FLEXIM

User Manual

UMFLUXUS_F5WDV1-1EN

Ultrasonic Flowmeter for Water

FLUXUS WD100

FLUXUS WD200

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User manual for
FLUXUS WD100, WD200
UMFLUXUS_F5WDV1-1EN, 2016-04-08
Firmware-Version: V6.24

Die Sprache, in der die Anzeigen auf dem Messumformer erscheinen, kann eingestellt werden (siehe Abschnitt 8.5).

The transmitter can be operated in the language of your choice (see section 8.5).

Il est possible de sélectionner la langue utilisée par le transmetteur à l'écran (voir section 8.5).

El caudalímetro puede ser manejado en el idioma de su elección (ver sección 8.5).

De transmitter kan worden gebruikt in de taal van uw keuze (zie paragraaf 8.5).

Имеется возможность выбора языка информации, отображаемой на экране преобразователя (смотри подраздел 8.5).

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1 Introduction

1.1 Regarding this User Manual

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

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

Note!	For technical data, see Technical Specifications.

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

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

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!

Observe these safety instructions!

1.3 Warranty

We warrant the reliability of the material and workmanship of FLUXUS for the term specified in the sales contract, provided that the measuring instrument is used for the purpose for which it was designed, and operated according to the instructions given in this user manual.

This includes:

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

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

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

In case of a problem which cannot be solved with the help of this user manual (see chapter 16), contact our sales office giving a precise description of the problem. Specify the type, serial number and firmware version of the measuring instrument.

2 Handling

2.1 First Inspection

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

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

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

2.2 General Precautions

FLUXUS is a precision measuring instrument and has to be handled with care. In order to obtain good measurement results and avoid damaging the measuring instrument, it is important that great attention is paid to the instructions given in this user manual, particularly to the following points:

- Protect the transmitter from shocks.
- Keep the transducers clean. Manipulate the transducer cables with caution. Avoid excessive cable bend.
- Make sure to work under correct ambient and operating temperatures. The ambient temperature has to be within the operating temperature range of the transmitter and the transducers (see Technical Specifications).
- Observe the degree of protection (see Technical Specifications).

Attention!	On the display of the transmitter and the window of the front plate (inside and outside) are protection films. Remove these protection films before using the transmitter.

2.3 Cleaning

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

3 General Principles

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

3.1 Measurement System

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

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

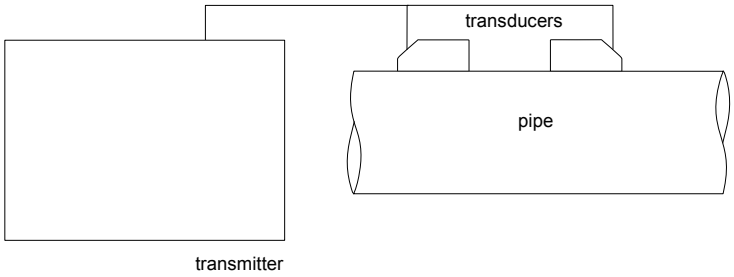


Fig. 3.1: Example of a measurement setup

3.2 Measurement Principle

The flow velocity of the fluid is measured using the transit time difference correlation principle (see section 3.2.2).

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 and against the flow direction. The flow velocity of the fluid in the pipe is determined from the transit time difference (see Fig. 3.2, Fig. 3.3 and Fig. 3.4).

Sound speed c

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

Flow velocity v

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

Acoustic calibration factor k_a

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

The acoustic calibration factor k_a is a 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

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 wedge of the receiving transducer (see Fig. 3.2 and Fig. 3.3). This causes a change in the transit times. The transit time of the signal in the flow direction is shorter than the transit time against the flow direction. This transit time difference is proportional to the average flow velocity.

The flow velocity of the fluid is calculated as follows:

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

with

v – flow velocity of the fluid

k_{Re} – fluid mechanics correction factor

k_a – acoustic calibration factor

Δt – transit time difference

t_{fl} – transit time in the fluid

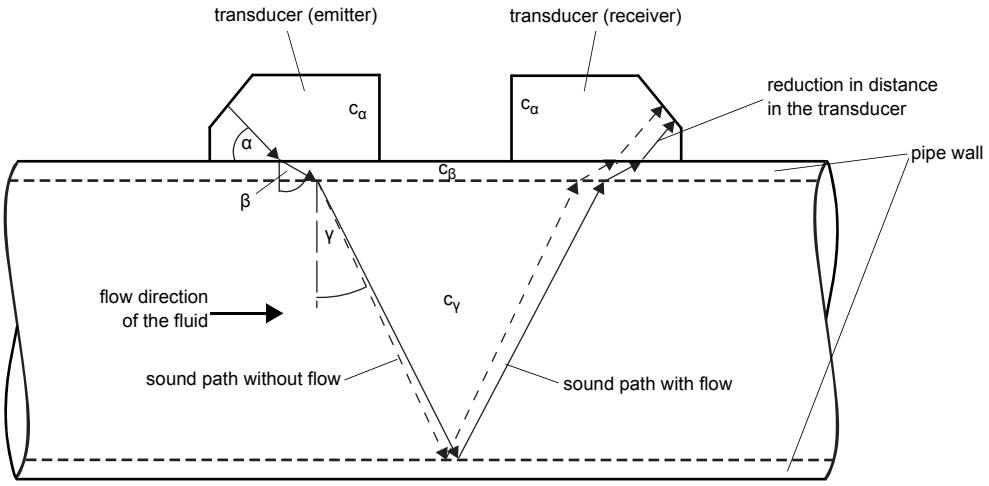


Fig. 3.2: Sound path of the signal in the flow direction

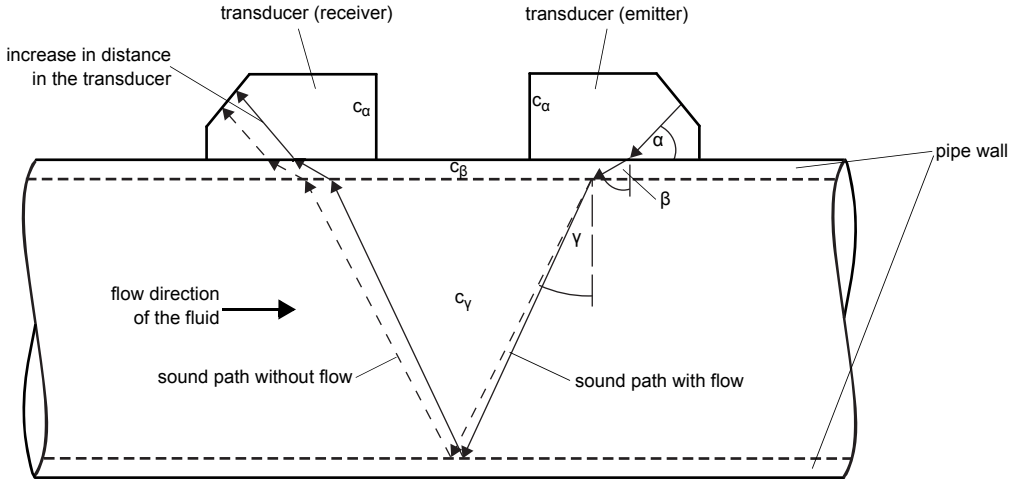


Fig. 3.3: Sound path of the signal against the flow direction

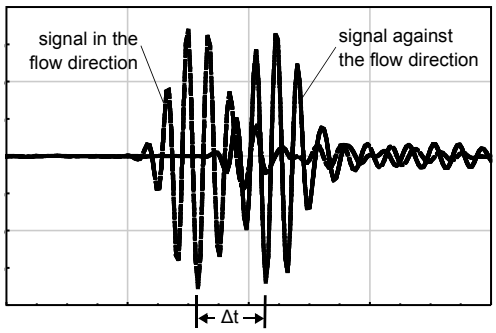


Fig. 3.4: Transit time difference Δt

3.3 Measurement Arrangements

3.3.1 Terms and Definitions

Diagonal arrangement

The transducers are mounted on the opposite sides of the pipe (see Fig. 3.5).

Reflection arrangement

The transducers are mounted on the same side of the pipe (see Fig. 3.6).

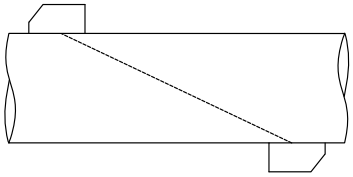


Fig. 3.5: Diagonal arrangement

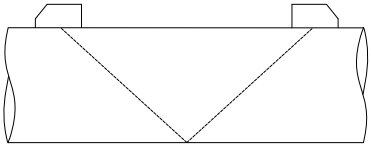


Fig. 3.6: Reflection arrangement

Sound path

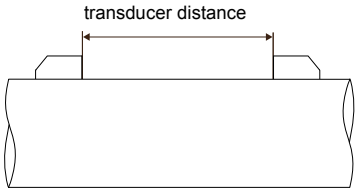
The distance covered by the ultrasonic signal after crossing the pipe once. The number of the sound paths is:

- odd if the measurement is conducted in the diagonal arrangement (see Fig. 3.5)
- even if the measurement is conducted in the reflection arrangement (see Fig. 3.6).

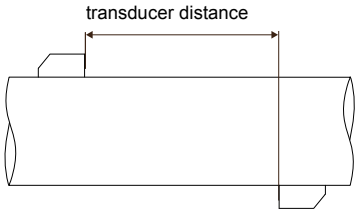
Transducer distance

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

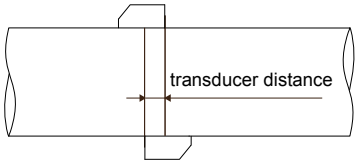
reflection arrangement



diagonal arrangement
(positive transducer distance)



diagonal arrangement
(negative transducer distance)



Sound plane

The plane containing one, two or more sound paths or beams (see Fig. 3.7).

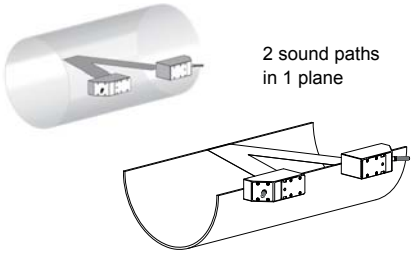
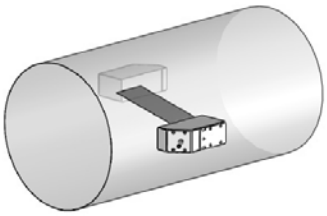
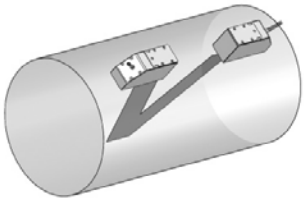


Fig. 3.7: Sound paths in one plane

3.3.2 Examples

Diagonal arrangement with 1 beam	Reflection arrangement with 1 beam
1 transducer pair 1 sound path 	1 transducer pair 2 sound paths 

4 Description of the Transmitter

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

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

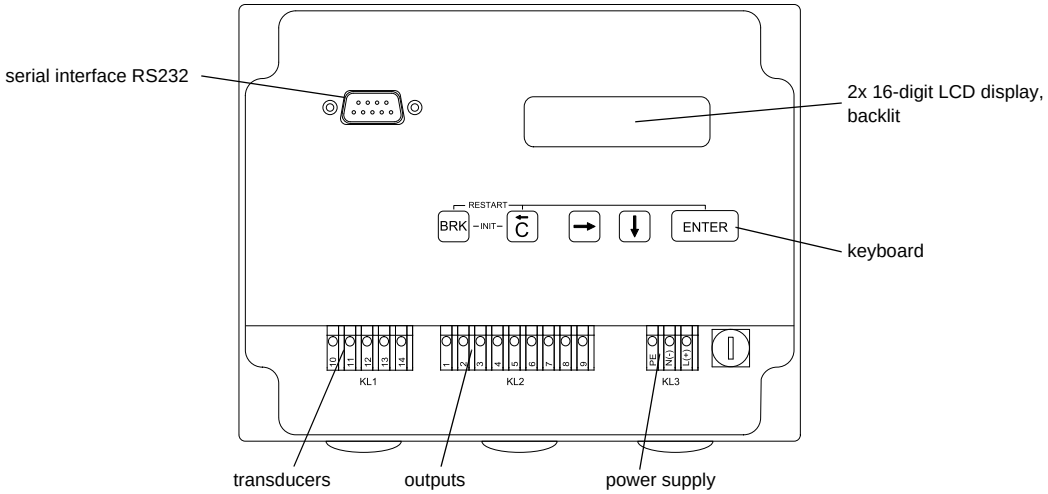


Fig. 4.1: Command panel

4.1 Keyboard

The keyboard consists of 5 keys.

Tab. 4.1: General functions

ENTER	confirmation of selection or entered value
BRK + C	INIT: When switching on the transmitter press these two keys simultaneously to execute the initialization (see section 8.2).
BRK + C + 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
C	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
C	reset all characters to the last stored entry

5 Selection of the Measuring Point

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

A measurement on a pipe is possible if

• the ultrasound propagates with a sufficiently high amplitude (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 transducers (see Technical Specifications).

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

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

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

5.1 Acoustic Penetration

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

The attenuation in the pipe and in the fluid depends on:

• kinematic viscosity of the fluid

• proportion of gas bubbles and solids in the fluid

• deposits on the inner pipe wall

• pipe material

The following requirements have to be met at the measuring point:

• the pipe is always filled completely

• no material deposits in the pipe

• no bubbles accumulate

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

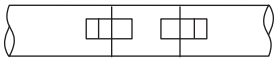
Observe the notes in the following table:

Tab. 5.1: Recommended transducer position

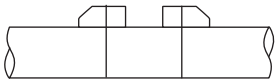
Horizontal pipe

Select a measuring point where the transducers can be mounted on the side of the pipe, allowing the sound waves to propagate in the pipe horizontally. Thus, solids at the bottom or gas bubbles in the pipe's upper part from will not influence the propagation of the signal.

correct:



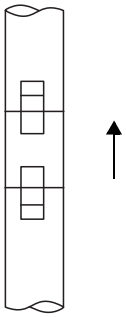
disadvantageous:



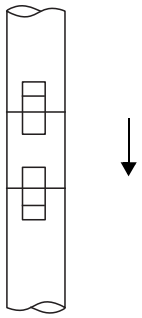
Vertical pipe

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

correct:



disadvantageous:

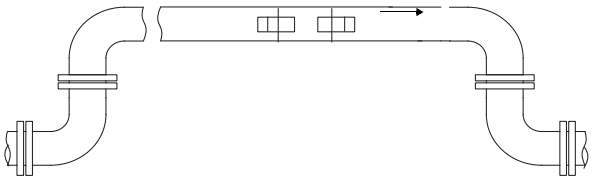


Free inlet or outlet pipe section:

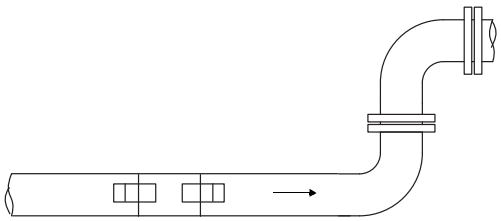
Select the measuring point at a pipe location where the pipe cannot run empty.

correct:

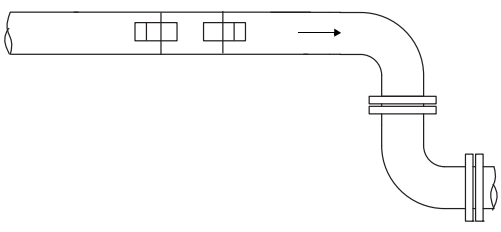
disadvantageous:



correct:



disadvantageous:



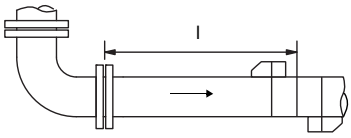
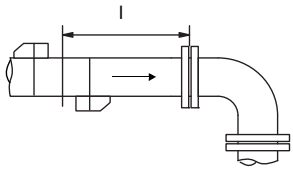
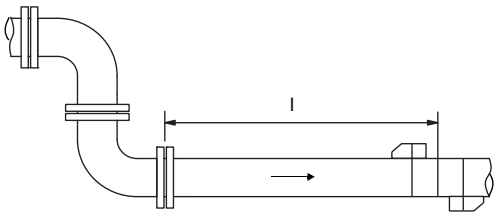
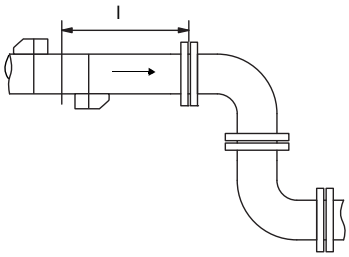
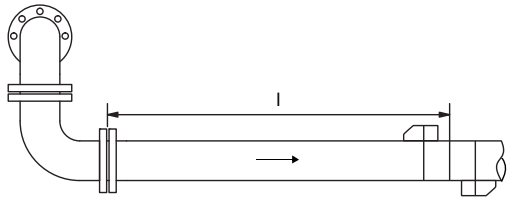
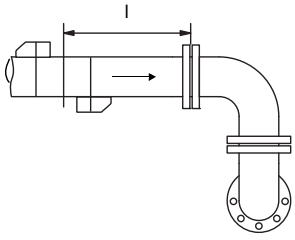
5.2 Undisturbed Flow Profile

Some flow elements (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.

