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# Portable Ultrasonic Flowmeter
# Portalok 7S






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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 Portalok 7S. 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.

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

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

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

## 1.2 Safety Instructions

The user manual contains instructions that are marked as follows:

| | |
|---|---|
| **Note!** | This text contains important information about the use of the measuring instrument. |

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

Observe these safety instructions!

## 1.3 Warranty

The Portalok 7S measuring instrument is guaranteed for the term and to the conditions specified in the sales contract provided the equipment has been used for the purpose for which it has been designed and operated according to the instructions given in this User Manual. Misuse of the flowmeter will immediately revoke any warranty given or implied.

This includes:

- replacement of a component of Portalok 7S with a component that was not approved by EESiFlo
- unsuitable or insufficient maintenance
- repair of Portalok 7S by unauthorized personnel

EESiFlo 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.

Portalok 7S 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 17), contact our sales office giving a precise description of the problem. Specify the type, serial number and firmware version of the measuring instrument.



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# 2 Handling

## 2.1 First Inspection

The measuring instrument has already been tested thoroughly at EESiFlo. At delivery, ensure 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

Portalok 7S is a precise measuring instrument and has to be handled with care. To obtain good measurement results and not damage the measuring instrument, it is important that great attention is paid to the instructions given in this user manual, particularly to the following points:

- Protect the transmitter from shocks.
- 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.
- Observe the degree of protection.

## 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.



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# 3 General Principles

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

## 3.1 Measurement System

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

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

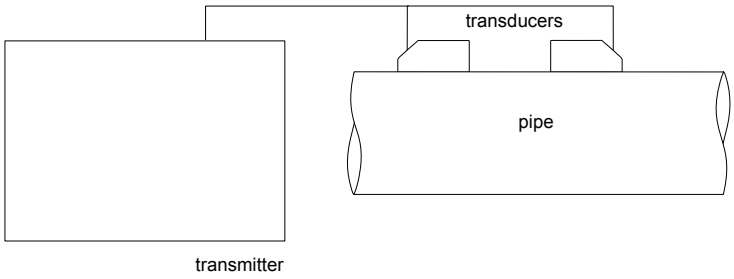



Fig. 3.1: Example of a measurement setup

## 3.2 Measurement Principle

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

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

**Laminar flow**

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

**Turbulent flow**

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

**Transition range**

The flow is partly laminar and partly turbulent.

**Transit time difference Δt**

Difference of the transit times of the signals in and against the flow direction. The flow velocity of the medium in the pipe is determined from the transit time difference (see Fig. 3.2 and Fig. 3.3).

**Sound speed c**

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



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**Flow velocity v**

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

**Acoustic calibration factor $k_a$**

$k_a = c_\alpha / \sin \alpha$

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

$k_a = c_\alpha / \sin \alpha = c_\beta / \sin \beta = c_\gamma / \sin \gamma$

**Volumetric Flow Rate $\dot{V}$**

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

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

**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.

**Mass flow rate $\dot{m}$**

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

The mass of the medium that passes through the pipe per unit time. The mass flow rate is calculated from the product of the volumetric flow rate $\dot{V}$ 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 medium moves, the signals propagating in the medium are displaced with the flow. This displacement causes a reduction in distance for the signal in the flow direction and an increase in distance for the signal against the flow direction in the wedge of the receiving transducer (see Fig. 3.2 and Fig. 3.3). This causes a change in the transit times. The transit time of the signal in the flow direction is shorter than the transit time against the flow direction. This transit time difference is proportional to the average flow velocity.

The flow velocity of the medium is calculated as follows:

$v = k_{Re} \cdot k_a \cdot \Delta t / (2 \cdot t_{fl})$

with

- $v$ - flow velocity of the medium
- $k_{Re}$ - fluid mechanics correction factor
- $k_a$ - acoustic calibration factor
- $\Delta t$ - transit time difference
- $t_{fl}$ - transit time in the medium



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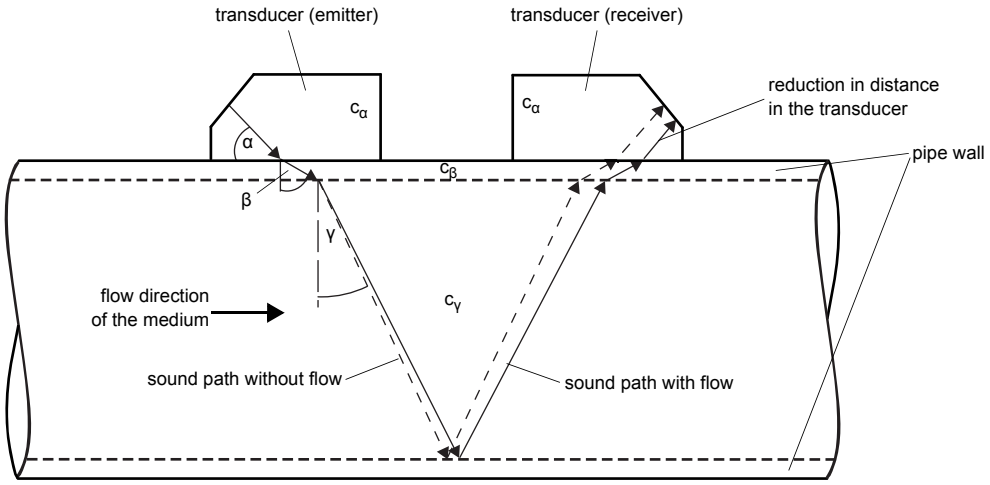



Fig. 3.2: Sound path of the signal in the flow direction

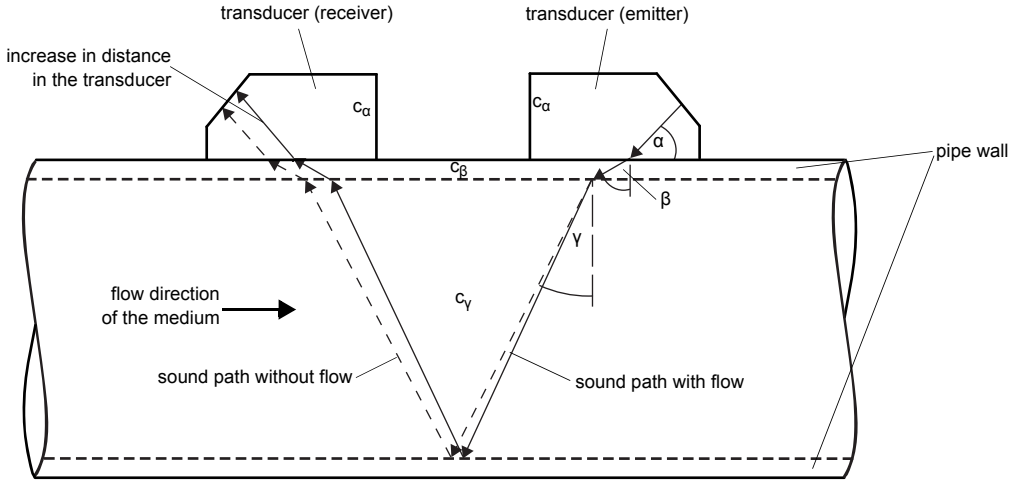



Fig. 3.3: Sound path of the signal against the flow direction

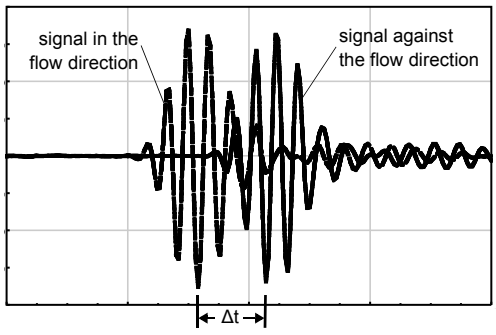



Fig. 3.4: Transit time difference Δt



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## 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).

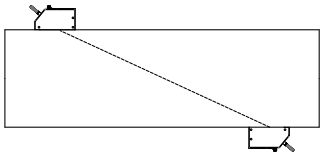


Fig. 3.5: Diagonal arrangement

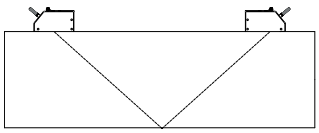


Fig. 3.6: Reflection arrangement

**Number of sound paths**

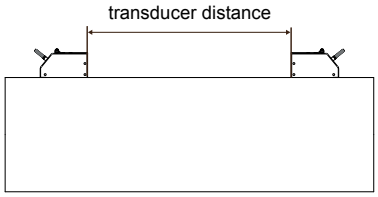
The number of times the ultrasonic signal traverses the liquid before arriving at the receiving transducer. The number of sound paths is:

- 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).

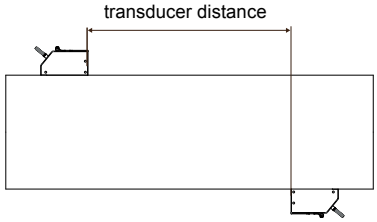
**Transducer distance**

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

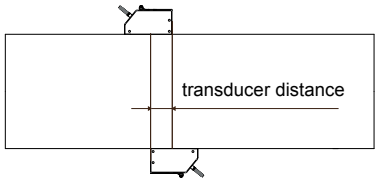
reflection arrangement




diagonal arrangement
(positive transducer distance)




diagonal arrangement
(negative transducer distance)




**Sound plane**

The plane containing the sound paths (see Fig. 3.7).

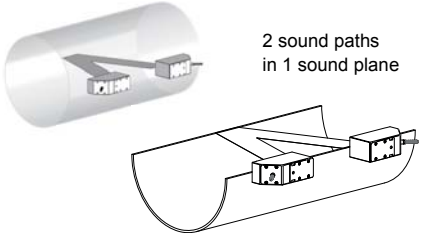
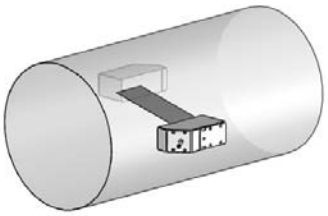
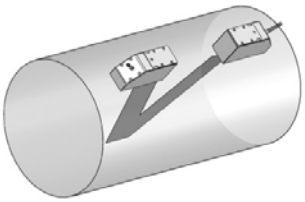



Fig. 3.7: Sound paths in a sound plane



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### 3.3.2 Examples

| Diagonal arrangement | Reflection arrangement |
|---|---|
| 1 transducer pair<br>1 sound path<br> | 1 transducer pair<br>2 sound paths<br> |



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# 4 Description of the Transmitter

The transmitter Portalok 7S has 1 measuring channel.

