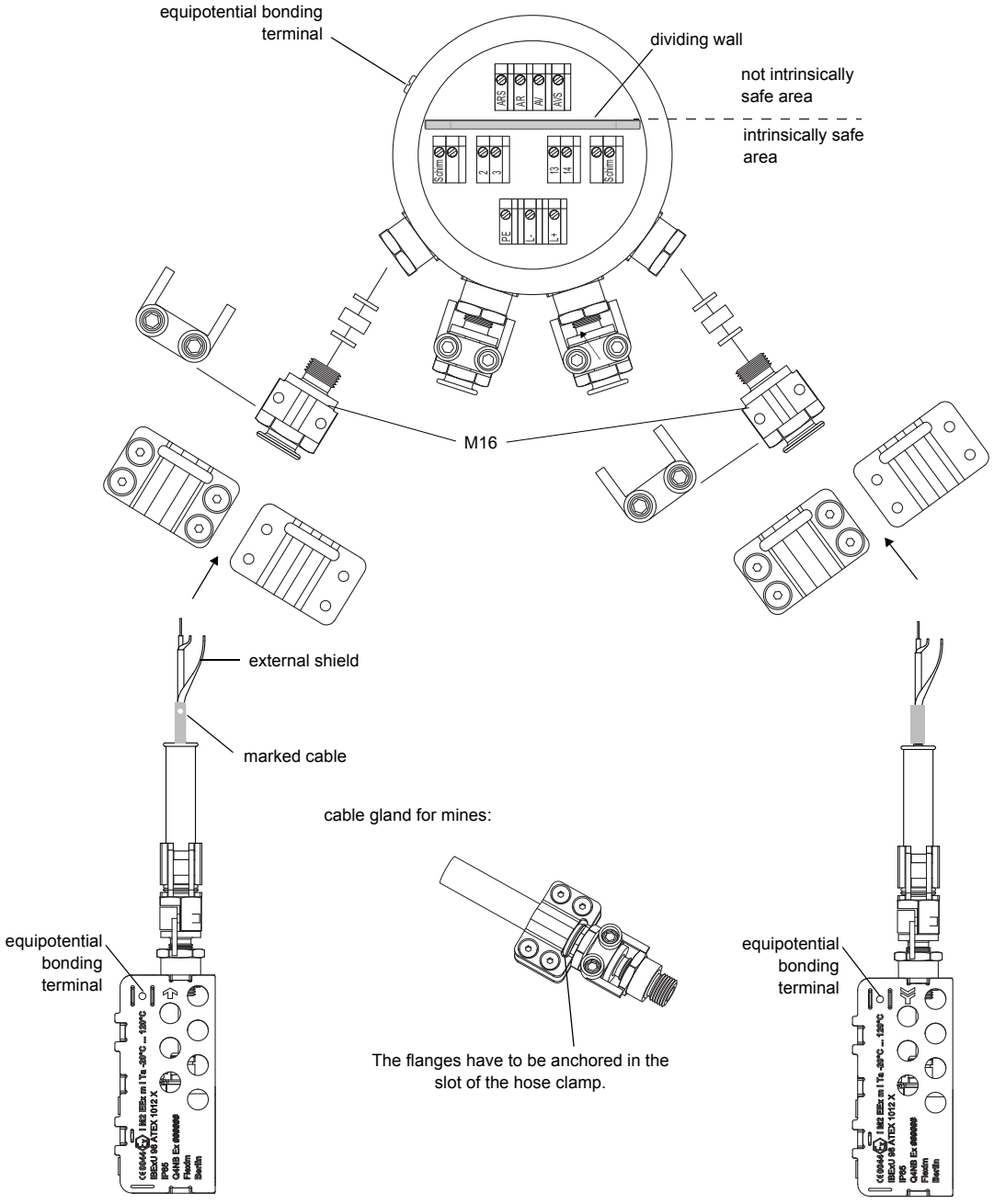


Fig. 8.6: Connection of the transducers for mines to the transmitter

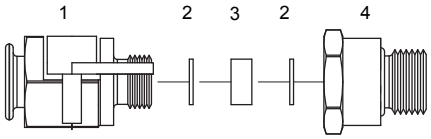
8.6 Connection of the Power Supply

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

The external protective earth is connected to the equipotential bonding terminal on the housing of the transmitter (see Fig. 8.2).

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.

- Select the cable gland for mines for the connection of the power supply. After the installation, the cable has to fit firmly in the cable gland for mines:
  - M25 (9/12) for cable diameters 9...12 mm
  - M25 (14/16) for cable diameters 14...16 mm
- Prepare the power cable with the cable gland for mines.
- Remove as little of the insulation as possible when stripping the cable. The insulation has to cover the lead up to the terminal.
- Push the power cable through the screwed socket (1), the compression rings (2), the sealing ring (3) and the gland body (4) (see Fig. 8.7).



1	screwed socket with clamp
2	compression ring
3	sealing ring
4	gland body

Fig. 8.7: Cable gland for mines M25

- Insert the power cable into the housing.
- Screw the gland body (4) into the housing (see Fig. 8.7).
- Fix the screwed socket (2) and the gland body (4) with the clamp by firmly tightening the screws of the clamp.

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

- Connect the leads to the terminals of the transmitter (see Fig. 8.3, Fig. 8.8 and Tab. 8.2).

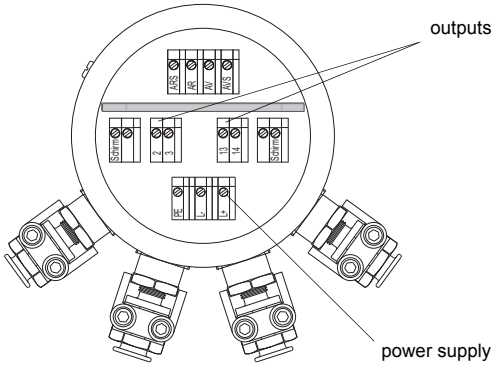


Fig. 8.8: Terminals for the connection of the power supply and the outputs

Connection of the FLUXUS ADM 8127B

Tab. 8.2: Connection of the intrinsically safe power supply

terminal	connection
PE	earth
L+	12 V DC (+), U_i = 13.2 V
L-	12 V DC (-), U_i = 13.2 V

Connection according to IBExU07ATEX1061 (system: power supply unit - cable - transmitter)

FLUXUS ADM 8127B has an ATEX certified system approval:

⟨Ex⟩ IM2 SYST Ex ib I
-20 °C ≤ Ta ≤ 50 °C
IBExU07ATEX1061

The system approval allows the connection of

– transmitter FLUXUS ADM 8127B
– power supply FHF Bergbautechnik NG3-12ib
– approved cable (max. 80 m) type L-YY(ZG)Y-2x2x0.5-60V-blue or type L-2YYC(ZG)Y-2x2x0.5

• Connect the protective earth to the terminal PE of FLUXUS ADM 8127B (see Tab. 8.3).
• Connect the approved cable to the terminals of the FLUXUS ADM 8127B and the terminals of the power supply unit.

Tab. 8.3: Connection according to IBExU07ATEX1061

terminal	connection
PE	earth
L+	terminal (+) on the power supply
L-	terminal (-) on the power supply

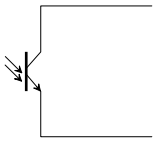
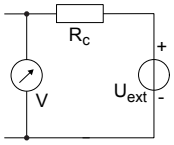
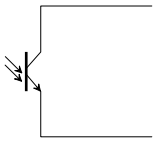
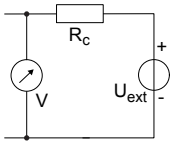
For a drawing of the system see annex E.

8.7 Connection of the Outputs

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

• Select the cable gland for mines for the connection of the outputs. After the installation, the cable has to fit firmly in the cable gland for mines:
  – M25 (9/12) for cable diameters 9...12 mm
  – M25 (14/16) for cable diameters 14...16 mm
• Prepare the output cable with the cable gland for mines.
• Remove as little of the insulation as possible when stripping the cable. The insulation has to cover the lead up to the terminal.
• Push the output cable through the screwed socket (1), the compression rings (2), the sealing ring (3) and the gland body (4) (see Fig. 8.7).
• Insert the output cable into the housing.
• Screw the gland body (4) into the housing (see Fig. 8.7).
• Fix the screwed socket (1) and the gland body (4) to the clamp by firmly tightening the screws of the clamp.
• Connect the leads to the terminals of the transmitter (see Fig. 8.3, Fig. 8.8 and Tab. 8.3).

Tab. 8.4: Circuits of the outputs

output	transmitter		external circuit	remark
	internal circuit	connection		
binary output (open collector)		B1: 14 B1: 13		U_i = 13.2 V U_{ext} = 5...12 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA
frequency output (open collector)		F1: 3 F1: 2		U_i = 13.2 V U_{ext} = 5...12 V R_c [kΩ] = U_{ext}/I_c [mA] I_c = 1...4 mA

8.8 Sensor Module (SENSPROM)

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

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

• Insert the sensor module into the socket of the measuring channel to which new transducers have to be connected.

9 Mounting of the Transducers

9.1 Preparation of the Pipe

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

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

• Clean the pipe at the selected measuring point:
  – If present, the paint layer has to be smoothed by sanding. The paint does not need to be removed completely.
  – Remove any rust or loose paint.
• Use coupling foil or apply a bead of acoustic coupling compound along the center line of the contact surface of the transducers.
• Observe that there must be no air pockets between the transducer contact surface and the pipe wall.

9.2 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. 9.1 and Fig. 9.2). 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. 9.1) and for the transducers for mines the distance between the marks on the transducers shoe (see Fig. 9.2).

For the determination of the flow direction see section 11.8.

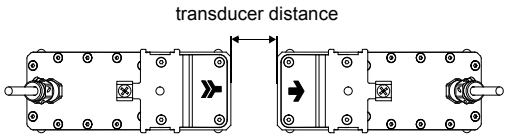


Fig. 9.1: Correct orientation of the transducers and transducer distance

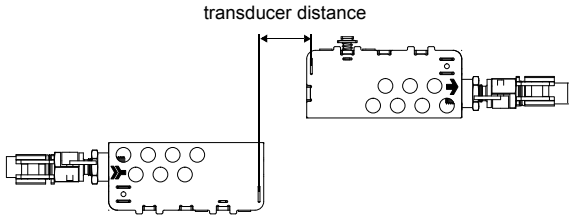


Fig. 9.2: Correct positioning of the transducers for mining and transducer distance

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

• Variofix L: see section 9.3
• Variofix C: see section 9.4
• Transducer for mines and FLEXIM clasp for mines: see section 9.5

9.3 Transducer Mounting Fixture Variofix L

When measuring in reflection arrangement, the transducer mounting fixtures are mounted on the same side of the pipe (see Fig. 9.3).

When measuring in diagonal arrangement, the transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 9.4).

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

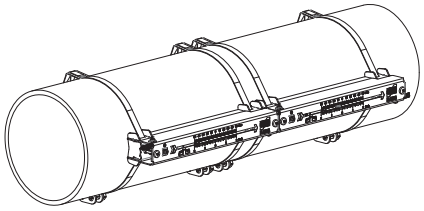


Fig. 9.3: Transducer mounting fixture Variofix L (reflection arrangement)

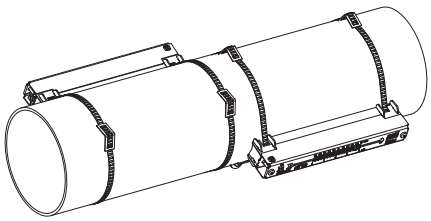


Fig. 9.4: Transducer mounting fixture Variofix L (diagonal arrangement)

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

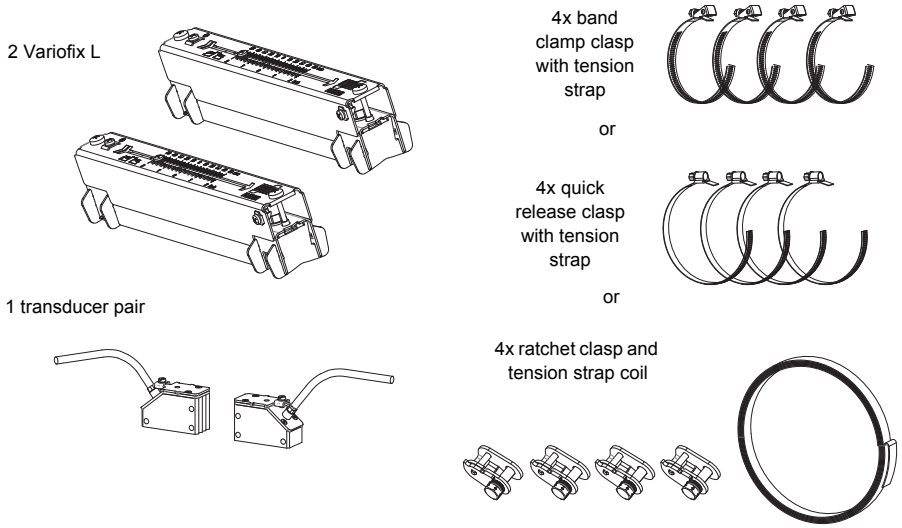


Fig. 9.5: Scope of delivery

If the transducer distance is small and when measuring in reflection arrangement, only one transducer mounting fixture has to be mounted (see Tab. 9.1).

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

Tab. 9.1: 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 rail [mm]**
Q	176	< 69
M, P	234	< 84 (Lamb wave transducers) < 100 (shear wave transducers)
G, H, K (all but ****LI*)	348	< 89
G, H, K (only ****LI*)	368	< 94

9.3.1 Disassembly of Variofix L

• Disassemble the transducer mounting fixture Variofix L (see Fig. 9.6).

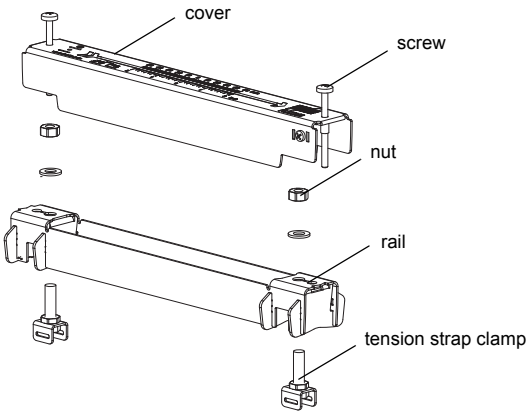


Fig. 9.6: Disassembly of Variofix L

9.3.2 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. 9.7).

Quick release clasp

The clasp is fixed to the tension strap (see Fig. 9.8).

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

Fig. 9.7: Band clamp clasp with tension strap

Fig. 9.8: 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. Remove the burr of the sharp edge.

• Insert approx. 100 mm of the tension strap into parts 1 and 2 of the clasp (see Fig. 9.9 a).
• Bend the tension strap.
• Insert the tension strap into part 1 of the ratchet clasp (see Fig. 9.9 b).
• Tighten the tension strap.
• Repeat the steps for the second tension strap.

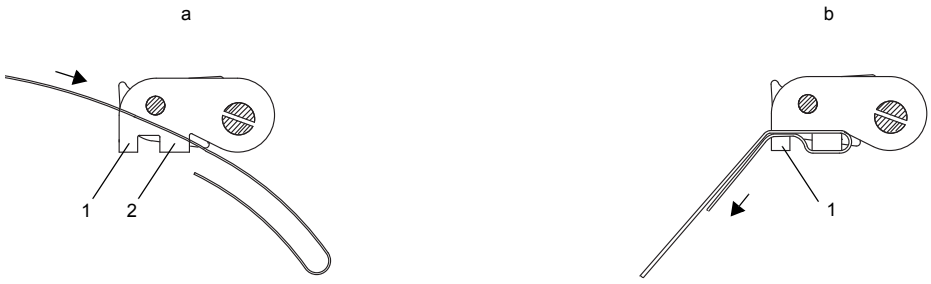


Fig. 9.9: Ratchet clasp with tension strap

9.3.3 Fixing the Tension Strap to the Pipe

One tension strap is fixed to the pipe (see Fig. 9.10). The second tension strap is mounted later.

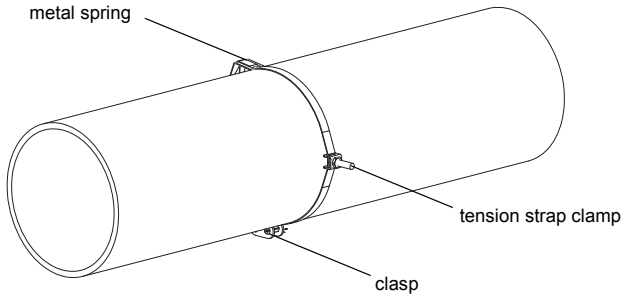


Fig. 9.10: Tension strap with tension strap clamp and metal spring on the pipe

Select the installation instructions of the supplied clasp:

Band clamp clasp

- Insert the tension strap into the tension strap clamp (see Fig. 9.11).
- Position the clasp and the tension strap clamp on the pipe (see Fig. 9.10).
  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. 9.13).
- 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. 9.11 and Fig. 9.12).
- Position the clasp, the metal spring and the tension strap clamp on the pipe (see Fig. 9.10):
  – 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.

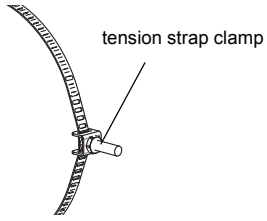


Fig. 9.11: Tension strap with tension strap clamp

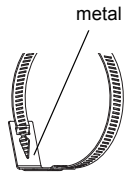


Fig. 9.12: Tension strap with metal spring

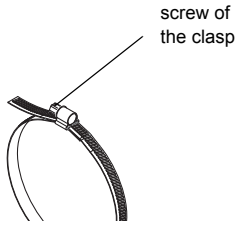


Fig. 9.13: Band clamp clasp with tension strap

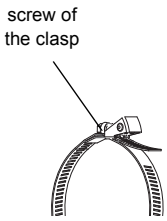


Fig. 9.14: Quick release clasp with tension strap

- Place the tension strap around the pipe and insert it into the clasp (see Fig. 9.14).
- Tighten the tension strap.
- Tighten the screw of the clasp.

Ratchet Clasp

- Insert the tension strap into the tension strap clamp and the metal spring (see Fig. 9.15). It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer pipe diameter < 80 mm or
  - on pipes that are not subjected to significant temperature fluctuations
- Position the clasp, the metal spring (if necessary) and the tension strap clamp on the pipe (see Fig. 9.10).
  - 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. 9.16).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 9.17).

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

- Tighten the screw of the clasp.

Fig. 9.15: Tension strap with the metal spring and the tension strap clamp

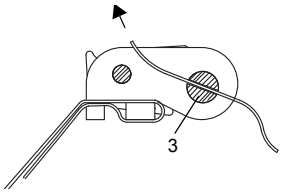


Fig. 9.16: Ratchet clasp with tension strap

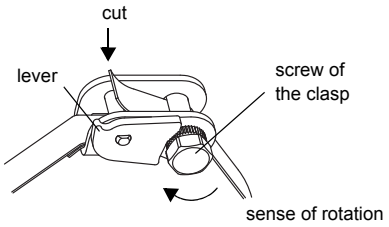


Fig. 9.17: Ratchet clasp with tension strap

Attention!	To release the screw and the tension strap, press the lever down (see Fig. 9.17).

9.3.4 Fixing the Rail to the Pipe

- Place one tension strap clamp in the rail (see tension strap clamp 1 in Fig. 9.18). 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. 9.19).
- Tighten the nut of tension strap clamp 2, but not too firmly in order not to damage the tension strap.

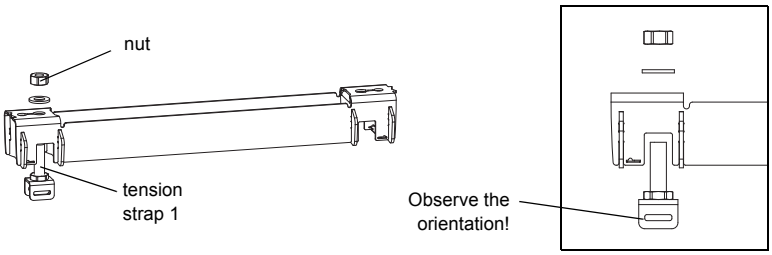


Fig. 9.18: Rail with tension strap clamp

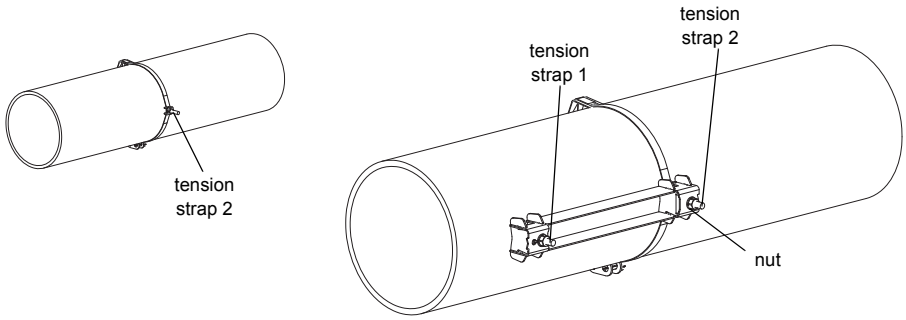


Fig. 9.19: Rail, mounted on one side of the pipe

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

Band clamp clasp

- Insert the tension strap into tension strap clamp 1 (see Fig. 9.20).
- Place the tension strap around the pipe and insert it into the clasp (see Fig. 9.21).
- 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. 9.20).

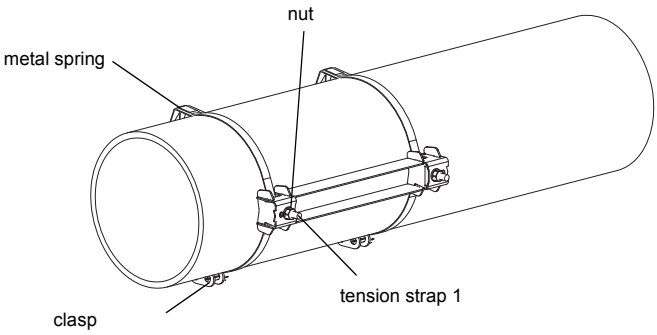


Fig. 9.20: Rail on the pipe

Quick release clasp

- Insert the tension strap into tension strap clamp 1 and the metal spring (see Fig. 9.22 and Fig. 9.20).
- 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. 9.20).