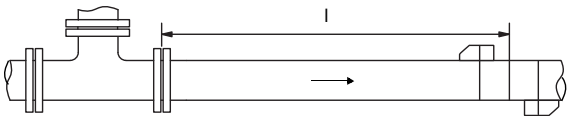
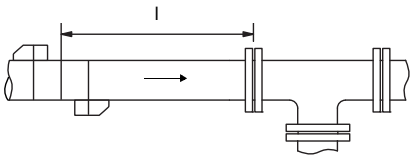
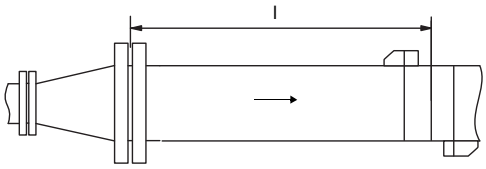
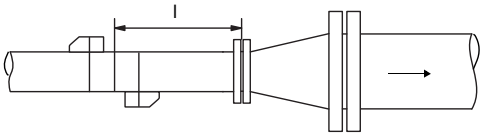
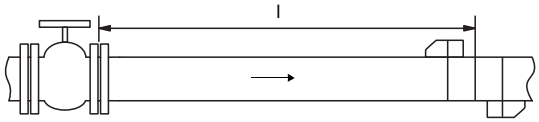
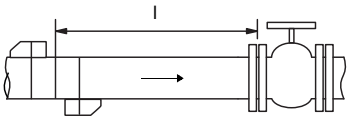
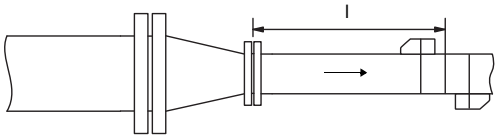
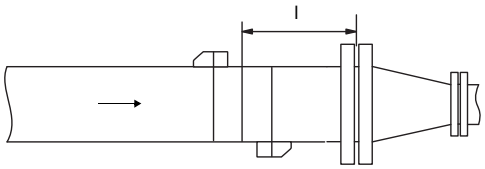
It is most important that the measuring point is chosen at a sufficient distance from any disturbance sources. Only then it can be assumed that the flow profile in the pipe is fully developed. However, measuring results can be obtained even if the recommended distance to disturbance sources cannot be 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 in same plane	
supply line: l ≥ 25 D	return line: l ≥ 5 D
	
disturbance source: 2x 90° elbows in different planes	
supply line: l ≥ 40 D	return line: l ≥ 5 D
	

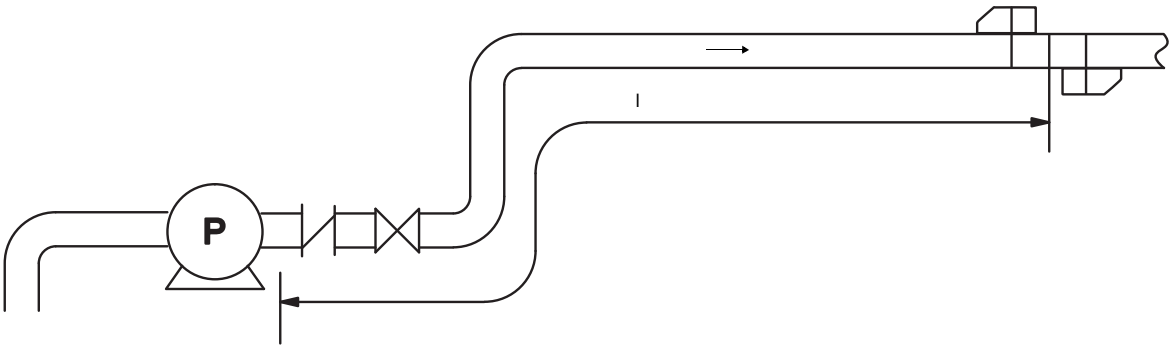
Tab. 5.2: Recommended distance from disturbance sources; D – nominal pipe diameter at the measuring point, l – recommended distance

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
	

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

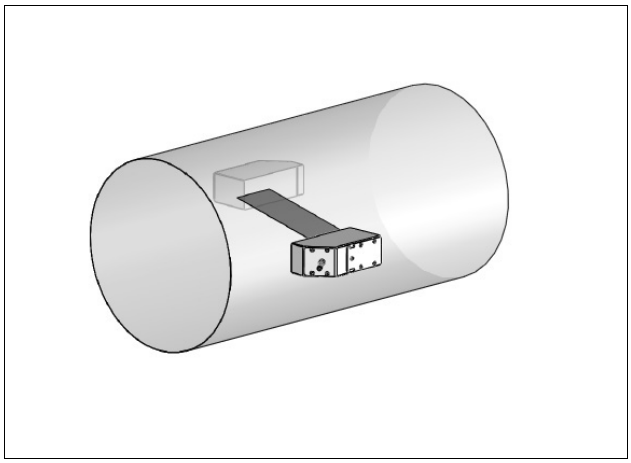
disturbance source:pump

supply line: l ≥ 50 D



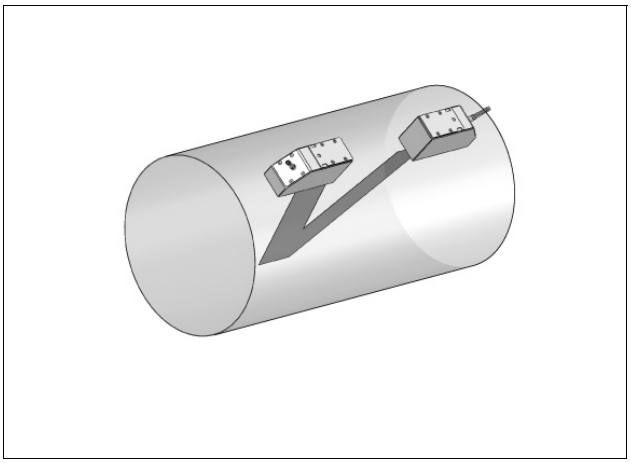
5.3 Selection of the Measurement Arrangement Taking into Account the Measuring Range and the Measuring Conditions

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 fluids (only 1 sound path)

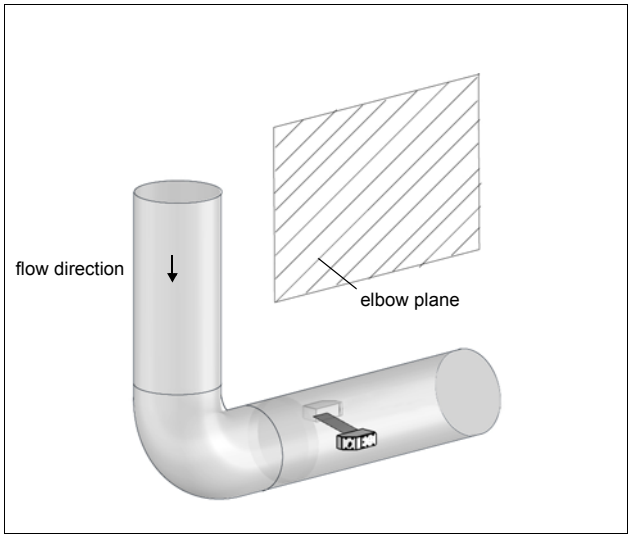
Reflection arrangement with 1 beam



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

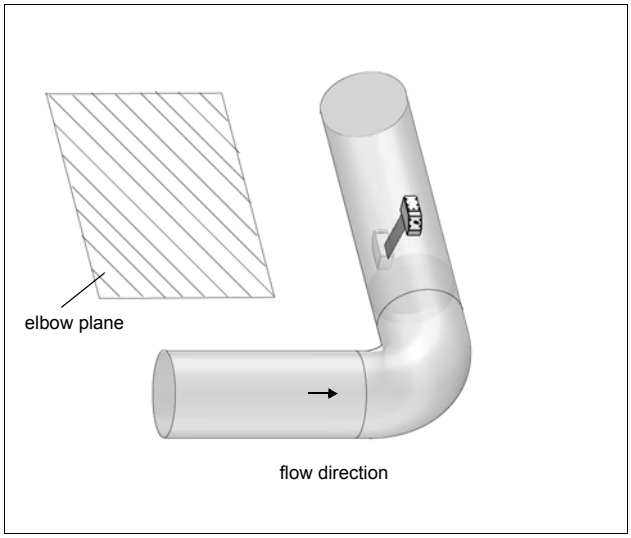
5.4 Selection of the Sound Beam Plane Near an Elbow

On vertical pipes



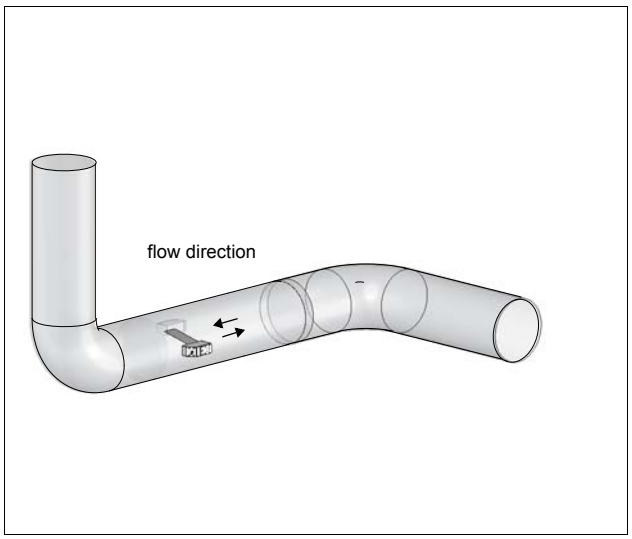
- The sound beam plane (see section 3.3.1) has an angle of 90° to the elbow plane. The elbow is upstream of the measuring point.

On horizontal pipes



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

With measurements in 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).

6 Installation of the Transmitter

6.1 Location

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

• Select the location of the flowmeter within cable reach of the measuring point.

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

6.2 Installation of the Transmitter

6.2.1 Opening and Closing the Housing

Opening

• Loosen the 4 screws of the housing.

• Open the front plate of the transmitter.

• Remove the protection films from the window of the front plate (inside and outside) and from the display of the transmitter (see Fig. 6.1).

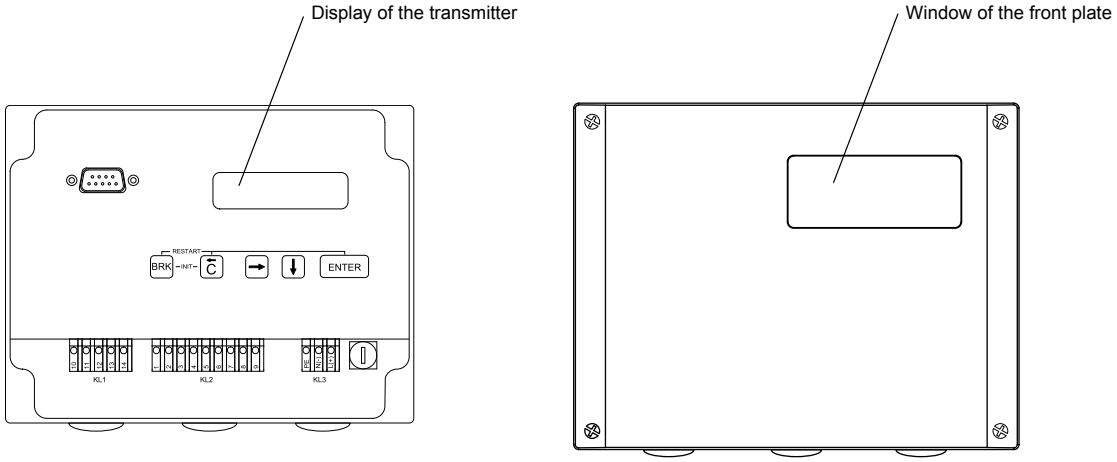


Fig. 6.1: FLUXUS WD100, WD200

Closing

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

• Close the front plate.

• Tighten the 4 screws of the housing of the transmitter.

6.2.2 Wall Installation

• Loosen the 4 screws of the housing.

• Open the front plate of the transmitter.

• Fix the housing to the wall (see Fig. 6.2).

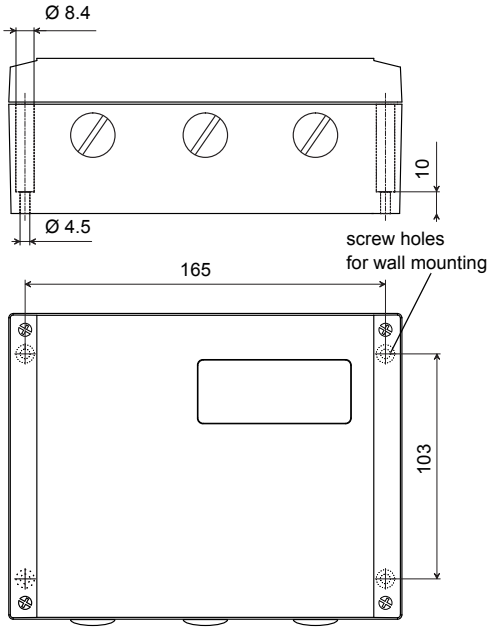


Fig. 6.2: FLUXUS WD100, WD200 (dimensions in mm)

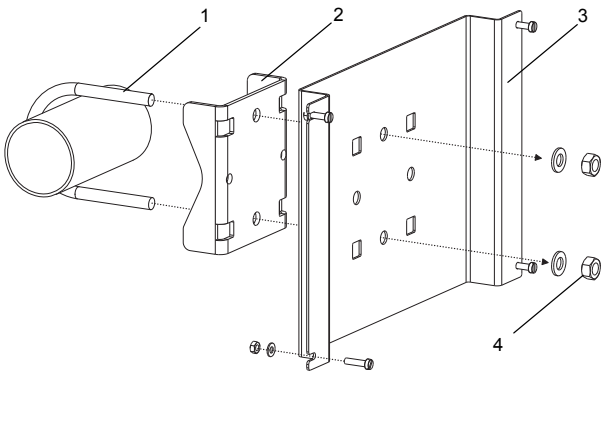
6.2.3 Pipe Installation

Installation on a 2 " pipe

• Fix the pipe mounting plate (2) to the pipe (see Fig. 6.3).
• Fix the instrument mounting plate (3) to the pipe mounting plate (2) with the nuts (4).
• Fix the bottom side of the housing to the instrument mounting plate (3).

Installation on a pipe > 2 "

The mounting kit is fixed to the pipe with tension straps (5) instead of the shackle (see Fig. 6.3.).
• 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	nut
5	tension strap

Fig. 6.3: Pipe installation set

6.3 Connection of the Transducers

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

6.3.1 Connection of the Transducers to the Transmitter

- Remove the left blind plug for the connection of the transducer cable (see Fig. 6.5).
- Open the cable gland of the transducer cable (see Fig. 6.4)
- Push the transducer cable through the cap nut and the compression part.
- Screw the gasket ring side of the basic part tightly into the housing.
- Insert the transducer cable into the housing.

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

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the leads to the terminals of the transmitter (see Fig. 6.6 and Tab. 6.1).

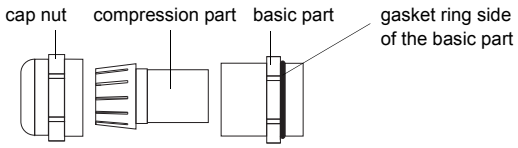


Fig. 6.4: Cable gland

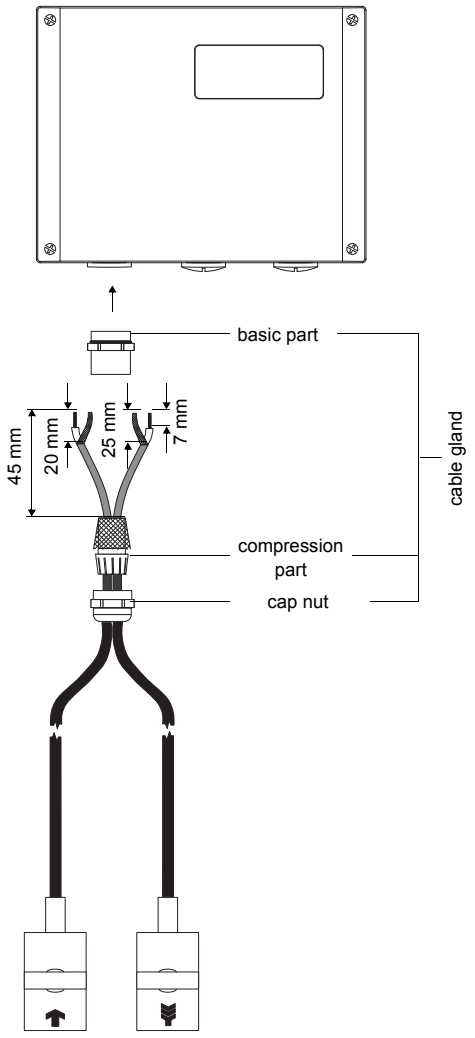


Fig. 6.5: Transducers – direct connection

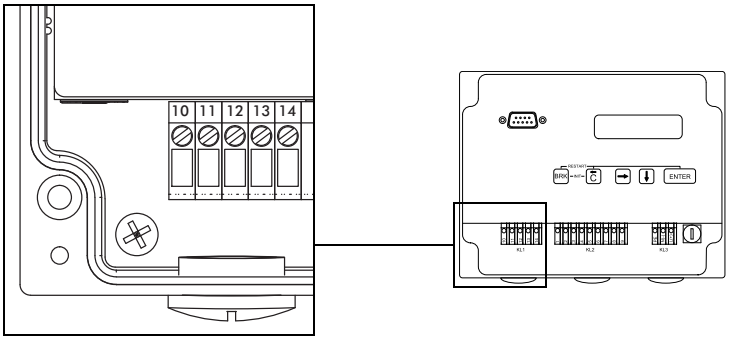


Fig. 6.6: Terminals of the transmitter

Tab. 6.1: Terminal assignment of FLUXUS WD100, WD200

terminal	**connection**
10	transducer ↑ (core)
11	transducer ↑ (inner shield)
12	not connected
13	transducer ↓ (internal shield)
14	transducer ↓ (core)

6.3.2 Connection of the Extension Cable to the Transmitter

• Remove the left blind plug for the connection of the transducers (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.
• Prepare the extension cable with the cable gland. Cut the external shield and brush it back over the compression part.
• Screw the gasket ring side of the basic part tightly into the housing.
• Insert the extension cable in the housing.

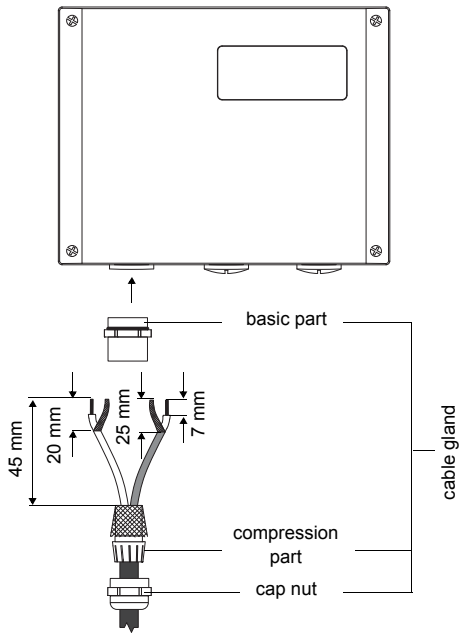


Fig. 6.7: Connection to the transmitter

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

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

Tab. 6.2: Terminal assignment of FLUXUS WD100, WD200

terminal	connection
10	white or marked cable (core)
11	white or marked cable (inner shield)
12	not connected
13	brown cable (inner shield)
14	brown cable (core)

6.3.3 Connection of the Extension Cable to the Junction Box

6.3.3.1 Without Potential Separation (Standard)

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

See section 6.3.3.2 if earthing on the same potential cannot be ensured.

- Remove the blind plug for the connection of the 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 and the compression part.

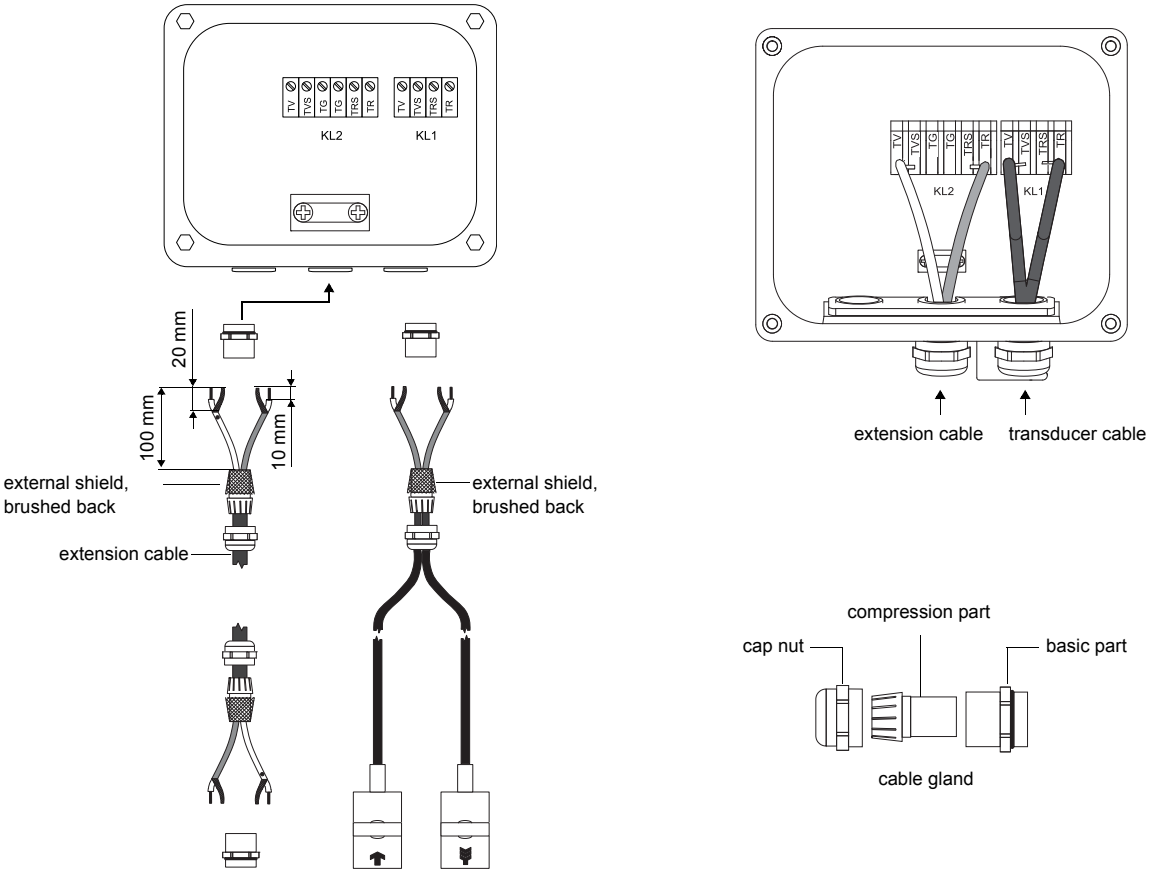


Fig. 6.8: Connection of the extension cable and the transducer cable to the junction box JBP3

- 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. 6.8 and Tab. 6.3).