The cover has to be opened to access the command panel.

| **Attention!** | The degree of protection of the transmitter is only ensured if the cable glands are firmly tightened, the housing is tightly screwed and the cover is closed and latched. |
|---|---|

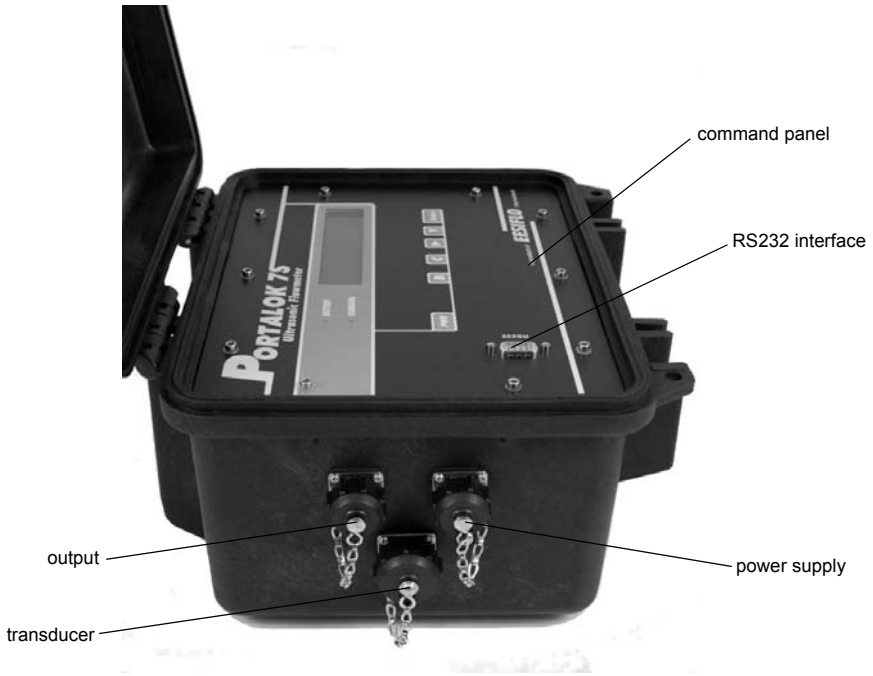



Fig. 4.1: Connections and command panel of the transmitter Portalok 7S




Fig. 4.2: Command panel of the transmitter Portalok 7S



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## 4.1 Keyboard

The keyboard consists of 5 keys.

Tab. 4.1: General functions

| | |
|---|---|
| PWR | switching the transmitter on/off, switching the backlight on/off<br>Press key PWR briefly to switch on the transmitter or to switch on/off the backlight when the transmitter is on. Press key PWR for 3 seconds to switch off the transmitter. |
| ENTER | confirmation of selection or entered value |
| B + C | INIT: Press these two keys while switching on the transmitter to perform an initialization (see section 8.2). |
| B + 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. |
| B | interruption of the measurement and selection of the main menu<br>Be careful not to stop a current measurement by inadvertently pressing key B! |

Tab. 4.2: Navigation

| | |
|---|---|
| ▶ | scrolling to the right or up through a scroll list |
| ▼ | scrolling to the left or down through a scroll list |

Tab. 4.3: Input of digits

| | |
|---|---|
| ▶ | moving the cursor to the right |
| ▼ | scrolling through the digits above the cursor |
| C | Moving the cursor to the left. If the cursor is on the left margin:<br>• an already edited value will be reset to the value which was stored previously<br>• an unedited value will be deleted.<br>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

| | |
|---|---|
| ▶ | moving the cursor to the right |
| ▼ | scrolling through the characters above the cursor |
| C | resetting all characters to the last stored entry |



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# 5 Selection of the Measuring Point

| | |
|---|---|
| **Attention!** | Portalok 7S is must not be used in explosive atmospheres. If the measuring point is within a potentially 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. |

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

A measurement on a pipe is possible if

- the ultrasound propagates with a sufficiently high amplitude (see section 5.1)
- the flow profile is fully developed (see section 5.2)

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

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

- diameter, material, lining, wall thickness and shape of the pipe
- medium
- gas bubbles in the medium

Avoid measuring points in the vicinity of deformations and defects of the pipe and in the vicinity of welds.

Avoid locations with deposit formation in the pipe.

The ambient temperature at the measuring point has to be within the operating temperature range of the transducers.

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.

## 5.1 Acoustic Penetration

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

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

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

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

- the pipe is always filled completely
- no material deposits in the pipe
- no bubbles accumulate

| | |
|---|---|
| **Note!** | Even bubble-free media can form gas bubbles when the medium expands, e.g., before pumps and after large increases of the pipe diameter. |

Observe the notes in the following table.



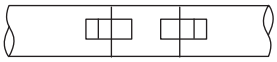
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Tab. 5.1: Recommended transducer position

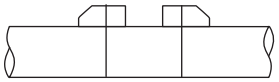
**Horizontal pipe**

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

correct:



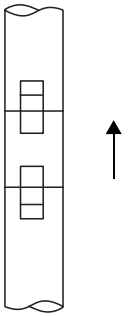
disadvantageous:



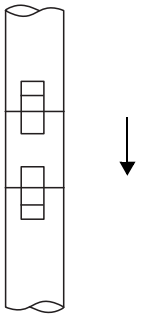
**Vertical pipe**

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

correct:



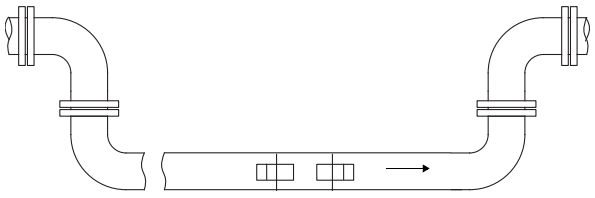
disadvantageous:



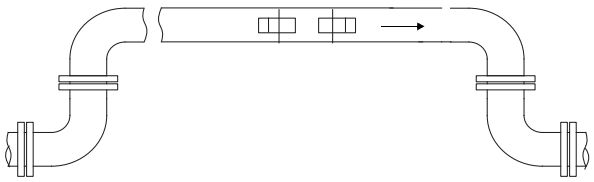
**Free inlet or outlet pipe section:**

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

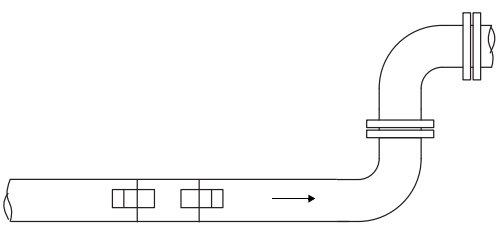
correct:



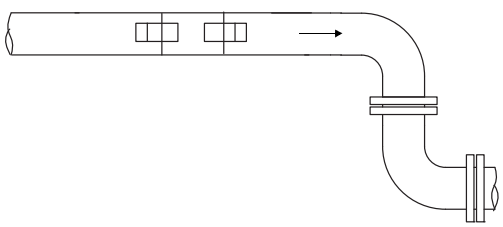
disadvantageous:



correct:



disadvantageous:





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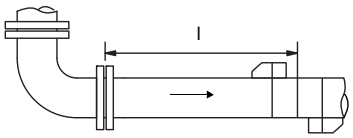
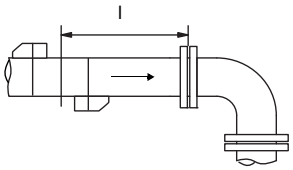
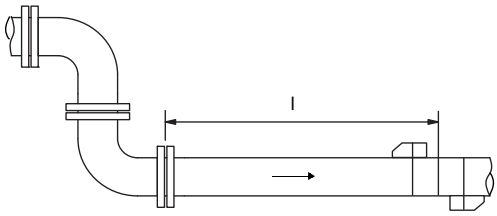
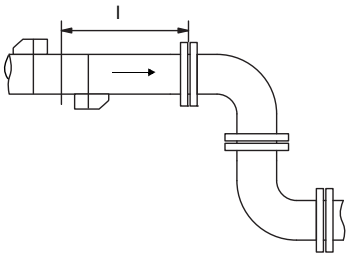
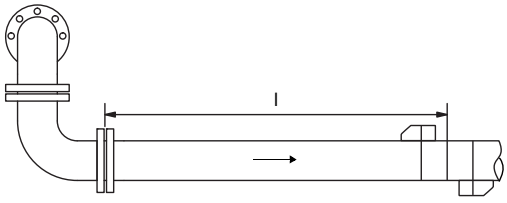
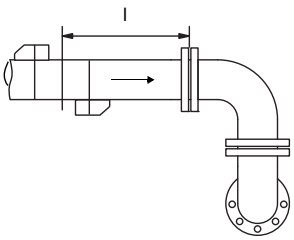
## 5.2 Undisturbed Flow Profile

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.

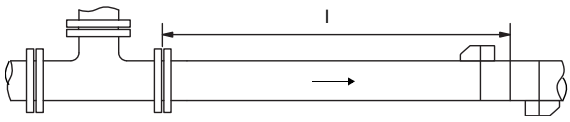
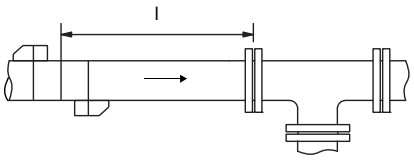
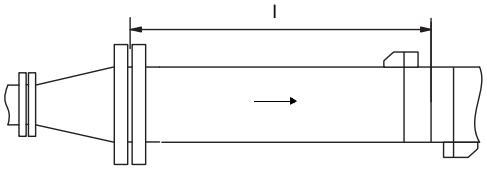
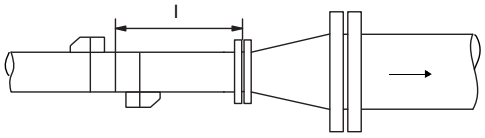
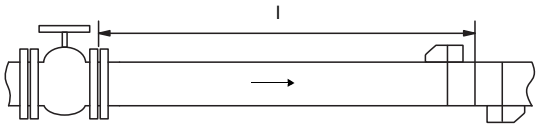
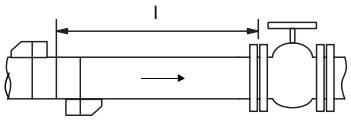
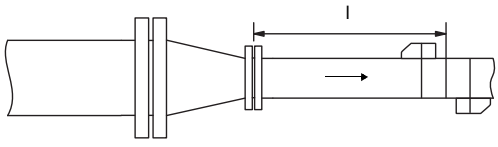
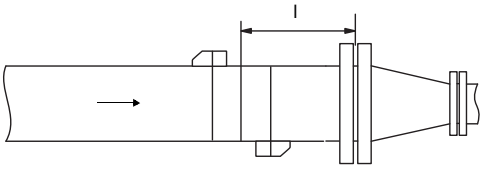
Tab. 5.2: Recommended distance from disturbance sources
D = nominal pipe diameter at the measuring point, l = recommended distance

| | |
|---|---|
| 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 |
|   |   |