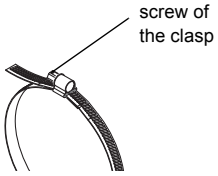


Fig. 9.21: Tension strap with band clamp clasp

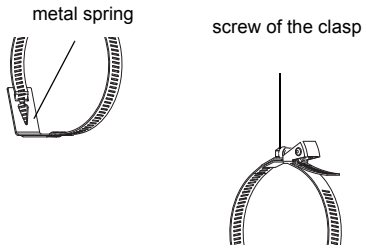


Fig. 9.22: Tension strap with quick release clasp and metal spring

Ratchet Clasp

- Insert the tension strap into tension strap clamp 1 and the metal spring (see Fig. 9.20 and Fig. 9.23). It is not necessary to mount the metal spring:
  - on steel pipes
  - on pipes with an outer pipe diameter < 80 mm or
  - on pipes that are not subjected to significant temperature fluctuations
- Position the clasp, the metal spring (if necessary) and tension strap clamp 1 on the pipe. Mount the metal spring on the opposite side of the tension strap clamp.
- Place the tension strap around the pipe and insert it into part 3 of the clasp (see Fig. 9.24).
- Tighten the tension strap.
- Cut off the protruding tension strap (see Fig. 9.25).

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

- Tighten the screw of the clasp.
- Tighten the nut of tension strap clamp 1, but not too firmly in order not to damage the tension strap (see Fig. 9.20).

Fig. 9.23: Tension strap with the metal spring and the tension strap clamp

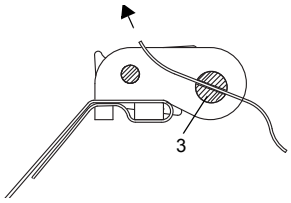


Fig. 9.24: Ratchet clasp with tension strap

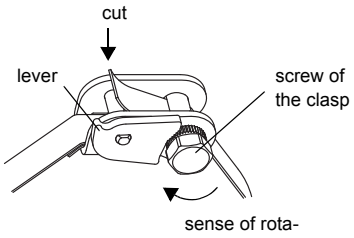


Fig. 9.25: Ratchet clasp with tension strap

Note!	To release the screw and the tension strap, press the lever down (see Fig. 1.21).

• Repeat the steps for fixing the second rail (see Fig. 9.26).

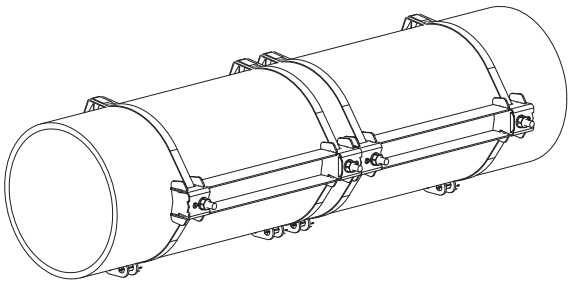


Fig. 9.26: Pipe with two rails

9.3.5 Installation of the transducers in Variofix L

• Press the transducers firmly on the transducer clamping fixture in the covers until the transducers are firmly fixed (one transducer in each cover). The transducer cables show in opposite directions (see Fig. 9.27).

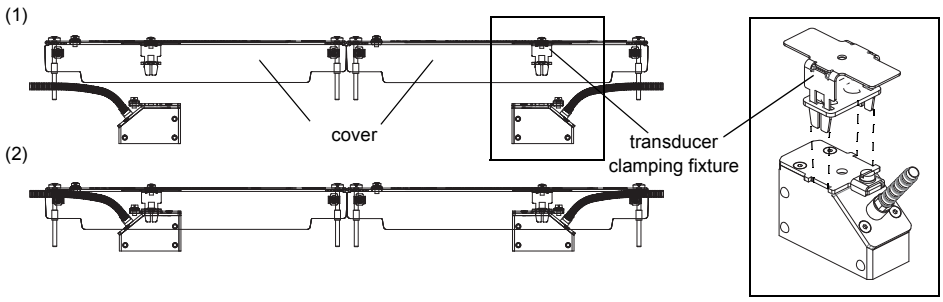


Fig. 9.27: Transducers in the cover

• Adjust the transducer distance displayed by the transmitter (see section 11.6 and Fig. 9.28).

• Fix the cables of the transducers with the strain relief clamp to protect them from mechanical strain (see Fig. 9.28).

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

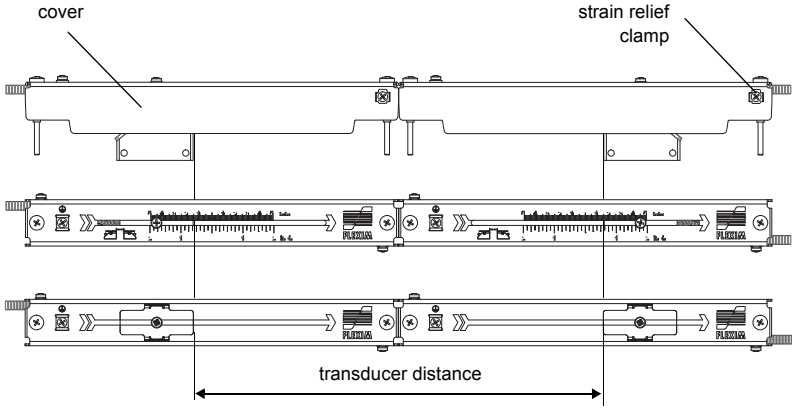


Fig. 9.28: Adjustment of the transducer distance

• Put the covers with the transducers on the rail.

• Correct the transducer distance, if necessary (see section 11.6.1 and 11.6.2).

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

• Tighten the screws of the cover (see Fig. 9.29).

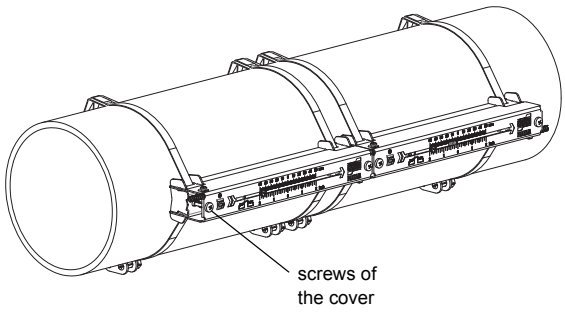


Fig. 9.29: Transducers with Variofix L on the pipe

9.4 Installation with Variofix C

When measuring in reflection arrangement, one transducer mounting fixture is mounted on the side of the pipe (see Fig. 9.30).

When measuring in diagonal arrangement, two transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 9.31).

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

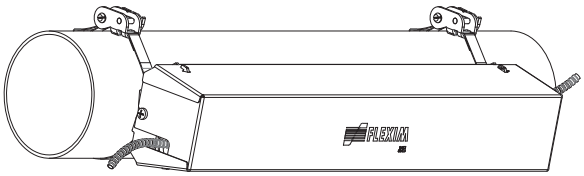


Fig. 9.30: Transducer mounting fixture Variofix C (reflection arrangement)

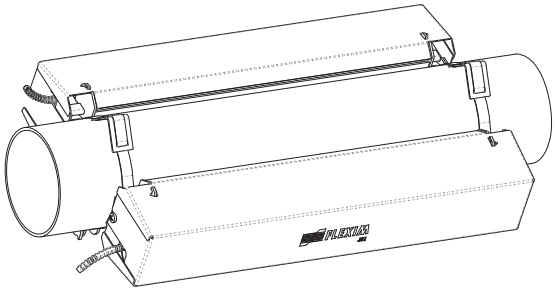


Fig. 9.31: Transducer mounting fixture Variofix C (diagonal arrangement)

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

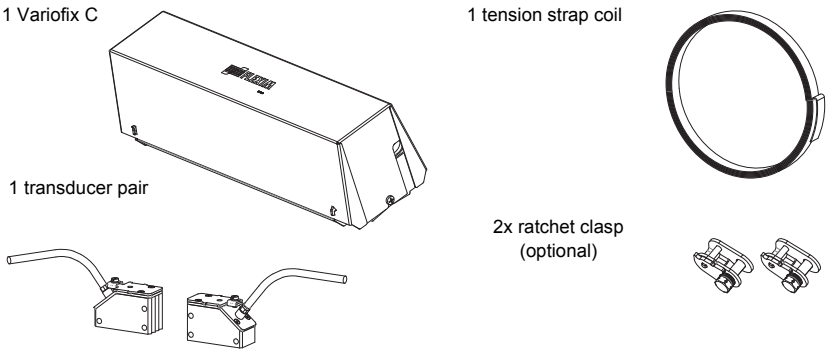


Fig. 9.32: Scope of delivery

9.4.1 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. 9.33).

In order to remove the spring clip from the rail, slide it over the indentation on the rail and lift it off (see Fig. 9.34).

Fig. 9.33: Removal of the cover

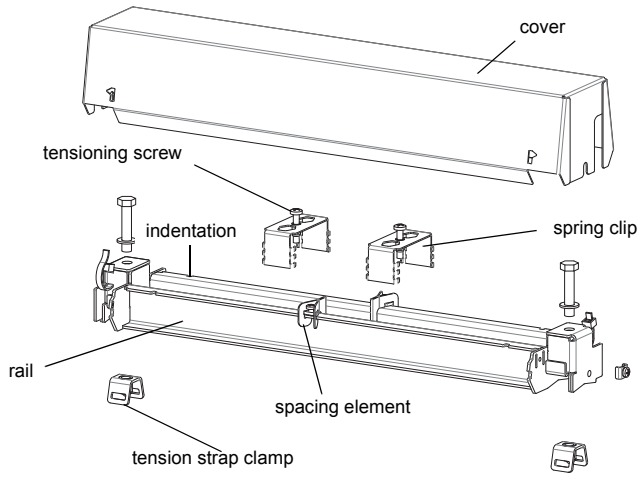


Fig. 9.34: Disassembly of Variofix C

9.4.2 Installation of the Rail

Select the installation instructions of the supplied clasp:

• see section Installation of the rail without a clasp

• see section Installation of the rail with the ratchet clasp

Installation of the rail without a clasp

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

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

• Insert approx. 100 mm of the tension strap into one of the slots of the tension strap clamp and bend it (see Fig. 9.35).

• If necessary, insert the long end of the tension strap into the metal spring (see Fig. 9.36). It is not necessary to mount the metal spring:
  – on steel pipes
  – on pipes with an outer pipe diameter < 80 mm or
  – on pipes that are not subjected to significant temperature fluctuations

• Place the tension strap around the pipe (see Fig. 9.37).

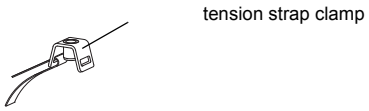


Fig. 9.35: Tension strap with tension strap clamp

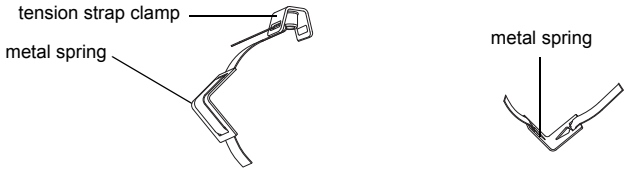
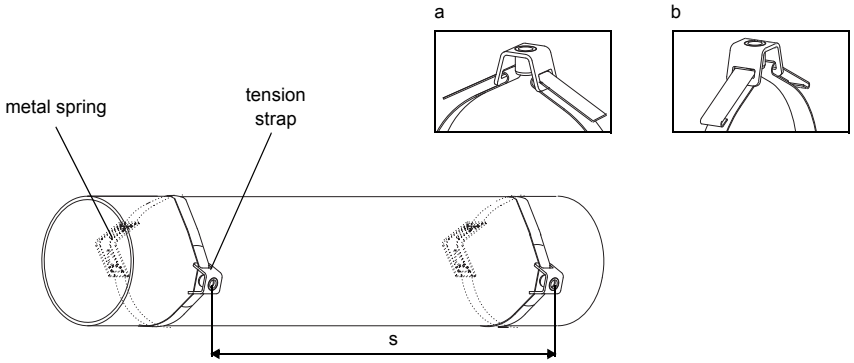


Fig. 9.36: Tension strap with the metal spring and the tension strap clamp

- Position the metal spring (if mounted) and the tension strap clamp (see Fig. 9.37):
  - 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. 9.37: Tension strap with the metal spring and the 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. 9.37 a).
- Tighten the tension strap and bend it.
- Bend both ends of the tension strap (see Fig. 9.37 b).
- Repeat the steps for the second tension strap. Position the tension strap at the distance s (see Fig. 9.37).
- Put the rail on the tension strap clamps.
- Use the screws to fix the rail to the tension strap clamps (see Fig. 9.38).
- Tighten the screws.

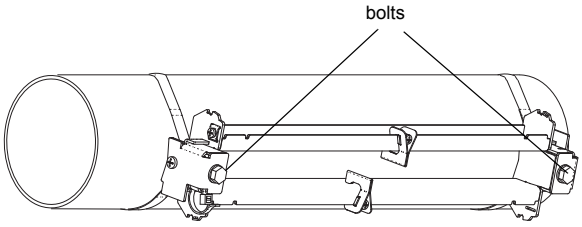


Fig. 9.38: Rail on the pipe

Installation of the rail with the ratchet clasp

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

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

• Insert approx. 100 mm of the tension strap into parts 1 and 2 of the ratchet clasp (see Fig. 9.39 a).

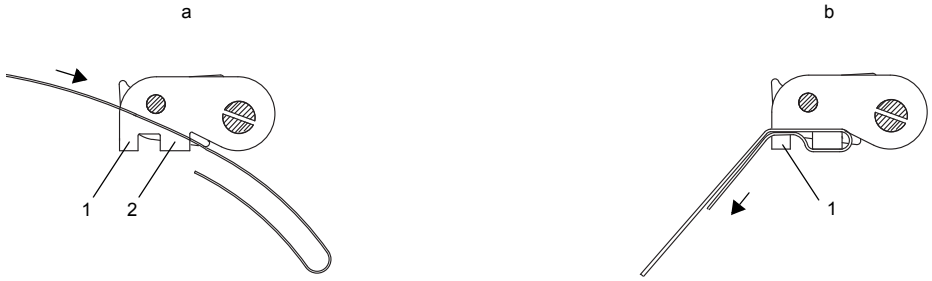


Fig. 9.39: Ratchet clasp with tension strap

• Bend the tension strap.
• Insert the tension strap into part 1 of the ratchet clasp (see Fig. 9.39 b).
• Tighten the tension strap.
• Insert the long end of the tension strap into the tension strap clamp and the metal spring (see Fig. 9.40). It is not necessary to mount the metal spring:
  – on steel pipes
  – on pipes with an outer pipe diameter < 80 mm or
  – on pipes that are not subjected to significant temperature fluctuations
• Place the tension strap around the pipe (see Fig. 9.41).

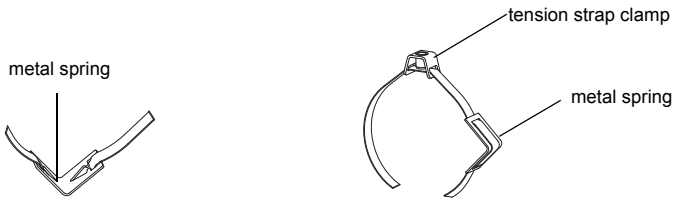


Fig. 9.40: Tension strap with the metal spring and the tension strap clamp

• Position the metal spring (if mounted), the ratchet clasp and the tension strap clamp:
  – On a horizontal pipe, mount the tension strap clamp on the side of the pipe, if possible.
  – Mount the metal spring (if necessary) on the opposite side of the tension strap clamp.
• Insert the long end of the tension strap into part 3 of the ratchet clasp (see Fig. 9.42).
• Tighten the tension strap.
• Cut off the protruding tension strap (see Fig. 9.43).
• Tighten the screw of the ratchet clasp.
• Repeat the steps for the second tension strap.

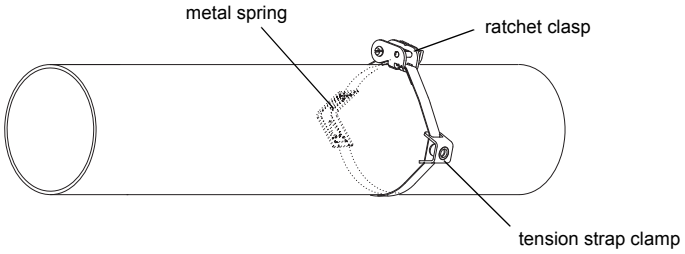


Fig. 9.41: Tension strap with the metal spring, the ratchet clasp and the tension strap clamp on the pipe

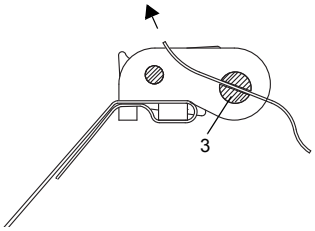


Fig. 9.42: Ratchet clasp with tension strap

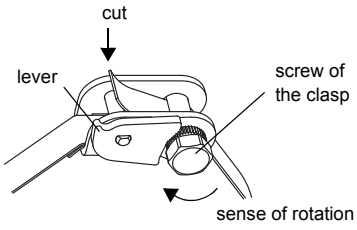


Fig. 9.43: Ratchet clasp with tension strap

Note!	To release the screw and the tension strap, press the lever down (see Fig. 9.43).

- Put the rail on the tension strap clamps (see Fig. 9.44).
- Fix the rail to the tension strap clamps with the screws.
- Tighten the screws.

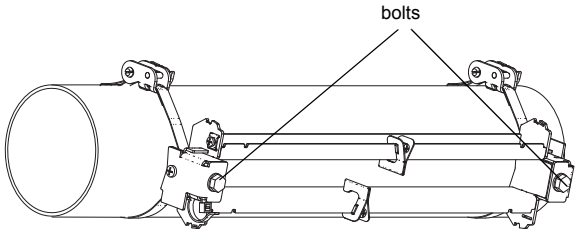


Fig. 9.44: Rail on the pipe

9.4.3 Installation of the Transducers in Variofix C

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

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

- Position the transducers on the rail in such way that the engravings on the transducers form an arrow. The transducer cables show in opposite directions (see Fig. 9.45).
- Adjust the transducer distance displayed by the transmitter (see section 11.6 and Fig. 9.45).
- Slide the spring clips on the transducers (see Fig. 9.46).
- 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. 9.45).
- Correct the transducer distance, if necessary (see section 11.6.1 and section 11.6.2).
- Tighten the tensioning screw.
- Fix the spacing element on the rail to mark the transducer position (see Fig. 9.45).
- Use a cable tie to fix the transducer cables in order to protect them from mechanical strain (see Fig. 9.46).
- Put the cover on the rail (see Fig. 9.47).
- Tighten the screws on both sides of the cover.

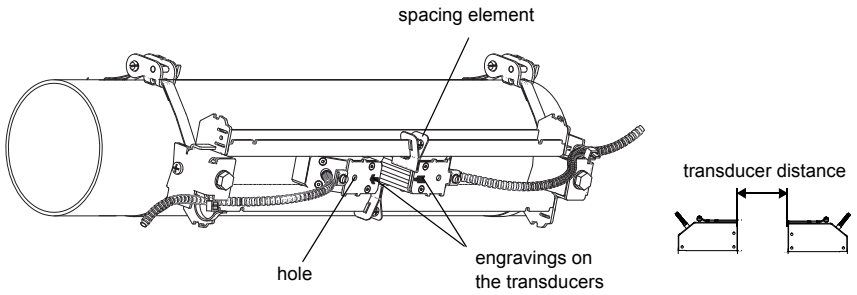


Fig. 9.45: Transducers in the rail (spring clip not shown)

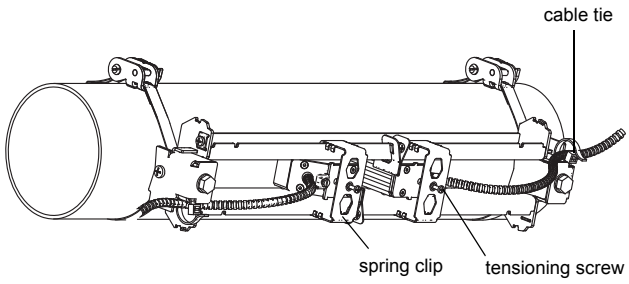


Fig. 9.46: Transducers in the rail

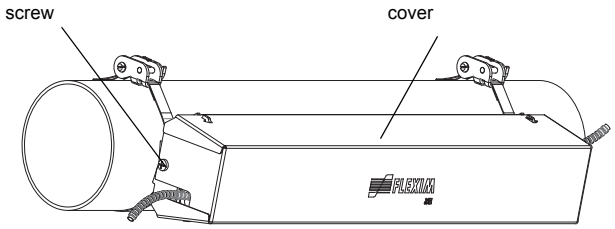


Fig. 9.47: Variofix C with transducer on the pipe

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

- Use a lever tool to remove the cover.
- Insert the lever tool in one of the four openings of the cover (see Fig. 9.48).
- Press the lever tool against the fixture.
- Bend the cover outwards and release it from the anchoring.
- Repeat the steps for the other three openings.
- Remove the cover from the rail.