Tab. 6.3: 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

6.3.3.2 With Potential Separation

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

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

- Remove the blind plug for the connection of the extension cable (see Fig. 6.9).
- Open the cable gland of the extension cable. The compression part remains in the cap nut.
- Push the extension cable through the cap nut, the compression part and the basic part of the cable gland.

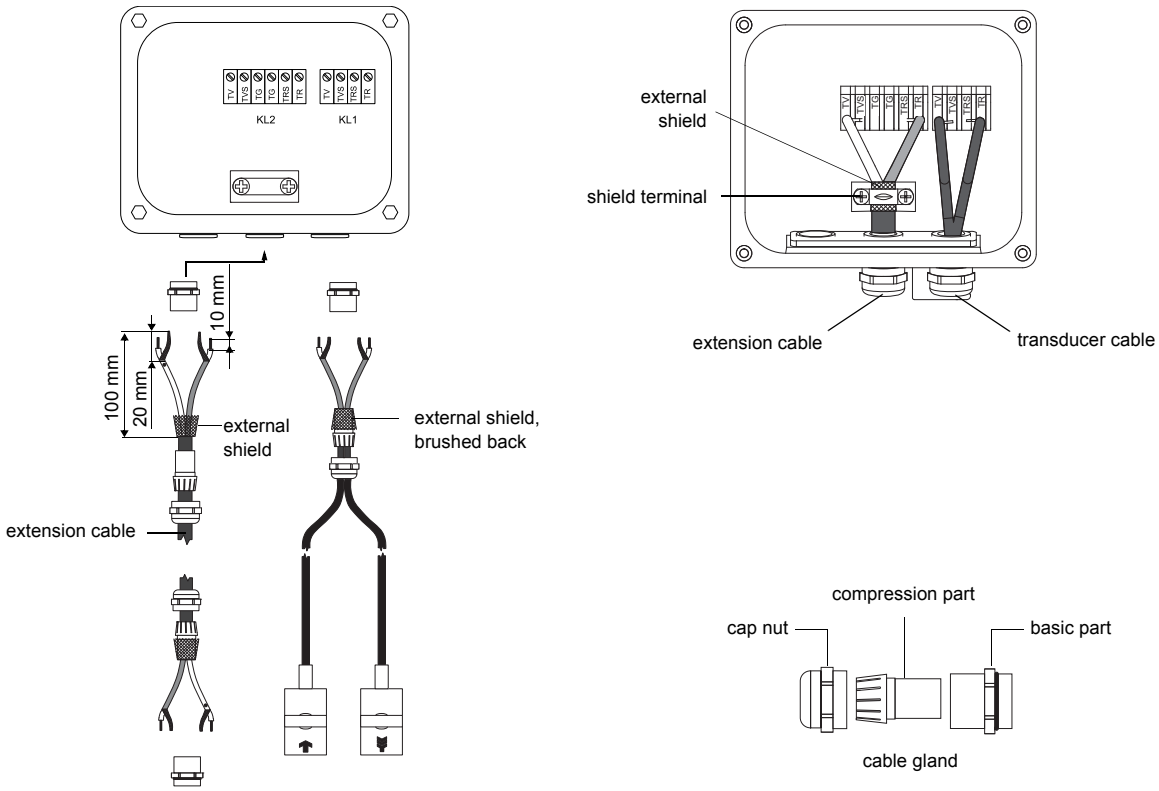


Fig. 6.9: Connection of the extension cable and the transducer cable to the junction box JBP3

- Insert the extension cable into the junction box.
- Prepare the extension cable.
- Cut the outer shield and brush it back.
- Pull the extension cable back until the brushed back external shield is below the shield terminal (see Fig. 6.9). The extension cable must remain completely insulated up to the shield terminal.
- Screw the gasket ring side of the basic part into the junction box.
- Fix the cable gland by screwing the cap nut onto the basic part.

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

- Fix the extension cable and the external shield to the shield terminal.
- Connect the extension cable to the terminals of the transmitter (see Fig. 6.9 and Tab. 6.3).

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

6.3.4 Connection of the Transducer Cable to the Junction Box

- Remove the left blind plug for the connection of the transducers (see Fig. 6.5).
- Open the cable gland of the tranducer cable (see Fig. 6.4).
- Push the extension cable through the cap nut and the compression part.
- Cut the external shield and brush it back over the compression part.
- Screw the gasket ring side of the basic part tightly into the housing.
- Insert the transducer cable into the housing.

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

- Fix the cable gland by screwing the cap nut onto the basic part.
- Connect the leads to the terminals of the junction box (see Fig. 6.8 or Fig. 6.9 and Tab. 6.5).

Tab. 6.5: Terminal assignment (transducer cable, KL1)

terminal	**connection**
TV	transducer ↑ (core)
TVS	transducer ↑ (inner shield)
TRS	transducer ↓ (internal shield)
TR	transducer ↓ (core)

6.4 Connection of the Power Supply

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

- Remove the right blind plug for the connection of the power supply (see Fig. 6.10).
- Prepare the power cable with an M20 cable gland.
- Push the extension cable through the cap nut, the compression part and the basic part of the cable gland (see Fig. 6.11).
- Insert the power cable into the housing (see Fig. 6.10).
- Screw the gasket ring side of the basic part tightly into the housing.
- Fix the cable gland by screwing the cap nut on the basic part (see Fig. 6.11).
- Connect the leads to the terminals of the transmitter (see Fig. 6.10 and Tab. 6.6).

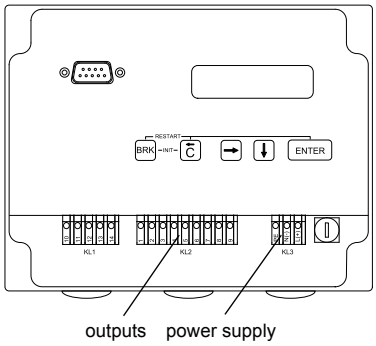


Fig. 6.10: Connection to the transmitter

Tab. 6.6: Terminal assignment - Connection of the power supply

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

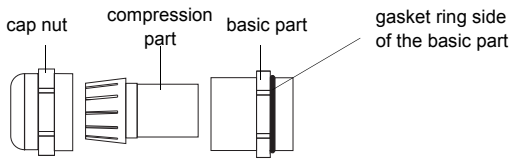
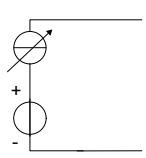
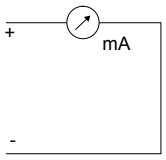
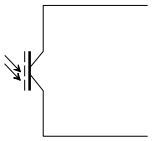
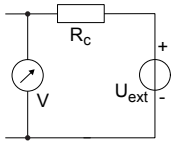
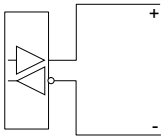
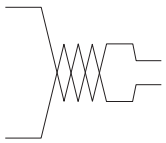


Fig. 6.11: Cable gland

6.5 Connection of the Outputs

• Remove the second blind plug from the right for the connection of the outputs (see Fig. 6.10).
• Prepare the output cable with an M20 cable gland.
• Push the extension cable through the cap nut, the compression part and the basic part of the cable gland (see Fig. 6.11).
• Insert the output cable into the housing.
• Screw the gasket ring side of the basic part tightly into the housing.
• Fix the cable gland by screwing the cap nut onto the basic part (see Fig. 6.11).
• Connect the leads to the terminals of the transmitter (see Fig. 6.10 and Fig. 6.6).
• Close the transmitter. Screw the front plate onto the housing.

Tab. 6.1: Circuits of the outputs

output	**transmitter**		**external circuit**	**remark**
	internal circuit	**connection**		
active current loop		I1: 6 I1: 5		R_{ext} < 500 Ω
binary output (optorelay)		B1/B2: 2/4 B1/B2: 1/3		U_{ext} = 28 V DC I_C ≤ 100 mA
RS485	 shield	8 (A+) 7 (B-) 9		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).

Tab. 6.1: Factory presets of the outputs

output	**current output I1**
source item	measured value
measured value	current physical quantity
output range	4...20 mA
error value	3.5 mA

These settings can be changed. For the installation of the outputs see section 15.1. For the activation of the outputs see section 15.3...15.5.

7 Installation of the Transducers

• Before starting this chapter, read and follow the instruction in chapter 9.

The transducers will be fixed to the pipe by means of the supplied transducer mounting fixture.

7.1 Preparation of the Pipe

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.

• Remove rust or loose paint. An existing paint layer on the pipe should be smoothed for a better measuring result.

• 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.

• Make sure that the transducer mounting exert the necessary pressure on the transducers.

7.2 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. 7.1). The transducer cables show in opposite directions.

For the determination of the flow direction see section 9.8.

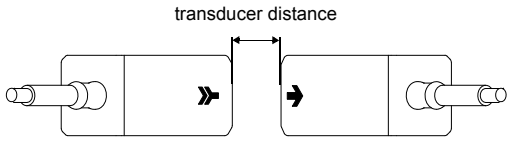


Fig. 7.1: Correct orientation of the transducers and transducer distance

7.3 Installation with Variofix C

When measuring in reflection arrangement, one transducer mounting fixture is mounted on the side of the pipe (see Fig. 7.2).

When measuring in diagonal arrangement, two transducer mounting fixtures are mounted on the opposite sides of the pipe (see Fig. 7.3).

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

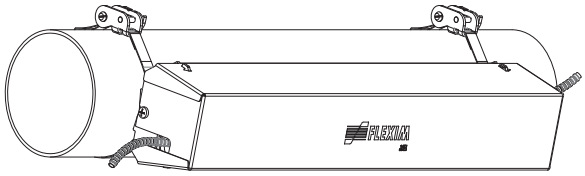


Fig. 7.2: Transducer mounting fixture Variofix C (reflection arrangement)

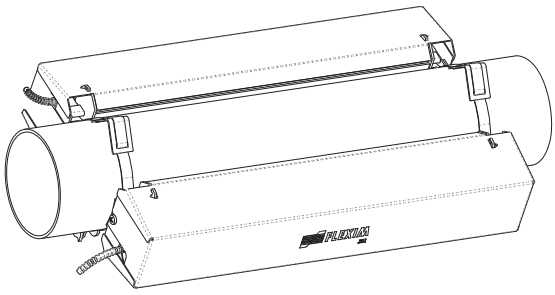


Fig. 7.3: Transducer mounting fixture Variofix C (diagonal arrangement)

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

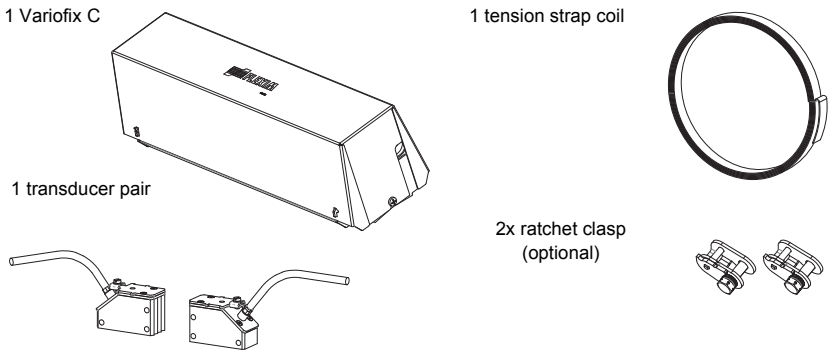


Fig. 7.4: Scope of delivery

7.3.1 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. 7.5).

In order to remove the spring clip from the rail, slide it over the indentation on the rail and lift it off (see Fig. 7.6).

Fig. 7.5: Removal of the cover

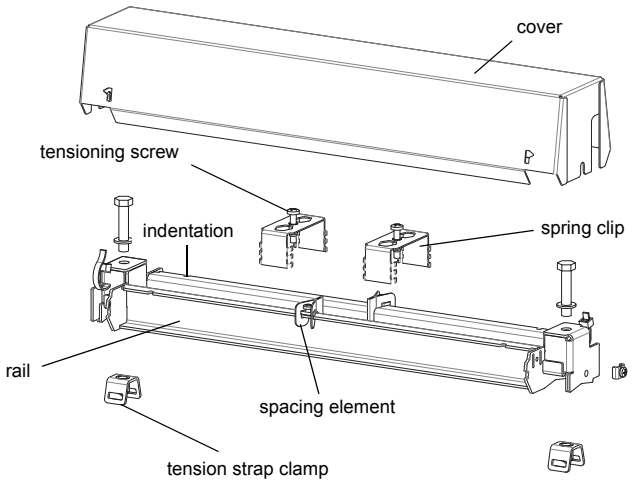


Fig. 7.6: Disassembly of Variofix C

7.3.2 Installation of the Rail

Select the installation instructions that correspond to the supplied clasp:

- see section Installation of the rail without a clasp
- see section Installation of the rail with the ratchet clasp

Installation of the rail without a clasp

- Cut the tension strap to length (pipe circumference + at least 120 mm).
- Insert approx. 100 mm of the tension strap into one of the slots of the tension strap clamp and bend it (see Fig. 7.7).
- If necessary, insert the long end of the tension strap into the metal spring (see Fig. 7.8). 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. 7.9).

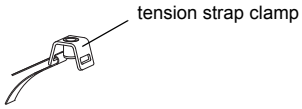


Fig. 7.7: Tension strap with tension strap clamp

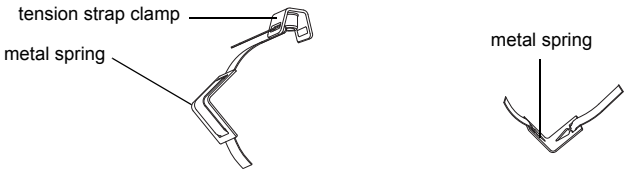
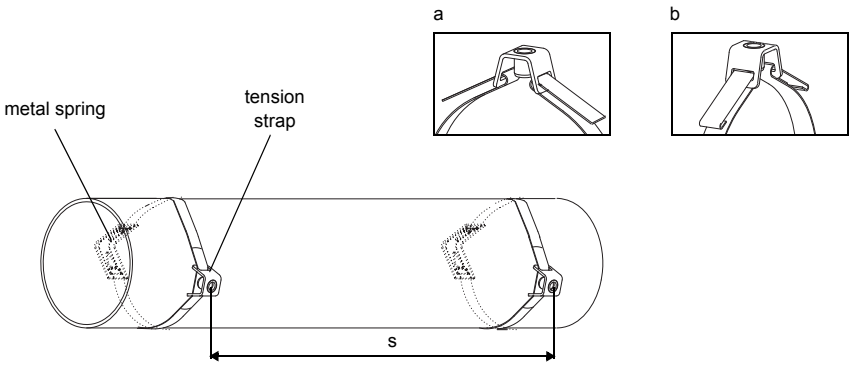


Fig. 7.8: Tension strap with the metal spring and the tension strap clamp

- Position the metal spring (if mounted) and the tension strap clamp (see Fig. 7.9):
  - 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. 7.9: 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. 7.9 a).
• Tighten the tension strap and bend it.
• Bend both ends of the tension strap (see Fig. 7.9 b).
• Repeat the steps for the second tension strap. Position the tension strap at the distance s (see Fig. 7.9).
• Put the rail on the tension strap clamps.
• Use the screws to fix the rail to the tension strap clamps (see Fig. 7.10).
• Tighten the screws.

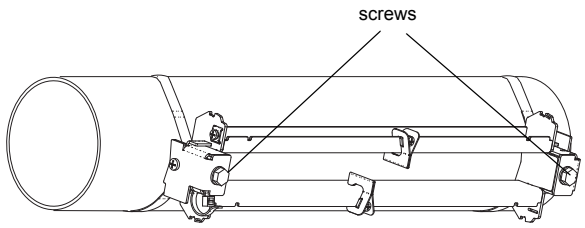


Fig. 7.10: Rail on the pipe

Installation of the rail with the ratchet clasp

• Cut the tension strap to length (pipe circumference + at least 120 mm).
• Insert approx. 100 mm of the tension strap into parts 1 and 2 of the ratchet clasp (see Fig. 7.11 a).

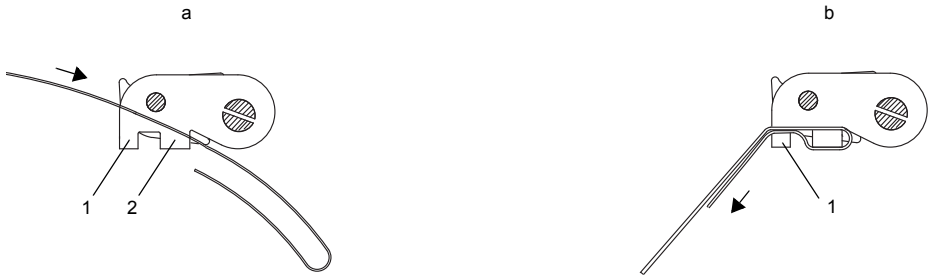


Fig. 7.11: Ratchet clasp with tension strap

• Bend the tension strap.
• Insert the tension strap into part 1 of the ratchet clasp (see Fig. 7.11 b).
• Tighten the tension strap.
• Insert the long end of the tension strap into the tension strap clamp and the metal spring (see Fig. 7.12). 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. 7.13).

Fig. 7.12: 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. 7.14).
• Tighten the tension strap.
• Cut off the protruding tension strap (see Fig. 7.15).
• Tighten the screw of the ratchet clasp.
• Repeat the steps for the second tension strap.

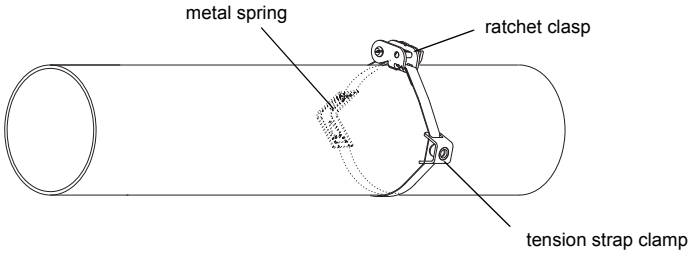


Fig. 7.13: Tension strap with the metal spring, the ratchet clasp and the tension strap clamp on the pipe

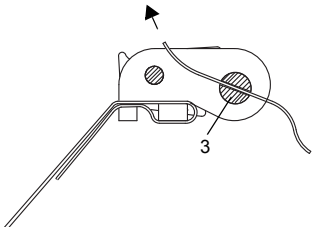


Fig. 7.14: Ratchet clasp with tension strap

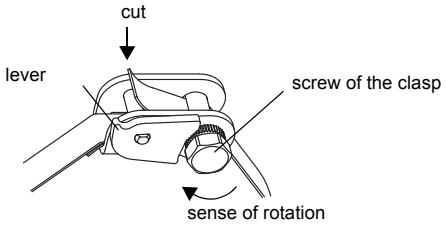


Fig. 7.15: Ratchet clasp with tension strap

• Put the rail on the tension strap clamps (see Fig. 7.16).
• Fix the rail to the tension strap clamps with the screws.
• Tighten the screws.