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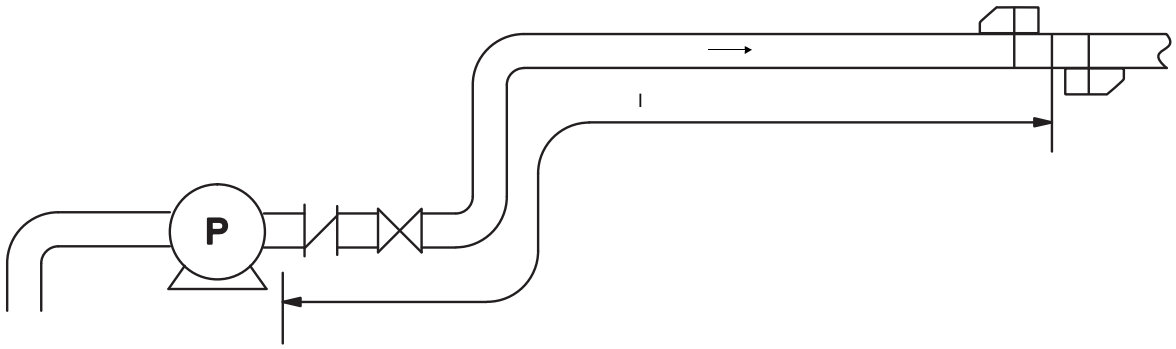
Tab. 5.2: Recommended distance from disturbance sources
D = nominal pipe diameter at the measuring point, l = recommended distance

| | |
|---|---|
| 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 |
|  |  |



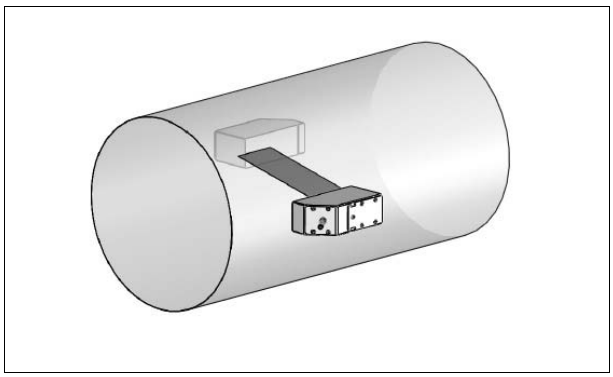
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Tab. 5.2: Recommended distance from disturbance sources
D = nominal pipe diameter at the measuring point, l = recommended distance

| |
|---|
| disturbance source: pump<br>supply line: l ≥ 50 D<br> |

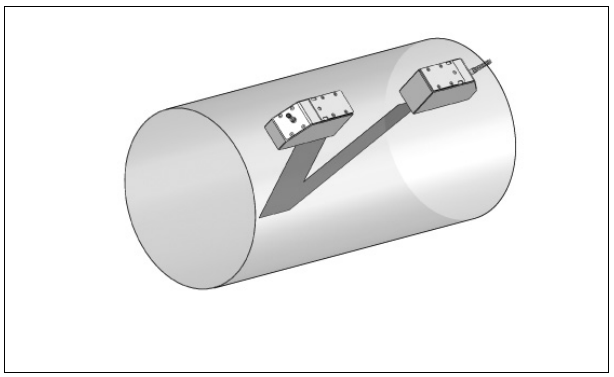
## 5.3 Selection of the Measurement Arrangement Taking onto Account the Measuring Range and the Measuring Conditions

**Diagonal arrangement**



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

**Reflection arrangement**



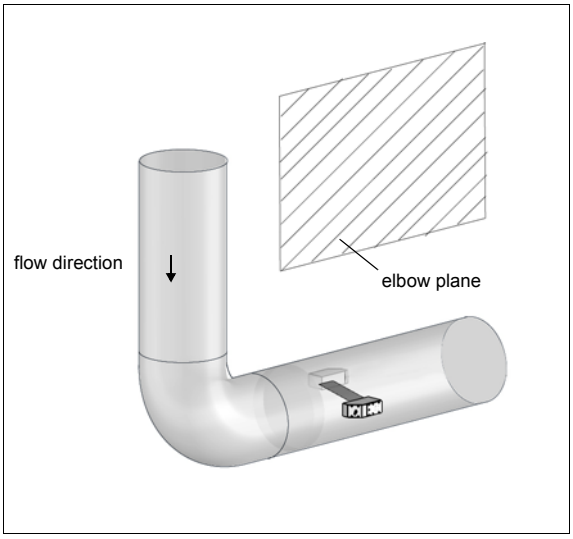
- smaller flow velocity and sound speed range compared to the diagonal arrangement
- transverse flow effects are compensated for because the beam crosses the pipe in 2 directions
- higher accuracy of measurement because the accuracy increases with the number of sound paths



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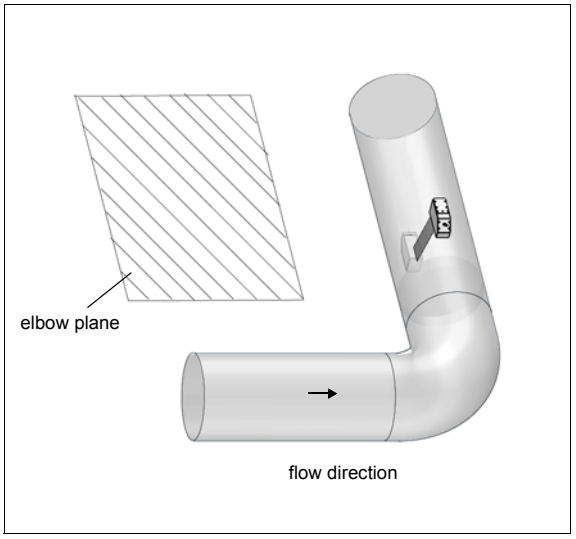
## 5.4 Selection of the Sound Plane Near an Elbow

**On vertical pipes**



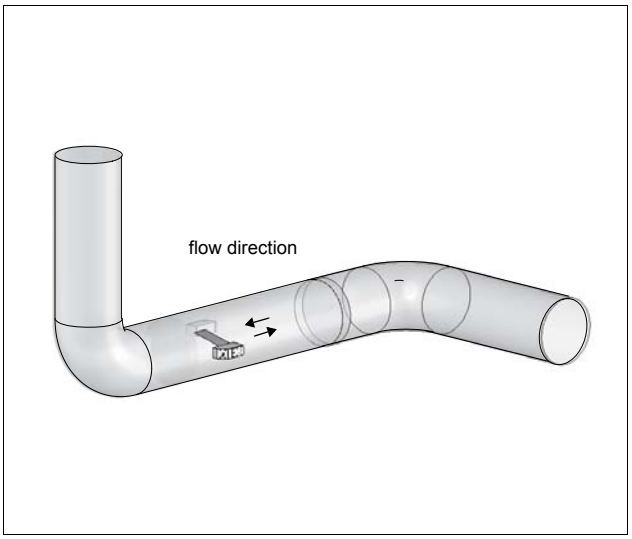

- The sound beam plane (see section 3.3) has an angle of 90° to the elbow plane. The elbow is upstream of the measuring point.

**On horizontal pipes**




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



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# 6 Installation of the Transmitter Portalok 7S

## 6.1 Location

Select the measuring point according to the recommendations in chapter 5. The ambient temperature has to be within the operating temperature range of the transducers.

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.

## 6.2 Connection of the Transducer

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

Connect the transducer to the transmitter (see Fig. 4.1).

## 6.3 Power Supply

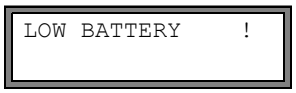
The transmitter can be operated with the battery (see section 6.3.1) or with the power supply unit (see section 6.3.2).

### 6.3.1 Power Supply with the Battery

The transmitter has a Li-Ion battery and can be operated independently of the power supply unit.

At delivery, the battery is charged approx. 30 %. The battery does not need to be fully charged before it is used for the first time.

This message will be displayed if the battery is almost empty:




The capacity is sufficient for the display and storing of the current parameter record. A measurement is no longer possible.

**Charging the battery**

Connect the power supply unit to the transmitter (see Fig. 4.1). Switch on the transmitter. Charging starts automatically. The max. charging time is approx. 8 h.

During the charging process, the ambient temperature should be in the range 0...45 °C (32...113 °F).

A measurement can be made during the charging process. Charging will be stopped automatically when the battery is fully charged.

**Storage of the battery**

The battery remains in the transmitter. After storage, the transmitter can immediately be operated with the battery.

- charge state: > 30 %
- storing temperature: 12...25 °C (54...77 °F)

**State of the battery**

The transmitter Portalok 7S has 2 LEDs which indicate the state of the battery.

The state indicator "BATTERY"

- is off when the battery is charged to > 50 %
- is on when the battery is charged to 20...50 %
- blinks when the battery is charged to < 20 %.

The state indicator "CHARGING"

- is off when the transmitter is not connected to the power supply
- is on when the transmitter is connected to the power supply and the battery is fully charged
- blinks when the transmitter is connected to the power supply and the battery is being charged.

### 6.3.2 Power Supply with the Power Supply Unit

| | |
|---|---|
| **Attention!** | • Use only the power supply unit supplied by EESiFlo.<br>• The power supply unit is not protected against moisture. Use it only in dry rooms.<br>• The voltage indicated on the power supply unit must not be exceeded.<br>• Do not connect a defective power supply unit to the transmitter. |

- Connect the power supply unit to the transmitter (see Fig. 4.1).

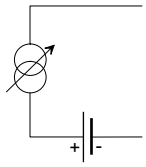
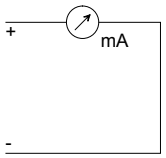
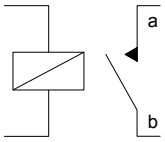


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## 6.4 Connection of the Output

For the connection of the output see Fig. 4.1, Fig. 6.1, Tab. 6.1 and Tab. 6.2.