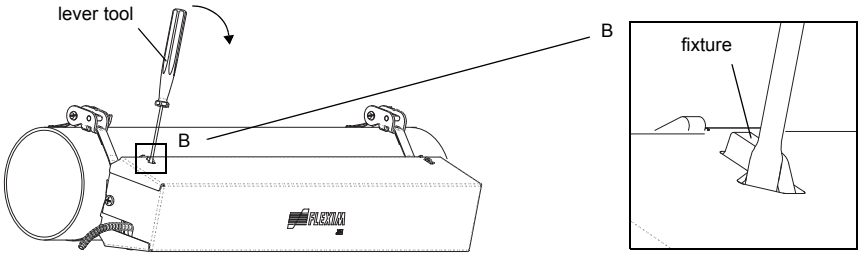


Fig. 9.48: Removal of the cover

9.5 Installation of the Transducers for Mines with FLEXIM Clasps for Mines

- Cut the tension straps to the appropriate length.
- Insert approx. 20 mm of the tension strap into the slot of part (1) of the clasp (see Fig. 9.49). Bend the end of the tension strap back.
- Insert the tension strap into the metal spring.
- Insert the other end of the tension strap into the groove on the upper side of the transducer shoe (see Fig. 9.50).
- Position the clasp on the side of the pipe and place the tension strap around the pipe. Turn the tension strap around the pipe while placing the transducer on the pipe. The metal spring should be positioned on the pipe at some distance to the clasp.

Note!	The clasp and the metal spring have to be in firm contact with the pipe to ensure a good fixation.

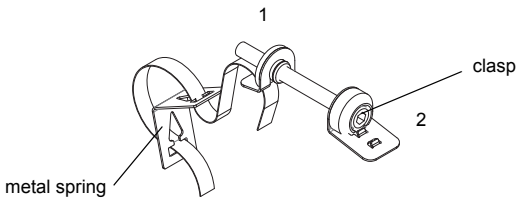


Fig. 9.49: Clasp, metal spring with tension strap

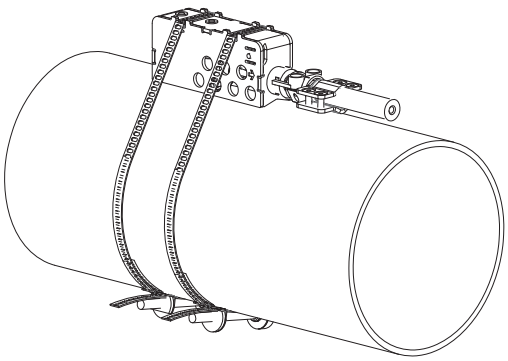


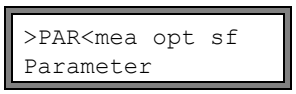
Fig. 9.50: Transducer in the mounting shoe, installed with tension strap and clasp

10 Start-Up of the Transmitter

10.1 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.

It is not possible to enter any data while the serial number is displayed.



Afterwards, the main menu is displayed in the default language. The language of the display can be set (see section 10.5).

10.2 Initialization

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

Proceed as follows to execute an initialization:

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

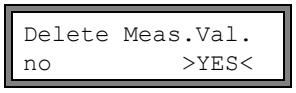
After the initialization has been executed, the message `INITIALISATION DONE` is displayed.

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.



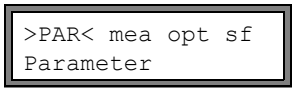
Select `yes` to delete the stored measured values or `no` to keep them stored.

Press ENTER.

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

10.3 Display

10.3.1 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 between arrows. The complete designation of the selected program branch is displayed in the lower line.

Select a program branch with key → and ↓ . Press ENTER.

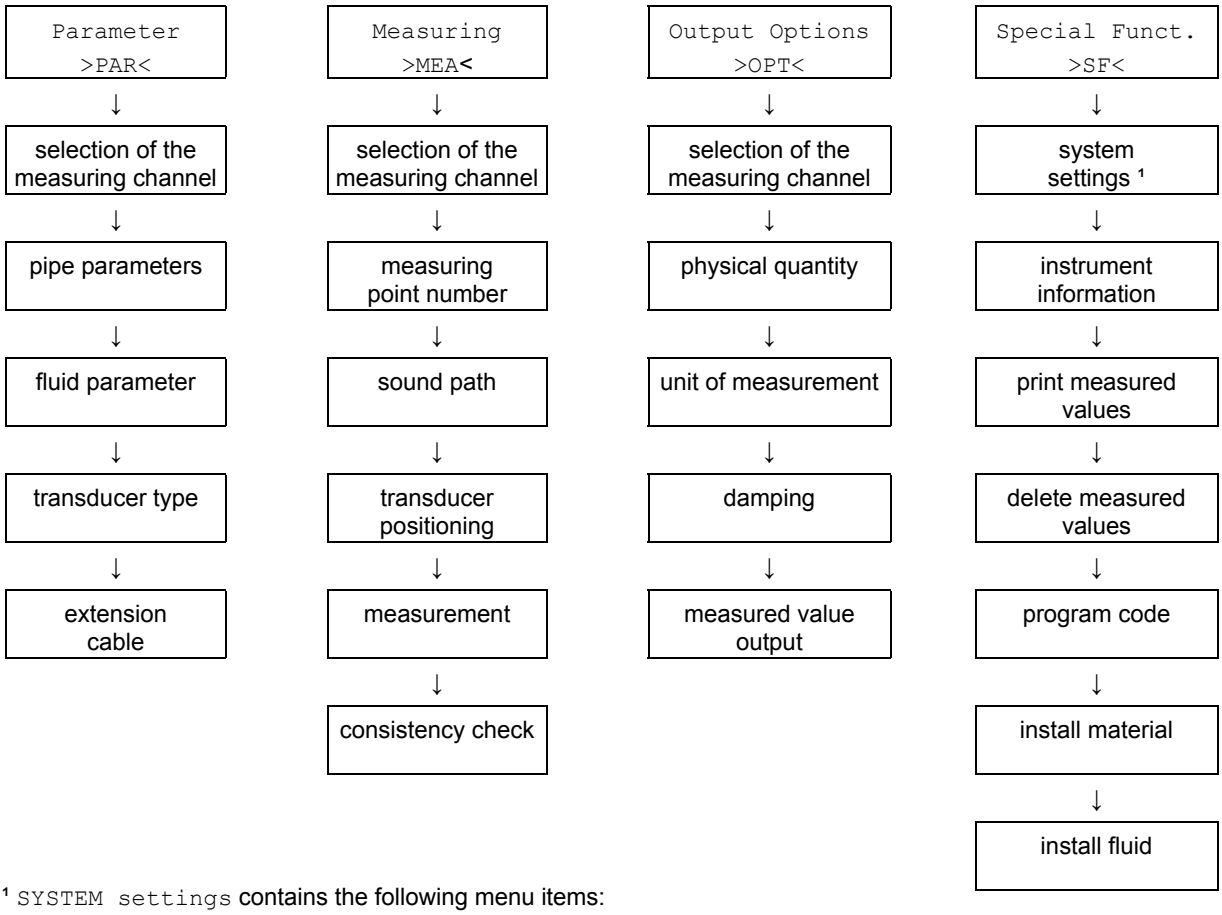
Note!	By pressing key BRK, the measurement is stopped and the main menu is selected.

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 "\".

10.3.2 Program Branches

- **Program branch** `Parameter`
  input of the pipe and fluid parameters
- **Program branch** `Measuring`
  processing of the steps for the measurement
- **Program branch** `Output Options`
  setting of the physical quantity, the unit of measurement and the parameters for the transmission of measured value
- **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:

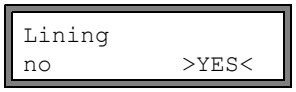
- set clock
- libraries
- dialogs and menus
- measurement
- outputs
- storing
- signal snap
- network
- serial transmission
- miscellaneous

10.3.3 Navigation

If a vertical arrow ↕ is displayed, the menu item contains a scroll list. The current list item is displayed in the lower line.

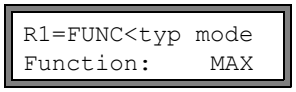
Press key ↓ and → to scroll and select a list item in the lower line. Press ENTER.

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



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

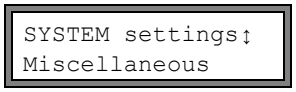


Press key → to scroll and select a list item in the upper line.
Press key ↓ to scroll and select a value for the selected list item in the lower line.
Press ENTER.

10.4 HotCodes

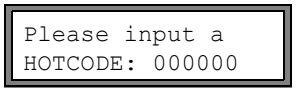
A HotCode is a key sequence that activates certain functions and settings:

function	HotCode	see section	deactivation
language selection	**9090xx**	10.5	
enabling the FastFood mode	**007022**	13.8.1	HotCode **007022**
manual input of the lower limit for the inner pipe diameter	**071001**	13.10	
activating the SuperUser mode	**071049**	17.1	HotCode **071049**
changing the transmission parameters of the RS232 interface	**232-0-**	14.2.4	
resetting the contrast of the display to medium	**555000**	16.4	

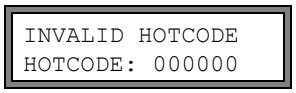


Select `Special Funct.`\`SYSTEM settings`\Miscellaneous.

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`.

10.5 Language Selection

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

Tab. 10.1: 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 is displayed in the selected language.

The selected language remains activated when the transmitter is switched off and on again. After an initialization of the transmitter, the language is reset to the default language.

10.6 Operation State Indication

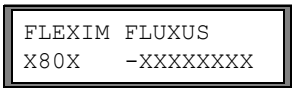
The operation state is indicated by 2 LEDs above the display.

Tab. 10.2: Operation state indication

LED off	transmitter in idle state (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

10.7 Interruption of the Power Supply

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



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.

11 Basic Measurement

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

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 of 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.

11.1 Input of the 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.

11.1.1 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 not within the range. The limit is displayed.

Example: upper limit 1 100 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 16.2.1).

If the input of the pipe circumference is activated and `0` (zero) is entered in `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.

11.1.2 Pipe Wall Thickness

```
Wall Thickness
      3.0      mm
```

Enter the pipe wall thickness. Press ENTER.

Note!	The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness) is calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed. It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 13.10).

11.1.3 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.

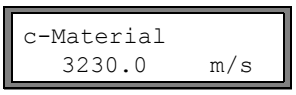
```
Pipe Material   ↕
Carbon Steel
```

Select the pipe material.

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

It can be specified which materials will be shown in the scroll list (see section 15.5).

When the pipe material has been selected, the corresponding sound speed is set automatically. If `Other Material` is selected, the sound speed has to be entered.

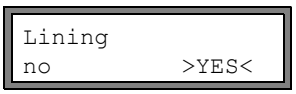


Enter the sound speed of the pipe material. Press ENTER.

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

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

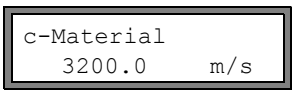
11.1.4 Pipe Lining



If the pipe has an inner lining, select `yes`. Press ENTER.
If `no` is selected, the next parameter will be displayed (see section 11.1.5).

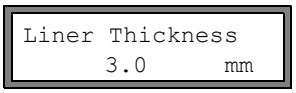
Select the lining material.
If the material is not in the scroll list, select `Other Material`. Press ENTER.

It can be specified which materials will be shown in the scroll list (see section 15.5).
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.

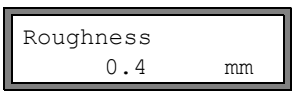


Enter the thickness of the liner. Press ENTER.

Note!	The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness - 2x liner thickness) is calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed. It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 13.10).

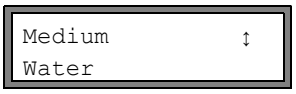
11.1.5 Pipe Roughness

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

11.2 Input of the Fluid Parameters



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

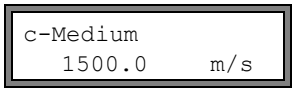
It is possible to specify which fluids will be displayed in the scroll list (see section 15.5).
For the programmed parameters of common fluids see section C.3.
If a fluid is selected from the scroll list, the menu item for the input of the fluid temperature will be displayed directly (see section 11.2.4).

If `Other Medium` is selected, the fluid parameters have to be entered first:

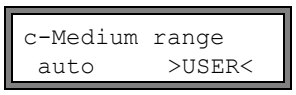
- average sound speed of the fluid
- range around the average sound speed of the fluid
- kinematic viscosity
- density

11.2.1 Sound Speed

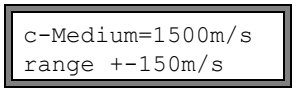
The sound speed of the fluid is used for the calculation of the transducer distance at the beginning of the measurement. However, the sound speed does affect the measuring result directly. Often, the exact value of the sound speed for a fluid is unknown. Therefore, a range of possible values for the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



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



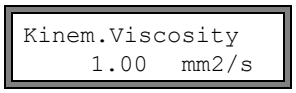
Select `auto` or `user`. Press ENTER.
`auto`: The area around the average sound speed is defined by the transmitter.
`user`: The area around the average sound speed has to be entered.



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

11.2.2 Kinematic Viscosity

The kinematic viscosity influences the flow profile of the fluid. The entered value and further parameters are used for the profile correction.

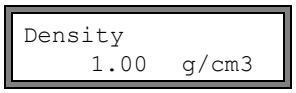


Enter the kinematic viscosity of the fluid. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

11.2.3 Density

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

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

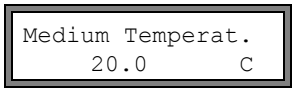


Enter the operating density of the fluid. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

11.2.4 Fluid Temperature

The fluid temperature is used for the interpolation of the sound speed and therefore for the calculation of the recommended transducer distance at the beginning of the measurement.

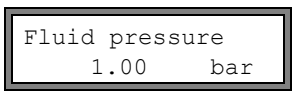
During the measurement, the fluid temperature is used for the interpolation of the density and viscosity of the fluid.



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

11.2.5 Fluid Pressure

The fluid pressure is used for the interpolation of the sound speed.



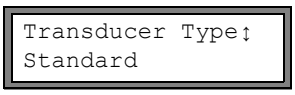
Enter the fluid pressure. Press ENTER.
This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Fluid pressure` is activated.

11.3 Other Parameters

11.3.1 Transducer Parameters

If transducers are detected at a measuring channel, the input of parameters will be finished. Press ENTER. The main menu will be displayed.

If no or special transducers are connected, the transducer parameters have to be entered.

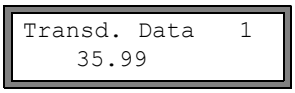


Select `Standard` to use the standard transducer parameters stored in the transmitter.

Select `Special Version` to enter the transducer parameters. The transducer parameters have to be provided by the manufacturer.

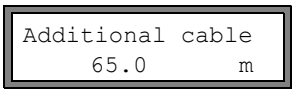
Press ENTER.

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



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

11.3.2 Extension Cable

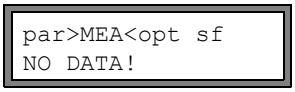


If the transducer cable is extended, enter the additional cable length (e.g., between the junction box and the transmitter). Press ENTER.

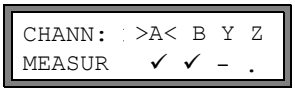
11.4 Selection of the Channels

The channels on which the measurement is conducted can be activated individually.

Select the program branch `Measuring`. Press ENTER.



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



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.

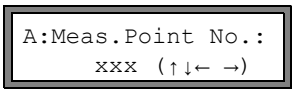
Note!	A channel cannot be activated if the parameters are not valid, e.g., if the parameters in the program branch `Parameter` of the channel are not complete.

• Select a channel with the key [→].

• Press key [↓] to activate or deactivate the selected channel. Press ENTER.

A deactivated channel will be ignored during the measurement. The parameters entered for this channel will remain unchanged.

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



Enter the measuring point number. Press ENTER.

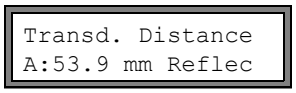
If arrows are displayed in the lower line on the right, ASCII text can be entered. If no arrows are displayed, only digits, point and hyphen can be entered.

11.5 Defining the Number of Sound Paths

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

For the definition of the sound paths see section 3.3.

11.6 Transducer Distance



A value for the transducer distance is recommended. Fix the transducers (see chapter 9). Adjust the transducer distance.

Press ENTER.

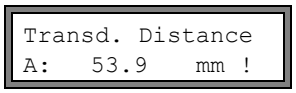
`A` - measuring channel
`Reflec` - reflection arrangement
`Diagon` - diagonal arrangement

The transducer distance is the distance between the inner edges of the transducers (see section 3.3) and for the transducers for mines the distance between the marks on the transducer shoe (see Fig. 9.2).

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

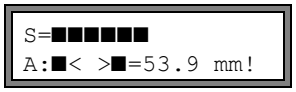
Note!	The accuracy of the recommended transducer distance depends on the accuracy of the entered pipe and fluid parameters.

11.6.1 Fine Adjustment of the Transducer Distance



If the displayed transducer distance is adjusted, press ENTER.

The measuring for the positioning of the transducers is started.

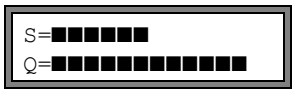


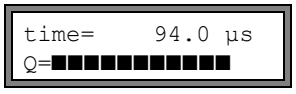
The amplitude of the received signal is displayed by the bar graph `S=`.

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 until the LED of the measuring channel lights green.



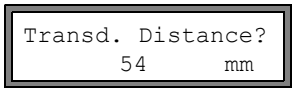


The following quantities can be displayed in the upper line by pressing key [→] and in the lower line by pressing key [↓]:

- ■<>■=: 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 positioning of the transducers, the recommended transducer distance is displayed again.

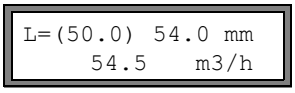
Enter the actual (precise) transducer distance. Press ENTER.

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

11.6.2 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 unknown, a consistency check is recommended.

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



The optimum transducer distance is displayed in brackets (here: 50.0 mm) in the upper line, 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.

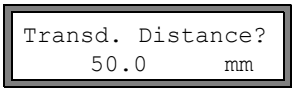
The optimum transducer distance is calculated on the basis of the measured sound speed. It is therefore a better approximation than the first recommended value which had been calculated on the basis of the sound speed range entered in the program branch `Parameter`.

If the difference between the optimum and the entered transducer distance is less than specified in Tab. 11.1, the measurement is consistent and the measured values are valid. The measurement can be continued.

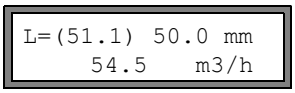
If the difference is greater, adjust the transducer distance to the displayed optimum value. Afterwards, check the signal quality and the signal amplitude bar graph (see section 11.6.1). Press ENTER.

Tab. 11.1: 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**
G	20	-45...+90
H	-	-30...+60
K	15	-20...+40
M	10	-10...+20
P	8	-5...+10
Q	6	-3...+5



Enter the new adjusted transducer distance. Press ENTER.



Press key [→] again to scroll until the transducer distance is displayed and check the difference between optimum and 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.

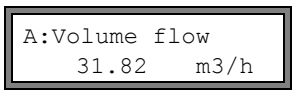
11.6.3 Value of the Sound Speed

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 11.6.2, 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 15.2 and 15.3).

11.7 Start of the Measurement



The measured values are displayed in the lower line. Press ENTER to return to the fine adjustment of the transducer distance (see section 11.6.1).

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 rate 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. If e.g., the measuring signal cannot be detected immediately, the measurement duration might be > 1 s.

The outputs and the serial interface continuously receive the measured values of the corresponding channel. The results are displayed according to the currently selected output options. The default unit of measurement of the volumetric flow rate is m³/h. For the selection of the values to be displayed and for the setting of the output options see chapter 12. For more measuring functions see chapter 13.

11.8 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 arrow direction if the displayed volumetric flow rate is negative (e.g., -54.5 m³/h).

11.9 Stopping the Measurement

The measurement is interrupted by pressing key BRK if it is not protected by a program code (see section 13.12).

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

12 Displaying the Measured Values

The physical quantity is set in the program branch `Output Options` (see section 12.1).

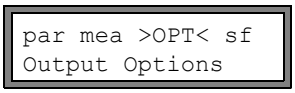
During the measurement, the designation of the physical quantity is displayed in the upper line, the measured value in the lower line. The display can be adapted (see section 12.3).

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

The following physical quantities can be measured:

- **sound speed**
- **flow velocity:** is calculated on the basis of the measured transit time difference
- **volumetric flow rate:** is calculated by multiplying the flow velocity by the cross-sectional pipe area
- **mass flow rate:** is calculated by multiplying the volumetric flow rate by the operating density of the fluid

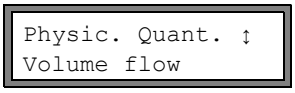
The physical quantity is selected as follows:



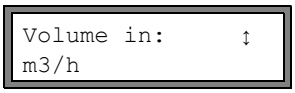
Select the program branch `Output Options`. Press ENTER.

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

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

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

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

12.2 Toggling between the Channels

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

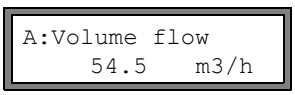
- AutoMux mode
  - all channels
  - only calculation channels
- HumanMux mode

The command →`Mux:Auto/Human` toggles between the modes (see section 13.1).

12.2.1 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 12.1). When the multiplexer switches to the next channel, the display is updated.



The default is the AutoMux mode. The AutoMux mode will be activated after an initialization of the transmitter.

All Channels

The measured values of all channels (measuring and calculation channels) are displayed. The next active channel is selected 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.

12.2.2 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 12.1).

12.3 Adjustment of the Display

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

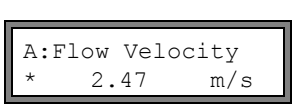
The following information can be displayed in the upper line:

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
`Rx=`	alarm state indication if it is activated (see section 18.7.5) and if alarm outputs are activated (see section 18.6).
`δc=`	difference between the measured sound speed and the sound speed of a selected reference fluid, if activated (see section 16.3)
	status line (see section 12.4)

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

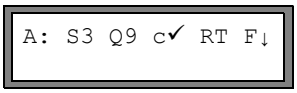
Press key [→] during the measurement to change the display in the upper line, press key [↓] to change the display in the lower line.



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

12.4 Status Line

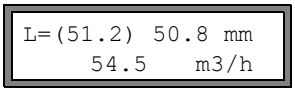
Important data of the ongoing measurement are shown in the status line. The quality and precision of the ongoing measurement can be estimated.