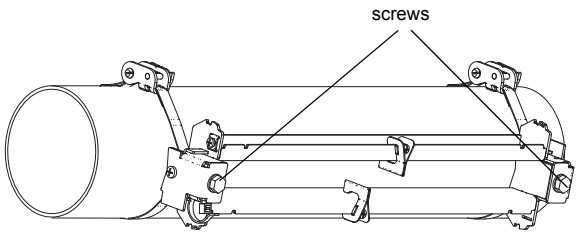


Fig. 7.16: Rail on the pipe

7.3.3 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. 7.17).
- Adjust the transducer distance displayed by the transmitter (see section 9.6 and Fig. 7.17).
- Slide the spring clips on the transducers (see Fig. 7.18).
- 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. 7.17).
- Correct the transducer distance, if necessary (see section 9.6.1 and section 9.6.2).
- Tighten the tensioning screw.
- Fix the spacing element on the rail to mark the transducer position (see Fig. 7.17).
- Use a cable tie to fix the transducer cables in order to protect them from mechanical strain (see Fig. 7.18).
- Put the cover on the rail (see Fig. 7.19).
- Tighten the screws on both sides of the cover.

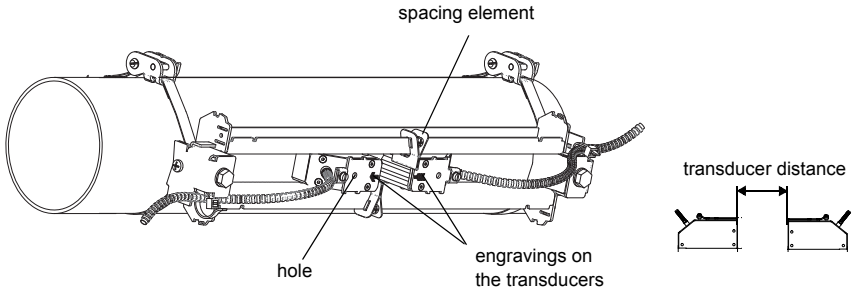


Fig. 7.17: Transducers in the rail (spring clip not shown)

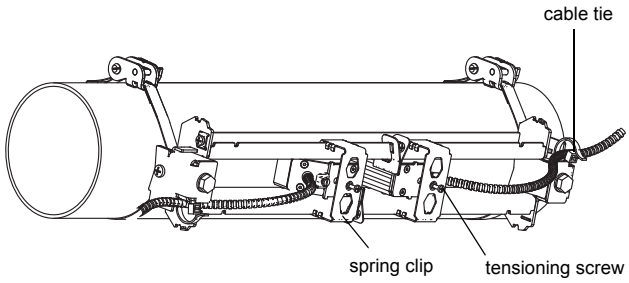


Fig. 7.18: Transducers in the rail

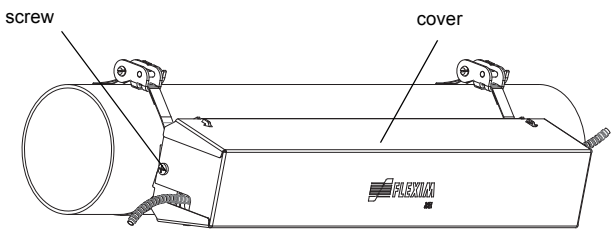


Fig. 7.19: Variofix C with transducer on the pipe

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

- Use a lever tool to remove the cover.
- Insert the lever tool in one of the four openings of the cover (see Fig. 7.20).
- 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.

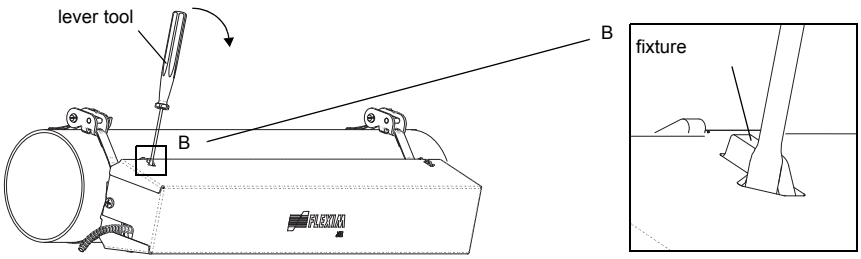


Fig. 7.20: Removal of the cover

8 Start-up of the Transmitter

8.1 Switching on

```
FLEXIM FLUXUS
XXXX   -XXXXXXXX
```

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

Data cannot be entered while the serial number is displayed.

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

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

8.2 Initialization

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

Proceed as follows to execute an initialization:

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

```
  INITIALISATION
   ----DONE----
```

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.

```
FACTORY DEFAULT?
no          >YES<
```

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.

```
Delete Meas.Val.
no          >YES<
```

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

Press ENTER.

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

8.3 Display

8.3.1 Main Menu

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

The main menu contains the following program branches:

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

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

Select a program branch by pressing key → and ↓. Press ENTER.

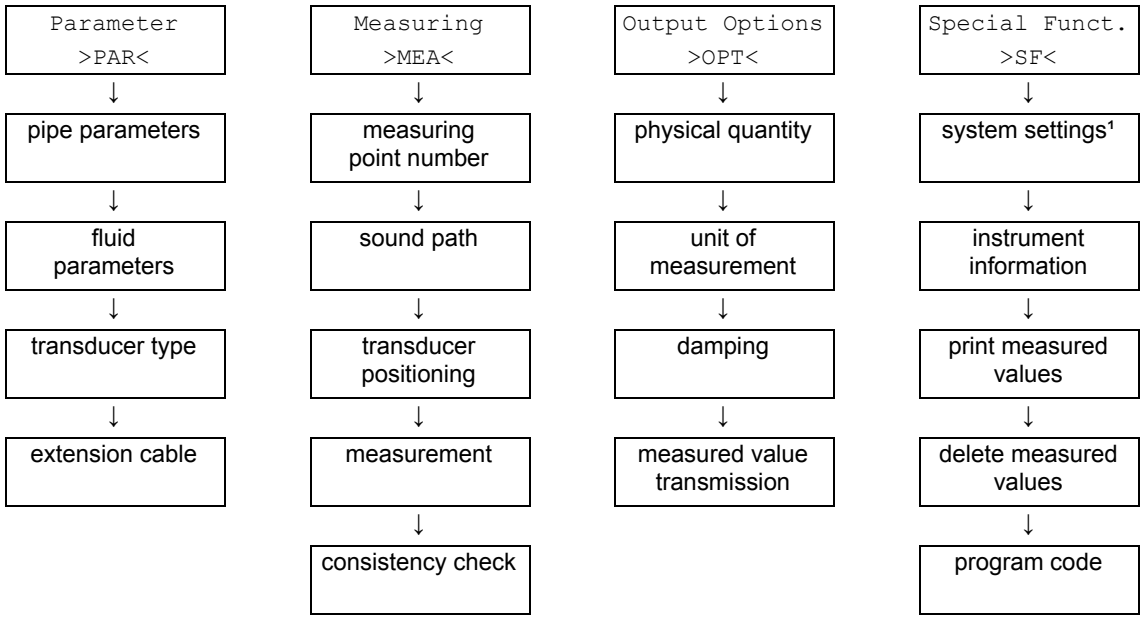
Note!	By pressing key BRK, the measurement will be stopped and the main menu is selected.

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

8.3.2 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 measured value transmission
- **Program branch `Special Funct.`**
  contains all functions that are not directly related to the measurement

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

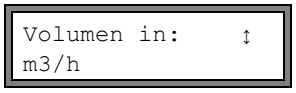


¹ `SYSTEM settings` contains the following menu items:

- set clock
- dialogs and menus
- measuring
- outputs
- storing
- serial transmission
- miscellaneous

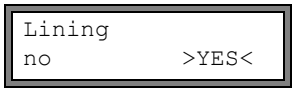
8.3.3 Navigation

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



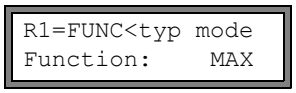
Use key → and ↓ to select a list item in the lower line. Press ENTER.

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



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

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

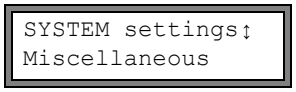


Press key → to scroll through the upper line and select a list item.
Press key ↓ to scroll through the lower line and select a value for the selected list item.
Press ENTER.

8.4 HotCodes

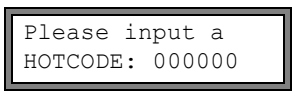
A HotCode is a key sequence that activates certain functions and settings:

function	HotCode	see section
language selection	**9090xx**	8.5
manual input of the lower limit for the inner pipe diameter	**071001**	11.7
activation/deactivation of the SuperUser mode	**071049**	14.1
change of the transmission parameters of the RS232 interface	**232-0-**	12.2.4
resetting the contrast of the display to fluid	**555000**	13.4

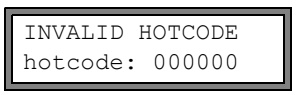


Select `Special Funct.\SYSTEM settings\Miscellaneous`.

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`.

8.5 Language Selection

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

Tab. 8.1: Language HotCodes

909031	Dutch
909033	French
909034	Spanish
909044	English
909049	German

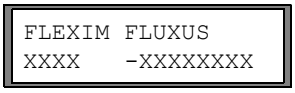
Depending on the technical data of the transmitter, some of the languages might not be implemented.

When the last digit has been entered, the main menu will be displayed in the selected language.

The selected language remains activated when the transmitter is switched off and on again. After an initialization, the default language set by the manufacturer is activated.

8.6 Interruption of the Power Supply

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



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

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

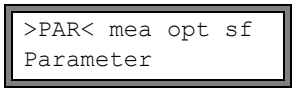
9 Basic Measurement

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 of the transmitter.

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

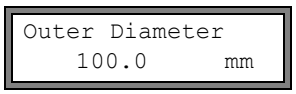
Note!	The parameters will only be stored when the program branch `Parameter` has been edited in its entirety.

9.1 Input of the Pipe Parameters

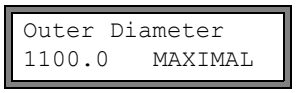


Select the program branch `Parameter`. Press ENTER.

9.1.1 Outer Pipe Diameter/Pipe Circumference



Enter the outer pipe diameter. Press ENTER.



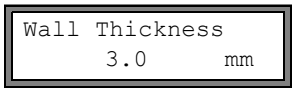
An error message will be displayed if the entered parameter is outside of the range. The limit will be displayed.

Example: upper limit 1100 mm for the connected transducers and for a pipe wall thickness of 50 mm.

It is possible to enter the pipe circumference instead of the outer pipe diameter (see section 13.2.1).

If the input of the pipe circumference has been activated and `0` (zero) is entered for the `Outer Diameter`, the menu item `Pipe Circumfer.` will be displayed. If the pipe circumference is not to be entered, press key BRK to return to the main menu and start the parameter input again.

9.1.2 Pipe Wall Thickness

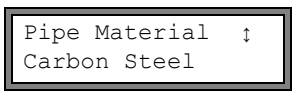


Enter the pipe wall thickness. Press ENTER.

Note!	The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness) is calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed. It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 11.7).

9.1.3 Pipe Material

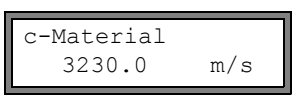
The pipe material has to be selected to be able to determine the sound speed. The sound speed for the materials in the scroll list are stored in the transmitter.



Select the pipe material.

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

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

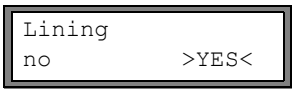


Enter the sound speed of the pipe material. Press ENTER.

Note!	Enter the sound speed of the material (i.e. longitudinal or transversal speed) which is nearer to 2 500 m/s.

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

9.1.4 Pipe Lining



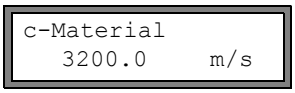
If the pipe has an inner lining, select `yes`. Press ENTER.

If `no` is selected, the next parameter will be displayed (see section 9.1.5).

Select the lining material.

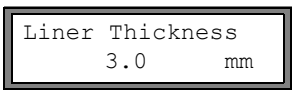
If the material is not in the scroll list, select `Other Material`. Press ENTER.

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.



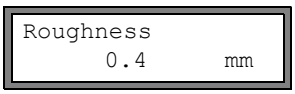
Enter the thickness of the liner. Press ENTER.

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 11.7).

9.1.5 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.

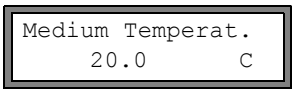
Change the value according to the condition of the inner pipe wall. Press ENTER.

9.2 Input of the Fluid Parameters

9.2.1 Fluid Temperature

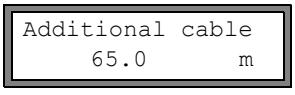
At the beginning of the measurement, the fluid temperature is used for the interpolation of the sound speed and thus, for the calculation of the recommended transducer distance.

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



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

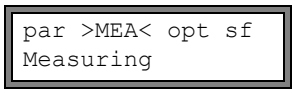
9.3 Extension Cable



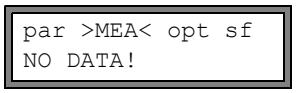
If the transducer cable has to be extended, enter the additional cable length (e.g., between the junction box and the transmitter). Press ENTER.

9.4 Input of the Measuring Point Number

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

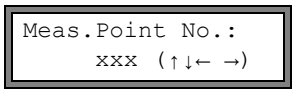


Select program branch `Measuring`. Press ENTER.



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

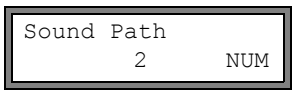
If the data logger or the serial interface is activated, the measuring point number has to be entered:



Enter the measuring point number. Press ENTER.

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

9.5 Defining the Number of Sound Paths

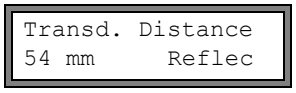


A number of sound paths is recommended according to the connected transducers and the entered parameters. Change the value, if necessary.

Press ENTER.

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

9.6 Transducer Distance



A value for the transducer distance is recommended. Fix the transducers (see chapter 7). Adjust the transducer distance.

Press ENTER.

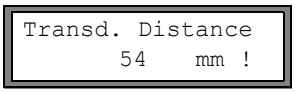
`Reflec` - reflection arrangement
`Diagon` - diagonal arrangement

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

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

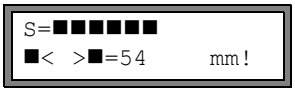
Note!	The accuracy of the recommended transducer distance depends on the accuracy of the entered pipe and fluid parameters.

9.6.1 Fine Adjustment of the Transducer Distance



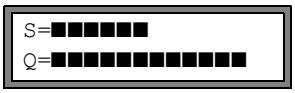
If the displayed transducer distance is adjusted, press ENTER.

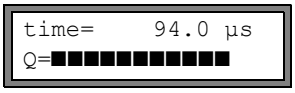
The measuring for the positioning of the transducers is started.



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

- Shift a transducer slightly within the range of the recommended transducer distanceuntil the bar graph reaches its max. length (max. 6 squares).



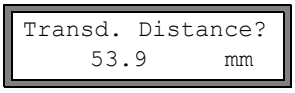


The following quantities can be displayed in the upper line by pressing key [→] and in the lower line by pressing key [↓]:

- ■<>■=: 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.



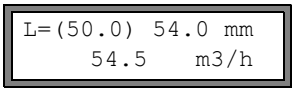
After the precise positioning of the transducers, the recommended transducer distance is displayed again.

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

9.6.2 Consistency Check

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

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



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

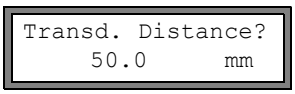
The optimum transducer distance is calculated on the basis of the measured sound speed. It is therefore a better approximation than the first recommended value which had been calculated on the basis of the sound speed range entered in the program branch Parameter.

If the difference between the optimum and the entered transducer distance is less than specified in Tab. 9.1, the measurement is consistent and the measured values are valid. The measurement can be continued.

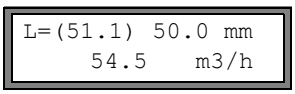
If the difference is greater, adjust the transducer distance to the displayed optimum value. Afterwards, check the signal quality and the signal amplitude bar graph (see section 9.6.1). Press ENTER.

Tab. 9.1: Standard values for signal optimization

transducer frequency	difference between the optimum and the entered transducer distance [mm]
G	20
K	15
M	10
P	8
Q	6



Enter the new adjusted transducer distance. Press ENTER.



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

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

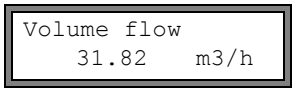
9.6.3 Value of the Sound Speed

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 9.6.2, it is recommended to write down the sound speed for the next measurement. By doing this, it will not be necessary to repeat the fine adjustment.

Also write down the fluid temperature because the sound speed depends on the temperature. The value can be entered in the program branch `Parameter`.

9.7 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 9.6.1).

The outputs and the serial interface continuously receive the measured values of the corresponding channel. The results are displayed according to the currently selected output options. The default unit of measurement of the volumetric flow rate is m³/h. For the selection of the values to be displayed and for the setting of the output options see chapter 10. For further measuring functions see chapter 11.

9.8 Detection of the Flow Direction

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

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

9.9 Interruption of the Measurement

The measurement is interrupted by pressing key BRK if it is not protected by a program code (see section 11.8).

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

10 Displaying the Measured Values

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

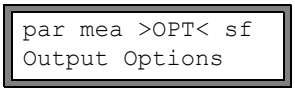
During the measurement, the designation of the physical quantity is displayed in the upper line, the measured value in the lower line. The display can be adapted (see section 10.2).

10.1 Selection of the Physical Quantity and the Unit of Measurement

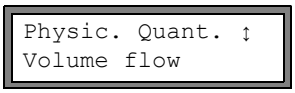
The following physical quantities can be measured:

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

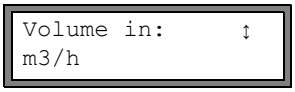
The physical quantity is selected as follows:



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



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



For the selected physical quantity, a scroll list with the available units of measurement is displayed. The unit of measurement which was selected previously is displayed first.

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

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

Note!	If the physical quantity or the unit of measurement is changed, the settings of the outputs have to be checked (see chapter 15).

10.2 Adjustment of the Display

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

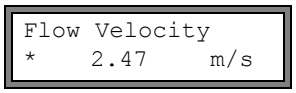
The following information can be displayed in the upper line:

display	explanation
`Mass Flow=`	designation of the physical quantity
`+8.879 m3`	values of the totalizers
`Mode=`	measuring mode
`L=`	transducer distance
`Rx=`	alarm state indication if it is activated (see section 15.6.3) and if alarm outputs are activated (see section 15.5).
	status line (see section 10.3)

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

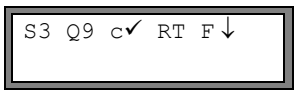
Press key [→] during the measurement to change the display in the upper line, press key [↓] to change the display in the lower line.



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

10.3 Status Line

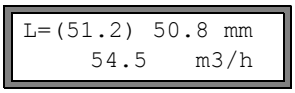
Important data on the ongoing measurement are displayed in the status line. The quality and precision of the ongoing measurement can be estimated.



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

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

10.4 Transducer Distance



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

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

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

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

Note!	Never change the transducer distance during the measurement!

11 Advanced Measuring Functions

11.1 Command Execution during Measurement

Commands that can be executed during a measurement are displayed in the upper line. A command begins with the arrow →. If programmed, a program code has to be entered first (see section 11.8).

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

Tab. 11.1: Commands that can be executed during the measurement

command	explanation
→Adjust transd.	S=■■■■■■ ■< >■=54 mm! Select transducer positioning. If a program code is active, the measurement will be continued 8 s after the last keyboard entry.
→Clear totalizer	32.5 m3 54.5 m3/h All totalizers will be reset to zero.
→Break measure	stop the measurement and return to the main menu

11.2 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. Strongly fluctuating values caused by high flow dynamics require a higher damping factor.

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

```
Damping
       10       s
```

Enter the damping factor. Press ENTER.

Press BRK to return to the main menu.