Tab. 6.1: Circuits of the outputs

| output | transmitter internal circuit | connection | external circuit | remark |
|---|---|---|---|---|
| active current loop |  | see Fig. 6.1 |  | $R_{ext}$ < 500 Ω |
| binary output (Reed relay) |  | see Fig. 6.1 | | $U_{max}$ = 48 V<br>$I_{max}$ = 250 mA |

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

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

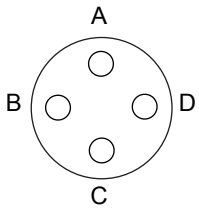



Fig. 6.1: Pin assignment for the connection of the output

Tab. 6.2: Pin assignment for the connection of the output

| pin | connection |
|---|---|
| A (+) | binary output B1 (Reed relay) |
| B (-) | binary output B1 (Reed relay) |
| C (+) | current output I1 |
| D (-) | current output I1 |

## 6.5 Connection of the Serial Interface

Connect the RS232 cable to the transmitter (see Fig. 4.1 and Fig. 4.2) and the serial interface of the PC. If the RS232 cable cannot be connected to the PC, use an RS232/USB adapter.



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# 7 Installation of the Transducers

## 7.1 Preparation of the Pipe

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

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

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

## 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.

The transducer distance is the distance between the inner edges of the transducers (see section 3.3 and Fig. 7.1)

For the determination of the flow direction see section 9.8.

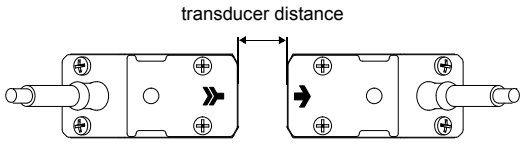



Fig. 7.1: Correct orientation of the transducers and transducer distance

## 7.3 Installation

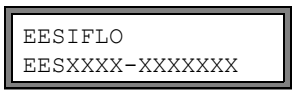
Fix the transducers onto the pipe using the supplied mounting hardware.



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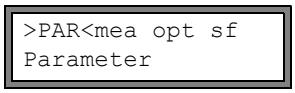
# 8 Start-up of the Transmitter

## 8.1 Switching on




Press key PWR to switch on the transmitter. The serial number of the transmitter is displayed for a short time.

Data cannot be entered while the serial number is displayed.




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

## 8.2 Initialization

During an initialization (INIT) of the transmitter, the settings in the program branches `Parameter` and `Output Options` and some of the settings in the program branch `Special Funct.` are reset to the default settings of EESiFlo.

For INIT-resistant settings, see annex A.

Proceed as follows to execute an initialization:

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




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

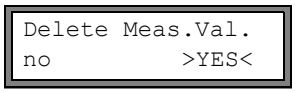
After the initialization, the remaining settings of the transmitter can be reset to the default settings and/or the stored measured values can be deleted.




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

Press ENTER.

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



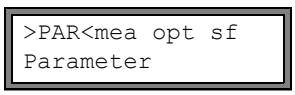

Select `yes` to delete the stored measured values or `no` to keep them stored.

Press ENTER.

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

## 8.3 Display

### 8.3.1 Main Menu




The main menu contains the following program branches:

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

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

Select a program branch by pressing key ▶ or ▼. Press ENTER.

| | |
|---|---|
| **Note!** | By pressing key B, 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 "`\`". |

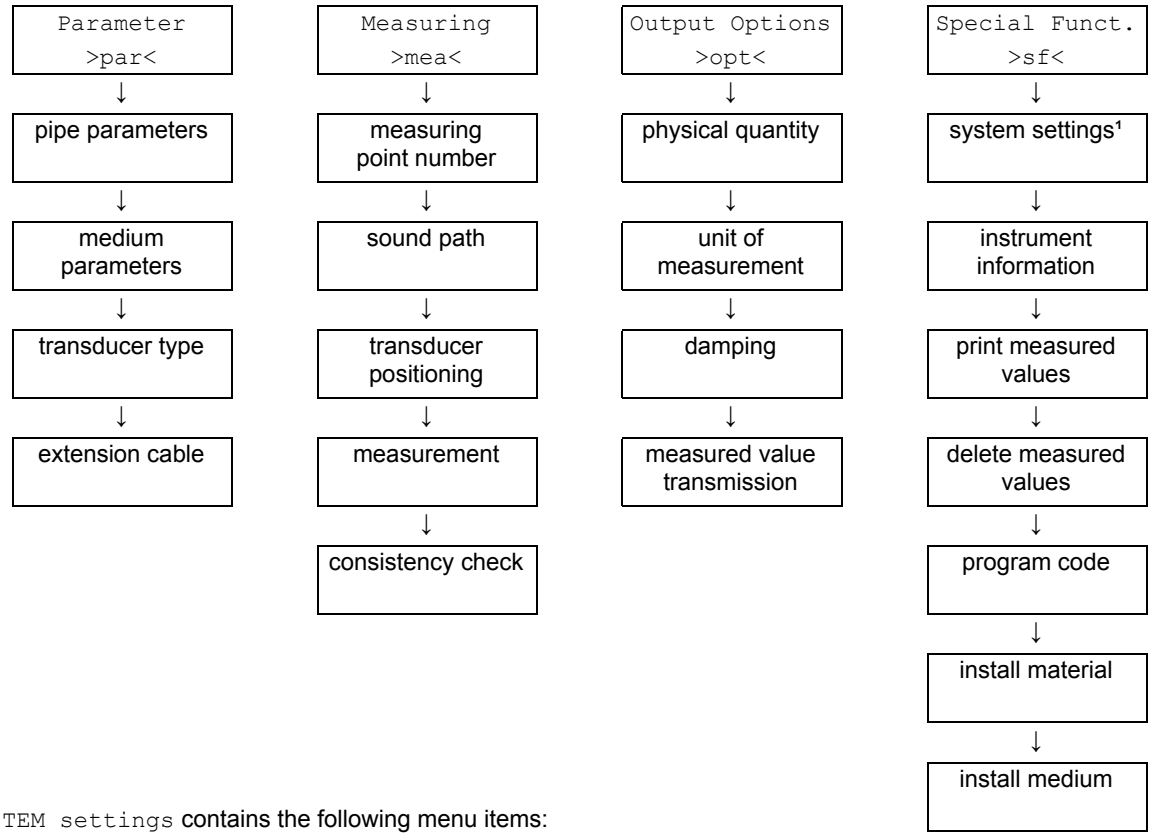


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### 8.3.2 Program Branches

- **Program branch `Parameter`**
  input of the pipe and medium parameters
- **Program branch `Measuring`**
  processing of the steps for the measurement
- **Program branch `Output Options`**
  setting of the physical quantity, the unit of measurement and the parameters for the measured value transmission
- **Program branch `Special Funct.`**
  contains all functions that are not directly related to the measurement

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




¹ `SYSTEM settings` contains the following menu items:

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



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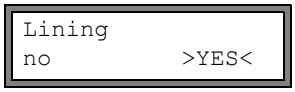
### 8.3.3 Navigation

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.



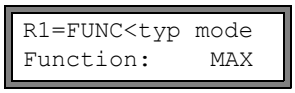

Use key ▼ and ▶ to select a list item in the lower line. Press ENTER.

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 ▼ or ▶ 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.

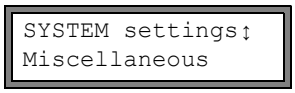



Press key ▶ to scroll through the upper line and select a list item.
Press key ▼ to scroll through the lower line and select a value for the selected list item.
Press ENTER.

## 8.4 HotCodes

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

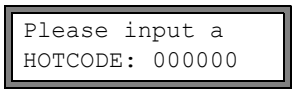
| function | HotCode | see section | deactivation |
|---|---|---|---|
| language selection | **9090xx** | 8.5 | |
| manual input of the lower limit for the inner pipe diameter | **071001** | 11.7 | |
| activation of the SuperUser mode | **071049** | 15.1 | HotCode **071049** |
| change of the transmission parameters of the RS232 interface | **232-0-** | 12.2.4 | |
| resetting the contrast of the display to medium | **555000** | 14.4 | |



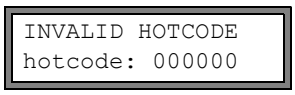

Select `Special Funct.\SYSTEM settings\Miscellaneous`.




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.



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## 8.5 Language Selection

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

Tab. 8.1: HotCodes for language selection

| | |
|---|---|
| **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 EESIFLo is activated.



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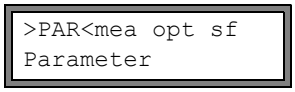
# 9 Basic Measurement

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

| | |
|---|---|
| **Note!** | During the parameter input, the transducers should be connected to the transmitter. |

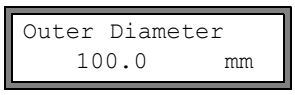
| | |
|---|---|
| **Note!** | The parameters will only be stored when the program branch `Parameter` has been edited in its entirety. |

## 9.1 Input of the Pipe Parameters

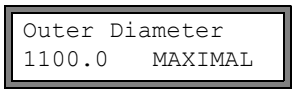



Select the program branch `Parameter`. Press ENTER.

### 9.1.1 Outer Pipe Diameter/Pipe Circumference




Enter the outer pipe diameter. Enter the actual pipe diameter, not the nominal pipe diameter. Press ENTER.



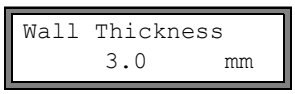

An error message will be displayed if the entered parameter is outside of the range. The limit will be displayed.

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

It is possible to enter the pipe circumference instead of the outer pipe diameter (see section 14.2.1).

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

### 9.1.2 Pipe Wall Thickness

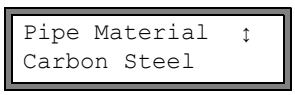



Enter the pipe wall thickness. Press ENTER.

| | |
|---|---|
| **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.<br>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.

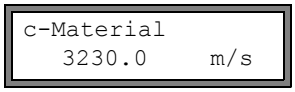



Select the pipe material.

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

It can be specified which materials will be displayed in the scroll list (see section 13.5).

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




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

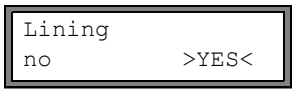
| | |
|---|---|
| **Note!** | Enter the sound speed of the material (i.e. longitudinal or transversal speed) which is nearer to 2500 m/s. |

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



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### 9.1.4 Pipe Lining

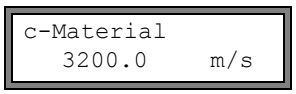



If the pipe has an inner lining, select `yes`. Press ENTER.
If `no` is selected, the next parameter will be displayed (see section 9.1.5).