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

	value	explanation
S		**signal amplitude**
	0	< 5 %
	…	…
	9	≥ 90 %
Q		**signal quality**
	0	< 5 %
	…	…
	9	≥ 90 %
c		**sound speed** comparison of the measured and the expected sound speed of the fluid. The expected sound speed is calculated on the basis of the fluid parameters (fluid selected in the program branch `Parameter`, temperature dependence, pressure 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 offset range of the measuring method
	?	unknown, cannot be measured

12.5 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) will be 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) will be compensated internally.

Note!	Never change the transducer distance during the measurement!

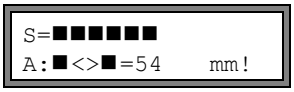
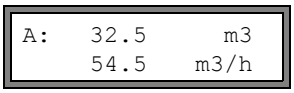
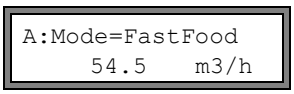
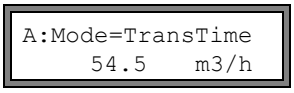
13 Advanced Measuring Functions

13.1 Command Execution during Measurement

Commands that can be executed during a measurement are shown in the upper line. A command begins with →. If programmed, a program code has to be entered (see section 13.12).

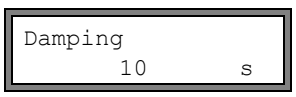
Press key [→] until the command is displayed. Press ENTER. The following commands are available:

Tab. 13.1: Executable commands during 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 flow totalizer will be reset to zero.
→Mux:Auto/Human	Toggle between the AutoMux and the HumanMux mode of the display (see section 12.2). This display will not be indicated if the transmitter has only one measuring channel or only one measuring channel is activated.
→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 activated.
→Break measure	stop the measurement and return to the main menu
→Toggle FastFood	 

13.2 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 of a higher flow dynamic, require a higher damping factor. Select the program branch `Output Options`. Press ENTER until the menu item `Damping` is displayed.



Enter the damping factor. Press ENTER.

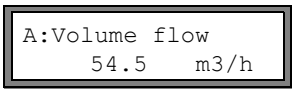
Press key BRK to return to the main menu.

13.3 Totalizer

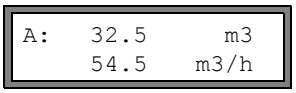
total volume or total mass of the fluid at the measuring point can be determined.

There are two flow totalizers, one for the positive flow direction, one for the negative flow direction. The unit of measurement used for totalization corresponds to the volume or mass unit selected for the physical quantity.

The value of a totalizer consists of max. 11 digits, including max. 4 decimal places. For the adjustment of the number of decimal places see section 17.7.



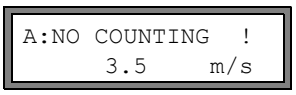
Press key → to scroll through the upper line and display the totalizers.



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

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

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



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

Selection of the Flow Totalizers for Storing

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

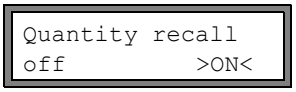
If `one` is selected, only the value of the totalizer that is currently displayed will be stored.

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

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

13.3.1 Overflow of the Flow Totalizers

The overflow behavior of the flow totalizers can be set:

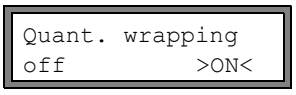
Without overflow:

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

With overflow:

- The flow 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.

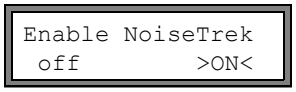
Independently of the setting, the flow totalizers can be reset to zero manually.

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

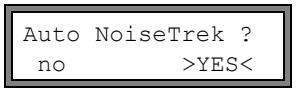
13.4 Settings of the HybridTrek Mode

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 depending on the gaseous or solid content in the fluid in order to receive valid measuring values.

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.

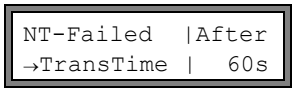
Select `yes` to activate the automatic toggling between the TransitTime and the NoiseTrek mode. The NoiseTrek mode can also be activated and deactivated manually during the measurement if `yes` is selected.

Press ENTER.

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

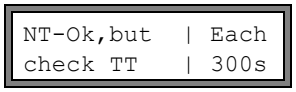
If the automatic toggling between the TransitTime and the NoiseTrek mode is activated, the toggling parameters have to be configured.

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

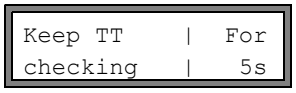


Enter the time after which the transmitter has to toggle to the TransitTime mode if there are no valid measured values in the NoiseTrek mode. If 0 (zero) is entered, the transmitter does not toggle to the TransitTime mode.

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



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



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

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

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

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

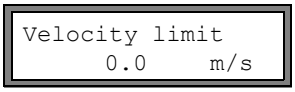
In order to toggle manually between the TransitTime mode and the NoiseTrek mode during the measurement, press key ENTER when the measuring mode is displayed.

13.5 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 preset upper limit. These measured values will be marked as outliers.

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



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

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

Press ENTER.

If the flow velocity is higher than the upper limit,

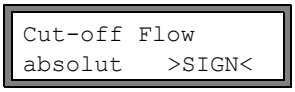
- the flow velocity will be marked as invalid. The physical quantity cannot be determined.
- the LED of the measuring channel will light red
- a "!" will be displayed after the unit of measurement (in case of a normal error, "?")

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

13.6 Cut-Off Flow

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

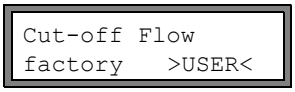
The cut-off flow can depend on the flow direction or not. The cut-off flow is set in `Special Funct.\SYSTEM settings\Measuring\Cut-off Flow`.



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

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

Press ENTER.



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

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

Press ENTER.

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

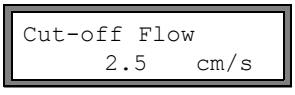
Enter the cut-off flow. Press ENTER.

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

13.7 Uncorrected Flow Velocity

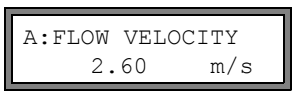
For special applications, the uncorrected flow velocity might be of interest.

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

Select `normal` to display and output the flow velocity with profile correction.

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

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



If `no` is selected, the profile correction will be switched off.

All physical quantities will be calculated with the uncorrected flow velocity.

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

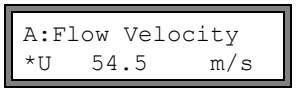
Press ENTER.

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

All other physical quantities (volumetric flow rate, mass flow, 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.`.

13.8 Measurement of High 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.

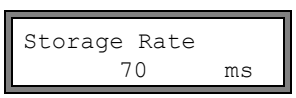
- The sound speed of the fluid is not updated. The last measured value of the sound speed before toggling to the FastFood mode is used.
- It is not possible to change the measuring channel. The measurement takes place on one channel only. During the activation of the FastFood mode no measurement is carried out on the other channels.
- The outputs for the FastFood mode activated channel can still be used.
- Outputs for further channels (multi-channel measurement) emit an error value.
- The measured values are stored with the storage rate of the FastFood mode (see section 13.8.2).
- The FastFood mode has to be enabled and activated.

13.8.1 Enabling/Disabling the FastFood Mode

Enter HotCode **007022** (see section 10.4).

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

13.8.2 Storage Rate of the FastFood Mode

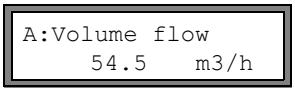


If the FastFood mode is enabled, a `Storage Rate` in ms will have to be entered in the program branch `Output Options`.

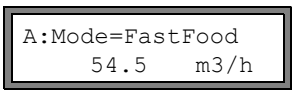
Press ENTER.

13.8.3 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 storing of measured values will be started. If the FastFood mode is deactivated or if the measurement is interrupted, the storing will be stopped.

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

13.9 Calculation Channels

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

In addition to the ultrasonic measuring channels, the transmitter has two virtual calculation channels Y and Z. The measured values of the measuring channels A and B can be calculated via the calculation channels.

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

13.9.1 Characteristics of the Calculation Channels

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

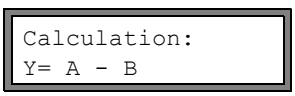
A calculation channel cannot be attenuated. The damping factor has to be set separately for each of the two measuring channels.

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

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

13.9.2 Parameterization 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.

```
>CH1< funct ch2↕
  A     -     B
```

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.

Press key [↓] to scroll 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.

```
Y: is valid if
A: and B: valid
```

This message will be displayed after the parameterization 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.

```
Y: is valid if
A: or B: valid
```

This message will be displayed after the parameterization 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.

13.9.3 Output Options for a Calculation Channel

```
Output Options ↕
for Channel   Y:
```

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

```
Physic. Quant. ↕
Mass Flow
```

Select the physical quantity to be calculated. Press ENTER.

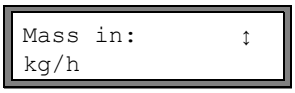
Make sure that the physical quantity selected for the calculation channel can be calculated from the physical quantities of the selected measuring channels. Possible combinations are shown in Tab. 13.3.

Tab. 13.3: 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 channel A and B can be the volumetric flow rate or the mass flow, but not the flow velocity. The physical quantities of the two measuring channels do not need to be identical (channel A = mass flow, channel B = volumetric flow rate).



Select the unit of measurement. Press ENTER.

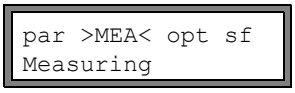
Two cut-off flow values for each calculation channel can be defined. They are defined in the unit of measurement of the physical quantity selected for the calculation channel.

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

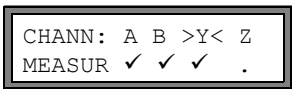
All negative calculated values that are greater than the limit will be set to 0.

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

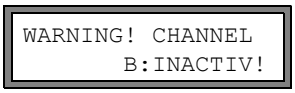
13.9.4 Measuring with Calculation Channels



Select the 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.

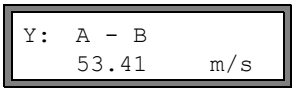


If a measuring channel that is needed for an activated calculation channel is not activated, a warning will be displayed. Press ENTER.

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 12.2) 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.

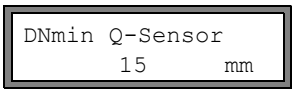


Press key → to display the calculation function.
Press key ↓ to display the measured values of the various channels.

13.10 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 HotCode **071001** (see section 10.4).



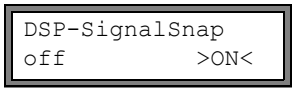
Enter the lower limit of the inner pipe diameter of the displayed transducer type. Press ENTER to select the next transducer type.

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

13.11 Diagnosis with the Snap Function

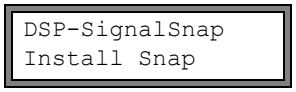
With the aid of the snap function it is possible to store measuring parameters which are useful for the evaluation of measuring results or for diagnostic purposes.

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

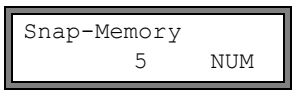


Select `on` to activate the snap function. Select `off` to deactivate the snap function.

Settings of the snap memory

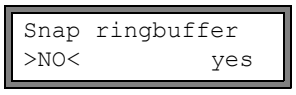


Select `Install Snap`. Press ENTER.



Enter the number of the snap memory capacity. Press ENTER.

Activation and deactivation of the auto-snap function. Press ENTER.

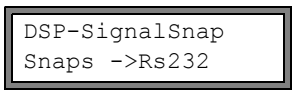


Activation and deactivation of the snap ringbuffer. Press ENTER.

Delete Snaps

Select `Clear Snaps`. Press ENTER.

Read Snaps



Select `Snaps ->Rs232`. Press ENTER.

Activation of the Snap Function

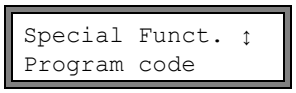
In order to activate the snap function, press key → during the measurement until `DSP-SignalSnap/Voltage` is displayed in the upper line. Press ENTER.

13.12 Program Code

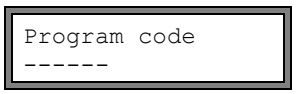
An ongoing measurement can be protected from an inadvertent intervention by means of a program code.

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

13.12.1 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 Hot-Code for language selection).

A program code will remain valid as long as:

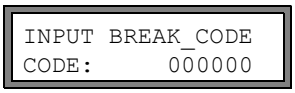
- no other valid program code is entered or
- the program code is not deactivated.

13.12.2 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 not valid, an error message will be displayed for a few seconds.

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

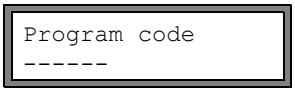
If a command is selected:

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

Enter the first three 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.

13.12.3 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.

14 Data Logger and Transmission of Data

The transmitter has a data logger in which the measured values are stored during the measurement (see section 14.1).

Additionally measured values can be transmitted to a PC via the serial interface (see section14.2). For the connection of the serial interface to the transmitter see section 6.8 (FLUXUS ADM 8027) or section 7.8 (FLUXUS F801).

14.1 Data Logger

The following data will be stored:

- date
- time
- measuring Point Number
- pipe parameters
- fluid parameter
- 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)
- values of the totalizers
- diagnostic values (if storing of diagnostic values is activated)

In order to store the measured data, the data logger has to be activated (see section 14.1.1).

The available data logger memory can be displayed (see section 14.1.6).

The storing of each measured value will be signalized acoustically. This signal can be de-activated (see section 14.1.3 in Acoustic Signal).

14.1.1 Activation/Deactivation of the Data Logger

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

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

Press ENTER until the menu item `Store Meas.Data` is displayed.

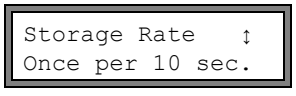
Select `yes` to activate the data logger, `no` to deactivate it. Press ENTER.

14.1.2 Setting the Storage Rate

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

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

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



Select a storage rate or `EXTRA`. Press ENTER.

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

If `EXTRA` is selected, enter the storage rate. Press ENTER.

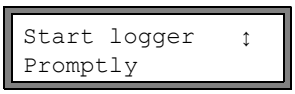
14.1.3 Settings for the Data Logger

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

- Start of Storing
- ringbuffer
- storage mode
- storing of the totalizers
- storing of the signal amplitude
- storing of the sound speed of the fluid
- storing of the diagnostic values
- acoustic signal during the storing

Start of Storing

In order to start storing of measured values with several measuring instruments at the same time it is possible to set a starting time.



Select the moment at which the storing has to start.

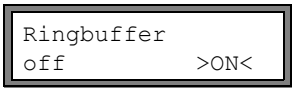
`Promptly`: The storing starts immediately.
`On full 5 min.`: The storing starts in the next full 5 minutes.
`On full 10 min.`: The storing starts in the next full 10 minutes.
`On quarter hour`: The storing starts in the next full 15 minutes.
`On half hour`: The storing starts in the next 30 minutes.
`On full hour`: The storing starts in the next full hour.

Example:	actual time: 09:06 am setting: `On full 10 min.` The storing starts at 09:10 am.

Ringbuffer

Setting the ringbuffer influences the storing of measured values once the data logger is full.

- If the ringbuffer is activated, the available data logger will be halved. The oldest measured values will be overwritten. Only the data logger memory that was free during the activation will be used by the ringbuffer. If more data logger memory is necessary, measured values in the data logger should previously be deleted.
- If the ringbuffer is deactivated, the storing of measured values will be stopped.



Select the behavior of the ringbuffer. Press ENTER.

Storage Mode

Select the storage mode. Press ENTER.

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

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

Note!	The storage mode does not affect the outputs.

Note!	`Storage mode` **=** `average` The average of the physical quantity and other physical quantities assigned to the measuring channel, will be calculated. If the storage rate < 5 s (see section 14.1.2) is selected, the `sample` will be used. If no average could be calculated over the complete storage interval, the value will be marked as invalid. The ASCII file will contain `???` for invalid average values of the measured value.

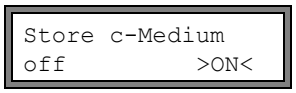
Storing of the Totalizers

See section 13.3.

Storing of the Signal Amplitude

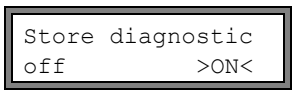
If `on` is selected and the data logger is activated, the amplitude of the measured signal will be stored together with the measured values. Press ENTER.

Storing of the Sound Speed of the Fluid



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.

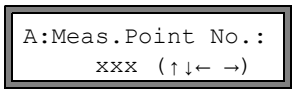
Acoustic Signal during the Storing

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

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

14.1.4 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 16.2.3.

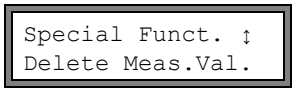
If `Output Options\Store Meas.Data` has been activated and `Special Funct.\Ringbuffer\` is deactivated, this error message will be displayed as soon as the data logger is full.

Press ENTER.

The error message will be displayed periodically.

Th Storing will be stopped.

14.1.5 Deleting the Measured Values

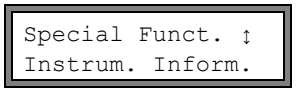


Select `Special Funct.\Delete Meas.Val.`. Press ENTER.

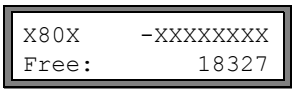
Select `yes` or `no`. Press ENTER.

14.1.6 Available Data Logger Memory

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



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

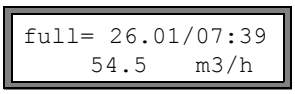


The type and the serial number of the transmitter is displayed in the upper line.

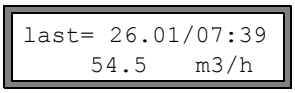
The available data logger memory will be displayed in the lower line (here: 18 327 additional measured values can be stored). Press key BRK twice to return to the main menu.

Max. 100 series of measured values can be stored. The number of series of measured values depends on the total number of measured values stored in the previous series of measured values.

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



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



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

14.2 Transmission of Data

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

14.2.1 Online Transmission of Data

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

Tab. 14.1: Overview online transmission of data

serial interface	transmission of data	see
RS-232	terminal program	section 14.2.5
RS485 (sender)	terminal program	section 14.2.5

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.

14.2.2 Offline Transmission of Data

The measurement data of the data logger are transmitted.

Tab. 14.2: Overview offline transmission of data

serial interface	transmission of data	see
RS-232	terminal program	section 14.2.6
RS-232	FluxData	section 14.2.7
RS485 (sender)	terminal program	section 14.2.6

Selection of the Serial Interface for the Offline Transmission of Data

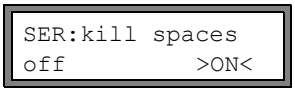
Select `Special Funct.\SYSTEM settings\serial transmis.` Press ENTER until `Send Offline via` is displayed.

Select the serial interface for the offline transmission.

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

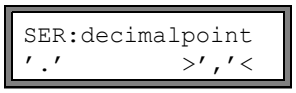
14.2.3 Formatting of the Measurement Data

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



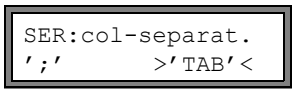
Select `on` if the space characters are not to be transmitted. Press ENTER.

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.

14.2.4 Transmission Parameters

• the transmitter sends CRLF-terminated ASCII

• max. line length: 255 digits

RS-232

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

The transmission parameters of the RS232 interface can be changed:

Enter HotCode **232-0**- (see section 10.4).

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

• `baud`: baud rate

• `data`: number of data bits

• `par`: parity

• `st`: number of stop bits

RS485

• default: 9600 bits/s, 8 data bits, even parity, 1 stop bit

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

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

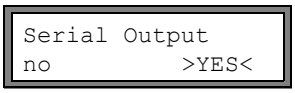
The default transmission parameters will be set if `default` is selected and the transmission parameters have not been changed.

14.2.5 Online Transmission of Data to a Terminal Program

- Start the terminal program.
- Enter the transmission parameters into the terminal program (see section 14.2.4). The transmission parameters of the terminal program and the transmitter have to be identical.

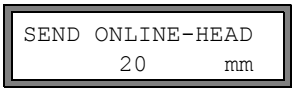
Settings in the Transmitter

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



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

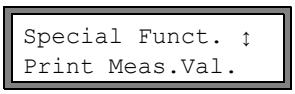
- Set the storage rate (see section 14.1.2).
- Start the measurement. The measuring point number will be requested (see section 14.1.4).



The measured values are transmitted during the measurement.

14.2.6 Offline Transmission of Data to a Terminal Program

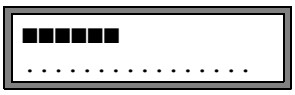
- Start the terminal program.
- Enter the transmission parameters into the terminal program (see section 14.2.4). The transmission parameters of the terminal program and the transmitter have to be identical.



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

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

This message will be displayed if the measurement values are transmitted.



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

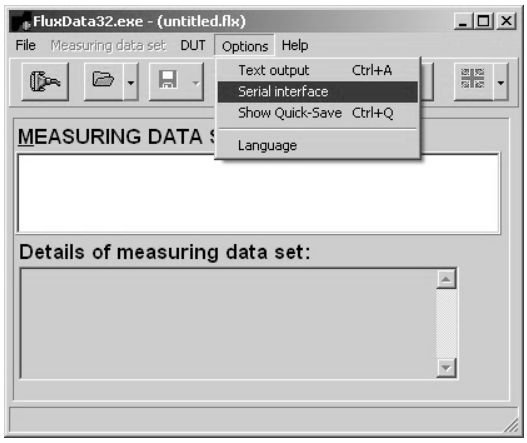
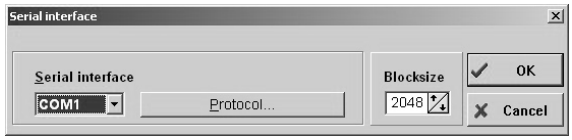
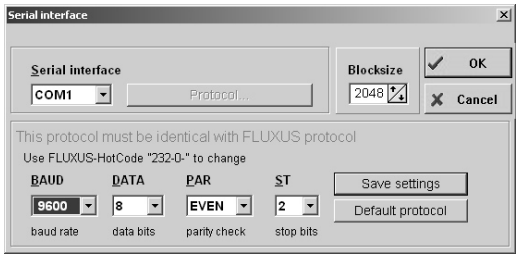
This error message will be displayed if an error has oc-curred during the serial transmission.
Press ENTER. Check the connections and make sure that the PC is ready to receive data.