11.3 Totalizers

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

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

The values of the totalizers can be displayed with up to 11 places, e.g., `74890046.03`. For the adjustment of the number of decimal places (max 4) see section 14.6.

```
Volume flow
     54.5    m3/h
```

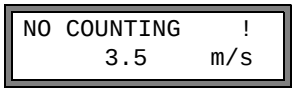
Press key [→] to scroll through the upper line to the display of the totalizers.

```
     32.5      m3
     54.5    m3/h
```

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

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

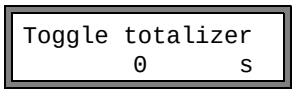
Select the command →`Clear totalizer` in the upper line to reset the totalizers to zero. Press ENTER.



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

Automatic toggling between the displays

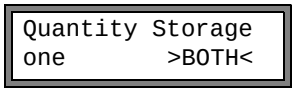
Select `Special Funct.\SYSTEM settings\Storing\Toggle totalizer` to toggle automatically between the flow totalizer displays for the positive and negative flow direction.



Enter a time interval between 0 (off) and 5 s. Press ENTER.

Selection of the totalizers for storing

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



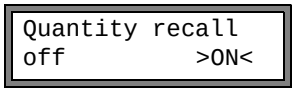
If `one` is selected, only the totalizer whose value is changing will be stored. This can apply to the totalizer for the positive or the negative flow direction.

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 totalizers will be stored and used for the next measurement.

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

11.3.1 Overflow of the Totalizers

The overflow behavior of the totalizers can be set:

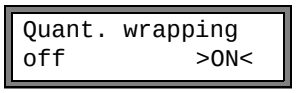
Without overflow:

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

With overflow:

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

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



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

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

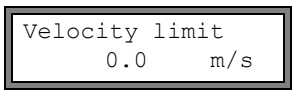
Note!	The transmission of the sum of both totalizers (the throughput ΣQ) via an output will not be valid after the first overflow (wrapping) of one of the corresponding totalizers. To signalize the overflow of a totalizer, an alarm output with the switching condition `QUANT.` and the type `HOLD` have to be activated.

11.4 Upper Limit of the Flow Velocity

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

It is possible to ignore all measured flow velocities higher than a 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,

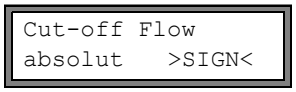
- the flow velocity will be marked as invalid. The physical quantity cannot be determined.
- "!" will be displayed after the unit of measurement (in case of a normal error, "?" is displayed).

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

11.5 Cut-off Flow

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

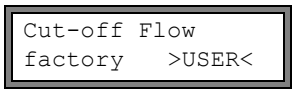
The cut-off flow can depend on the flow direction or not. The cut-off flow is set in `Special Funct.\SYSTEM settings\Measuring\Cut-off Flow`.



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

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

Press ENTER.

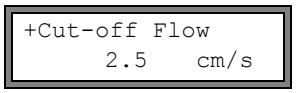


Select `factory` to use the default limit of 2.5 cm/s (0.025 m/s) for the cut-off flow.

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

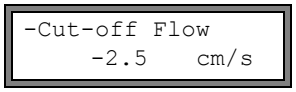
Press ENTER.

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



Enter the cut-off flow. Press ENTER.

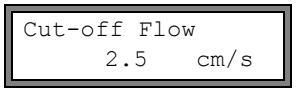
All positive values of the flow velocity that are lower than this limit will be set to zero.



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 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.

11.6 Uncorrected Flow Velocity

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

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

```
Flow Velocity
>NORMAL< uncorr.
```

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

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

```
PROFILE CORR.
>NO<         yes
```

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.

```
FLOW VELOCITY
     2.60     m/s
```

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.

```
PROFILE CORR.
NO          >YES<
```

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

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

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

Press ENTER.

```
Flow Velocity
*U   54.5     m/s
```

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`.

11.7 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**.

```
DNmin Q-Sensor
       15      mm
```

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

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

11.8 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).

11.8.1 Defining a Program Code

A program code will remain valid as long as:

• no other valid program code is entered or

• the program code is not deactivated.

Note!	Do not forget the program code!

11.8.2 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 C.

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.

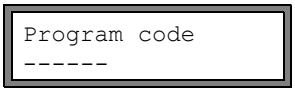
If a command is selected:

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.

11.8.3 Deactivation of the Program Code



Select `Special Funct.\Program code`.

The program code is deleted by entering "------". Press ENTER.

If the character "-" is entered less than six times, this character sequence will be used as the new program code.

12 Data Logger and Transmission of Data

The transmitter has a data logger in which the measured values are stored during the measurement (see section 12.1).

The measured values are transmitted to a PC via the serial interface directly during the measurement (see section 12.2). For the connection of the serial interface see section 6.5.

12.1 Data Logger

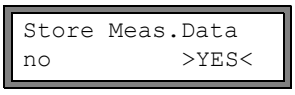
The following data will be stored:

- date
- time
- measuring point number
- pipe parameters
- fluid parameters
- transducer data
- sound path (reflection or diagonal arrangement)
- transducer distance
- damping factor
- storage rate
- physical quantity
- unit of measurement
- measured values (physical quantity and input quantities)
- totalizer values
- diagnostic values

In order to store the measured data, the data logger has to be activated (see section 12.1.1).

The available data logger memory can be displayed (see section 12.1.6).

12.1.1 Activation/Deactivation of the Data Logger



Select the program branch `Output Options`. Press ENTER until the menu item `Store Meas.Data` is displayed.

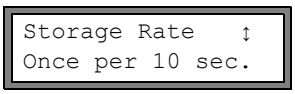
Select `yes` to activate the data logger, `no` to deactivate it. Press ENTER.

12.1.2 Setting the Storage Rate

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

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

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



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

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

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

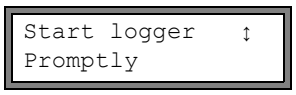
12.1.3 Settings of the Data Logger

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

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

Start of the storing

If it is necessary to synchronize the storing of measured values on several transmitters, the starting time of the storing can be set.



Select the starting time of the storing of measured values.

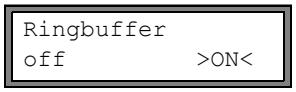
`Promptly`: Storing will be started immediately.
`On full 5 min.`: Storing will be started on the next full 5 minutes.
`On full 10 min.`: Storing will be started on the next full 10 minutes.
`On quarter hour`: Storing will be started on the next full 15 minutes.
`On half hour`: Storing will be started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

Example:	current time: 9:06 setting: `On full 10 min.` Storing will be started at 9:10.

Ringbuffer

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

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



Select the behavior of the ringbuffer. Press ENTER.

Storage mode

Select the storage mode. Press ENTER.

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

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

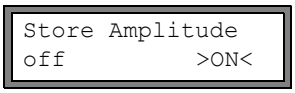
Note!	The storage mode does not affect the outputs.

Note!	`Storage mode` = `average` The average of the physical quantity and other physical quantities assigned to the measuring channel will be calculated. If the storage rate < 5 s (see section 12.1.2) is selected, `sample` will be used. If no average could be calculated over the complete storage interval, the value will be marked as invalid. The ASCII file will contain "`???`" instead of invalid average values of the physical quantity.

Storing of the totalizers

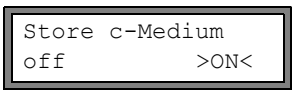
see section 11.3

Storing of the signal amplitude



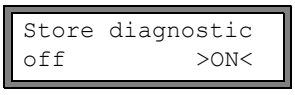
If `on` is selected and the data logger is activated, the amplitude of the measured signal will be stored together with the measured values. Press ENTER.

Storing of the sound speed



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

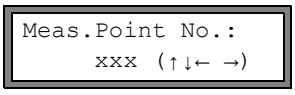
Storing of the diagnostic values



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

12.1.4 Measurement with Activated Data Logger

• Start the measurement.



Enter the measuring point number. Press ENTER.

If arrows are displayed in the lower line on the right, ASCII text can be entered. If digits are displayed, only digits, point and hyphen can be entered.

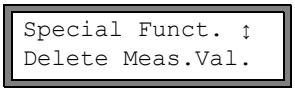
For the setting of the input mode see section 13.2.2.

If `Output Options\Store Meas.Data` has been activated and `Special Funct.\SYSTEM settings\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.

12.1.5 Deleting the Measured Values

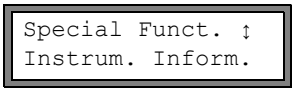


Select `Special Funct.\Delete Meas.Val.` Press ENTER.

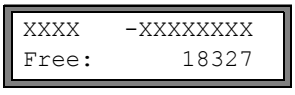
Select `yes` or `no`. Press ENTER.

12.1.6 Available Data Logger Memory

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



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

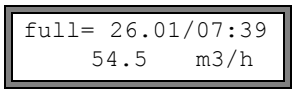


The type and the serial number of the transmitter will be displayed in the upper line.

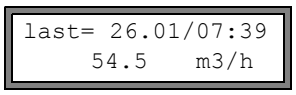
The available data logger memory will be displayed in the lower line (here: 18 327 additional measured values can be stored). Press key BRK twice to return to the main menu.

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

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



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



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

12.2 Transmission of Data

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

12.2.1 Online Transmission of Data

The measured values are transmitted during the measurement.

Tab. 12.1: Overview online transmission of data

serial interface	transmission of data	see
RS232	terminal program	section 12.2.5
RS485 (sender)	terminal program	section 12.2.5

The measured value memory is independent 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.

12.2.2 Offline Transmission of Data (option)

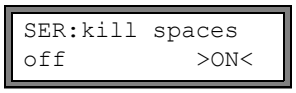
The measurement data of the data logger are transmitted.

Tab. 12.2: Overview offline transmission of data

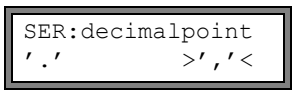
serial interface	transmission of data	see
RS232	terminal program	section 12.2.6
RS232	FluxData	section 12.2.7
RS485 (sender)	terminal program	section 12.2.6

12.2.3 Formatting of the Measurement Data

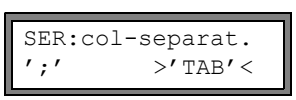
Select `Special Funct.\SYSTEM settings\serial transmis.`



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.

12.2.4 Transmission Parameters

• the transmitter sends CRLF-terminated ASCII

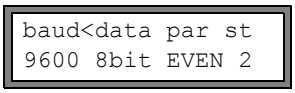
• max. line length: 255 digits

RS232

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

The transmission parameters of the RS232 interface can be changed:

Enter HotCode **232-0-**.



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

• `baud`: baud rate

• `data`: number of data bits

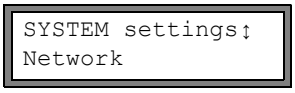
• `par`: parity

• `st`: number of stop bits

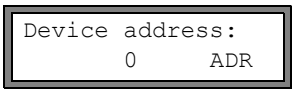
RS485

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

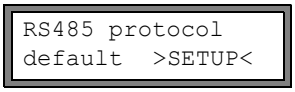
The transmission parameters of the RS485 interface can be changed in the program branch `Special Funct.\SYSTEM settings\Network`. This display will only be indicated if the transmitter has an RS485 interface.



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.

12.2.5 Online Transmission of Data to a Terminal Program

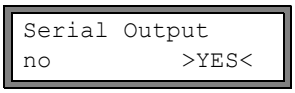
• Start the terminal program.

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

Settings in the transmitter

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

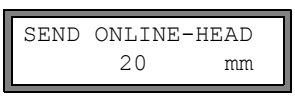
• Select the channel for which the online transmission of data is to be activated. Press ENTER until the menu item `Serial Output` is displayed.



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

• Set the storage rate (see section 12.1.2).

• Start the measurement. The measuring point number will be requested (see section 12.1.4).



The measured values are transmitted during the measurement.

12.2.6 Offline Transmission of Data to a Terminal Program

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

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

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

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

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

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

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

```
■■■■■■
................
```

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

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

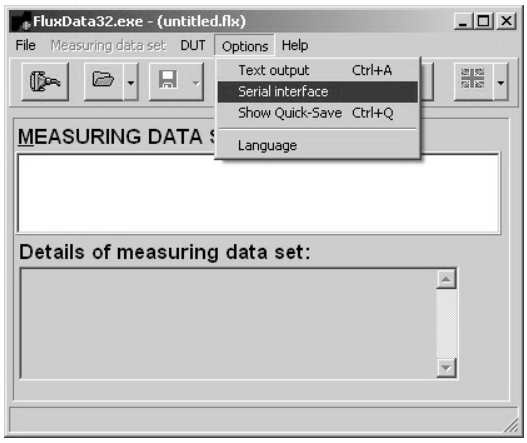
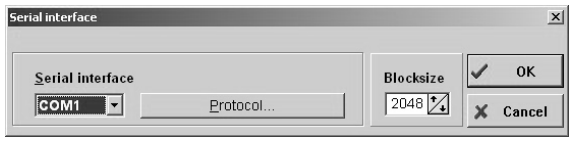
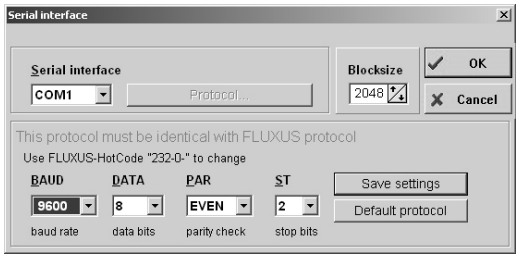
This error message will be displayed if an error has occurred during the serial transmission. Press ENTER. Check the connections and make sure that the PC is ready to receive data.

12.2.7 Offline Transmission of Data with the Program FluxData

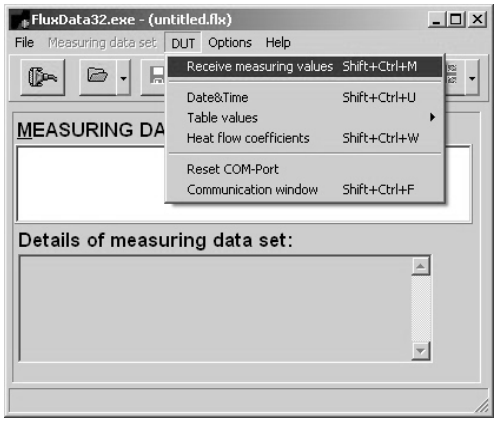
The measurement data in the data logger are transmitted to a PC via the serial interface RS232 with the FLEXIM program FluxData.

Settings in the program

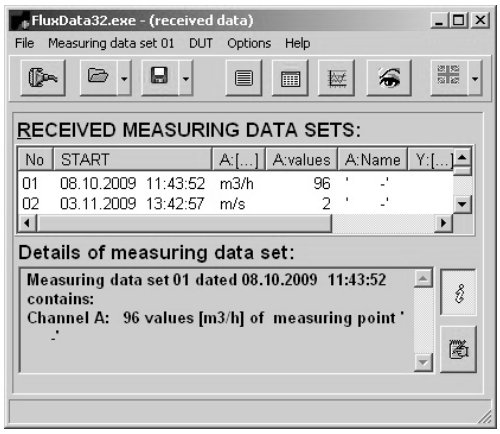
Start the program FluxData V3.0 or higher on the PC.

<table>
<tr><td> 
</td><td>Select the menu:
Options > Serial interface.</td></tr>
<tr><td> 
</td><td>Select the serial interface used by the PC (e.g., COM1).
Click on Protocol. Click on OK.</td></tr>
<tr><td> 
</td><td>Enter the transmission parameters (see section 12.2.4). If the default settings of the transmission parameters are be used, click on Default protocol.
The transmission parameters of the program FluxData and the transmitter have to be identical.
Click on <code>OK</code>.</td></tr>
</table>

Transmission of Data

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

Stop of the transmission of data

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

12.2.8 Structure of the Data

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

Example:

```
\DEVICE            : XXXX -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` will be transmitted next. Afterwards the column titles will be transmitted for the respective channel (see Tab. 12.3) The measured values are transmitted afterwards.

Example:

```
\DATA
\*MEASURE;         Q_POS;        Q_NEG;
```

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

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

The following data columns can be transmitted:

Tab. 12.3: Columns of data

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

Online transmission of data

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

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

Offline transmission of data

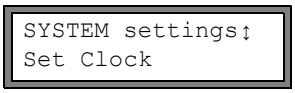
During the offline output, columns will only be created if at least one measured value is stored in the series of measured values.

13 Settings

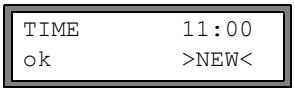
13.1 Time and Date

The transmitter has a battery-powered clock.

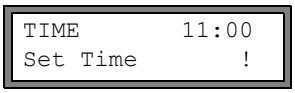
13.1.1 Time



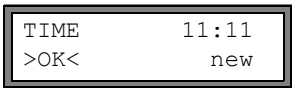
Select `Special Funct.\SYSTEM settings\Set Clock`. Press ENTER.



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



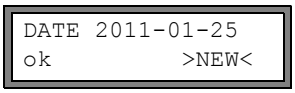
Press key → to select the digit to be edited.
Press key ↓ to edit the selected digit. Press ENTER.



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

13.1.2 Date

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



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

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

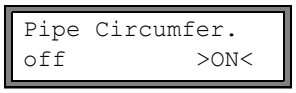
The new date is displayed. Select `ok` to confirm the date or `new` to set the date again. Press ENTER.

13.2 Dialogs and Menus

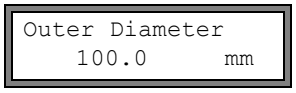
Select `Special Funct.\SYSTEM settings\Dialogs/Menus`. Press ENTER.

Note!	The settings of the menu item `Dialogs/Menus` will be stored at the end of the dialog. If the menu item is quit before the end of the dialog, the settings will not be effective.

13.2.1 Pipe Circumference

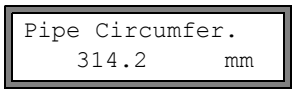


Select `on` if the pipe circumference is to be entered instead of the pipe diameter in the program branch `Parameter`. Press ENTER.



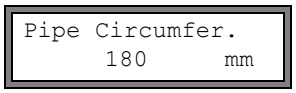
If `on` has been selected for `Pipe Circumfer.`, the outer pipe diameter will nevertheless be requested in the program branch `Parameter`.

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

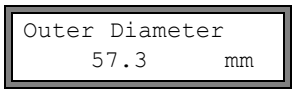


The value displayed in `Pipe Circumfer.` is calculated on the basis of the last displayed value of the outer pipe diameter.

example: 100 mm · π = 314.2 mm



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



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

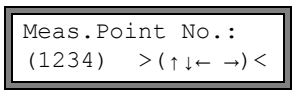
example: 180 mm : π = 57.3 mm

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

Example:	entered pipe circumference: 100 mm displayed outer pipe diameter: 31.8 mm When the transmitter switches back to the display of the pipe circumference, 99.9 mm will be displayed.

13.2.2 Measuring Point Number

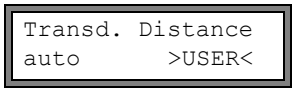
This display will only be indicated if the transmitter has an RS485 interface.



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

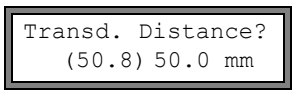
Select `(↑↓← →)` if the measuring point is to be designated with ASCII characters.

13.2.3 Transducer Distance

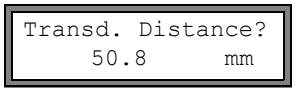


recommended setting: `user`

- `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.

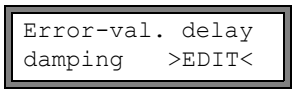


During transducer positioning in the program branch `Measuring`

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

13.2.4 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 15.1.2 and 15.2.

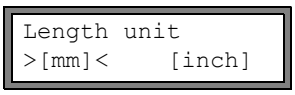
13.2.5 Alarm State Indication

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

Fur further information on the alarm outputs see section 15.5.

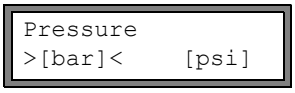
13.2.6 Units of Measurement

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

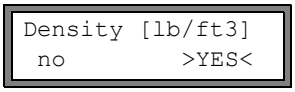


Select `mm` or `inch` as the unit of measurement for the length. Press ENTER.

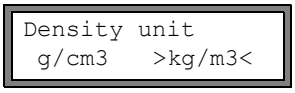
Select `°C` or `°F` as the unit of measurement for the temperature. Press ENTER.



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

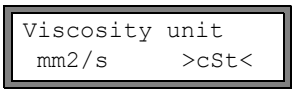


Select `yes` if `lb/ft3` is to be used as the unit of measurement for the density. Press ENTER.

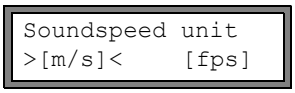


Select `g/cm3` or `kg/m3` as the unit of measurement for the density. Press ENTER.

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



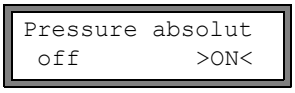
Select `mm2/s` or `cSt` as the unit of measurement for the kinematic viscosity. Press ENTER.



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

13.2.7 Setting for the Fluid Pressure

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

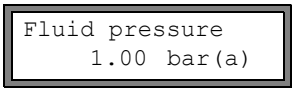


Select `on` or `off`. Press ENTER.

If `on` has been selected, the absolute pressure p_a will be displayed/input/output.

If `off` has been selected, the relative pressure p_g will be displayed/input/output.

$p_g = p_a - 1.01$ bar

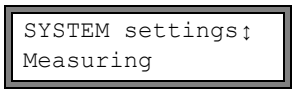


The pressure and its unit of measurement will, e.g., be displayed in the program branch `Parameter`. It will be followed by the selected pressure, indicated in parentheses.

a - absolute pressure
g - relative pressure

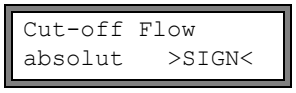
Note!	All changes will be stored at the end of the dialog.

13.3 Measurement Settings

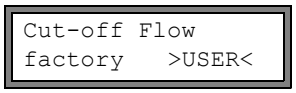


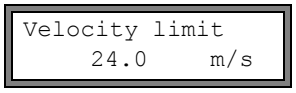
Select `Special Funct.\SYSTEM settings\Measuring`. Press ENTER.

Note!	The settings of the menu item `Measuring` will be stored at the end of the dialog. If the menu item is quit before the end of the dialog, the settings will not be effective.

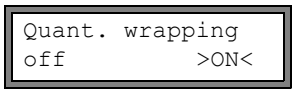


A lower limit for the flow velocity can be entered (see section 11.5).





An upper limit for the flow velocity can be entered (see section 11.4).
Enter `0` (zero) to deactivate the flow velocity check.

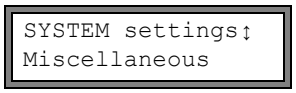


Select the overflow behavior of the totalizers (see section 11.3.1).

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.

Note!	All changes will be stored at the end of the dialog.

13.4 Setting the Contrast



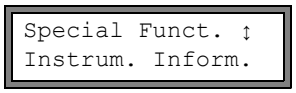
Select `Special Funct.\SYSTEM settings\Miscellaneous` to set the contrast of the display of the transmitter. Press ENTER.

The contrast of the display is adjusted with the follow ing keys:
→ increases the contrast
↓ reduces the contrast

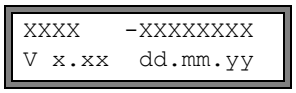
It is possible to reset the display to fluid contrast. Enter HotCode **555000**.

Note!	After an initialization of the transmitter, the display is displayed to fluid contrast.

13.5 Instrument Information



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



The type and the serial number of the transmitter will be displayed in the upper line.
The firmware version of the transmitter with date is displayed in the lower line.
Press ENTER.

14 SuperUser Mode

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

- Defaults will not be observed.
- There are no plausibility checks when parameters are being entered.
- There is no check whether the entered parameters are within the limits determined by the laws of physics and technical data.
- The cut-off flow is not active.
- A value for the number of sound paths has to be entered.
- Some menu items that are not visible in the normal 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.

14.1 Activation/Deactivation

Enter HotCode **071049**.

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.

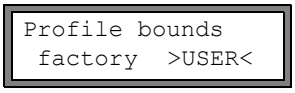
Attention!	Some of the defined parameters are still active after the deactivation of the SuperUser mode.

14.2 Defining the Flow Parameters

In the SuperUser mode, it is possible to define some flow parameters (profile bounds, correction of the flow velocity) for the specific application or measuring point.

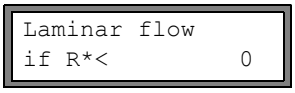
Select `Special Funct.\SYSTEM settings\Measuring\Calibration`.
Press ENTER.

14.2.1 Profile Bounds



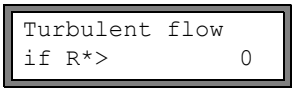
Select `user` if the profile bounds are to be defined. If `factory` is selected, the default profile bounds will be used and the menu item `Calibration` will be displayed (see section 14.2.2).

Press ENTER.



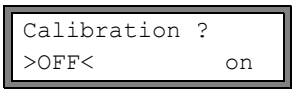
Enter the max. Reynolds number at which the flow is laminar. The entered number will be rounded to the hundreds. Enter `0` (zero) to use the default value 1 000.

Press ENTER.



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

Press ENTER.



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

For the definition of the correction of the flow velocity see section 14.2.2.

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.

14.2.2 Correction of the Flow Velocity

After the profile bounds have been defined (see section 14.2.1), it is possible to define a correction of the flow velocity.

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

with

v – measured flow velocity

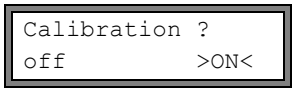
m – slope, range: -2.000...+2.000

n – offset, range: -12.7...+12.7 cm/s

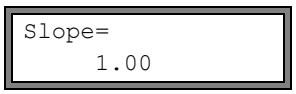
v_{cor} – corrected flow velocity

All quantities derived from the flow velocity will be calculated with the corrected flow velocity. The correction data will be transmitted to the PC or printer during the online or offline transmission of data.

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

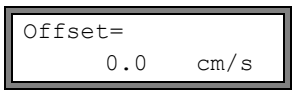


Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.



If `on` has been selected, enter the slope. If `0.0` is entered, the correction will be deactivated.

Press ENTER.



Enter the offset. Enter `0` (zero) to work without an offset.

Press ENTER.

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.

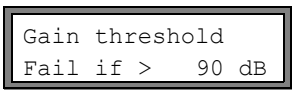
Attention! The correction of the flow velocity is still active after the deactivation of the SuperUser mode.

14.3 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,

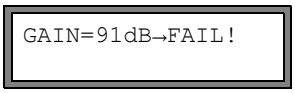
- the flow velocity will be marked as invalid. The physical quantity cannot be determined.
- a hash symbol "#" will be displayed after the unit of measurement (in case of a normal error, "?" is displayed).

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 signal amplification (`GAIN=`) can be displayed in the upper line in the program branch `Measuring`. If the current value of the signal amplification is higher than the max. signal amplification, `→FAIL!` will be displayed after the current value.

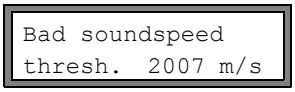
Attention!	The limit of the signal amplification is still active after the deactivation of the SuperUser mode.

14.4 Upper Limit of the Sound Speed

When the plausibility of the signal is evaluated, it will be checked if the sound speed is within a defined range. The upper limit used for the evaluation is the greater of the following values:

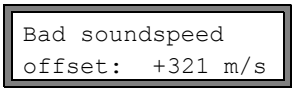
- fixed upper value, default: 1 848 m/s
- value of the sound speed curve of the fluid at the operating point plus offset, default offset: 300 m/s

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 of 1 848 m/s.

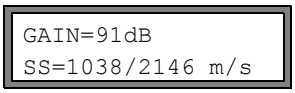
Press ENTER.



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.



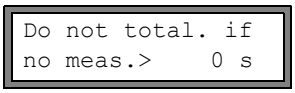
It is possible to display the valid range for the sound speed (`SS=`) in the lower line during the measurement. The second value (here: 2 146 m/s) is the upper limit at the operating point.

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

14.5 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.

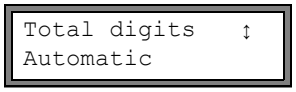


Enter the time. If `0` (zero) is entered, the default value 30 s will be used.

14.6 Number of Decimal Places of the Totalizers

The values of the totalizers can be displayed with up to 11 places, e.g., `74890046.03`. In the SuperUser mode, it is possible to define the number of decimal places.

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



Select one of the following list items:

`Automatic`: dynamic adjustment
`Fixed to x digit`: x decimal places (range: 0...4)

Press ENTER.

`Total digits = Automatic`

The number of decimal places will be adjusted dynamically. Low values will first be displayed with 3 decimal places. With greater values, the number of decimal places will be reduced.

max. value	display		
< 10^6	±0.00	...	±999999.999
< 10^7	±1000000.00	...	±9999999.99
< 10^8	±10000000.0	...	±99999999.9
< 10^{10}	±1000000000	...	±9999999999

`Total digits` = `Fixed to x digit`

The number of decimal points is constant. The max value of the totalizer is reduced with each additional decimal place.

decimal places	max. value	max. display
0	< 10^{10}	±9999999999
1	< 10^8	±99999999.9
2	< 10^7	±9999999.99
3	< 10^6	±999999.999
4	< 10^5	±99999.9999

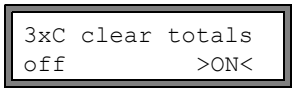
Note!	The number of decimal places and the max. value defined here only affect the display of the totalizers.

For setting the behavior of the totalizers when the max. value is reached see section 11.3.1.

14.7 Manual Reset of the Totalizers

If the manual reset of the totalizers is activated, the totalizers can be reset to zero during the measurement by pressing key C three times, even if a program code is activated.

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



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

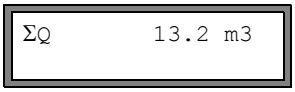
Note!	The manual reset of the totalizers is still active after the deactivation of the SuperUser mode.

14.8 Display of the Sum of the Totalizers

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

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

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



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

14.9 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.

14.10 Display During the Measurement

In the SuperUser mode, the following information can be displayed during the measurement besides the normal information (see section 10.2):

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

15 Outputs

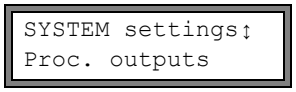
If the transmitter is equipped with outputs, they have to be installed and activated before they can be used:

- assign the physical quantity (source item) to be transmitted to the output 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`

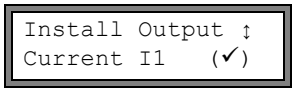
15.1 Installation of an Output

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

Note!	The configuration of an output will be stored at the end of the dialog. If the dialog is quit by pressing key BRK, the changes will not be stored.

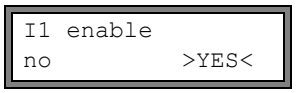


Select `Special Funct.\SYSTEM settings\Proc. outputs`. Press ENTER.

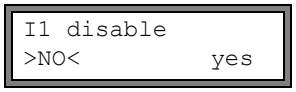


Select the output to be installed. Press ENTER.

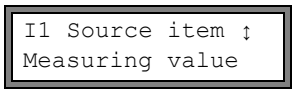
The scroll list contains all available outputs. A tick ✓ after a list item indicates that this output has already been installed.



This display will be indicated if the output has not been installed yet. Select `yes`. Press ENTER.



If the output has already been installed, select `no` to reconfigure it or `yes` to uninstall the output and to return to the previous menu item to select another output. Press ENTER.



Select the physical quantity (source item) to be transmitted from the source channel to the output.

If a binary output is configured, only the list items `Limit` and `Impuls` will be displayed.

The source items and their scroll lists are shown in Tab. 15.1.

Tab. 15.1: 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)
`Impuls`	`from abs(x)`	pulse without sign consideration
	`from x > 0`	pulse for positive measured values
	`from x < 0`	pulse for negative measured values
`Miscellaneous`	`c-Medium`	sound speed of the fluid
	`Signal`	signal amplitude of a measuring channel
	`VariAmp`	standard deviation of the signal amplitude
	`Density`	density of the fluid
	`Pressure`	pressure of the fluid

15.1.1 Output Range

```
I1 Output range↕
   4/20 mA
```

During the configuration of an analog output, the output range is defined. Select a list item or `other range...` to enter the output range manually.

```
I1 Output MIN  ↕
    10.0      mA
```

If `other range...` has been selected, enter the values `Output MIN` and `Output MAX`. Press ENTER after each input.

```
I1 Output MAX  ↕
    11.0      mA
```

```
I1 Output MAX  ↕
    12.0 minimal
```

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

15.1.2 Error Output

In the following dialog, an error value can be defined which is to be output if the source item cannot be measured, e.g., if there are gas bubbles in the fluid:

Tab. 15.2: Error output

error value	**result**
`Minimum`	output of the lower limit of the output range
`Hold last value`	output of the last measured value
`Maximum`	output of the upper limit of the output range
`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 15.2): > 0

The volumetric flow rate cannot be measured during the time interval t_0...t_1 (see Fig. 15.1). The error value will be output.

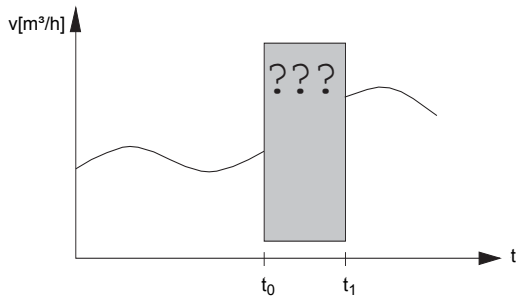
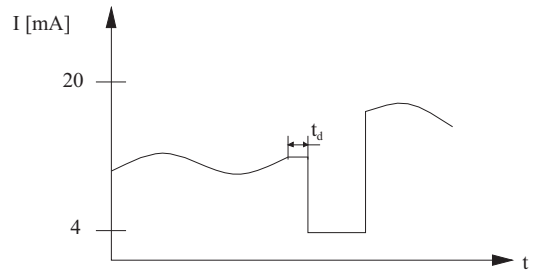
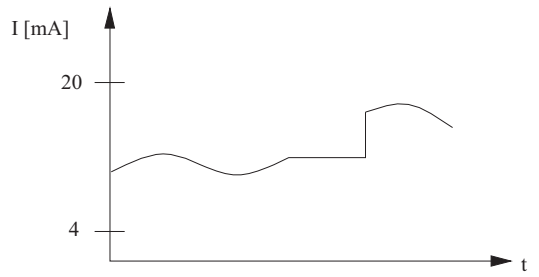
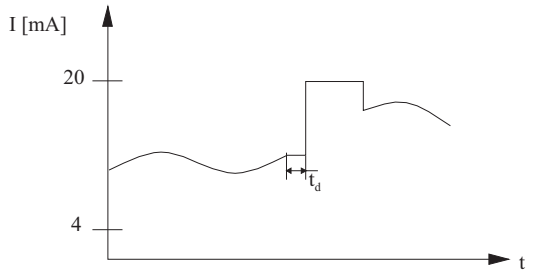
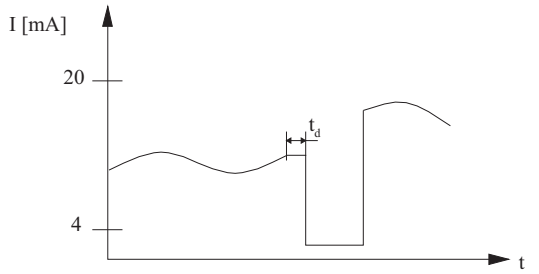


Fig. 15.1: Error output

Tab. 15.3: 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	

Error-value ↕
Minimum (4.0mA)

Select a list item for the error output. Press ENTER.

Error-value
3.5 mA

If `Other value` has been selected, enter an error value. It has to be within the limits of the output.

Press ENTER.

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

I1 active loop
Terminal:P1+,P1-

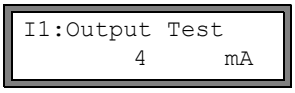
The terminals for the connection of the output are displayed (here: `P1+` and `P1-` for the active current loop).

Press ENTER.

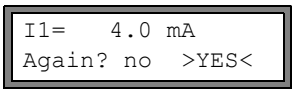
15.1.3 Function Test

The function of the installed output can now be tested. Connect a multimeter with the installed output.

Test of the analog output



The current output is tested in the display. Enter a test value. It has to be within the output range. Press ENTER.

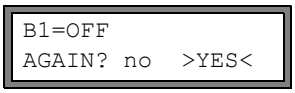


If the multimeter displays the entered value, the output functions correctly.

Press `yes` to repeat the test, `no` to return to the `SYSTEM settings`. Press ENTER.

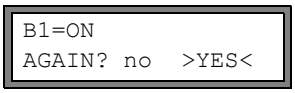
Test of the binary outputs

Select `Opto-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.

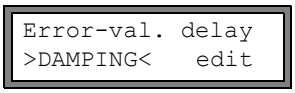
Select `Opto-Relay ON` or `Open collect. ON` in the scroll list `Output Test` to test the energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be low ohmic.



Select `yes` to repeat the test, `no` to return to `SYSTEM settings`. Press ENTER.

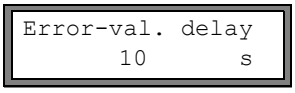
15.2 Error Value Delay

The error value delay is the time interval after which the error value will be transmitted to the output in case no valid measured values are available. The error value delay can be entered in the program branch `Output Options` if this menu item has previously been activated in the program branch `Special Funct.`. If the error value delay is not entered, the damping factor will be used.



Select `Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay.`

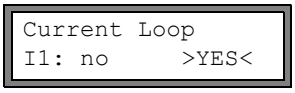
Select `Damping` if the damping factor is to be used as the error value delay. Select `Edit` to activate the menu item `Error-val. delay` in the program branch `Output Options`.



From now on, the error value delay can be entered in the program branch `Output Options`.

15.3 Activation of an Analog Output

Note!	An output can only be activated in the program branch `Output Options` if it has previously been installed.

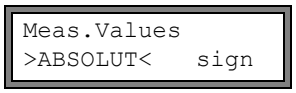


Select the program branch `Output Options`. Press ENTER until `Current Loop` is displayed.

Select `yes` to activate the output. Press ENTER.

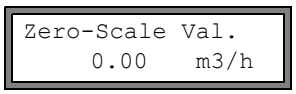
15.3.1 Measuring Range of the Analog Outputs

After an analog output has been activated in the program branch `Output Options`, the measuring range of the source item has to be entered.



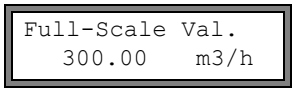
Select `sign` if the sign of the measured values is to be considered for the output.

Select `absolut` if the sign is not to be considered.



Enter the lowest expected measured value. The unit of measurement of the source item will be displayed.

`Zero-Scale Val.` is the measured value that corresponds to the lower limit of the output range as defined in section 15.1.1.



Enter the highest expected measured value.

`Full-Scale Val.` is the measured value that corresponds to the upper limit of the output range as defined in section 15.1.1.

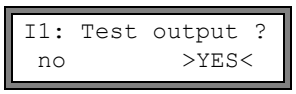
Example:

output: current output
output range: 4…20 mA
`Zero-Scale Val.`: 0 m³/h
`Full-Scale Val.`: 300 m³/h

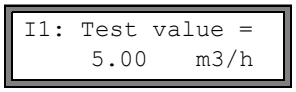
volumetric flow rate = 0 m³/h, corresponds to 4 mA
volumetric flow rate = 300 m³/h, corresponds to 20 mA

15.3.2 Function Test

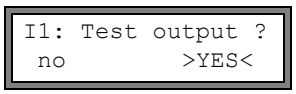
The function of the installed output can now be tested. Connect a multimeter to the installed output.



Select `yes` to activate the output. Press ENTER.



Enter a test value. The value has to be indicated on the connected multimeter. Press ENTER.



Select `yes` to repeat the test. Press ENTER.

Example:

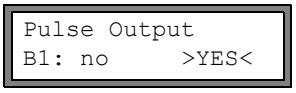
output: current output
output range: 4…20 mA
`Zero-Scale Val.`: 0 m³/h
`Full-Scale Val.`: 300 m³/h

`Test value` = 150 m³/h (middle of the measuring range corresponds to 12 mA)
If the multimeter displays 12 mA, the current output functions correctly.

15.4 Activation of a Binary Output as a Pulse Output

A pulse output is an integrating output which emits a pulse when the volume or the mass of the fluid which has passed the measuring point reaches a given value (`Pulse Value`). The integrated quantity is the selected physical quantity. Integration is restarted as soon as a pulse is emitted.

Note!	The menu item `Pulse Output` will only be indicated in the program branch `Output Options` if a pulse output has been installed.

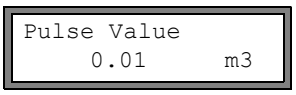


Select the program branch `Output Options`. Press ENTER until `Pulse Output` is displayed.

Select `yes` to activate the output. Press ENTER.

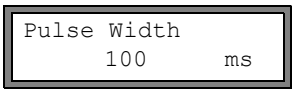
This error message will be displayed if the flow velocity has been selected as the physical quantity.

The use of the pulse output is not possible in this case because integrating the flow velocity does not result in a reasonable value.



Enter the pulse value. The unit of measurement will be displayed according to the current physical quantity.

When the totalized physical quantity reaches the pulse value, a pulse will be emitted.



Enter the pulse width.

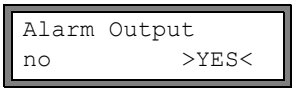
The range of possible pulse widths depends on the specification of the measuring instrument (e.g., counter, PLC) that is to be connected to the output.

The max. flow that the pulse output can work with will be displayed now. This value is calculated on the basis of the entered pulse value and pulse width.

If the flow exceeds this value, the pulse output will not function properly. In this case, the pulse value and the pulse width have to be adapted to the flow conditions.Press ENTER.

15.5 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.

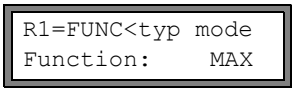


Select the program branch `Output Options`. Press ENTER until `Alarm Output` is displayed.

Select `yes` to activate the alarm output. Press ENTER.

15.5.1 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. 15.4: Alarm properties

alarm property	setting	description
func (switching condition)	MAX	The alarm will switch if the measured value exceeds the upper limit.
	MIN	The alarm will switch if the measured value falls below the lower limit.
	+→- -→+	The alarm will switch if the flow direction changes (sign change of measured value).
	QUANT.	The alarm will switch if totalizing is activated and the totalizer reaches the limit.
	ERROR	The alarm will switch if a measurement is not possible.
	OFF	The alarm is switched off.
typ (holding behavior)	NON-HOLD	If the switching condition is not true anymore, the alarm will return to the idle state after approx. 1 s.
	HOLD	The alarm remains activated even if the switching condition is not true anymore.
mode (switching function)	NO Cont.	The alarm is energized if the switching condition is true and de-energized if idle.
	NC Cont.	The alarm is de-energized if the switching condition is true and energized if idle.

Note! If no measurement is made, all alarms will be de-energized, independently of the programmed switching function.

15.5.2 Setting the Limits

If the switching condition MAX or MIN is selected in the scroll list func, the limit of the output 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.