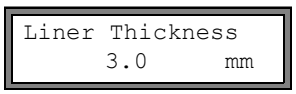

Select the lining material.
If the material is not in the scroll list, select `Other Material`. Press ENTER.

It can be specified which materials will be displayed in the scroll list (see section 13.5).
If `Other Material` is selected, the sound speed has to be entered.




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

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



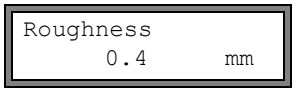

Enter the thickness of the liner. Press ENTER.

| | |
|---|---|
| **Note!** | The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness - 2x liner thickness) is calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed.<br>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

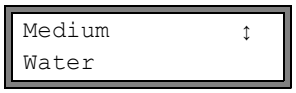
The flow profile of the medium is influenced by the roughness of the inner pipe wall. The roughness is used for the calculation of the profile correction factor. As, in most cases, the pipe roughness cannot be determined exactly, it has to be estimated.

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




Enter the roughness of the selected pipe or liner material.
Change the value according to the condition of the inner pipe wall. Press ENTER.

## 9.2 Input of the Medium Parameters




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

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

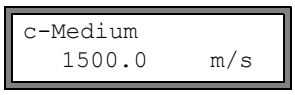
- average sound speed of the medium
- range around the average sound speed of the medium
- kinematic viscosity
- density



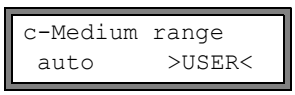
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### 9.2.1 Sound Speed

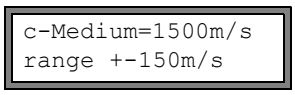
The sound speed of the medium is used for the calculation of the transducer distance at the beginning of the measurement. However, the sound speed does affect the measuring result directly. Often, the exact value of the sound speed for a medium is unknown. Therefore, a range of possible values for the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




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



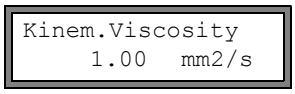

Select `auto` or `user`. Press ENTER.
`auto`: The area around the average sound speed is defined by the transmitter.
`user`: The area around the average sound speed has to be entered.




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

### 9.2.2 Kinematic Viscosity

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

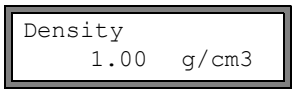



Enter the kinematic viscosity of the medium. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

### 9.2.3 Density

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

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

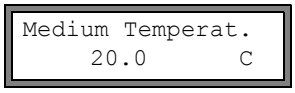



Enter the operating density of the medium. Press ENTER.
This display will only be indicated if `Other Medium` is selected.

### 9.2.4 Medium Temperature

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

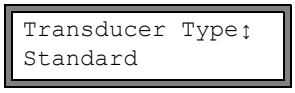
During the measurement, the medium temperature is used for the interpolation of the density and the viscosity of the medium.




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

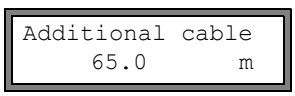
## 9.3 Other Parameters

### 9.3.1 Transducer Parameters




Select `Standard` to use the standard transducer parameters stored in the transmitter.
Press ENTER.
This display will only be indicated if no transducers are connected to the transmitter.

### 9.3.2 Extension Cable

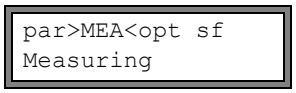



If the transducer cable has to be extended, enter the additional cable length (e.g., between the junction box and the transmitter). Press ENTER.

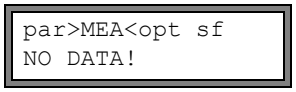


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## 9.4 Defining the Measuring Point Number

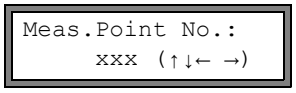



Select program branch `Measuring`. Press ENTER.




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

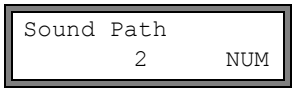
Optional: If the data logger or the serial interface is activated, the measuring point number has to be entered:




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

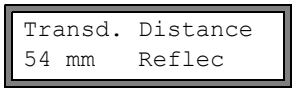



A number of sound paths is recommended according to the connected transducers and the entered parameters. Change the value, if necessary.

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 Fig. 7.1)

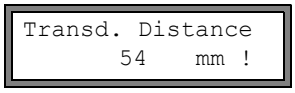
In case of a measurement in diagonal arrangement on very small pipes, a negative transducer distance is possible.

| **Note!** | The accuracy of the recommended transducer distance depends on the accuracy of the entered pipe and medium parameters. |
|---|---|



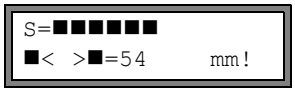
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### 9.6.1 Fine Adjustment of the Transducer Distance



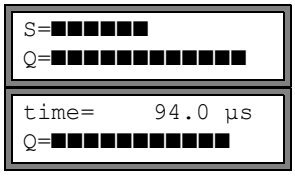

If the displayed transducer distance is adjusted, press ENTER.

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 distance until the bar graph reaches its max. length.

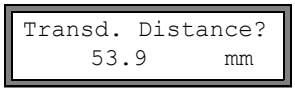



The following quantities can be displayed in the upper line by pressing key ▶ and in the lower line by pressing key ▼:

- ■<>■=: 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.



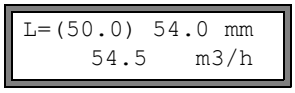

After the precise positioning of the transducers, the recommended transducer distance is displayed again.

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

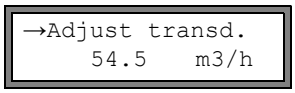
### 9.6.2 Consistency Check

If a wide range for the sound speed has been entered in the program branch Parameter or the exact parameters of the medium 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.




If necessary, scroll in the upper line until →Adjust transd. is displayed. Press ENTER. The amplitude of the received signal S= is displayed again. Press ENTER to adjust the transducer distance.

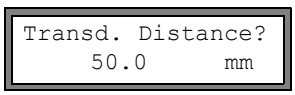
The optimum transducer distance is calculated on the basis of the measured sound speed. It is therefore a better approximation than the first recommended value which had been calculated on the basis of the sound speed range entered in the program branch Parameter.

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.

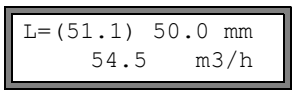
If the difference is greater, adjust the transducer distance to the displayed optimum value. Afterwards, check the signal quality and the signal amplitude bar graph (see section 9.6.1). Press ENTER.

Tab. 9.1: Standard values for signal optimization

| transducer frequency | difference between the optimum and the entered transducer distance [mm] |
|---|---|
| M | 10 |
| P | 10 |




Enter the new adjusted transducer distance. Press ENTER.




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

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



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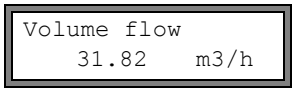
### 9.6.3 Value of the Sound Speed

The sound speed of the medium can be displayed during the measurement by pressing key [▼] .

If an approximate range for the sound speed has been entered in the program branch `Parameter` and the transducer distance has been optimized afterwards as described in section 9.6.2, it is recommended to write down the sound speed for the next measurement. By doing this, it will not be necessary to repeat the fine adjustment.

Also write down the medium temperature because the sound speed depends on the temperature. The value can be entered in the program branch `Parameter` or a user defined medium can be created for this sound speed (see section 13.2 and 13.3).

## 9.7 Start of the Measurement




The measured values are displayed in the lower line.

If necessary, scroll in the upper line until →`Adjust transd.` is displayed and 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 measuring channel. The results are displayed according to the currently selected output options. The default unit of measurement of the volumetric flow rate is m³/h. For the selection of the values to be displayed and for the setting of the output options see chapter 10. For further measuring functions see chapter 11.

## 9.8 Detection of the Flow Direction

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

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

## 9.9 Interruption of the Measurement

The measurement is interrupted by pressing key B 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 B! |
|---|---|



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# 10 Displaying the Measured Values

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

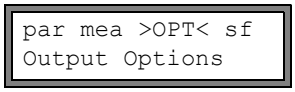
During the measurement, the designation of the physical quantity is displayed in the upper line, the measured value in the lower line. The display can be adapted (see section 10.2).

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

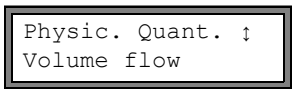
The following physical quantities can be measured:

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

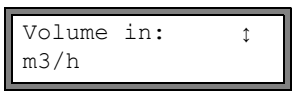
The physical quantity is selected as follows:




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




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




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

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

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

| | |
|---|---|
| **Note!** | If the physical quantity or the unit of measurement is changed, the settings of the outputs will have to be checked (see chapter 16). |

## 10.2 Adjustment of the Display

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

The following information can be displayed in the upper line:

| display | explanation |
|---|---|
| `Mass Flow=` | designation of the physical quantity |
| `+8.879 m3` | values of the totalizers |
| `full=` | date and time at which the data logger will be full, if activated |
| `Mode=` | measuring mode |
| `L=` | transducer distance |
| `Rx=` | alarm state indication if it is activated (see section 16.6.5) and if alarm outputs are activated (see section 16.6). |
| | status line (see section 10.3) |

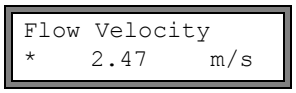
The measured values of the physical quantity selected in the program branch `Output Options` can be displayed in the lower line:

| 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 |



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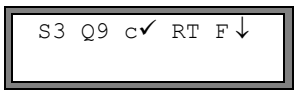
Press key ▶ during the measurement to change the display in the upper line, press key ▼ to change the display in the lower line.




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.



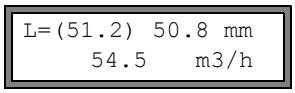

Press key ▶ during the measurement to scroll through the upper line to the status line.

| | value | explanation |
|---|---|---|
| S | | signal amplitude |
| | 0 | < 5 % |
| | … | … |
| | 9 | ≥ 90 % |
| Q | | **signal quality** |
| | 0 | < 5 % |
| | … | … |
| | 9 | ≥ 90 % |
| c | | **sound speed**<br>comparison of the measured and the expected sound speed of the medium. The expected sound speed is calculated on the basis of the medium parameters (medium 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**<br>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**<br>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 |



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## 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! |
|---|---|



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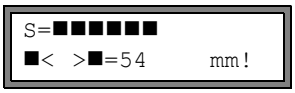
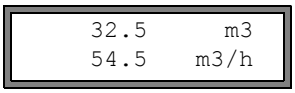
# 11 Advanced Measuring Functions

## 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

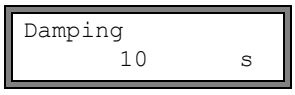
| command | explanation |
|---|---|
| →Adjust transd. |  Select transducer positioning. If a program code is active, the measurement will be continued 8 s after the last keyboard entry. |
| →Clear totalizer |  All totalizers will be reset to zero. |
| →Break measure | Stop the measurement and return 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.