14.2.7 Offline Transmission of Data with the Program FluxData

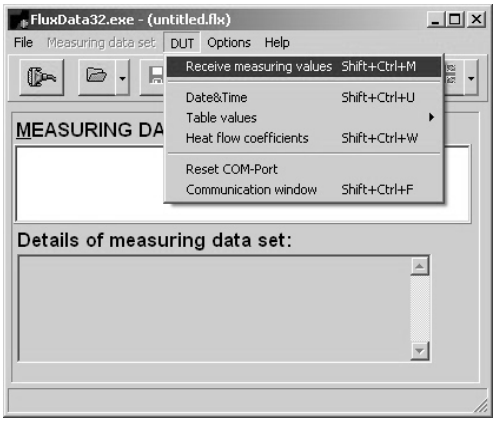
The measurement data in the data logger are transmitted to a PC via the serial interface RS232 with the FLEXIM program FluxData.

Settings in the Program

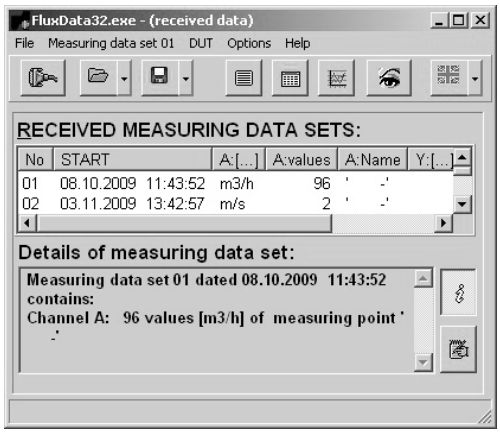
Start the program FluxData V3.0 or higher on the PC.

	Select the menu: Options > Serial interface.
	Select the serial interface used from the PC (e.g., COM1). Click Protocol. Click OK.
	Enter the transmission parameters (see section 14.2.4). If the default settings of the transmission parameters are to be used, click Default protocol. The transmission parameters of FluxData and transmitter have to be identical. Click OK.

Transmission of Data

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

Stop the Transmission of Data

	Select the menu: File > Save.
	Select the series of measured values to be stored. Click OK. Select the path on which the data should be stored and enter the file name. Click Save. The file will be stored with the file extension .flx.

14.2.8 Structure of the Data

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

Example:

```
\DEVICE             : X80X -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
```

The line \DATA is transmitted next followed once by the column titles (see Tab. 14.3) for the corresponding channel. The measured values are transmitted afterwards.

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

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

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

The following data columns can be transmitted:

Tab. 14.3: Columns of data

column title	column format	content
*MEASURE	###000000.00	the 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 generated.

Offline Transmission of Data

During the offline transmission of data, columns will only be created if at least one measured value is stored in the data set.

15 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 area). The coefficient memory has to be partitioned first (see section 15.1).

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

• as constants without the extended library (see section 15.2)

• as constants or temperature and pressure dependent functions by means of the extended library (see section 15.3)

The material and fluid scroll lists displayed in the program branch `Parameter` can be arranged (see section 15.5). The shorter scroll lists make the work more efficient.

15.1 Partitioning of the Coefficient Memory

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

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

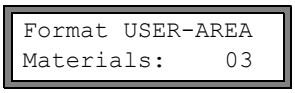
For the max. number of data sets for each category of these material data see Tab. 15.1.

Tab. 15.1: Capacity of the coefficient memory

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

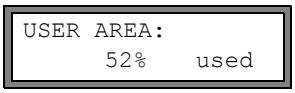
Select `Special Funct.\SYSTEM settings\Libraries\Format USER-AREA`. Press ENTER.

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.

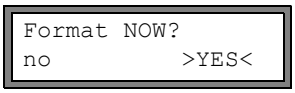


Enter the number of the user defined materials. Press ENTER.

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 being partitioned. This procedure takes a few seconds.

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

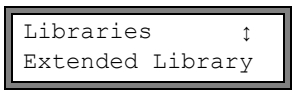
15.1.1 Data Retention during Coefficient Memory Partitioning

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

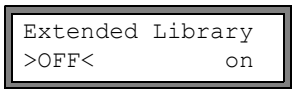
Example 1:	The number of user defined materials is reduced from 5 to 3. The data sets #01 to #03 are retained. The data sets #04 and #05 are deleted.
Example 2:	The number of user defined materials is increased from 5 to 6. All 5 data sets are kept.

15.2 Input of Material/Fluid Parameters without the Extended Library

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



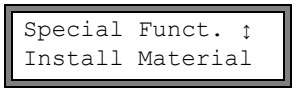
Select `Special Funct.\SYSTEM settings\Libraries\Extended Library`. Press ENTER.



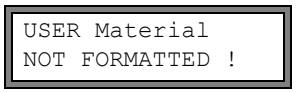
Select `off` to deactivate the extended library. Press ENTER.

The parameter 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.



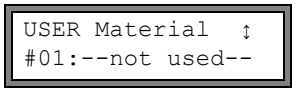
Select `Special Funct.\Install Material` or `Install Medium`.
Press ENTER.



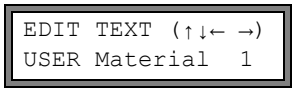
This error message will be displayed if the coefficient memory does not contain an area for user defined materials/fluids.

Partition the coefficient memory (see section 15.1).

Select `edit`. Press ENTER.



Select a user defined material/fluid. Press ENTER.

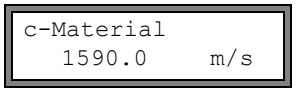


Change the designation of the material/fluid.

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

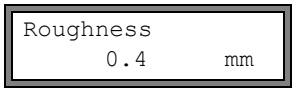
Note!	95 ASCII characters (letters, capital letters, numbers, special characters [! ? " + - ( ) > < % * etc.]) are available for the designation of materials/fluids. A designation can have max. 16 characters. The input of text is described in section 4.3.

Material Parameter



Enter the sound speed of the material. Press ENTER.

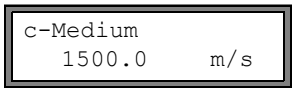
For the sound speed of some materials see annex C.1.



Enter the roughness of the material. Press ENTER.

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

Fluid Parameter



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

This display will only be indicated if `user` is 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.

15.3 Extended Library

15.3.1 Introduction

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

Tab. 15.2: Material and fluid parameters that can be stored

parameter	**parameters 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 the measurement
viscosity	profile correction of the flow velocity
density	mass flow rate calculation

Enter only the properties 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 grade 1 to 4 or
- with customized interpolation functions.

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

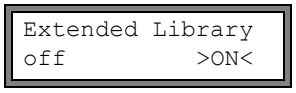
If, e.g., the temperature fluctuations at the measuring point are low compared to the temperature dependence of the material properties, the linearization or the complete neglect of the temperature dependency will not result in a considerable additional measuring error.

If, however, the process conditions fluctuate strongly and the fluid parameters depend strongly on the temperature (e.g., viscosity of hydraulic oil), polynomials or customized interpolation functions should be used. Contact FLEXIM to find the best solution for the measuring task.

Customized Interpolation Functions

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

15.3.2 Activation of the Extended Library



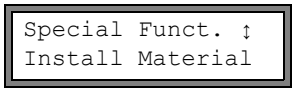
Select `Special Funct.\SYSTEM settings\Libraries\Extended Library`. Press ENTER.

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

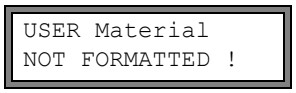
15.3.3 Input of the Material/Fluid Parameters

The parameter 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.

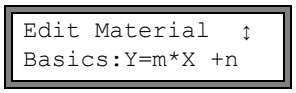


Select `Special Funct.\Install Material` or `Install Medium`. Press ENTER.



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 15.1).



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

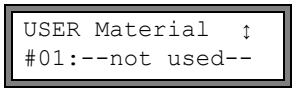
`Y=CONST.`: constants

`Y=M*X+N`: linear function of the temperature

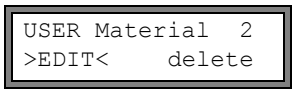
`Y=Polynom`: $y = k_0 + k_1 \cdot x + k_2 \cdot x^2 + k_3 \cdot x^3 + k_4 \cdot x^4$

`Y=F(X,Z)`: customized interpolation function (only for experienced users or after consultation with FLEXIM)

`go back`: return to the previous menu item

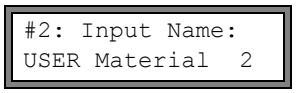


Select a user defined material/fluid.



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.

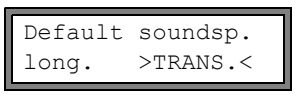
Material Parameter

Enter the material's:

- transversal sound speed
- longitudinal sound speed

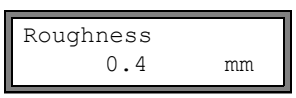
1...5 values depending on the selected function have to be entered. Press ENTER after each input.

If an already defined material is edited, for each parameter there will be a request whether it is to be edited. Select `yes` or `no`. Press ENTER. Change the values, if necessary.

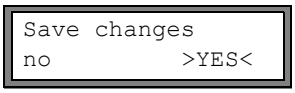


Select the type of sound wave to be used for the flow measurement. Press ENTER.

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 Parameter

Enter the fluid's:

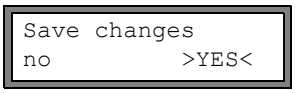
• longitudinal sound speed

• 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.



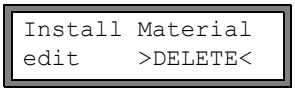
Select yes to store the entered properties, no to quit the menu item without storing. Press ENTER.

15.4 Deleting a User Defined Material/Fluids

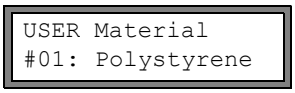
To delete a user defined material/fluid, proceed as follows:

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.



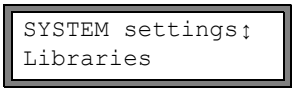
Select the material/fluid to be deleted. Press ENTER.

Select yes or no. Press ENTER.

15.5 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 or in the fluid scroll list.

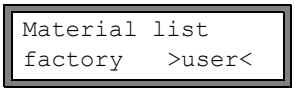
Note!	User defined materials/fluids will always be displayed in the scroll lists of the program branch Parameter.



Select Special Funct.\SYSTEM settings\Libraries. Press ENTER.

Select Material list to edit the material scroll list or Media list to edit the fluid scroll list.

Select back to return to SYSTEM setting. Press ENTER.



Select factory if all materials/fluids of the internal database are to be displayed in the scroll list. An already existing scroll list will not be deleted but only deactivated.

Select user to activate the user defined scroll list. Press ENTER.

If user is selected, the material or fluid scroll list can be edited (see section 15.5.1...15.5.3).

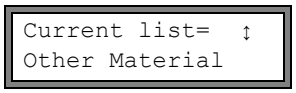
Select `End of Edit` to stop editing. Press ENTER.

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.

15.5.1 Displaying a Scroll List

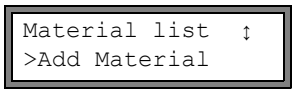
Select `Show list`. Press ENTER to display the scroll list as in the program branch `Parameter`.



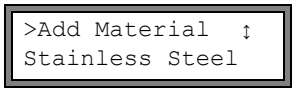
The current scroll list is displayed in the lower line.

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

15.5.2 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.

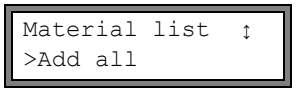


All materials/fluids that are not contained in the current scroll list will be displayed in the lower line.

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.

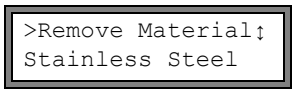
15.5.3 Adding all Materials/Fluids to the Scroll List



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

15.5.4 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.

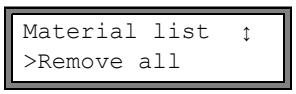


All materials/fluids of the current scroll list will be displayed in the lower line.

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.

15.5.5 Removing all Materials/Fluids from the Scroll List



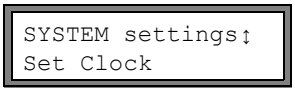
Select `Remove all` to remove all materials/fluids from the scroll list. Press ENTER. User defined materials/fluids will not be removed.

16 Settings

16.1 Time and Date

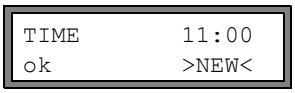
The transmitter has a battery-powered clock. Measured values are automatically stored with the date and time.

16.1.1 Time

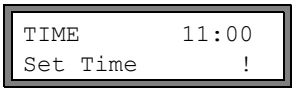


Select `Special Funct.\SYSTEM settings\Set Clock`.

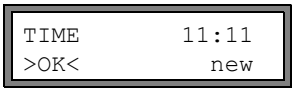
Press ENTER.



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



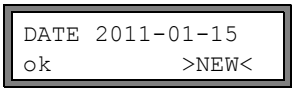
Select the character to be edit with key [→].
Edit the selected character with key [↓] and CLR. Press ENTER.



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

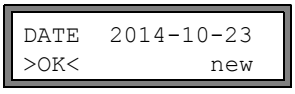
16.1.2 Date

After the time has been set, `DATE` is displayed.



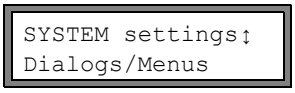
Select `ok` to confirm the date or `new` to set the date. Press ENTER.

Select the character to be edit with key [→].
Edit the selected character with key [↓] and CLR. Press ENTER.



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

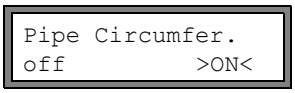
16.2 Dialogs and Menus



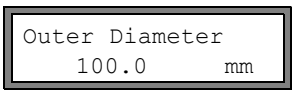
Select `Special Funct.\SYSTEM settings`\Dialogs/Menus. Press ENTER.

Note!	The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.

16.2.1 Pipe Circumference

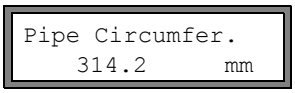


Select `on` if the pipe circumference is to be entered instead of the pipe diameter in the program branch `Parameter`. Press ENTER.



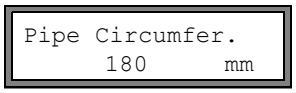
If `on` is selected for `Pipe Circumfer.`, the outer pipe diameter will nevertheless be requested in the program branch `Parameter`.

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

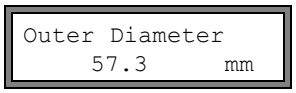


The value displayed in `Pipe Circumfer.` is calculated on the basis of the last displayed value of the outer pipe diameter.

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.

16.2.2 Fluid Pressure

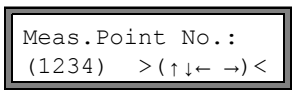
The dependence of the parameters of a fluid on the pressure can be taken into account.

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

If `off` is 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.

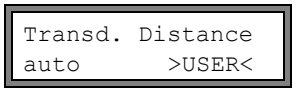
16.2.3 Measuring Point Number



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

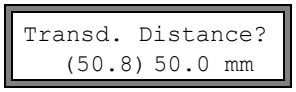
Select (↑↓← →) if the measuring point is to be designated with ASCII characters.

16.2.4 Transducer Distance

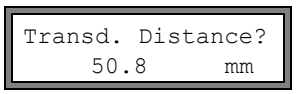


recommended setting: `user`

- `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 distance are not identical.

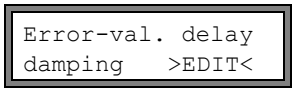


During transducer positioning in the program branch `Measuring`

- only the entered transducer distance will be displayed if `Transd. Distance` = `user` is selected and the recommended and the entered transducer distances are identical
- only the recommended transducer distance will be displayed if `Transd. Distance` = `auto` is selected.

16.2.5 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.

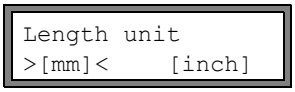
For further information on the behavior of missing measured values see section 18.1.2 and 18.2.

16.2.6 Alarm State Indication

Select `on` to display the alarm state during the measurement.
For further information on the alarm outputs see section 18.6.

16.2.7 Units of Measurement

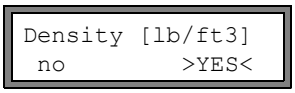
It is possible to set the units of measurement for the length, temperature, pressure, density and kinematic viscosity and sound speed:



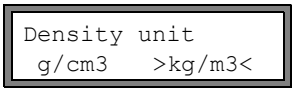
Select `mm` or `inch` as the unit of measurement for the length. Press ENTER.

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

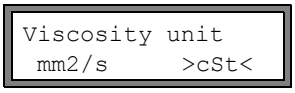
Select `bar` or `psi` as the unit of measurement for the pressure. Press ENTER.



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



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.

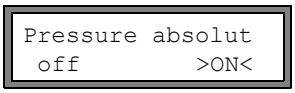


Select mm²/s or `cSt` as the unit of measurement for the kinematic viscosity. Press ENTER.

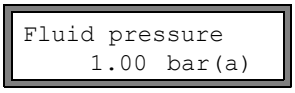
Select `m/s` or `fps` as the unit of measurement for the sound speed. Press ENTER.

16.2.8 Setting for the Fluid Pressure

It is possible to set whether the absolute or the relative pressure will be used:



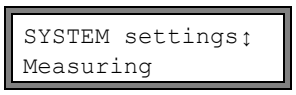
Select `on` or `off`. Press ENTER.
If `on` is selected, the absolute pressure p_a will be displayed/input/transmitted.
If `off` is selected, the relative pressure p_g will be displayed/input/transmitted.
$p_g = p_a - 1.01$ bar



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

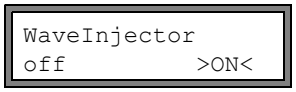
Note!	The settings will be stored at the end of the dialog.

16.3 Measurement Settings

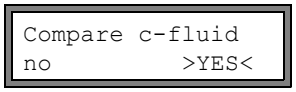


Select `Special Funct.\SYSTEM settings\Measuring`. Press ENTER.

Note! The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.



This menu item will only be displayed if a WaveInjector is in the scope of delivery (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

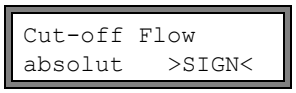
$\delta c = c_{mea} - c_{stored}$

between the two sound speeds will be displayed during the measurement. c_{stored} is the sound speed stored in the database.

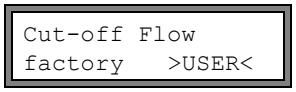
Press key [→] during the measurement to scroll to the display of `δc`.

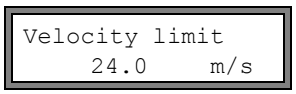
Select `normal` to display and transmit the profile corrected flow values, `uncorr.` to display and output the flow values without flow profile correction. Press ENTER.

For further information see section 13.7.



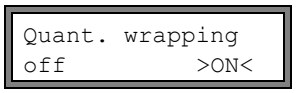
A lower limit for the flow velocity can be entered (see section 13.6).





An upper limit for the flow velocity can be entered (see section 13.5).

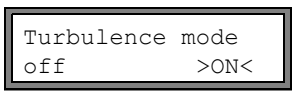
Enter `0` (zero) to deactivate the flow velocity check.



Select the overflow behavior of the totalizers (see section 13.3.1).

Select `on` to keep the previous totalizer values after a restart of the measurement.

Select `off` to reset the totalizers to zero after a restart of the measurement.



The activation of the turbulence mode can improve the signal quality if the flow is highly turbulent (e.g., in the vicinity of an elbow or valve). An SNR value of min. 6 dB is required during the measurement.

Note! The settings will be stored at the end of the dialog.

16.4 Setting the Contrast

Select `Special Funct.\SYSTEM settings\ Miscellaneous` to set the contrast of the display of the transmitter. Press ENTER.

The contrast of the display is adjusted with the following keys:

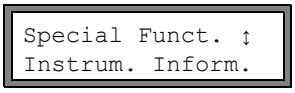
→ increases the contrast

↓ reduces the contrast

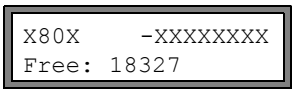
It is possible to reset the display to medium contrast. Enter HotCode **555000** (see section 10.4).

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

16.5 Instrument Information



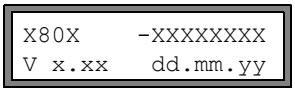
Select `Special Funct.\Instrum. Inform.` to display information about the transmitter. Press ENTER.



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

The available data logger memory will be displayed in the lower line (here: 18 327 additional measured values can be stored). For further information about the data logger see section 14.1.6.

Press ENTER.



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

The firmware version of the transmitter with the date is displayed in the lower line.

Press ENTER.

17 SuperUser-Modus

The SuperUser mode offers the possibility of an advanced analysis of the signal and the measured values as well as the definition of additional parameters adapted to the measuring point, in order to achieve better measuring values or during experimental work. Features of the SuperUser mode are:

- Default settings are not complied.
- There are no plausibility during parameter entry.
- 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 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.

17.1 Activation/Deactivation

Enter HotCode **071049** (see section 10.4).

It is displayed that the SuperUser mode is activated. Press ENTER. The main menu will be displayed.

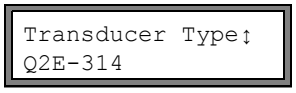
Enter HotCode **071049** again to deactivate the SuperUser mode.

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.

17.2 Transducer Parameters

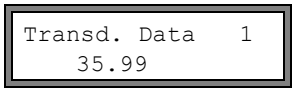
In the SuperUser mode, the menu item `Transducer Type` will be displayed in the program branch `Parameter` at the end of the input even if the transducers are detected by the transmitter.



Press ENTER.

or:

Select `Special Version` to enter the transducer parameters. Press ENTER.



If `Special Version` is selected, the transducer parameters have to be entered.