```
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

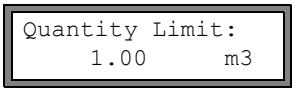
volumetric flow rate = -11 m³/h
the limit is not exceeded, the alarm does not switch

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 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.

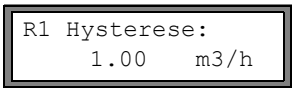
Example 1:	physical quantity: volumetric flow rate in m³/h Quantity Limit: 1 m³
Example 2:	physical quantity: volumetric flow rate in m³/h Low Limit: 60 m³/h The unit of measurement of the physical quantity is changed to m³/min. The new limit to be entered is 1 m³/min.

15.5.3 Defining the Hysteresis

A hysteresis can be defined for the alarm output R1 to prevent a constant triggering of the alarm due to small fluctuations of the measured values around the limit.

The hysteresis is a symmetrical range around the limit. The alarm will be activated if the measured values exceed the upper limit and deactivated if the measured values fall below the lower limit.

Example:	High Limit: 30 m³/h Hysterese: 1 m³/h The alarm will be triggered at values > 30.5 m³/h and deactivated at values < 29.5 m³/h.



switching condition: MIN or MAX

Enter the value for Hysterese.

or

Enter 0 (zero) to work without a hysteresis.

Press ENTER.

15.6 Behavior of the Alarm Outputs

15.6.1 Apparent Switching Delay

Measured values and totalizer values will be displayed rounded to two decimal places. The limits, however, will be compared to the non-rounded measured values. This might cause an apparent switching delay when the measured value changes marginally (less than two decimal places). In this case, the switching accuracy of the output is greater than the accuracy of the display.

15.6.2 Reset and Initialization of the Alarms

After an initialization, all alarm outputs will be initialized as follows:

Tab. 15.5: Alarm state after an initialization

func	OFF
typ	NON-HOLD
mode	NO Cont.
Limit	0.00

Press key C three times during the measurement to set all alarm outputs to the idle state. Alarm outputs whose switching condition is still met will be activated again after 1 s. This function is used to reset alarm outputs of the type HOLD if the switching condition is no longer met.

By pressing key BRK, the measurement will be stopped and the main menu selected. All alarm outputs will be de-energized, independently of the programmed idle state.

15.6.3 Alarm Outputs During Transducer Positioning

At the beginning of the transducer positioning (bar graph display), all alarm outputs switch back to the programmed idle state.

If the bar graph is selected during the measurement, all alarm outputs will switch back to the programmed idle state.

An alarm output of the type HOLD that has been activated during the previous measurement will remain in the idle state after the transducer positioning if the switching condition is no longer met.

Switching of the alarm outputs into the idle state will not be displayed.

15.6.4 Alarm Outputs During the Measurement

An alarm output with switching condition MAX or MIN will be updated max. once per second to avoid humming (i.e. fluctuation of the measured values around the value of the switching condition).

An alarm output of the type NON-HOLD will be activated if the switching condition is met. It will be deactivated if the switching condition is no longer met. The alarm will remain activated min. 1 s even if the switching condition is met for a shorter period of time.

Alarm outputs with the switching condition QUANT. will be activated if the limit is reached.

Alarm outputs with the switching condition ERROR will only be activated after several unsuccessful measuring attempts. Therefore, typical short-term disturbances of the measurement (e.g., switching on of a pump) will not activate the alarm.

Alarm outputs with the switching condition +→- -→+ and the type NON-HOLD will be activated with each change of the flow direction for approx. 1 s (see Fig. 15.2).

Alarm outputs with the switching condition +→- -→+ and the type HOLD will be active after the first change of the flow direction. They can be switched back by pressing key C three times (see Fig. 15.2).

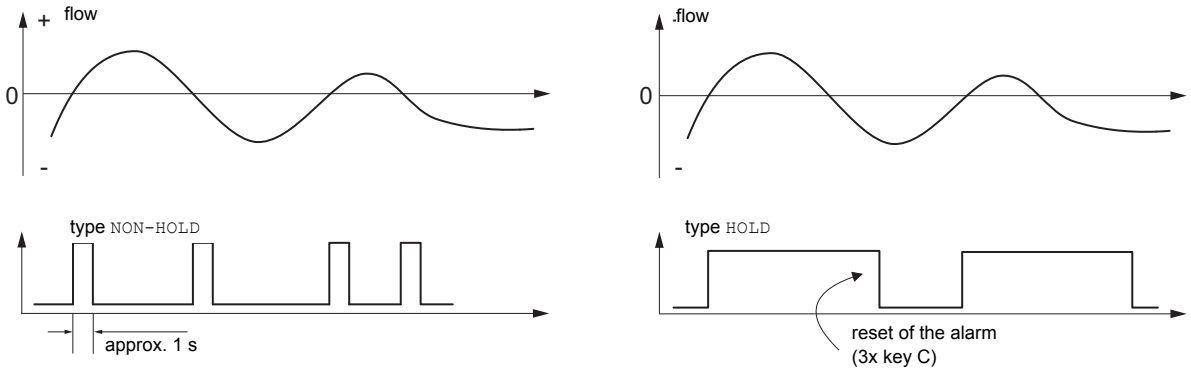


Fig. 15.2: Behavior of a relay when the flow direction changes

If there is an internal adaptationto changing measuring conditions, e.g., to a considerable rise of the fluid temperature, the alarm will not switch. Alarm outputs with the switching condition OFF will be set automatically to the switching function NO Cont..

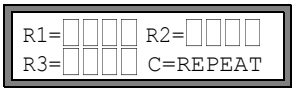
15.6.5 Indication of the Alarm State

Note!	There is no visual or acoustic indication of alarm output switching.

After the configuration of the alarm outputs and during the measurement, the state of the alarms can be indicated. This function is activated in the program branch `Special Funct.\SYSTEM settings\Dialogs/Menus`. It is recommended to activate this function if the alarm outputs often have to be reconfigured.

Select the menu item `SHOW RELAIS STAT`. Select `on` to activate the indication of the alarm state.

If the indication of the alarm state is activated, the state of the alarm outputs will be indicated after the configuration of the alarm outputs:



The indication of the alarm state is structured as follows:

`RX =` □ □ □ □, where `X` is the number of the alarm output and □ is a pictogram according to Tab. 15.6.

It is possible to repeat the configuration of the alarm outputs by pressing key C. If the configuration of the alarm outputs is complete, press ENTER. The main menu will be displayed.

If the indication of the alarm state is activated, it is possible to show the alarm state during the measurement. Press key → to scroll through the upper line and ↓ to scroll through the lower line until the alarm state is indicated.

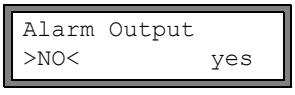
Tab. 15.6: Pictograms for the alarm state indication

	Nr.		`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 =`

15.7 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.

16 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.

The display does not work at all or fails regularly

Check the contrast setting of the transmitter (see section 13.4).

Make sure that the correct voltage is available at the terminals. The voltage is indicated on the metal plate below the outer right terminal.If the power supply is ok, the transducers or an internal component of the transmitter are defective. The transducers and the transmitter have to be sent to FLEXIM for repair.

The message SYSTEM ERROR is displayed

Press key BRK to return to the main menu.

If this message is displayed repeatedly, write down the number in the lower line. Track down the situations when the error is displayed. Contact FLEXIM.

The transmitter does not react when key BRK is pressed during the measurement

A program code has been defined. Press key C and enter the program code.

The backlight of the display does not work, but all other functions are available.

The backlight is defective. This problem does not affect the other functions of the display. Send the transmitter to FLEXIM for repair.

Date and time are wrong

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 15.1.3. If the output is defective, contact FLEXIM.

A measurement is impossible or the measured values substantially differ from the expected values

see section 16.1.

The values of the totalizer are wrong

see section 16.6.

16.1 Problems with the Measurement

A measurement is impossible because no signal is received. A question mark is displayed in the lower line on the right

- Check if the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound speed of the fluid. (Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.)
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point has been selected (see section 16.2).
- Try to establish better acoustic contact between the pipe and the transducers (see section 16.3).
- 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 16.4).

The measuring signal is received but no measured values can be obtained

- An exclamation mark "!" in the lower line on the right indicates that the defined upper limit of the flow velocity is exceeded and, therefore, the measured values are marked as invalid. The limit has to be adapted to the measuring conditions or checking has to be deactivated (see section 11.4).
- If no exclamation mark "!" is displayed, a measurement at the selected measuring point is not possible.

Loss of signal during the measurement

- If the pipe had run empty: Was there no measuring signal afterwards? Contact FLEXIM.
- Wait briefly until acoustic contact is reestablished. The measurement can be interrupted by a temporarily higher proportion of gas bubbles and solids in the 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 16.5 for the description of typical situations in which wrong measured values are obtained.

16.2 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).

16.3 Maximum Acoustic Contact

Observe the instructions in chapter 7.

16.4 Application Specific Problems

The entered sound speed of the fluid is wrong

The entered sound speed is used to calculate the transducer distance and is therefore very important for the transducer positioning. The sound speeds stored in the transmitter only serve as orientation.

The entered pipe roughness is not appropriate

Check the entered value. The state of the pipe should be taken into account.

Measurements on porous pipe materials (e.g., concrete or cast iron) are only possible under certain conditions

Contact FLEXIM.

The pipe lining may cause problems during the measurement if it is not firmly attached to the inner pipe wall or consists of an acoustically absorbing material

Try measuring on a liner free section of the pipe.

Highly viscous fluids strongly attenuate the ultrasonic signal

Measurements on fluids with a viscosity > 1000 mm²/s are only possible under certain conditions.

A higher proportion of gas bubbles or solids in the fluid scatter and absorb the ultrasonic signal and therefore attenuate the measuring signal

A measurement is impossible if the value is ≥ 10 %. If the proportion is high, but < 10 %, a measurement is only possible under certain conditions.

The flow is in the transition range between laminar and turbulent flow where flow measurement is difficult

Calculate the Reynolds number of the flow at the measuring point with the program FluxFlow (free download: www.flexim.com). Contact FLEXIM.

16.5 Large Deviations of the Measured Values

The entered sound speed of the fluid is wrong

A wrong sound speed can result in the ultrasonic signal that is reflected directly on the pipe wall being mistaken for the measuring signal that has passed through the fluid. The flow calculated on the basis of the wrong signal by the transmitter is very small or fluctuates around zero.

There is gas in the pipe

If there is gas in the pipe, the measured flow will always be too high because both the gas volume and the liquid volume are measured.

The defined upper limit of the flow velocity is too low

All measured flow velocities that are greater than the upper limit will be ignored and marked as invalid. All quantities derived from the flow velocity will also be marked as invalid. If several correct measured values are ignored, the totalizer values will be too low.

The entered cut-off flow is too high

All flow velocities below the cut-off flow are set to zero. All derived quantities are also set to zero. The cut-off flow (default: 2.5 cm/s) has to be set to a low value in order to be able to measure at low flow velocities.

The entered pipe roughness is not appropriate

The flow velocity of the fluid is outside the measuring range of the transmitter

The measuring point is not appropriate

Select another measuring point to check whether the results are better. Because pipes are never rotationally symmetric, the flow profile is affected. Change the transducer position according to the pipe deformation.

16.6 Problems with the Totalizers

The values of the totalizer are too high

See `Special Function\SYSTEM settings\Measuring\Quantity recall`. If this menu item is activated, the values of the totalizer will be stored. The totalizer will continue with this value at the start of the next measurement.

The values of the totalizer are too low

One of the totalizers has reached the upper limit and has to be reset to zero manually.

The sum of the totalizers is not correct

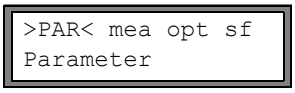
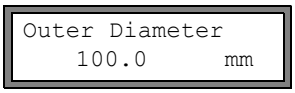
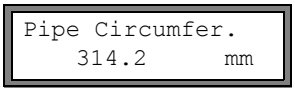
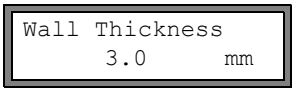
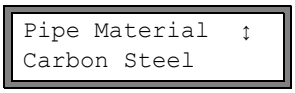
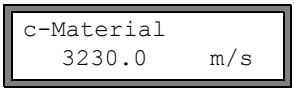
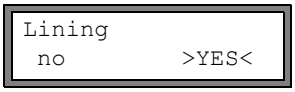
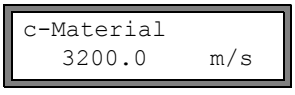
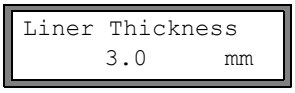
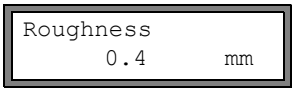
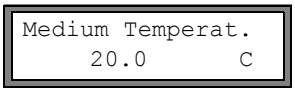
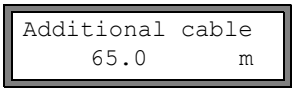
See `Special Function\SYSTEM settings\Measuring\Quant. wrapping`. The sum of both totalizers (throughput) transmitted via an output is not valid after the overflow (wrapping) of one of the totalizers.

16.7 Data Transmission

The file with the transmitted measuring data contains meaningless strings

The transmission parameters of the transmitter and the transmission program are not identical. Adjust the transmission parameters the transmitter (see section 12.2.4) and the terminal program.

A Menu Structure

	INIT-resistant
Program Branch `Parameter`	
 main menu: selection of the program branch `Parameter`	
 input of the outer pipe diameter	
 input of the pipe circumference This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Pipe Circumfer.` is activated and `Outer Diameter` = `0` has been entered.	
 input of the pipe wall thickness range: depends on the connected transducers default: 3 mm	
 selection of the pipe material	
 input of the sound speed of the pipe material range: 600...6553.5 m/s This display will only be indicated if `Other Material` has been selected.	
 selection whether the pipe is lined	
 selection of the lining material This display will only be indicated if `Lining` = `yes` has been selected.	
 input of the sound speed of the lining material range: 600...6553.5 m/s This display will only be indicated if `Other Material` has been selected.	
 input of the liner thickness default: 3 mm	
 input of the roughness of the inner pipe wall range: 0...5 mm default: 0.1 mm (for steel as pipe material)	
 input of the fluid temperature default: 20 °C	
 input of the length of an extension cable	

	INIT-resistant
Program Branch `Measuring`	

`par >MEA< opt sf`
`Measuring`
main menu: selection of the program branch `Measuring`	

`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.	

`PROFILE CORR.`
`>NO< yes`
activation/deactivation of the flow profile correction
This display will only be indicated if `Special Funct.\SYSTEM settings\Measuring\Flow Velocity` = `uncorr.` has been selected.	

`Sound Path`
`2 NUM`
input of the number of sound paths	

`Transd. Distance`
`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`	

`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	

`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.	

Current Loop	

`Current Loop`
`I1: no >YES<`
activation of a current output
This display will only be indicated if the current output has been installed in `Special Funct.\SYSTEM settings\Proc. outputs`.	

`Meas.Values`
`>ABSOLUT< sign`
selection whether the sign of the measured values is to be considered for the output
This display will only be indicated if `Current Loop` is activated.	

`Zero-Scale Val.`
`0.00 m3/h`
input of the lowest/highest measured value to be expected for the current output
The values are assigned to the lower/upper limit of the output range.
These displays will only be indicated if `Current Loop` is activated.	