Enter the damping factor. Press ENTER.

Press B to return to the main menu.

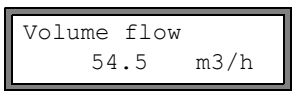
## 11.3 Totalizers

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

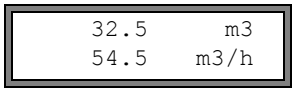
There are two totalizers, one for the positive flow direction, one for the negative flow direction.

The unit of measurement used for totalizing corresponds to the 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 definition of the number of decimal .

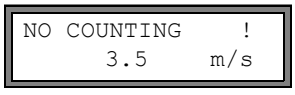



Press key [▶] to scroll through the upper line to the display of the totalizers.




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

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



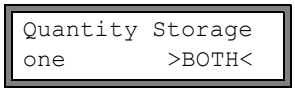

This error message will be displayed if the totalizers are to be activated. The flow velocity cannot be totalized.



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**Selection of the totalizers for storing**

It is possible to store the totalizer for one flow direction or the totalizers for both flow directions. Select `Special Funct.\SYSTEM settings\Storing\Quantity Storage`.



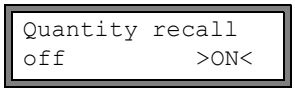

If `one` is selected, only the totalizer whose value is changing will be stored. This can apply to the totalizer for the positive or the negative flow direction.

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:

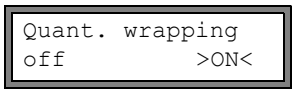
**Without overflow:**

- 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.

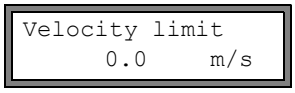
| | |
|---|---|
| **Note!** | The overflow of a totalizer influences all output channels, e.g., data logger, online transmission of data.<br>The transmission of the sum of both totalizers (the throughput ΣQ) via an output will not be valid after the first overflow (wrapping) of one of the corresponding totalizers.<br>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 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". |

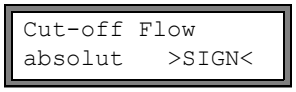


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## 11.5 Cut-off Flow

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

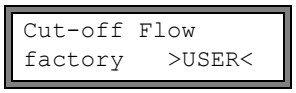
The cut-off flow can depend on the flow direction or not. The cut-off flow is set in `Special Funct.\SYSTEM settings\Measuring\Cut-off Flow`.




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

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

Press ENTER.

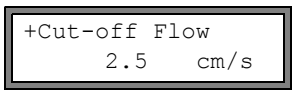



Select `factory` to use the default limit of 2.5 cm/s (0.025 m/s) for the cut-off flow.

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

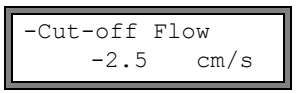
Press ENTER.

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




Enter the cut-off flow. Press ENTER.

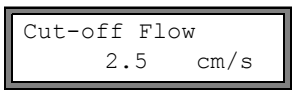
All positive values of the flow velocity that are lower than this limit will be set to zero.




Enter the cut-off flow. Press ENTER.

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

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



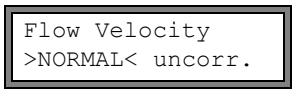

Enter the cut-off flow. Press ENTER.

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

## 11.6 Uncorrected Flow Velocity

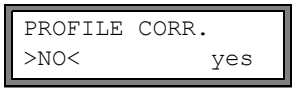
For special applications, the uncorrected flow velocity might be of interest.

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

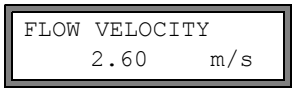



Select `normal` to display and transmit the flow velocity with profile correction.

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




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

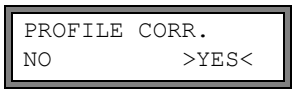



If `no` is selected, the profile correction will be switched off.

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

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

Press ENTER.

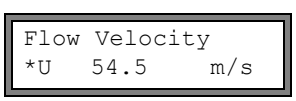



If `yes` is selected, the uncorrected flow velocity will only be used if the flow velocity is selected as the physical quantity in the program branch `Output Options`.

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

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

Press ENTER.




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

Press key [▼] to scroll until the flow velocity is displayed. The uncorrected flow velocity is marked with `U`.

Uncorrected flow velocities transmitted to a PC are marked with `uncorr.`

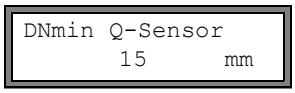


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## 11.7 Change of the Limit for the Inner Pipe Diameter

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

Enter HotCode **071001**.




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

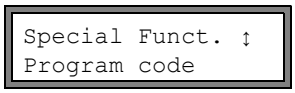
| **Note!** | If a transducer is used below its recommended inner pipe diameter, a measurement might be impossible. |
|---|---|

## 11.8 Program Code

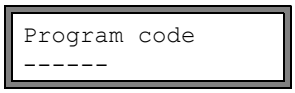
An ongoing measurement can be protected from an inadvertent intervention by means of a program code.

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

### 11.8.1 Defining a Program Code




Select `Special Funct.\Program code`.




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




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

A program code will remain valid as long as:

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

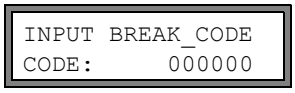
| **Note!** | Do not forget the program code! |
|---|---|

### 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 B 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:**

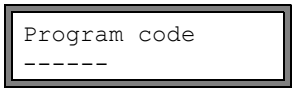



To execute a command, it is sufficient to enter the first three digits of the program code (= access code).

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.



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# 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:

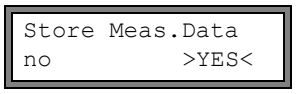
- date
- time
- measuring point number
- pipe parameters
- medium parameters
- transducer data
- sound path (reflection or diagonal arrangement)
- transducer distance
- damping factor
- storage rate
- physical quantity
- unit of measurement
- measured values (physical quantity and input quantities)
-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

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

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

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

### 12.1.1 Activation/Deactivation of the Data Logger



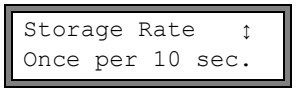

Select program branch `Output Options`. Press ENTER until the menu item `Store Meas.Data` is displayed.

Select `yes` to activate the data logger. Press ENTER.

### 12.1.2 Setting the Storage Rate

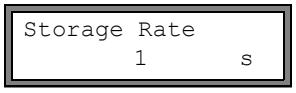
The storage rate is the frequency at which the measured values are transmitted or stored.

If the storage rate is not set, the storage rate which was selected previously will be used. Min. 4 s is 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:

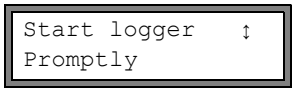
- start of the storing
- ringbuffer
- storage mode
- storing of the totalizers
- storing of the signal amplitude
- storing of the sound speed
- acoustic signal during the storing



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### 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.

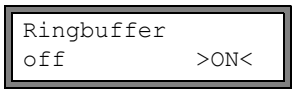
`Promptly`: Storing will be started immediately.
`On full 5 min.`: Storing will be started on the next full 5 minutes.
`On full 10 min.`: Storing will be started on the next full 10 minutes.
`On quarter hour`: Storing will be started on the next full 15 minutes.
`On half hour`: Storing will be started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

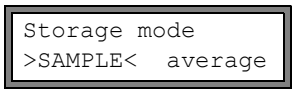
The setting of ringbuffer affects the storing of measured values as soon as the data memory is full:

- 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 will be calculated.

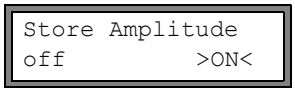
If the storage rate < 5 s (see section 12.1.2) is selected, `sample` will be used.

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

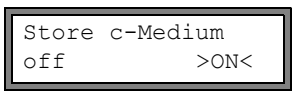
see section 11.3

### Storing of the signal amplitude



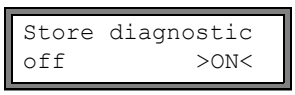

If `on` is selected and the data logger is activated, the amplitude of the measured signal will be stored together with the measured values. Press ENTER.

### Storing of the sound speed




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

### Storing of the diagnostic values



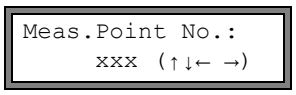

If `on` is selected and the data logger is activated, the diagnostic values will be stored together with the measured values. Press ENTER.



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### 12.1.4 Measurement with Activated Data Logger

- Start the measurement.

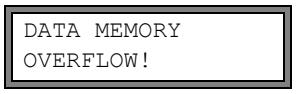



Enter the measuring point number. Press ENTER.

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

For the setting of the input mode see section 14.2.2.

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.

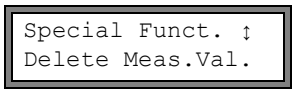



Press ENTER.

The error message will be displayed periodically.

The storing will be stopped.

### 12.1.5 Deleting the Measured Values



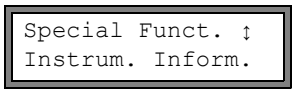

Select `Special Funct.\Delete Meas.Val.` Press ENTER.



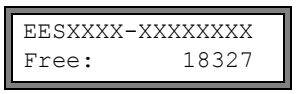

Select `yes` or `no`. Press ENTER.

### 12.1.6 Available Data Logger Memory

If the data logger is empty and a measurement is started with one physical quantity 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.

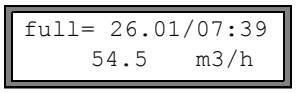



The type and the serial number of the transmitter will be displayed in the upper line.

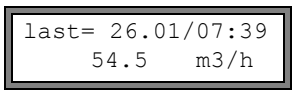
The available data logger memory will be displayed in the lower line (here: 18 327 additional measured values can be stored). Press key B twice to return to the main menu.

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 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.



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## 12.2 Transmission of Data

The measured values can be transmitted to a PC via the serial interface RS232.

### 12.2.1 Online Transmission of Data

The measured values are transmitted during the measurement. If the data logger is activated, the measured values will also be stored.

Tab. 12.1: Overview online transmission of data

| serial interface | transmission of data | see |
|---|---|---|
| RS232 | terminal program | section 12.2.5 |

### 12.2.2 Offline Transmission of Data

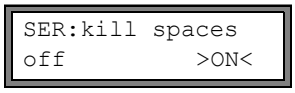
The measurement data of the data logger are transmitted.