The transducer parameters have to be provided by the transducer manufacturer. Press ENTER after each input.

17.3 Defining 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.

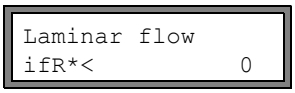
Select `Special Funct.\SYSTEM settings\Measuring\Calibration`. Press ENTER.

Select the measuring channel for which the flow parameters are to be defined. Press ENTER.

17.3.1 Profile Bounds

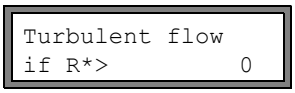
Select `user` if the profile bounds are to be defined. If `factory` is selected, the default profile bounds will be used and the menu item `Calibration` will be displayed (see section 17.3.2).

Press ENTER.



Enter the max. Reynolds number at which the flow is laminar. The entered number will be rounded to the hundreds. Enter `0` (zero) to use the default value of 1 000.

Press ENTER.



Enter the min. Reynolds number at which the flow is turbulent. The entered number will be rounded to the hundreds. Enter `0` (zero) to use the default value of 3 000.

Press ENTER.

A request is displayed if an additional correction of the flow velocity is to be defined. Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.

For the definition of the correction of the flow velocity see section 17.3.2.

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.

17.3.2 Correction of the Flow Velocity

After the profile bounds have been defined (see section 17.3.1), it is possible to define a correction of the flow velocity.

$v_{cor} = m \cdot v + n$

with

v – measured flow velocity

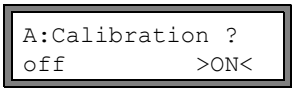
m – slope, range: -2.000...+2.000

n – offset, range: -12.7…+12.7 cm/s

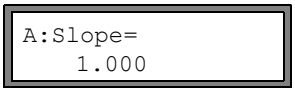
v_{cor} – corrected flow velocity

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.

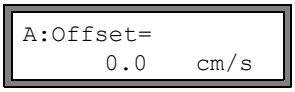
Note! During the measurement, it will not be displayed that the correction of the flow velocity is active.



Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.



If `on` is selected, enter the slope. The input `0.0` deactivates the correction. Press ENTER.



Enter the offset. Enter `0` (zero) to work without an 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, before the calculation of the derived quantities, it will be corrected as follows:

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

Example 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.

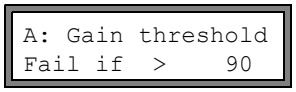
Attention! The correction of the flow velocity is still active after the deactivation of the SuperUser mode.

17.4 Limit of the Signal Amplification

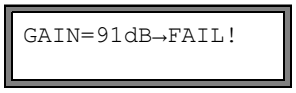
In order to prevent disturbing and/or pipe wall signals (e.g., if the pipe has run empty) from being interpreted as useful signals, it is possible to define a max. signal amplification. If the signal amplification is greater than the max. signal amplification,

- 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, `?` is displayed).

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 gain (`GAIN=`) can be displayed in the upper line in the program branch `Measuring`. If the actual value of the gain is higher than the max. gain, the actual value is displayed with →`FAIL`!.

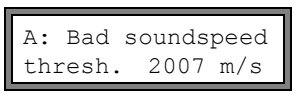
Attention! The limit of the signal amplification is still active after the deactivation of the SuperUser mode.

17.5 Upper Limit of the Sound Speed

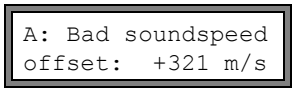
When the plausibility of the signal is evaluated, it will be checked if the sound speed is within a defined range. The upper limit of the flow velocity for the fluid is calculated from the greatest of the following values:

- 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.

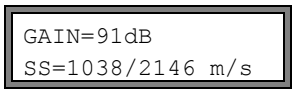


Enter for each measuring channel the fixed upper limit of the sound speed. Enter `0` (zero) to use the default value 1 848 m/s.
Press ENTER.



Enter for each measuring channel the offset. 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 2 007, this value will be used as the upper limit of the sound speed when the plausibility of the signal is evaluated.



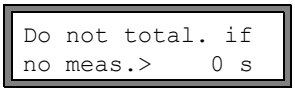
It is possible to display the valid range for the sound speed (`SS=`) in the lower line within the program branch `Measuring` during the measurement. The second value (here: 2 146 m/s) is the upper limit at the operating point.

Attention! The defined upper limit of the sound speed remains active after the deactivation of the SuperUser mode.

17.6 Detection of Long Measurement Failures

If there are no valid measured value during a long time interval, new increments of the totalizers will be ignored. The values of the totalizers remain unchanged.

In the SuperUser mode, it is possible to set the time interval. Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `Do not total. if no meas.` is displayed.



Enter the time. If `0` (zero) is entered, the default value 30 s will be used.

17.7 Number of Decimal Places of the Totalizers

The value of a totalizer consists of max. 11 digits, including max. 4 decimal places. 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 totalizer values will first be displayed with 3 decimal places. For higher totalizer values, the number of decimal places will be reduced.

max. value	display		
< 10^6	±0.000	...	±999999.999
< 10^7	±1000000.00	...	±9999999.99
< 10^8	±10000000.0	...	±99999999.9
< 10^{10}	±1000000000	...	±9999999999

`Total digits` = `Fixed to x digit`

The number of decimal points is constant. The max value of the totalizer is reduced with the number of decimal places.

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

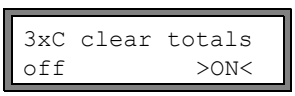
Note!	The number of decimal places and the max. value defined here only affect the display of the totalizers.

For setting the behavior of the totalizers after reaching the max. value see section 13.3.1.

17.8 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 key CLR three times, even if a program code is activated.

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `3xC-clear totals` is displayed.



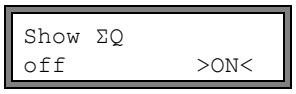
Select `on` to activate the manual reset of the totalizers, `off` to deactivate it. Press ENTER.

Note!	The manual reset of the totalizers is still active after the deactivation of the SuperUser mode.

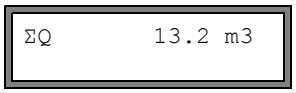
17.9 Display of the Sum of the Totalizers

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

Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `Show ΣQ` is displayed.



Select `on` to activate the display of the sum of the totalizers, `off` to deactivate it. Press ENTER.



If the display of the sum of the totalizers is activated, the sum `ΣQ` of the totalizer can be displayed in the upper line during the measurement.

17.10 Display of the Last Valid Measured Value

If the signal is not sufficient for a measurement, usually `UNDEF` will be 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.

17.11 Display During the Measurement

In the SuperUser mode, the following parameters can be displayed during the measurement besides the normal information (see section 12.3):

display	**explanation**
`t=`	transit time of the measuring signal
`c=`	sound speed
`REYNOLD=`	Reynolds number
`VARI A=`	standard deviation of the signal amplitude
`VARI T=`	standard deviation of the transit time of the measuring signal
`dt-norm=`	transit time difference standardized to the transducer frequency
	density of the fluid

18 Outputs

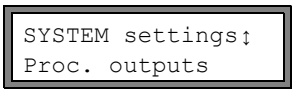
If the transmitter is equipped with outputs, they have to be installed and activated before they can be used:

- assign a measuring channel (source channel) to the output (if the transmitter has more than one measuring channel)
- assign the physical quantity (source item) to be transmitted to the output by the source channel, and the properties of the signal
- define the behavior of the output in case no valid measured values are available
- activation of the installed output in the program branch `Output Options`

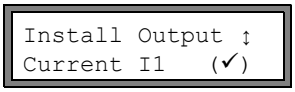
18.1 Installation of an Output

All outputs are installed in `Special Funct.\SYSTEM settings\Proc. outputs`.

Note!	The settings will be stored at the end of the dialog. If the menu item is quit by pressing key BRK, the changes will not be stored.

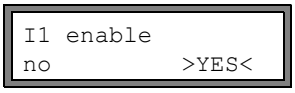


Select `Special Funct.\SYSTEM settings\Proc. outputs`. Press ENTER.

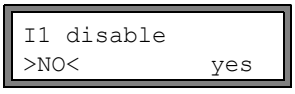


Select the output to be installed. Press ENTER.

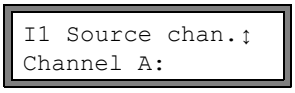
The scroll list contains all actually available outputs. A tick (✓) after a list item indicates that this output has already been installed.



This display will be indicated if the output has not been installed yet. Select `yes`. Press ENTER.

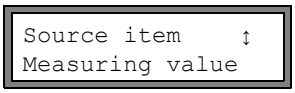


If the output has already been installed, select `no` to reconfigure it or `yes` to uninstall the output and to return to the previous menu item in order to select another output. Press ENTER.



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 a physical quantity (source item) to be transmitted to the output by the source channel.

If a binary output is configured, only the list items `Limit` and `Pulse` will be displayed.

The source items and their scroll lists are described in Tab. 18.1.

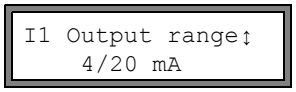
Tab. 18.1: Configuration of the outputs

source item	**list item**	**output**
`Measuring value`		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)
`Pulse`	`from abs(x)`	pulse without sign consideration
	`from x > 0`	pulse for positive measured values
	`from x < 0`	pulse for negative measured values

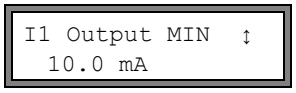
Tab. 18.1: Configuration of the outputs

source item	list item	output
Miscellaneous	c-Medium	sound speed of the fluid
	Concentration	concentration of the fluid
	Signal	signal amplitude of a measuring channel
	SCNR	ratio useful signal to correlated disturbance signal
	VariAmp	standard deviation of the signal amplitude
	Density	density of the fluid
	Pressure	pressure of the fluid

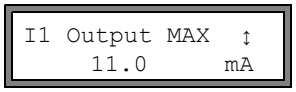
18.1.1 Output Range

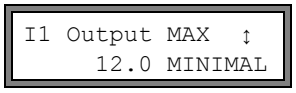


When configuring an analog output, the output range will be defined now. Select a list item or other range... to enter the output range manually.



If other range... is 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} ≥ 2 mA for a 4…20 mA current output

18.1.2 Error Value

In the following dialog, an error value can be defined which is output in case a source item cannot be measured, e.g., if there are gas bubbles in the fluid.

Tab. 18.2: Error output

error value	results
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 18.2): > 0

The volumetric flow rate cannot be measured during the time interval t_0...t_1 (see Fig. 18.1). The error value will be transmitted.

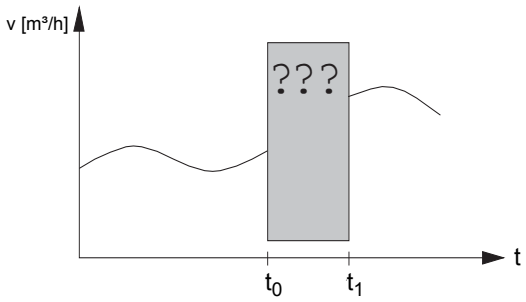
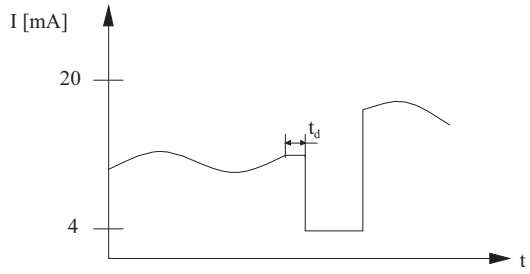
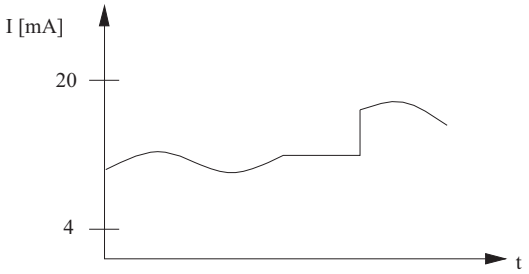
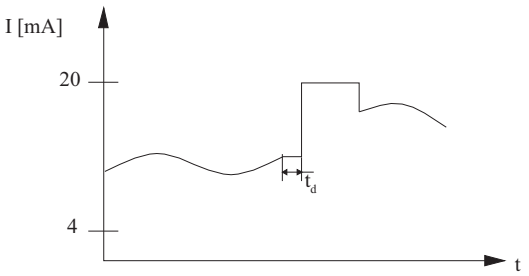
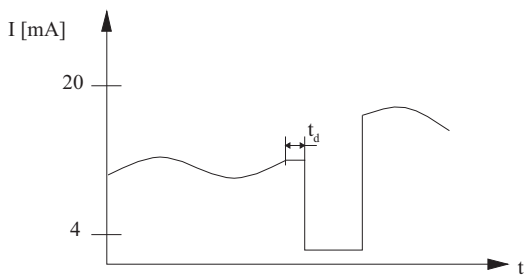
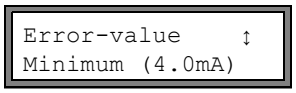


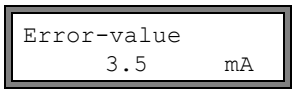
Fig. 18.1: Error output

Tab. 18.3: 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	

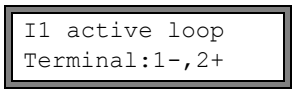


Select a list item for the error output. Press ENTER.



If `Other value` is 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.

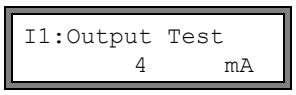


The terminals for the connection of the output are displayed (here: `1-` and `2+` for the active current loop).
Press ENTER.

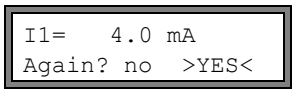
18.1.3 Function Test

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

Test of the Analog Outputs

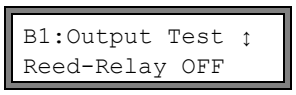


The current output is tested in the display. Enter a test value. It has to be within the output range. Press ENTER.

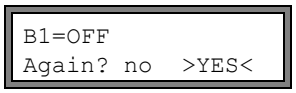


If the multimeter displays the entered value, the output functions correctly.
Select `yes` to repeat the test, `no` to return to `SYSTEM settings`. Press ENTER.

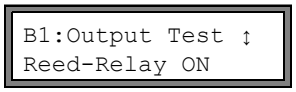
Test of the Binary Outputs



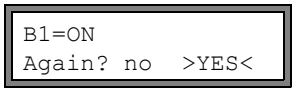
Select `Reed-Relay OFF` or `Open collect OFF` in the scroll list `Output Test` to test the de-energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be high ohmic.



Select `yes`. Press ENTER.



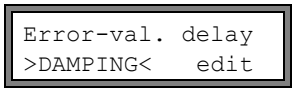
Select `Reed-Relay ON` or `Open collect. ON` in the scroll list `Output Test` to test the energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be low ohmic.



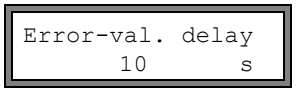
Select `yes` to repeat the test, `no` to return to `SYSTEM settings`. Press ENTER.

18.2 Error Value Delay

The error value delay is the time interval after which the entered value for the 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`.



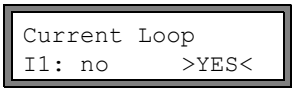
From now on, the error value delay can be entered in the program branch `Output Options`.

18.3 Activation of an Analog Output

Note!	An output can only be activated in the program branch `Output Options` if it has previously been installed.

In the program branch `Output Options`, select the channel for which an output is to be activated. Press ENTER.

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



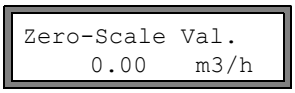
Press ENTER until `Current Loop` is displayed. Select `yes` to activate the output. Press ENTER.

18.3.1 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.

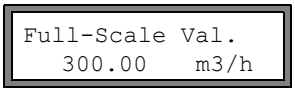
Select `sign` if the sign of the measured values is to be considered for the output.

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 corresponding to the lower limit of the output range as defined in section 18.1.1.



Enter the highest expected measured value.

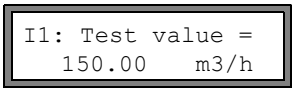
`Full-Scale Val.` is the measured value corresponding to the upper limit of the output range as defined in section 18.1.1.

Example:	output: current output output range: 4…20 mA `Zero-Scale Val.`: 0 m³/h `Full-Scale Val.`: 300 m³/h volumetric flow rate = 0 m³/h, corresponds to 4 mA volumetric flow rate = 300 m³/h, corresponds to 20 mA

18.3.2 Function Test

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

Select `yes` to test the output. Press ENTER.



Enter a test value for the selected physical quantity. If the multimeter displays the corresponding current value, the output functions correctly. Press ENTER.

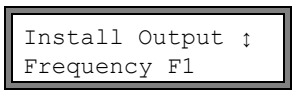
Select `yes` to repeat the test. Press ENTER.

Example:	output: current output output range: 4…20 mA `Zero-Scale Val.`: 0 m³/h `Full-Scale Val.`: 300 m³/h `Test value` = 150 m³/h (center of the measuring range, corresponds to 12 mA) If the multimeter displays 12 mA, the current output functions correctly.

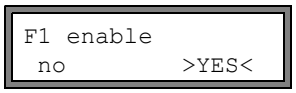
18.4 Configuration of a Frequency Output as a Pulse Output

A A frequency output sends a signal with a frequency that depends on the volumetric flow rate. The frequency output can be configured in such way that the source item can be totalized by using each period of the output signal as the increment.

18.4.1 Installation of a Frequency Output (optional)

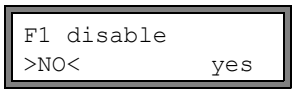


Select `Frequency F1` in `Special Funct.\SYSTEM settings\Proc. outputs`. Press ENTER.

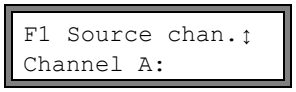


Select `yes` if the output has not been installed. Press ENTER.

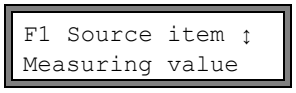
or



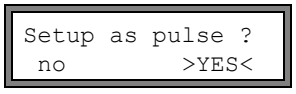
Select `no` if the output has already been installed. Press ENTER.



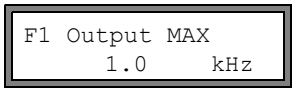
Select in the scroll list the measuring channel to be assigned to the output as the source channel. Press ENTER.



Select in the scroll list `Measuring value` (but not `Pulse`!). Press ENTER.



If `Measuring value` is 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.



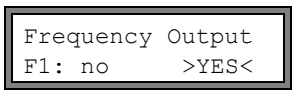
Enter the upper limit of the frequency. Press ENTER.

The lower limit of the frequency and the error value will be set automatically to 0.5 Hz.

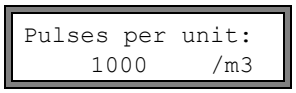
18.4.2 Activation of the Output

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.

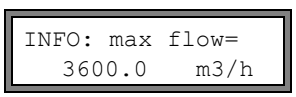


Select `yes` to activate the output. Press ENTER.



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.

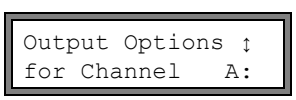


The max. flow depending on the upper limit of the frequency and pulse value is indicated. Press ENTER.

18.5 Activation of a Binary Output as a Pulse Output

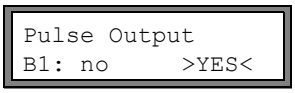
A pulse output is an integrating output which emits a pulse when the volume or the mass of the fluid which has passed the measuring point reaches a given value (`Pulse Value`). The integrated quantity is the selected physical quantity. Integration is restarted as soon as a pulse is emitted.

Note!	The menu item `Pulse Output` will only be indicated in the program branch `Output Options` if a pulse output has been installed.



Select in the program branch `Output Options` the channel for which a pulse output is be activated. Press ENTER.

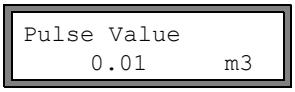
This display will not be indicated if the transmitter has only one measuring channel.



Select `yes` to activate the output. Press ENTER.

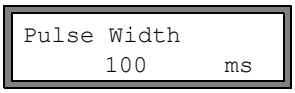
This error message will be displayed if the flow velocity is selected as the physical quantity.

The use of the pulse output is not possible in this case because integrating the flow velocity does not result in a reasonable value.



Enter the pulse value. The unit of measurement will be displayed according to the actual physical quantity.

When the counted physical quantity reaches the introduced pulse value, a pulse will be transmitted.



Enter the pulse width.

The range of possible pulse widths depends on the specification of the instrument (e.g., counter, PLC) that is to be connected to the output.

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.

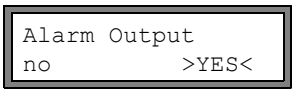
If the flow exceeds this value, the pulse output does not work correctly. In this case, the pulse value and the pulse width have to be adapted to the flow conditions. Press ENTER.

18.6 Activation of a Binary Output as an Alarm Output

Note!	The menu item `Alarm Output` will only be displayed in the program branch `Output Options` if an alarm output has been installed.

Select in the program branch `Output Options` the channel for which an alarm output is to be activated. Press ENTER until the menu item `Alarm Output` is displayed.

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

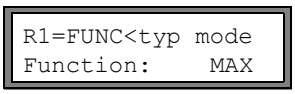


Select `yes` to activate the alarm output. Press ENTER.

Max. 3 alarm outputs R1, R2, R3 per channel operating independently of each other can be configured. The alarm outputs can be used to output information on the current measurement or to start and stop pumps, motors, etc.

18.6.1 Alarm Properties

The switching condition, the holding behavior and the switching function of an alarm output can be defined.



Three scroll lists will be displayed:

- `func`: switching condition
- `typ`: holding behavior
- `mode`: switching function

Press key [→] 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. 18.4: 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 no longer true, the alarm will return to the idle state after approx. 1 s.
	HOLD	The alarm remains activated even if the switching condition is no longer true.
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.