`Full-Scale Val.` `300.00 m3/h`	

		INIT-resistant
Error-val. delay 10 s	input of the error value delay, i.e. of the time interval after which the value entered for the error output will be transmitted to the output if no valid measured values are available This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay` = `EDIT` has been selected.	
Pulse Output		
Pulse Output B1: no >YES<	activation of a pulse output This display will only be indicated if a pulse output has been installed in `Special Funct.\SYSTEM settings\Proc. outputs`.	
Pulse Value 0.01 m3	input of the pulse value (value of the totalizer at which a pulse will be emitted) This display will only be indicated if `Pulse Output` is activated.	
Pulse Width 100 ms	input of the pulse width range: 80...1000 ms This display will only be indicated if `Pulse Output` is activated.	
Alarm Output		
Alarm Output no >YES<	activation of an alarm output This display will only be indicated if an alarm output has been installed in `Special Funct.\SYSTEM settings\Proc. outputs`.	
R1=FUNC<typ mode Function: MAX	Selection of the switching condition (`func`), the holding behavior (`typ`) and the switching function (`mode`) of the alarm output. This display will only be indicated if `Alarm Output` is activated.	
R1 Input: ↕ Volume flow	selection of the physical quantity to be monitored This display will only be indicated for R1 if `Alarm Output` is activated.	
High Limit: 10.00 m3/h	input of the upper limit of the physical quantity to be monitored This display will only be indicated if `Alarm Output` has been activated and `MAX` has been selected as the switching condition.	
Low Limit: -10.00 m3/h	input of the lower limit of the physical quantity to be monitored This display will only be indicated if `Alarm Output` has been activated and `MIN` has been selected as the switching condition.	
Quantity Limit: 1.00 m3	input of the limit for the totalizer of the physical quantity to be monitored This display will only be indicated if `Alarm Output` has been activated and `QUANT.` has been selected as the switching condition.	
R1 Hysterese: 1.00 m3/h	input of the hysteresis for the lower or upper limit This display will only be indicated if `Alarm Output` has been activated and `MIN` or `MAX` has been selected as the switching condition.	
Program Branch `Special Funct.`		
par mea opt >SF< Special Funct.	main menu: selection of the program branch `Special Funct.`	
`SYSTEM settings`		
Special Funct. ↕ SYSTEM settings	selection of `Special Funct.\SYSTEM settings`	

		INIT-resistant
SYSTEM settings\Set Clock		
SYSTEM settings↕ Set Clock	selection of the displays for the input of the date and the time	
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
Meas.Point No.: (1234) >(↑↓← →)<	selection of the input mode for the measuring point number in the program branch `Measuring`: `(1234)`: digits, point, hyphen `(↑↓← →)`: ASCII editor	x
Transd. Distance auto >USER<	setting for the display for the input of the transducer distance in the program branch `Measuring`: • `user`: only the entered transducer distance will be displayed if the recommended and the entered transducer distances are identical • `auto`: only the recommended transducer distance will be displayed recommended setting: `user`	x
Error-val. delay damping >EDIT<	selection of the error value delay • `damping`: The damping factor will be used. • `edit`: The menu item for the input of the error value delay in the program branch `Output Options` will be activated.	x
SHOW RELAIS STAT off >ON<	activation of the display of the alarm state during the measurement	x
Length unit >[mm]< [inch]	selection of the unit of measurement for the length	x
Temperature >[°C]< [°F]	selection of the unit of measurement for the temperature	x
Pressure absolut off >ON<	selection if the absolute pressure p_a or the relative pressure p_g is to be used	x
Pressure >[bar]< [psi]	selection of the unit of measurement for the pressure	x
Density [lb/ft3] no >YES<	selection if lb/ft^3 is to be used as the unit of measurement for the density	x
Density unit g/cm3 >kg/m3<	selection of the unit of measurement for the density This display will only be indicated if lb/ft^3 has not been selected as the unit of measurement for the density	x

		INIT-resistant
`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 settings of the measurement	
`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` has been selected.	x
`-Cut-off Flow` `-2.5 cm/s`	input of the cut-off flow for negative measured values range: -12.7...0 cm/s default: -2.5 cm/s This display will only be indicated if `Cut-off Flow` = `sign` and `Cut-off Flow` = `user` has been selected.	x
`Cut-off Flow` `2.5 cm/s`	input of the cut-off flow for the absolute value of the measured values range: 0...12.7 cm/s default: 2.5 cm/s This display will only be indicated if `Cut-off Flow` = `absolut` and `Cut-off Flow` = `user` has been selected.	x
`Gain threshold` `Fail if > 90 dB`	input of the max. signal amplification range: 0...255 0: no limit of the signal amplification This display will only be indicated if the SuperUser mode is activated.	x
`Bad soundspeed` `thresh. 2007 m/s`	input of the fixed upper limit of the sound speed range: 0...3 000 m/s 0: the default value 1 848 m/s is used This display will only be indicated if the SuperUser mode is activated.	x

		INIT-resistant
Bad soundspeed offset: +321 m/s	input of the offset range: 0...900 m/s 0: the default value 300 m/s is used This display will only be indicated if the SuperUser mode is activated.	x
Quant. wrapping off >ON<	activation of the overflow of the totalizers	x
Quantity recall off >ON<	activation of the taking-over of the totalizer values after a restart of the measurement	x
Do not total. if no meas.> 0 s	input of the time interval without any valid measured values after which the transmitter recognizes a long measurement failure 0: the default value 30 s is used This display will only be indicated if the SuperUser mode is activated.	x
Total digits ↕ Automatic	input of the number of decimal places for the totalizers: `Automatic`: dynamic adjustment `Fixed to x digit`: 0...4 decimal places This display will only be indicated if the SuperUser mode is activated.	x
Toggle totalizer 0 s	input of the time duration after which the flow totalizer display toggles between positive and negative flow direction	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
Show ΣQ off >ON<	activation of the display of the sum of the totalizers 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
SYSTEM settings\Proc. outputs		
SYSTEM settings↕ Proc. outputs	selection of the displays for the setting of the outputs of the transmitter	
Install Output ↕ Current I1	selection of the output to be installed	
SYSTEM settings\Storing (only with the optional RS485)		
SYSTEM settings↕ Storing	selection of the displays for the storing of measured values in the data logger	
Ringbuffer off >ON<	setting of the overflow behavior of the data logger	x

		INIT-resistant
Storage mode sample >AVERAGE<	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
Quantity Storage one >BOTH<	setting of the storing behavior of the totalizers • one: the value of the totalizer that is currently displayed will be stored • both: one value for each flow direction will be stored	x
Store Amplitude off >ON<	activation of the storing of the signal amplitude The value will only be stored if the data logger is activated.	x
Store c-Medium off >ON<	activation of the storing of the sound speed of the fluid The value will only be stored if the data logger is activated.	x
Store diagnostic off >ON<	activation of the storing of diagnostic values	x
SYSTEM settings\Miscellaneous		
SYSTEM settings↕ Miscellaneous	selection of the display for the setting of the contrast	
SETUP DISPLAY ← CONTRAST →	setting of the contrast of the display	
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	
XXXX -XXXXXXXX V x.xx dd.mm.yy	display of the type, serial number and firmware version with the 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.	

		INIT-resistant
SERIAL ERROR ! Print Meas.Val.	error message that there is a problem with the serial transmission of data	
■■■■■■	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.	
Program Code		
Special Funct. ↕ set program code	selection of the displays for the input of a program code	
set program code ------	defining a program code	
INPUT BREAK_CODE CODE: 000000	input of the break code (= program code)	
INP. ACCESS CODE CODE: 000000	input of the access code (= the first three digits of the program code)	
After the Input of HotCode 071001		
DNmin Q-Sensor 15 mm	input of the lower limit of the inner pipe diameter for the displayed transducer type range: 3...63 mm	x

B Units of Measurement

Length/roughness	
unit of measurement	description
mm	millimeter
inch	inch

Temperature	
unit of measurement	description
°C	degree Celsius
°F	degree Fahrenheit

Pressure	
unit of measurement	description
bar(a)	bar (absolute)
bar(g)	bar (relative)
psi(a)	pound per square inch (absolute)
psi(g)	pound per square inch (relative)

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

Sound speed	
unit of measurement	description
m/s	meter per second

Kinematic viscosity	
unit of measurement	description
mm2/s	square millimeter per second

1 mm²/s = 1 cSt

Flow velocity	
unit of measurement	description
m/s	meter per second
cm/s	centimeter per second
in/s	inch per second
fps (ft/s)	foot per second

Volumetric flow rate		**Volume (totalized)**
unit of measurement	description	unit of measurement
m3/d	cubic meter per day	m3
m3/h	cubic meter per hour	m3
m3/min	cubic meter per minute	m3
m3/s	cubic meter per second	m3
km3/h	1000 cubic meters per hour	km3
ml/min	milliliter per minute	l or m3*
l/h	liter per hour	l or m3*
l/min	liter per minute	l or m3*
l/s	liter per second	l or m3*
hl/h	hectoliter per hour	hl or m3*
hl/min	hectoliter per minute	hl or m3*
hl/s	hectoliter per second	hl or m3*
Ml/d (Megalit/d)	megaliter per day	Ml or m3*
bbl/d	barrel per day	bbl
bbl/h	barrel per hour	bbl
bbl/m	barrel per minute	bbl
USgpd (US-gal/d)	gallon per day	gal
USgph (US-gal/h)	gallon per hour	gal
USgpm (US-gal/m)	gallon per minute	gal
USgps (US-gal/s)	gallon per second	gal
KGPM (US-Kgal/m)	kilogallon per minute	kgal
MGD (US-Mgal/d)	million gallons per day	Mg
CFD	cubic foot per day	cft**
CFH	cubic foot per hour	cft
CFM	cubic foot per minute	cft
CFS	cubic foot per second	aft***
MMCFD	million cubic feet per day	MMCF
MMCFH	million cubic feet per hour	MMCF

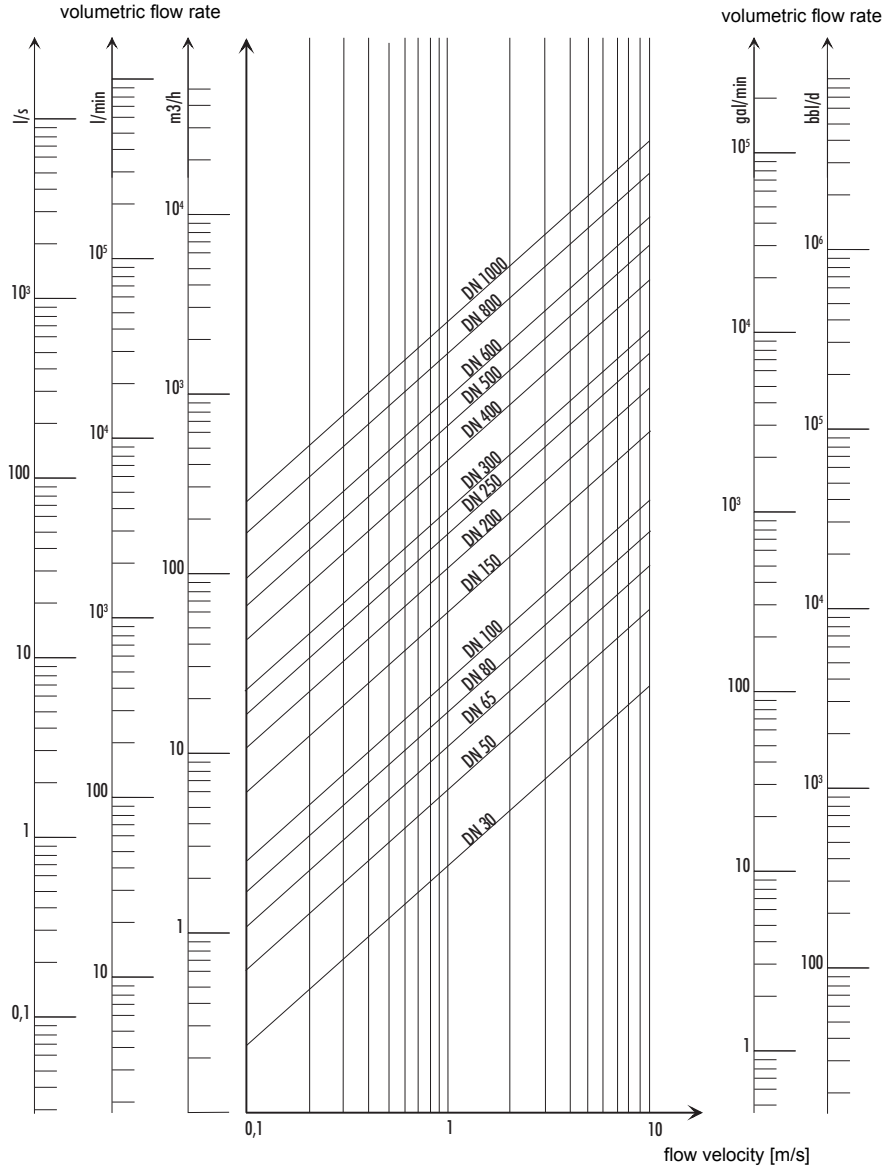
* Selection with HotCode 007027, firmware version V5.91 or higher
** cft: cubic foot
*** aft: acre foot

1 US-gal = 3.78541 l
1 bbl = 42 US-gal = 158.9873 l

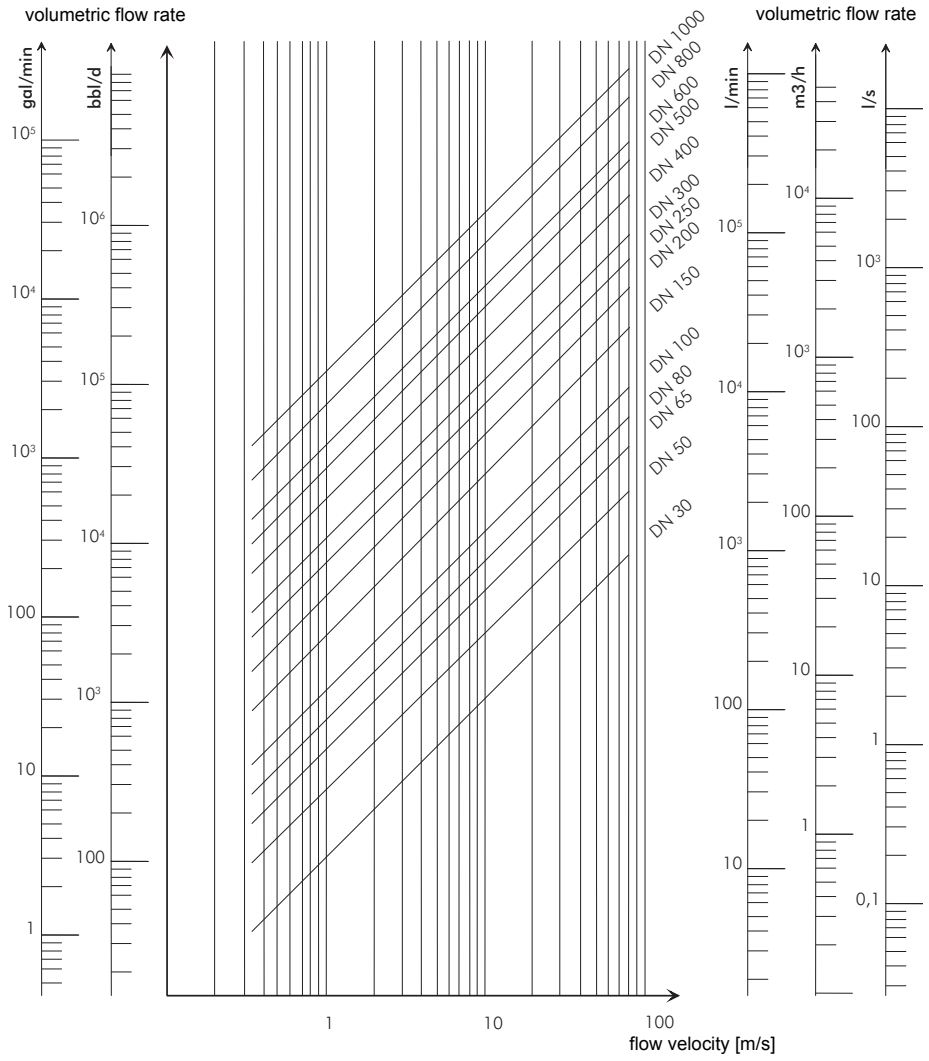
Mass flow rate		**Mass (totalized)**
unit of measurement	description	unit of measurement
t/h	metric ton per hour	t
t/d	metric ton per day	t
kg/h	kilogram per hour	kg
kg/min	kilogram per minute	kg
kg/s	kilogram per second	kg
g/s	gram per second	g
lb/d	pound per day	lb
lb/h	pound per hour	lb
lb/m	pound per minute	lb
lb/s	pound per second	lb
klb/h	kilopound per hour	klb
klb/m	kilopound per minute	klb

1 lb = 453.59237 g
1 t = 1000 kg

Flow Nomogram (metrical)



Flow Nomogram (imperial)



C Reference

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

C.1 Sound Speed of Selected Pipe and Lining Materials at 20 °C

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

Material (display)	Explanation	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
Carbon Steel	carbon steel	3 230	5 930	trans
Stainless Steel	stainless steel	3 100	5 790	trans
DUPLEX	duplex stainless steel	3 272	5 720	trans
Ductile Iron	ductile cast iron	2 650	-	trans
Asbestos Cement	asbestos cement	2 200	-	trans
Titanium	titanium	3 067	5 955	trans
Copper	copper	2 260	4 700	trans
Aluminium	aluminum	3 100	6 300	trans
Brass	brass	2 100	4 300	trans
Plastic	plastic	1 120	2 000	long
GRP	glass-reinforced plastic	-	2 650	long
PVC	polyvinyl chloride	-	2 395	long
PE	polyethylene	540	1 950	long
PP	polypropylene	2 600	2 550	trans
Bitumen	bitumen	2 500	-	trans
Acrylic	acrylic glass	1 250	2 730	long
Lead	lead	700	2 200	long
Cu-Ni-Fe	alloy of copper, nickel, and iron	2 510	4 900	trans
Grey Cast Iron	gray cast iron	2 200	4 600	trans
Rubber	rubber	1 900	2 400	trans
Glass	glass	3 400	5 600	trans
PFA	perfluoroalkoxy	500	1 185	long
PVDF	polyvinylidene fluoride	760	2 050	long
Sintimid	Sintimid	-	2 472	long
Teka PEEK	Teka PEEK	-	2 534	long
Tekason	Tekason	-	2 230	long

The sound speed depends on the composition and the manufacturing process of the material. The sound speed of alloys and cast materials fluctuates strongly. The values only serve as an orientation.

C.2 Typical Roughnesses of Pipes

The values are based on experience and measurements.

Material	Absolute roughness [mm]
drawn pipes of non-ferrous metal, glass, plastics and light metal	0…0.0015
drawn steel pipes	0.01…0.05
fine-planed, polished surface	max. 0.01
planed surface	0.01…0.04
rough-planed surface	0.05…0.1
welded steel pipes, new	0.05…0.1
after long use, cleaned	0.15…0.2
moderately rusted, slightly encrusted	max. 0.4
heavily encrusted	max. 3
cast iron pipes:	
bitumen lining	> 0.12
new, without lining	0.25…1
rusted	1…1.5
encrusted	1.5…3

C.3 Properties of Water at 1 bar and at Saturation Pressure

Fluid temperature [°C]	Fluid pressure [bar]	Sound speed [m/s]	Density [kg/m³]	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 Declarations of Conformity

FLEXIM

Declaration of Conformity
KEFLUXUS_5x07V2-1EN

We,

FLEXIM Flexible Industriemesstechnik GmbH
Wolfener Str. 36
12681 Berlin
Germany,

declare under our sole responsibility that the transmitters

FLUXUS ADM 5x07, F501,

to which this declaration relates, are in conformity with the following EC directives:

- EMC Directive 2004/108/EC for Electromagnetic Compatibility
- Low Voltage Directive 2006/95/EC for Electrical Safety

The transmitters are in conformity with the following European standards when used with the FLEXIM transducers and accessories:

EC Directive	Class	Standard	Description
EMC Directive	EMC Requirement	EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use - EMC requirements - General requirements
	- Immunity	EN 61326-1:2013	Electrical equipment for continuous, unattended operation
		EN 61000-4-2:2009	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test
		EN 61000-4-3:2006 + A1:2008 + A2:2010	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
		EN 61000-4-4:2004 + A1:2010	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrical fast transient/ burst immunity test
		EN 61000-4-5:2006	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Surge immunity test
		EN 61000-4-6:2009	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
		EN 61000-4-11:2004	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests
	- Emission	EN 61326-1:2013	Electrical equipment class A
		EN 55011:2009 + A1:2010	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement

(continuation on verso)

EC Directive	Class	Standard	Description
Low Voltage Directive	Equipment Safety Requirement	EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use - General requirements
		EN 61010-2-030:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use - Particular requirements for testing and measuring circuits
	- Insulation	EN 61010-1:2010	Pollution degree 2 Overvoltage category 2 Safety class 1

The installation, operating and safety instructions have to be observed!

Berlin, 2015-06-15

Dipl.-Ing. Jens Hilpert
Managing Director