Tab. 12.2: Overview offline transmission of data

| serial interface | transmission of data | see |
|---|---|---|
| RS232 | terminal program | section 12.2.6 |

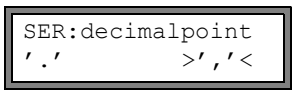
### 12.2.3 Format of the Measurement Data

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



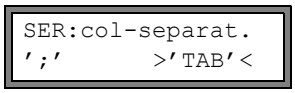

Select `on` if the space characters are not to be transmitted. Press ENTER.

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




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

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




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

### 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-** (see section 8.4).




Set the transmission parameters in the 4 scroll lists. Press EN-TER.

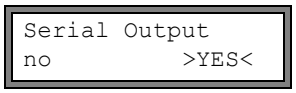
- `baud`: baud rate
- `data`: number of data bits
- `par`: parity
- `st`: number of stop bits

### 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 of the transmitter have to be identical.
- Select the program branch `Output Options`. Press ENTER.
- Press ENTER until the menu item `Serial Output` is displayed.

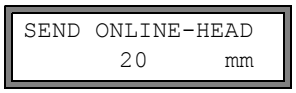


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Select `yes` to activate the online transmission of data.

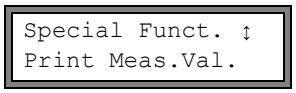
- Set the storage rate (see section 12.1.2).
- Start the measurement. The measuring point number will be requested (see section 12.1.4).




The measured values are transmitted during the measurement.

### 12.2.6 Offline Transmission of Data to a Terminal Program

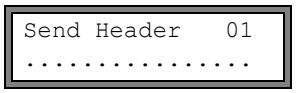
- Start the terminal program.
- Enter the transmission parameters into the terminal program (see section 12.2.4). The transmission parameters of the terminal program and of the transmitter have to be identical.



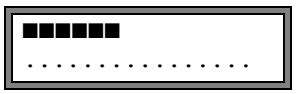

Select `Special Funct.\Print Meas.Val.`. Press ENTER.




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




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




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




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

### 12.2.7 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.

**Example:**

```
\DEVICE             : EESXXXX8X27-XXXXXXXX
\MODE               : ONLINE
DATE                : 2011-01-09
TIME                : 19:56:52
Par.Record
Meas.Point No.:     : 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     : 11.00 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
```



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The line \DATA will be transmitted next. Afterwards the column titles will be transmitted (see Tab. 12.3) The measured values are transmitted afterwards.

**Example:**

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

In every storage interval, one data line 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 restarted 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 medium |
| 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.



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# 13 Libraries

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

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

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

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

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

## 13.1 Partitioning of the Coefficient Memory

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

- material parameters:
  - transversal and longitudinal sound speed
  - typical roughness
- medium parameters:
  - min. and max. sound speed
  - kinematic viscosity
  - density

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

Tab. 13.1: Capacity of the coefficient memory

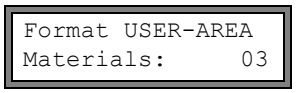
| | max. number of data sets | occupancy of the coefficient memory in % |
|---|---|---|
| materials | 13 | 97 |
| media | 13 | 97 |




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



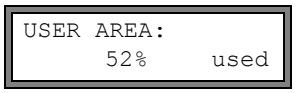

This error message will be displayed if the entered number of data sets for a category of material data exceeds the capacity of the coefficient memory.



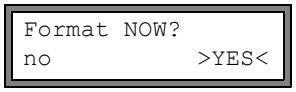

Enter the number of the user defined materials. Press ENTER.




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




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




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




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




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



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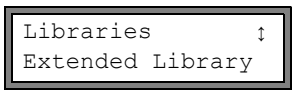
### 13.1.1 Data Retention During the Partitioning of the Coefficient Memory

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

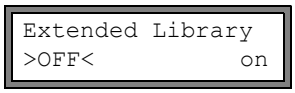
| | |
|---|---|
| **Example 1:** | The number of user defined materials is reduced from 5 to 3. The data sets #01 to #03 are retained. The data sets #04 and #05 are deleted. |
| **Example 2:** | The number of user defined materials is increased from 5 to 6. All 5 data sets are kept. |

## 13.2 Input of Material/Medium Parameters Without the Extended Library

To enter the material/medium parameters as constants, the extended library has to be deactivated.



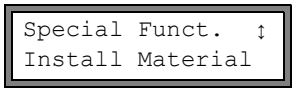

Select `Special Funct.\SYSTEM settings\Libraries\Extended Library`. Press ENTER.



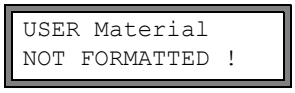

Select `off` to deactivate the extended library. Press ENTER.

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

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




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

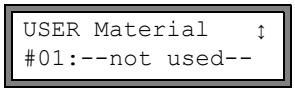



This error message will be displayed if the coefficient memory does not contain an area for user defined materials/media.

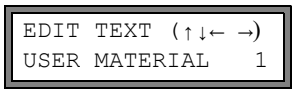
Partition the coefficient memory accordingly (see section 13.1).




Select `edit`. Press ENTER.




Select a user defined material/medium. Press ENTER.

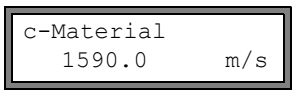



Change the designation of the material/medium.

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

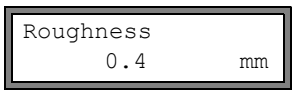
| | |
|---|---|
| **Note!** | 95 ASCII characters (letters, capital letters, numbers, special characters [!? " + - ( ) > < % * etc.]) are available for the designation of materials/media.<br>A designation can have max. 16 characters. The input of text is described in section 4.1. |

**Material parameters**




Enter the sound speed of the material. Press ENTER.

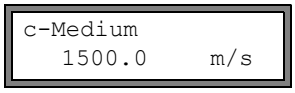
For the sound speed of some materials annex C.1.




Enter the roughness of the material. Press ENTER.

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

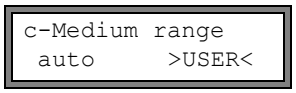
**Medium parameters**




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



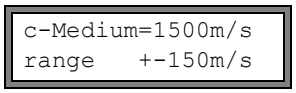
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Select `auto` or `user`. Press ENTER.

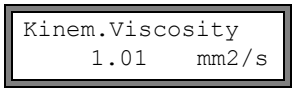
`auto`: The area around the average sound speed is defined by the transmitter.

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

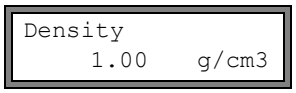



Enter the area around the average sound speed of the medium. Press ENTER.

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




Enter the kinematic viscosity of the medium. Press ENTER.




Enter the density of the medium. Press ENTER.

## 13.3 Extended Library

### 13.3.1 Introduction

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

Tab. 13.2: Material and medium parameters that can be stored

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

Enter only the parameters needed for the measuring task.

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

- as constants
- as linear function
- with polynomials of grade 1 to 4
- with customized interpolation functions

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

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

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

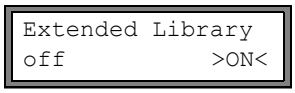
#### Customized interpolation functions

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



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### 13.3.2 Activation of the Extended Library



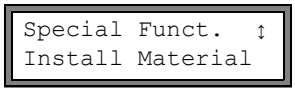

Select `Special Funct.\SYSTEM settings\Libraries\Extended Library`. Press ENTER.

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

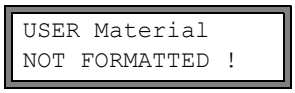
### 13.3.3 Input of Material/Medium Parameters

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

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

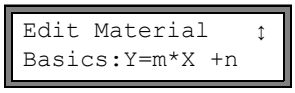



Select `Special Funct.\Install Material` or `Install Medium`. Press ENTER.




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

Partition the coefficient memory accordingly (see section 13.1).




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

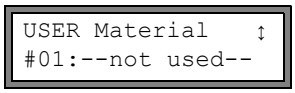
`Y=const.`: constants

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

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

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

`go back`: return to the previous menu item

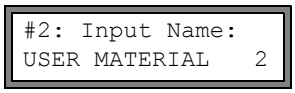



Select a user defined material/medium.




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

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




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

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

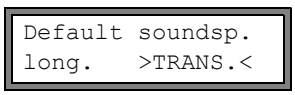
**Material parameters**

Enter the material's:

- transversal sound speed
- longitudinal sound speed

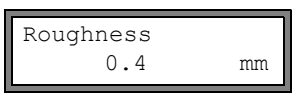
1...5 values depending on the selected function have to be entered. Press ENTER after each input.

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

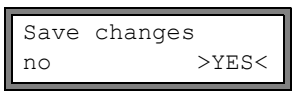



Select the type of sound wave to be used for the flow measurement. Press ENTER.

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




Enter the typical roughness of the material. Press ENTER.




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



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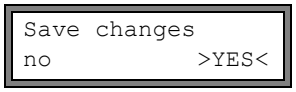
**Medium parameters**

Enter the medium's:

- longitudinal sound speed
- kinematic viscosity
- density

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

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



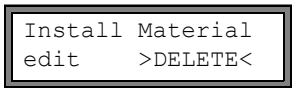

Select `yes` to store the entered parameters, `no` to quit the menu item without storing. Press ENTER.

## 13.4 Deleting a User Defined Material/Medium

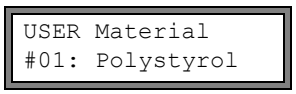
To delete a user defined material/medium, proceed as follows:

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

If the extended library is activated, press ENTER until the request for deleting is displayed.




Select `delete`. Press ENTER.




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

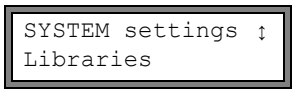



Select `yes` or `no`. Press ENTER.

## 13.5 Arrangement of the Material/Medium Scroll List

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

| | |
|---|---|
| **Note!** | User defined materials/media will always be displayed in the scroll lists of the program branch `Parameter`. |

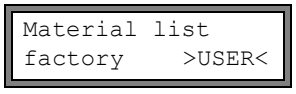



Select `Special Funct.\SYSTEM settings\Libraries`. Press ENTER.




Select `Material list` to edit the material scroll list or `Medium list` to edit the medium scroll list.

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




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

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




If `user` has been selected, the material or medium scroll list can be edited (see section 13.5.1...13.5.3).