18.6.2 Setting the Limits

If the switching condition MAX or MIN is selected in the scroll list func, the limit of the output will have to be defined:

```
R1 Input:       ↕
Volume flow
```

Select in the scroll list Input the physical quantity to be used for the comparison. The following list items are available for the alarm output R1:

- selected physical quantity
- signal amplitude
- sound speed of the fluid

Press ENTER.

For the alarm outputs R2 and R3 the current physical quantity is set 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.

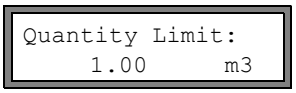
Example 1: High Limit: -10 m³/h

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 if 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.

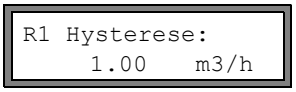
Example 1:	physical quantity: volumetric flow rate in m³/h Quantity Limit: 1 m³
Example 2:	physical quantity: volumetric flow rate in m³/h Low Limit: 60 m³/h The unit of measurement of the physical quantity is changed to m³/min. The new limit to be entered is 1 m³/min.

18.6.3 Defining the Hysteresis

A hysteresis can be defined for the alarm output R1 to prevent a constant triggering of the alarm due to small fluctuations of the measured values around the limit. 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 is triggered for measured values > 30.5 m³/h and deactivated for measured values < 29.5 m³/h.



switching condition: MIN or MAX
Enter the value for the hysteresis.
or
Enter 0 (zero) to work without a hysteresis.
Press ENTER.

18.7 Behavior of the Alarm Outputs

18.7.1 Apparent Switching Delay

The measured values and the totalizer values will be displayed rounded to 2 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 2 decimal places). In this case the switching accuracy of the output is higher than the accuracy of the display.

18.7.2 Reset and Initialization of the Alarms

After an initialization of the transmitter all alarm outputs will be configured as follows:

Tab. 18.5: 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 is stopped and the main menu is selected. All alarm outputs will be de-energized, independently of the programmed idle state.

18.7.3 Alarm Outputs during Transducer Positioning

At the beginning of the transducer positioning (bar graph display), all alarm outputs switch back to the programmed idle state.

If the bar graph is selected during measurement, all alarm outputs will switch back to the programmed idle state.

An alarm output of the type HOLD that has been activated during the previous measurement will remain in the idle state after the transducer positioning if the switching condition is no longer met.

Switching of the alarms into the idle state will not be displayed.

18.7.4 Alarm Outputs during Measurement

An alarm output with switching condition MAX or MIN will be updated max. once per second to avoid humming (i.e. fluctuation of the measured values around the value of the switching condition).

An alarm output of the type NON-HOLD will be activated if the switching condition is met. It will be deactivated if the switching condition is no longer met. The alarm will remain activated min. 1 s even if the switching condition is met for a shorter period of time.

Alarm output s with the switching condition QUANT. will be activated if the limit is reached.

Alarm outputs with the switching condition ERROR will only be activated after several unsuccessful measuring attempts. Therefore, typical short-term disturbances of the measurement (e.g., switching on of a pump) will not activate the alarm.

Alarm outputs with the switching condition +→− −→+ and of the type NON-HOLD will be activated with each change of the flow direction for approx. 1 s (see Fig. 18.2).

Alarm outputs with the switching condition +→− −→+ and of the type HOLD will be activated after the first change of the flow direction. They can be switched back by pressing key CLR 3 times (see Fig. 18.2).

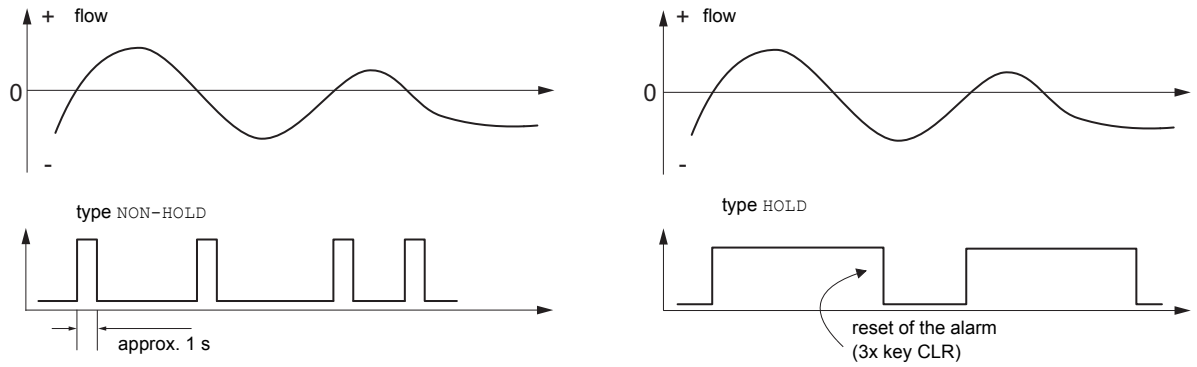


Fig. 18.2: Behavior of a relay when the flow direction changes

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..

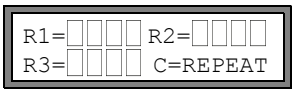
18.7.5 Alarm State Indication

Note!	There is no visual or 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 `Special Funct.\SYSTEM settings\Dialogs/Menus`. The activation of this function is recommended when alarm outputs have to be reconfigured frequently.

Select the menu item `SHOW RELAIS STAT`. Select `on`to activate the arlarm state indication.

If the alarm state indication is activated, the alarm output state is displayed after configuring the alarm outputs:



The alarm state indication is structured as follows:

Rx = , with x being the number of the alarm output and a pictogram according to Tab. 18.6.

The configuration of the alarm outputs can be repeated by pressing key CLR. If the configuration of the alarm outputs is finished, press enter. The main menu will be displayed.

If the alarm output indication is activated, the alarm state can be displayed during the measurement. Press key → to scroll through the upper line or key ↓ in the lower line until the alarm state is displayed.

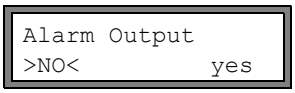
Tab. 18.6: Pictograms for the alarm state indication

	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 =

18.8 Deactivation of the Outputs

If the programmed outputs are no longer required, they can be deactivated. The configuration of a deactivated output is stored and will be available if the output is activated again.



Select `no` in `Output Options\Alarm Output` to deactivate an output. Press ENTER.

19 Troubleshooting

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

Calibration

FLUXUS is a very reliable instrument. It is manufactured under strict quality control using modern production techniques. If installed as recommended in an appropriate location, used cautiously and taken care of conscientiously, no troubles should appear. The transmitter has been calibrated at the factory and, usually, a re-calibration of the transmitter will not be necessary. A re-calibration is recommended if

- the contact surface of the transducers shows visible wear or
- the transducers were used for a prolonged period of time at a high temperature (several months >130 °C for normal transducers or > 200 °C for high temperature transducers).

The transmitter has to be sent to FLEXIM for recalibration under reference conditions.

The display does not work at all or fails regularly

Check the contrast setting of the transmitter (see section 16.4).

Make sure that the correct voltage is available at the terminals. The voltage is indicated on the nameplate below the outer right terminal.If the power supply is ok, the transducers or an internal component of the transmitter are defective. The transducers and the transmitter have to be sent to FLEXIM for repair.

The message "System Error" is displayed

Press key BRK to return to the main menu.

If this message is displayed repeatedly, write down the number in the lower line. Track down the situations when the error is displayed. Contact FLEXIM.

The transmitter does not react when key BRK is pressed during the measurement

A program code has been defined. Press key 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 18.1.3. If the output is defective, contact FLEXIM.

A measurement is impossible or the measured values substantially differ from the expected values

see section 19.1.

The values of the totalizers are wrong

see section 19.6.

19.1 Problems with the Measurement

A measurement is impossible because no signal is received. A question mark is displayed in the lower line on the right

- Check if the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound speed of the 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 is selected (see section 19.2).
- Try to establish better acoustic contact between the pipe and the transducers (see section 19.3).
- Enter a lower value for the number of sound paths. The signal attenuation might be too high due to a high fluid viscosity or deposits on the inner pipe wall (see section 19.4).

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

- An exclamation mark ! in the lower line on the right indicates that the defined upper limit of the flow velocity is exceeded and, therefore, the measured values are marked as invalid. The limit has to be adapted to the measuring conditions or the check has to be deactivated (see section 13.5).
- If no exclamation mark ! is displayed, a measurement at the selected measuring point is not possible.

Loss of signal during the measurement

- If the pipe had been run empty: Was there no measuring signal afterwards? Contact FLEXIM.
- Wait briefly until acoustic contact is reestablished. The measurement can be interrupted by a temporarily higher proportion of gas bubbles and solids in the 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 19.5 for the description of typical situations in which wrong measured values are obtained.

19.2 Selection of the Measuring Point

- Make sure that the recommended min. distance to any disturbance source is observed (see chapter 5, Tab. 5.2).
- Avoid measuring points with deposit formation in the pipe.
- Avoid measuring points in the vicinity of deformations and defects on the pipe and in the vicinity of welds.
- Measure the temperature at the measuring point and make sure that the transducers are suitable for this temperature.
- Make sure that the outer pipe diameter is within the measuring range of the transducers.
- When measuring on a horizontal pipe, the transducers have to be mounted on the side of the pipes.
- A vertical pipe always has to be filled at the measuring point and the 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).

19.3 Maximum Acoustic Contact

Observe the instructions in chapter 9.

19.4 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 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.

19.5 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 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 transducer

The measuring point is not appropriate

Select another measuring point to check whether the results are better. Because pipes are never rotationally symmetric, the flow profile is affected. Change the transducer position according to the pipe deformation.

19.6 Problems with the Totalizers

The values of the totalizers are too high

See `Special Function\SYSTEM settings\Measuring\Quantity recall`. If this menu item is activated, the values of the totalizer will be stored. The totalizer will continue with this value at the start of the next measurement.

The values of the totalizers are too small

One of the totalizers has reached the upper limit and has to be reset to 0 manually.

The sum of the totalizers is not correct

See `Special Function\SYSTEM settings\Measuring\Quantity wrapping`. The sum of both totalizers (throughput) transmitted via an output is not valid after the overflow (wrapping) of one of the totalizers.

19.7 Transmission of Data

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 14.2.4) and of the terminal program.

A Menu Structure

	INIT-resistant
Program branch `Parameter`	

`>PAR< mea opt sf`
`Parameter`
main menu: selection of the program branch `Parameter`	

`Parameter ↕`
`for Channel A:`
selection of a measuring channel (A, B) or of 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)	

`Outer Diameter`
`100.0 mm`
input of the outer pipe diameter	

`Pipe Circumfer.`
`314.2 mm`
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.	

`Wall Thickness`
`3.0 mm`
input of the pipe wall thickness
range: depends on the connected transducers
default: 3 mm	

`Pipe Material ↕`
`Carbon Steel`
selection of the pipe material	

`c-Material`
`3230.0 m/s`
input of the sound speed of the pipe material
range: 600…6553.5 m/s
This display will only be indicated if `Other Material` is selected.	

`Lining`
`no >YES<`
selection whether the pipe is lined	

`Lining ↕`
`Bitumen`
selection of the lining material
This display will only be indicated if `Lining` = `yes` is selected.	

`c-Material`
`3200.0 m/s`
input of the sound speed of the lining material
range: 600…6553.5 m/s
This display will only be indicated if `Other Material` is selected.	

`Liner Thickness`
`3.0 mm`
input of the liner thickness
range: 0...50 mm
default: 3 mm	

`Roughness`
`0.4 mm`
input of the roughness of the inner pipe wall
range: 0…5 mm
default: 0.1 mm (for steel as pipe material)	

`Medium ↕`
`Water`
selection of the fluid	

`c-Medium`
`1500.0m/s`
input of the average sound speed of the fluid
range: 500...3500 m/s
This display will only be indicated if `Other Medium` is selected.	

		INIT-resistant
c-Medium range auto >USER<	selection of the sound speed range `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 area around the average sound speed of the fluid This display will only be indicated if `user` is 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` is selected.	
Density 1.00 g/cm3	input of the operation density of the fluid range: 0.01...20 g/cm³ This display will only be indicated if `Other Medium` is 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\Measuring\Gas-Measuring` is activated or if `Gas-Measuring` is deactivated and `\Special Funct.\SYSTEM settings\Dialogs/Menus` is 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 are only 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 the flow profile correction This display will only be indicated if `Special Funct.\SYSTEM settings\Measuring\Flow Velocity` = `uncorr.` is selected.	

		INIT-resistant
A: Sound Path 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 values transmission to a PC or a printer via a 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` is 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. the time interval after which the error value is transmitted to the output in case no valid measured values are available This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay` = `EDIT` is 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 `SYSTEM settings\Proc. outputs\\`.	
Pulse Value 0.01 m3	input of the pulse value (totalizer value 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` is activated and `MAX` is 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` is activated and `MIN` is selected as the switching condition.	
Quantity Limit: 1.00 m3	input of the limit for the flow totalizer of the physical quantity to be monitored This display will only be indicated if `Alarm Output` is activated and `QUANT.` is 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` is activated and `MIN` or `MAX` is 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`	
`SYSTEM settings\Set Clock`		
SYSTEM settings↕ Set Clock	selection of the displays for the input of the date and the time	

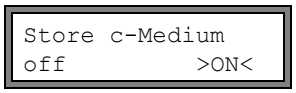
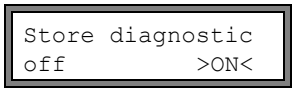
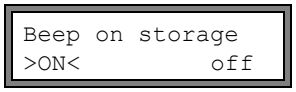
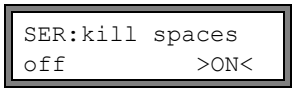
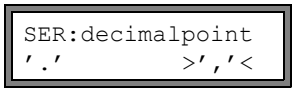
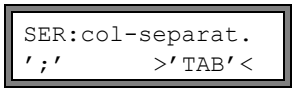
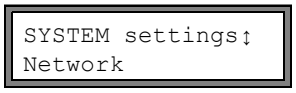
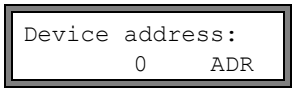
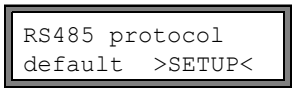
		INIT-resistant
SYSTEM settings\Libraries		
SYSTEM settings↕ Libraries	selection of the displays for the management of the material and fluid scroll lists	
SYSTEM settings\Libraries\Material list		
Libraries ↕ Material list	selection of the displays for the arrangement of the material scroll list (pipe and lining materials)	
SYSTEM settings\Libraries\Medium list		
Libraries ↕ Medium list	selection of the displays for the arrangement of the fluid scroll list	
SYSTEM settings\Libraries\Format USER-AREA		
Libraries ↕ Format USER-AREA	selection of the displays for the partitioning of the coefficient memory for the storing of user defined material and fluid parameters	
Format USER-AREA Materials: 03	input of the number of user defined materials	
Format USER-AREA Media: 03	input of the number of user defined fluids	
USER AREA: 52% used	display of the occupancy of the coefficient memory	
Format NOW? no >YES<	confirmation of the selected partition	
FORMATTING ... ■■■■■■ ...	the coefficient memory is being partitioned	
SYSTEM settings\Libraries\Extended Library		
Libraries ↕ Extended Library	selection of the displays for the activation of the extended library	
Extended Library off >ON<	Activation of the Extended Library	x
SYSTEM settings\Dialogs/Menus		
SYSTEM settings↕ Dialogs/Menus	selection of the displays for the activation/deactivation or setting of the menu items in the other program branches	
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

		INIT-resistant
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 whether the absolute pressure p_a or 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/ft³ is to be used as 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/ft³ 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
`SYSTEM settings\Measuring`		
SYSTEM settings↕ Measuring	selection of the displays for the measurement settings	
WaveInjector off >ON<	activation of the WaveInjector (optional)	x

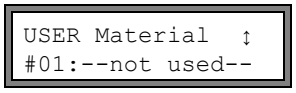
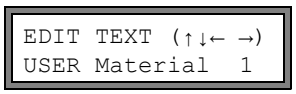
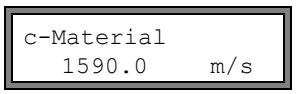
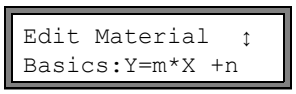
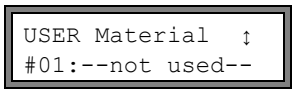
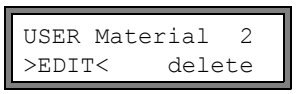
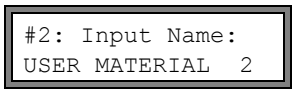
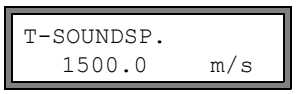
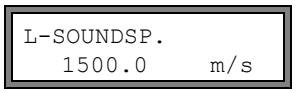
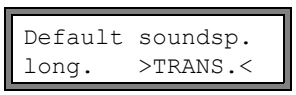
		INIT-resistant
`Enable NoiseTrek` ` off >ON<`	enabling the NoiseTrek mode	x
`Auto NoiseTrek ?` ` no >YES<`	Selection whether the toggling between the TransitTime mode and the NoiseTrek mode is to be carried out manually or automatically. This display will only be indicated if the NoiseTrek mode is enabled.	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: without toggling to the NoiseTrek mode This display will only be indicated if the automatic toggling between the TransitTime mode and NoiseTrek mode is activated.	x
`NT-Failed |After` `→TransTime | 60s`	Input of the time after which the transmitter toggles to the TransitTime mode if there are no valid measured values in the NoiseTrek mode. range: 0...9999 s 0: without toggling to the TransitTime mode This display will only be indicated if the automatic toggling between the TransitTime mode and 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: without toggling to the TransitTime mode This display will only be indicated if the automatic toggling between the TransitTime mode and NoiseTrek mode is activated.	x
`Keep TT | For` `checking | 5s`	Inputof 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 mode and 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
`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 (0.127 m/s) default: 2.5 cm/s (0.025 m/s) This display will only be indicated if `Cut-off Flow` = `sign` and `Cut-off Flow` = `user` is selected.	x

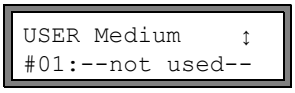
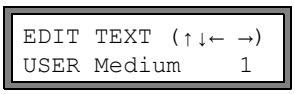
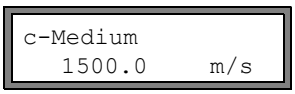
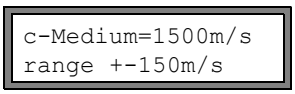
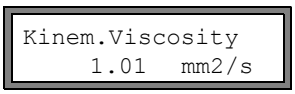
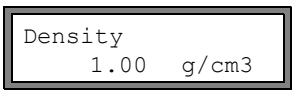
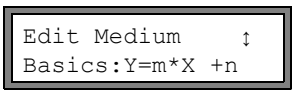
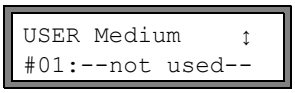
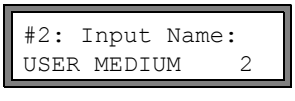
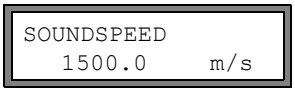
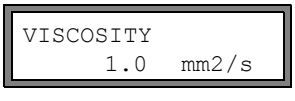
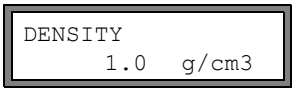
		INIT-resistant
-Cut-off Flow -2.5 cm/s	input of the cut-off flow for negative measured values range: -12.7...0 cm/s default: -2.5 cm/s This display will only be indicated if `Cut-off Flow` = `sign` and `Cut-off Flow` = `user` is selected.	x
Cut-off Flow 2.5 cm/s	input of the cut-off flow for the absolute 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` is selected.	x
A: Gain threshold Fail if> 90	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 limit of 1 848 m/s will be used This display will only be indicated if the SuperUser mode is activated.	x
A: Bad soundspeed offset: +321	Input of the offset. range: 0...900 m/s 0: the default limit of 300 m/s will be used This display will only be indicated if the SuperUser mode is activated.	x
Quant. wrapping off >ON<	activation of the totalizers overflow	x
Quantity recall off >ON<	activation of the taking-over of the totalizer values after the measurement restart	x
Do not total. if no meas.> 0 s	input of a time interval after which the transmitter has to detect a long measurement failure if there are no valid measured values 0: the default value of 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 of 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
ShowΣQ off >ON<	activation of the display of the totalizer sum This display will only be indicated if the SuperUser mode is activated.	x
Keep display val off >ON<	activation of the display of the last valid measured value This display will only be indicated if the SuperUser mode is activated.	x
Turbulence mode off >ON<	activation of the turbulence mode	x

		INIT-resistant
Special Funct.\SYSTEM settings\Measuring\Calibration		
Calibrat. data ↕ for Channel A:	selection of the measuring channel whose flow parameters are to be defined This display will only be indicated if the SuperUser mode is activated.	
A:Profile bounds factory >USER<	determination of the profile bounds factory: the default profile bounds will be used user: the profile bounds can be defined This display will only be indicated if the SuperUser mode is activated.	
Laminar flow ifR*< 0	Input of the max Reynolds number at which the flow is laminar. range: 0...25 500 (rounded to hundreds) 0: the default limit of 1 000 will be used This display will only be indicated if the SuperUser mode is activated and Profile bounds = user is selected.	
Turbulent flow if R*> 0	Input of the min. Reynolds number at which the flow is turbulent. range: 0...25 500 (rounded to hundreds) 0: the default limit of 3 000 will be used This display will only be indicated if the SuperUser mode is activated and Profile bounds = user is selected.	
A:Calibration ? >OFF< on	request if an additional correction of the flow velocity is to be defined on: the correction data can be defined off: without correction of the flow velocity This display will only be indicated if the SuperUser mode is activated.	
A:Slope= 1.000	Input of the slope for the correction formula. range: -2.000...+2.000 0.0: without correction This display will only be indicated if the SuperUser mode is activated and Calibration = onis selected.	
A:Offset= 0.0 cm/s	Input of the offset. range: -12.7…+12.7 cm/s 0: without offset This display will only be indicated if the SuperUser mode is activated and Calibration = onis selected.	
SYSTEM settings\Proc. outputs		
SYSTEM settings↕ Proc. outputs	selection of the displays for the transmitter outputs setting	
Install Output ↕ Current I1	selection of the output to be installed	
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 data logger overflow behavior	x

		INIT-resistant
	selection of the sample mode • sample: storing and online transmission of the displayed measured value • average: storing and online transmission of the average of all measured values of a storage interval	x
	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
	activation of the signal amplitude storing The value will only be stored if the data logger is activated.	x
	activation of the fluid sound speed storing The value will only be stored if the data logger is activated.	x
	activation of storing of the diagnostic values	x
	activation of an acoustic signal every time a measured value is stored or transmitted	x
SYSTEM settings\serial transmis.		
	selection of the displays for the formatting of the serial transmission of measured values	
	activation of the serial transmission with/without blanks	x
	selection of the decimal marker for floating point numbers	x
	selection of the character for column separation	x
	selection of the serial interface default: RS232 This display will only be indicated if the transmitter has an RS485 interface.	x
SYSTEM settings\Network		
	change of settings for the transmission parameters of the RS485 interface	
	input of the address of the measuring instrument	x
	confirmation or change of the transmission parameters	x
	change of the baud rate, parity or number of stop bits	x

		INIT-resistant
SYSTEM settings\Miscellaneous		
SYSTEM settings↕ Miscellaneous	selection of the display for the setting of the contrast and input of a HotCode	
SETUP DISPLAY ← CONTRAST →	setting of the display contrast	
Input a HOTCODE no >YES<	confirmation that a HotCode has to be entered	
Please input a HOTCODE: 000000	input of a HotCode	
Instrum. Inform.		
Special Funct. ↕ Instrum. Inform.	selection of the displays for information about the transmitter	
X80X -XXXXXXXX Free: 18327	display of the type, serial number and max. available data logger memory	x
X80X -XXXXXXXX V x.xx dd.mm.yy	display of type, serial number and firmware version with date (dd - day, mm - month, yy - year)	x
Print Meas.Val.		
Special Funct. ↕ Print Meas.Val.	selection of the displays for the transmission of stored measured values to a PC	
NO VALUES ! Print Meas.Val.	error message that no measured values are stored	
Send Header 01	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.	
SERIAL ERROR ! Print Meas.Val.	error message that there is a problem with the serial transmission	
■■■■■■	display of the data transmission progress	
Delete Meas.Val.		
Special Funct. ↕ Delete Meas.Val.	selection of the displays for the deleting of stored measured values	
Really Delete? no >YES<	confirmation for the deleting of measured values This display will only be indicated if measured values are stored in the data logger.	

	INIT-resistant
Install Material	
 selection of the displays for the input of tube and lining materials	
`Install Material with Special Funct.\SYSTEM settings\ Libraries\Extended Library = off`	
 selection whether a user defined material is to be edited or deleted	
 selection of a user defined material	
 input of a designation for the selected material	
 input of the sound speed of the material range: 600...6553.5 m/s	
 input of the roughness of the material	
`Install Material with Special Funct.\SYSTEM settings\ Libraries\Extended Library = on`	
 selection of the function for the temperature and pressure dependence of the material parameters	
 selection of a user defined material	
 selection whether the user defined material is to be edited or deleted This display will only be indicated if the selected material already exists.	
 input of a designation for the selected material	
 input of the constants for the transversal sound speed of the material The number of constants depends on the function selected above.	
 input of the constants for the longitudinal sound speed of the material The number of constants depends on the function selected above.	
 selection of the sound wave type for the flow measurement	
 input of the roughness of the material	
 confirmation that the changes are to be saved This display will only be indicated if a new material has been entered or the parameters 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 average sound speed of the fluid range: 500.0...3500.0 m/s	
 input of the area 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 operation 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 parameters	
 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 operation density of the fluid	

		INIT-resistant
Save changes no >YES<	confirmation that the changes are to be saved This display will only be indicated if a new fluid has been entered or the parameters 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

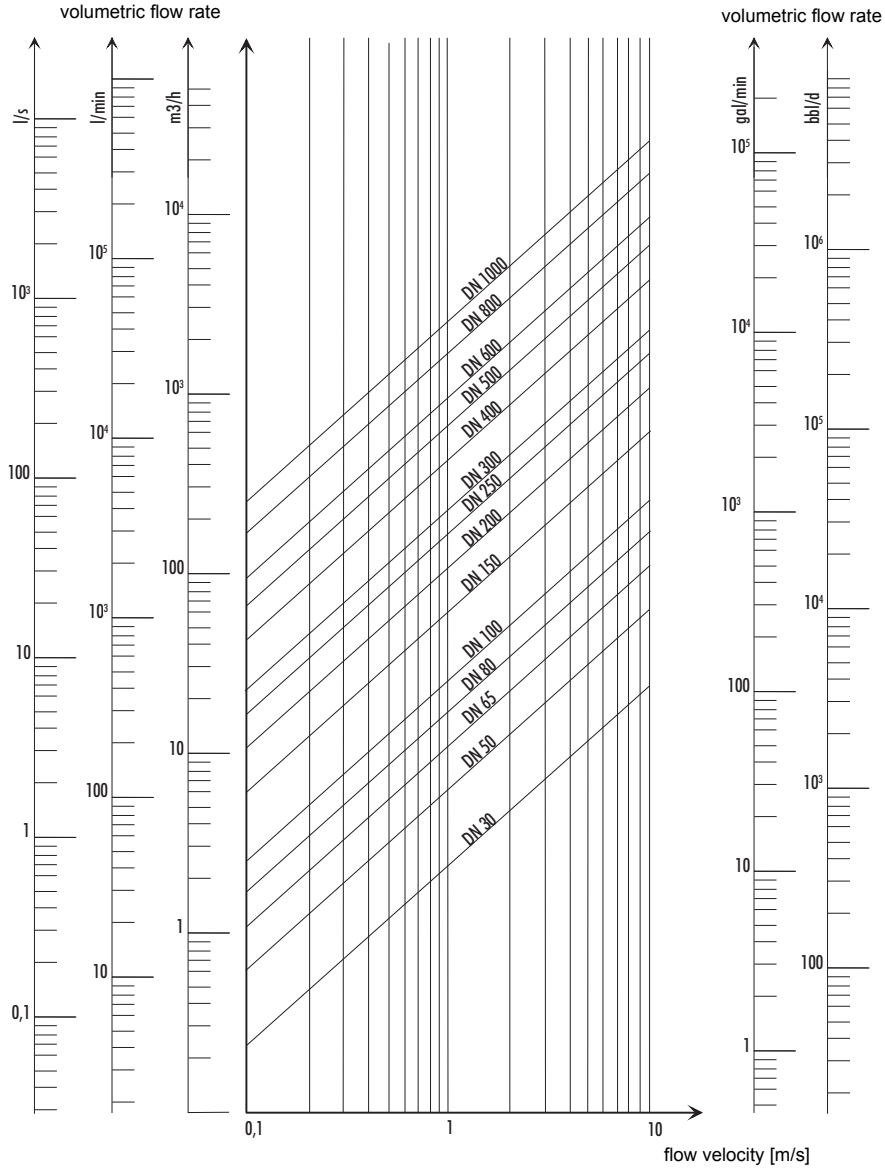
heat flow rate		**Heat quantity (totalized)**
unit of measurement	description	unit of measurement
W	Watt	Wh or J*
kW	kilowatt	kWh or kJ*
MW	megawatt	MWh or MJ*
GW	gigawatt	GWh or GJ*
kBTU/minute	kBTU per minute	kBT
kBTU/hour	kBTU per hour	kBT
MBTU/hour	MBTU per hour	MBT
MBTU/day	MBTU per day	MBT
TON (TH)	TON, totals in TONhours	TH
TON (TD)	TON, totals in TONdays	TD
kTON (kTH)	kTON, totals in TONhours	kTH
kTON (kTD)	kTON, totals in TONdays	kTD

BTU: British Thermal Unit
1 W = 1 J/s = (1/1055.05585262) BTU/s

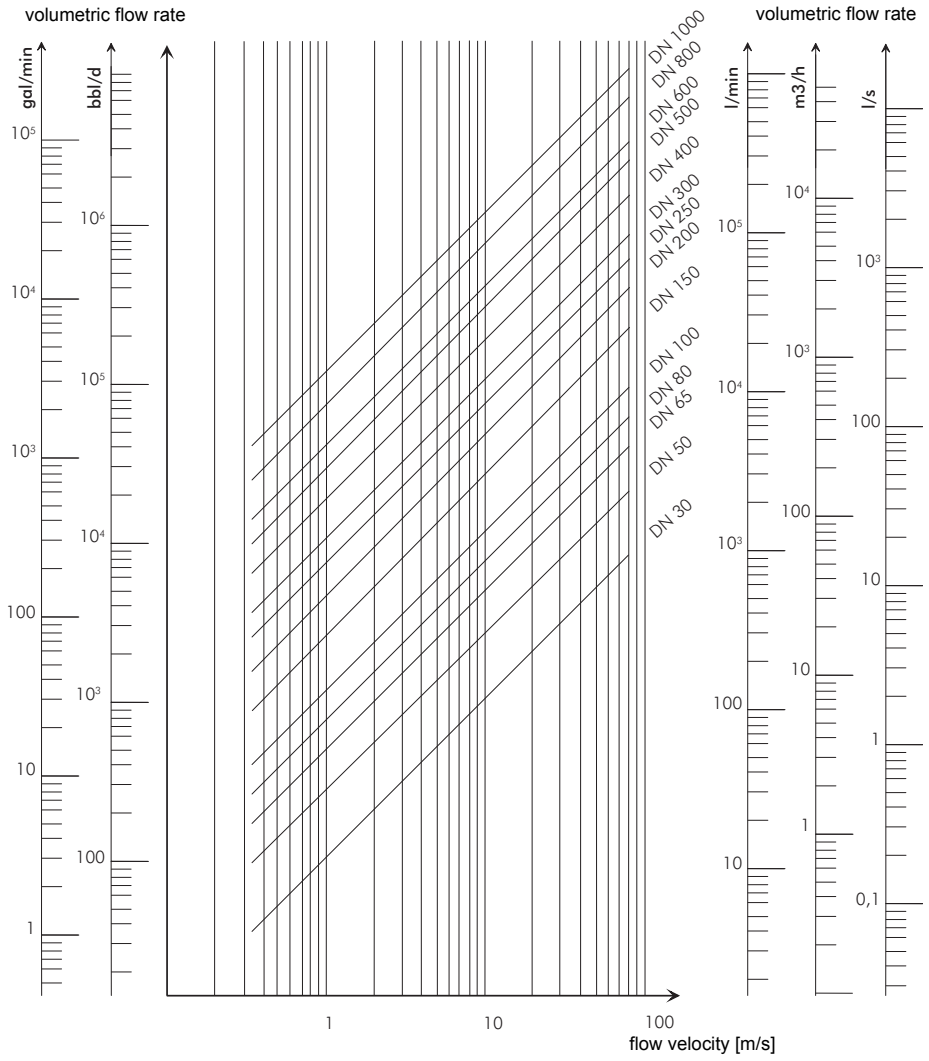
TON: ton of refrigeration
1 W = 1 J/s = (1/3516.852842) TON
1 TON = 200 BTU/min

*Selection in `Special function\SYSTEM settings\Measurement`

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	steel (normal)	3 230	5 930	trans
Stainless Steel	steel, stainless	3 100	5 790	trans
DUPLEX	duplex steel	3 272	5 720	trans
Ductile Iron	ductile 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 (GRP)	-	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	copper-nickel-iron alloy	2 510	4 900	trans
Grey Cast Iron	grey cast iron	2 200	4 600	trans
Rubber	rubber	1 900	2 400	trans
Glass	glass	3 400	5 600	trans
PFA	perfluoralcoxy	500	1 185	long
PVDF	polyvinylidene fluorid	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	0.7300
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	1 210	7.1	0.8260
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
ISO VG 220	ISO VG 220	1 487	811.1	0.8690

Fluid (display)	Explanation	Sound speed [m/s]	Kinematic viscosity [mm²/s]	Density [g/cm³]
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%	soda lye, 10 %	1 762	2.5	1.1140
caustic soda 20%	soda lye, 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	seawater	1 522	1.0	1.0240
Shell Thermina B	Shell Thermina B	1 365	89.3	0.8630
Silicon oil	silicon 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]	Sound speed [m/s]	Density [g/cm^3]	Specific heat capacity* [kJ/kg/K^{-1}]
0.1	1,013	1402.9	999.8	4,219
10	1,013	1447.3	999.7	4,195
20	1,013	1482.3	998.2	4,184
30	1,013	1509.2	995.6	4,180
40	1,013	1528.9	992.2	4,179
50	1,013	1542.6	988.0	4,181
60	1,013	1551.0	983.2	4,185
70	1,013	1554.7	977.8	4,190
80	1,013	1554.4	971.8	4,197
90	1,013	1550.5	965.3	4,205
100	1,013	1543.2	958.3	4,216
120	1,985	1519.9	943.1	4,244
140	3,615	1486.2	926.1	4,283
160	6,182	1443.2	907.4	4,335
180	10.03	1391.7	887.0	4,405
200	15.55	1332.1	864.7	4,496
220	23.20	1264.5	840.2	4,615
240	33.47	1189.0	813.4	4,772
260	46.92	1105.3	783.6	4,986
280	64.17	1012.6	750.3	5,289
300	85.88	909.40	712.1	5,750
320	112.8	793.16	667.1	6,537
340	146.0	658.27	610.7	8,208
360	186.7	479.74	527.6	15.00
373,946	220,640	72,356	322.0	∞

* at constant pressure

D Maintenance

The transmitter and the transducers are practically maintenance-free.

D.1 Cleaning

- Clean the transmitter with a soft cloth. Do not use detergents.
- Remove traces of acoustic coupling compound from the transducers with a paper tissue.

D.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 flameproof enclosure housing (FLUXUS ADM 8027, see Fig. D.1, FLUXUS F801, see Fig. D.2).

Flameproof enclosure

- If the O-ring is defective or the housing does not seal anymore, change it (see Tab. D.1).

Housing with increased safety

- If the O-ring is defective or the housing does not seal anymore, have it replaced.

Note!	Store the O-ring replacement in a hermetically sealed and dark place.

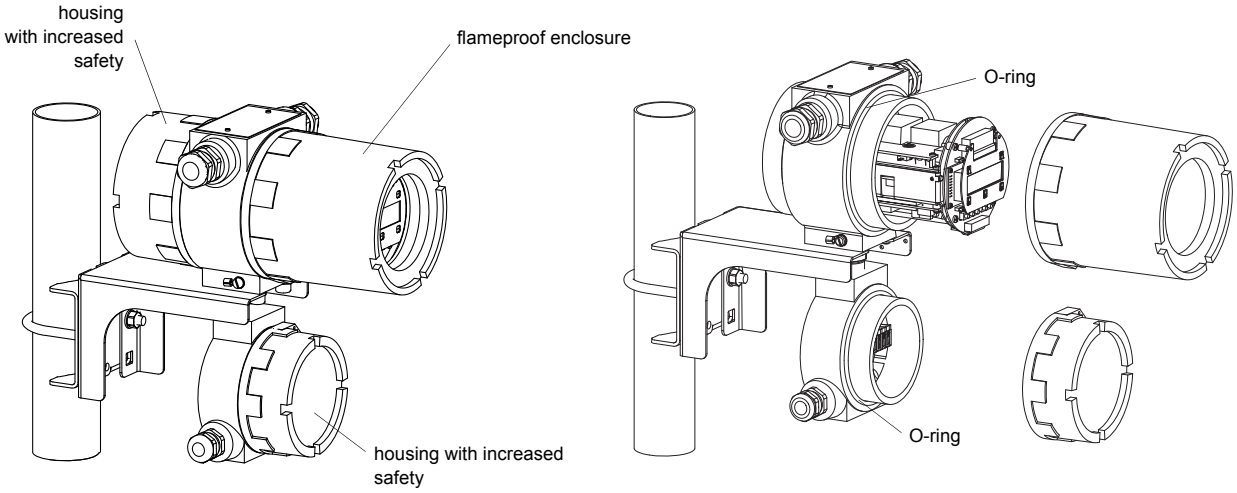


Fig. D.1: FLUXUS ADM 8027

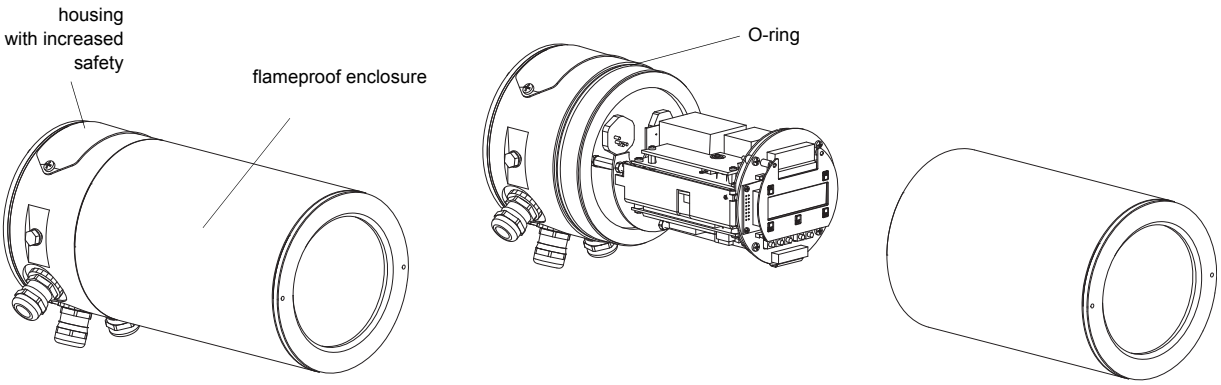
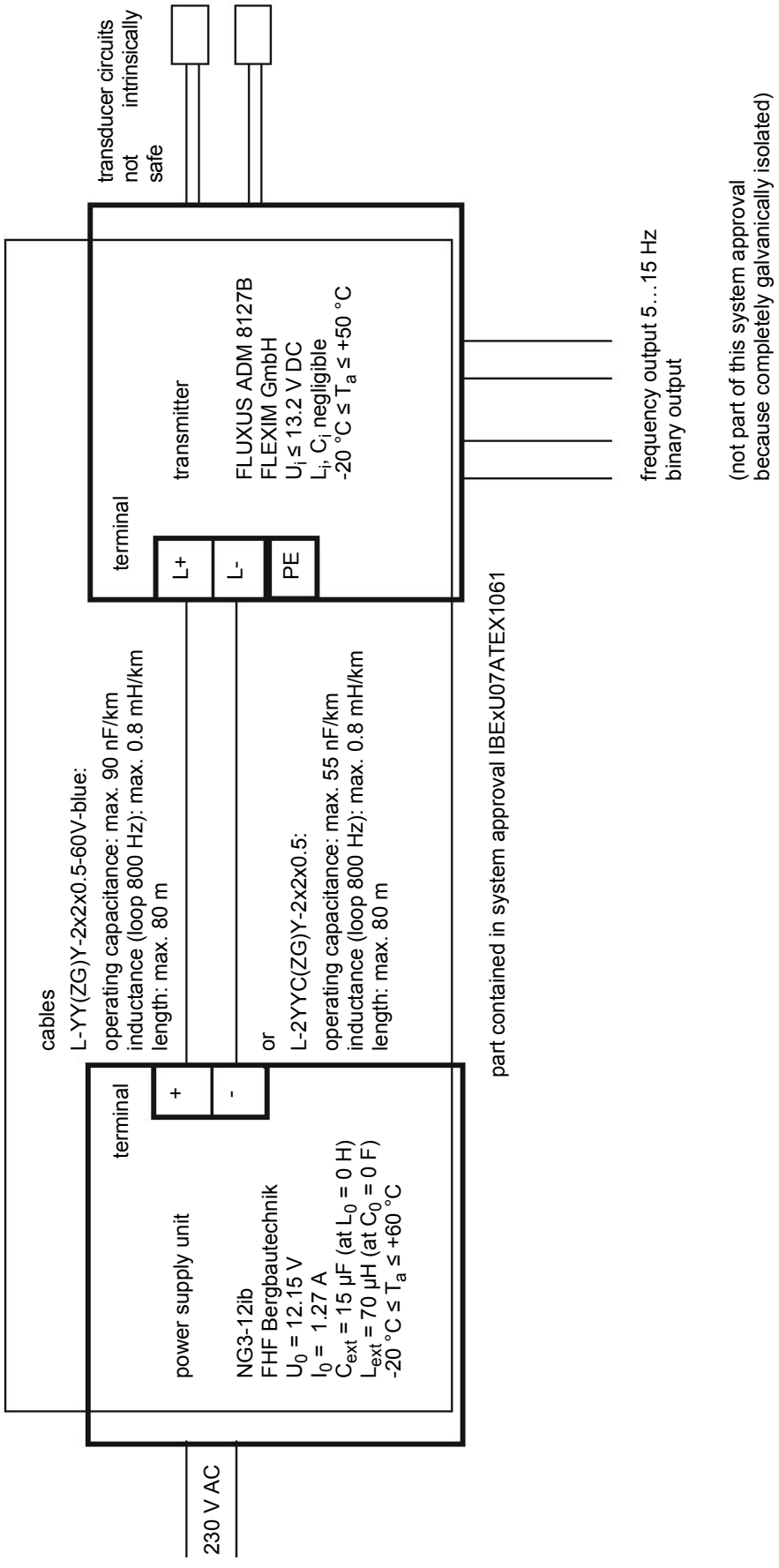


Fig. D.2: FLUXUS F801

Tab. D.1

transmitter	**O-ring**	**item number**
FLUXUS ADM 8027, upper housing	gasket Adalet 120 mm	990735-1
FLUXUS ADM 8027, lower housing	gasket Adalet 95 mm	990735-2
FLUXUS F801	O-ring-125x2,5	on request

E System Design in Accordance with IBExU07ATEX1061



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