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




Select `yes` to store all changes of the scroll list or `no` to quit the menu item without storing. Press ENTER.

| | |
|---|---|
| **Note!** | If the material/medium scroll list is quit by pressing key B before storing, all changes will be lost. |

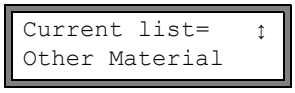


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### 13.5.1 Displaying a Scroll List



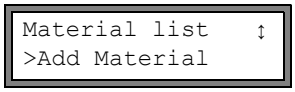

Select `Show list`. Press ENTER to display the scroll list as in the program branch `Parameter`.



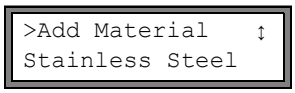

The current scroll list is displayed in the lower line.

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

### 13.5.2 Adding a Material/Medium to the Scroll List




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

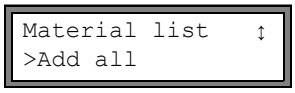



All materials/media that are not contained in the current scroll list will be displayed in the lower line.

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

| **Note!** | The materials/media are displayed in the order in which they have been added. |
|---|---|

### 13.5.3 Adding all Materials/Media to the Scroll List

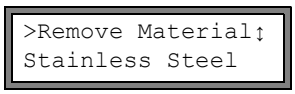



Select `Add all` to add all materials/media of the database to the current scroll list. Press ENTER.

### 13.5.4 Removing a Material/Medium from the Scroll List




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

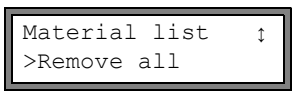



All materials/media of the current scroll list will be displayed in the lower line.

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

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

### 13.5.5 Removing all Materials/Media from the Scroll List




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



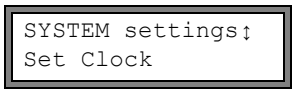
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# 14 Settings

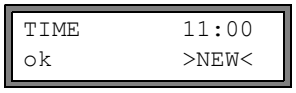
## 14.1 Time and Date

The transmitter has a battery-powered clock.

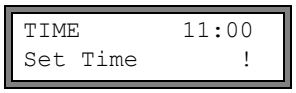
### 14.1.1 Time



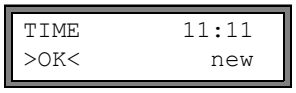

Select `Special Funct.\SYSTEM settings\Set Clock`. Press ENTER.




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



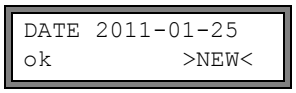

Press key ▶ to select the digit to be edited.
Press key ▼ and C to edit the selected digit. Press ENTER.




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

### 14.1.2 Date

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




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




Press key ▶ to select the digit to be edited.
Press key ▼ and C to edit the selected digit. Press ENTER.




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

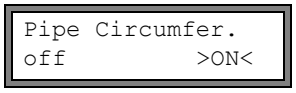
## 14.2 Dialogs and Menus



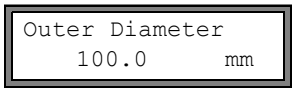

Select `Special Funct.\SYSTEM settings\Dialogs/Menus`. Press ENTER.

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

### 14.2.1 Pipe Circumference

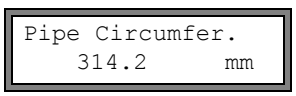



Select `on` if the pipe circumference is to be entered instead of the pipe diameter in the program branch `Parameter`. Press ENTER.



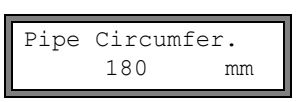

If `on` has been selected for `Pipe Circumfer.`, the outer pipe diameter will nevertheless be requested in the program branch `Parameter`.

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




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

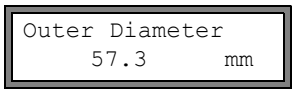
example: 100 mm · π = 314.2 mm




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



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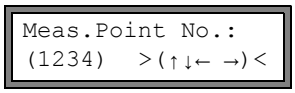

During the next scroll through the program branch `Parameter`, the outer pipe diameter that corresponds to the entered pipe circumference will be displayed.

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<br>displayed outer pipe diameter: 31.8 mm<br>When the transmitter switches back to the display of the pipe circumference, 99.9 mm will be displayed. |
|---|---|

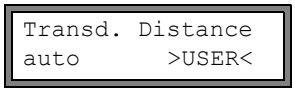
### 14.2.2 Measuring Point Number




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

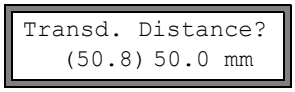
Select `(↑↓← →)` if the measuring point is to be designated with ASCII characters.

### 14.2.3 Transducer Distance

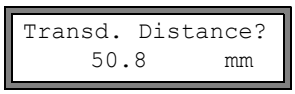



recommended setting: `user`

- `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.

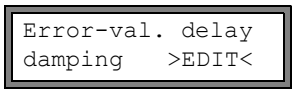



During transducer positioning in the program branch `Measuring`

- 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.

### 14.2.4 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 16.1.2 and 16.2.

### 14.2.5 Alarm State Indication

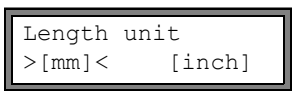



Select `on` to display the alarm state during the measurement.

Fur further information on the alarm outputs see section 16.5.

### 14.2.6 Units of Measurement

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



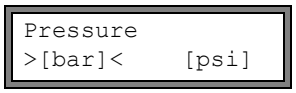

Select `mm` or `inch` as the unit of measurement for the length. Press ENTER.



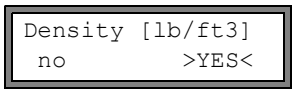

Select `°C` or `°F` as the unit of measurement for the temperature. Press ENTER.



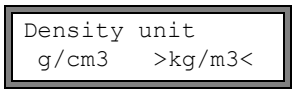
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Select bar or psi as the unit of measurement for the pressure. Press ENTER.

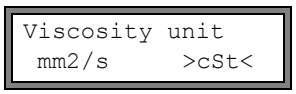



Select yes if lb/ft3 is to be used as the unit of measurement for the density. Press ENTER.

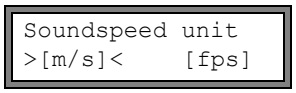



Select g/cm3 or kg/m3 as the unit of measurement for the density. Press ENTER.

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



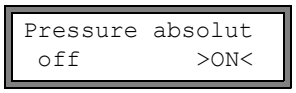

Select mm2/s or cSt as the unit of measurement for the kinematic viscosity. Press ENTER.




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

### 14.2.7 Setting for the Medium Pressure

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

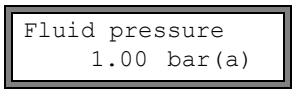



Select on or off. Press ENTER.

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

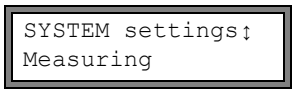



The pressure and its unit of measurement will, e.g., be displayed in the program branch Parameter. It will be followed by the selected pressure, indicated in parentheses.

a - absolute pressure
g - relative pressure

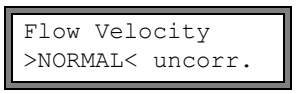
| **Note!** | All changes will be stored at the end of the dialog. |
|---|---|

## 14.3 Measurement Settings



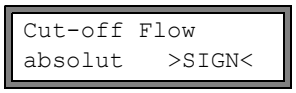

Select Special Funct.\SYSTEM settings\Measuring. Press ENTER.

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



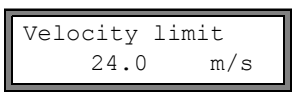

Select normal to display and transmit the profile corrected flow values, uncorr. to display and transmit the flow values without flow profile correction. Press ENTER.

Fur further information see section 11.6.



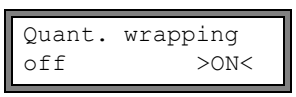

A lower limit for the flow velocity can be entered (see section 11.5).




An upper limit for the flow velocity can be entered (see section 11.4).

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




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



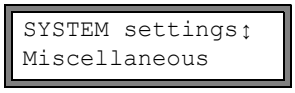
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Select `on` to keep the previous totalizer values after a restart of the measurement.
Select `off` to reset the totalizers to zero after a restart of the measurement.

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

## 14.4 Setting the Contrast




Select `Special Funct.\SYSTEM settings\Miscellaneous` to set the contrast of the display of the transmitter. Press ENTER until the menu item `SETUP DISPLAY` is displayed.

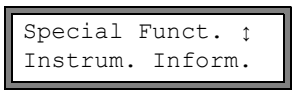



The contrast of the display is adjusted with the following keys:
→ increases the contrast
↓ reduces the contrast

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

| **Note!** | After an initialization of the transmitter, the display is displayed to medium contrast. |
|---|---|

## 14.5 Instrument Information




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




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



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# 15 SuperUser Mode

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

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

| | |
|---|---|
| **Attention!** | The SuperUser mode is intended for experienced users with advanced application knowledge. The parameters can affect the normal measuring mode and lead to wrong measuring values or to a failure of the measurement when a new measuring point is set up. |

## 15.1 Activation/Deactivation

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.

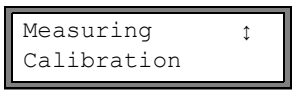



It is displayed that the SuperUser mode is deactivated. Press ENTER. The main menu will be displayed.

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

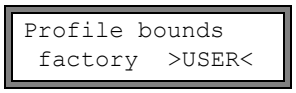
## 15.2 Defining the Flow Parameters

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.



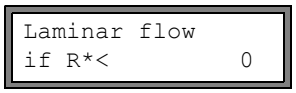

Select `Special Funct.\SYSTEM settings\Measuring\Calibration`. Press ENTER.

### 15.2.1 Profile Bounds



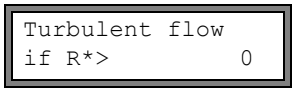

Select `user` if the profile bounds are to be defined. If `factory` is selected, the default profile bounds will be used and the menu item `Calibration` will be displayed (see section 15.2.2).

Press ENTER.



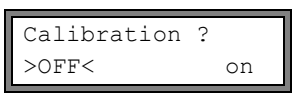

Enter the max. Reynolds number at which the flow is laminar. The entered number will be rounded to the hundreds. Enter `0` (zero) to use the default value 1 000.

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 15.2.2.



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| | |
|---|---|
| **Example:** | profile bound for the laminar flow: 1 500<br>profile bound for the turbulent flow: 2 500<br>At Reynolds numbers < 1 500, the flow during the measurement is regarded as laminar for the calculation of the physical quantity. At Reynolds numbers > 2 500, the flow is regarded as turbulent. The range 1 500...2 500 is the transition range between laminar and turbulent flow. |

| | |
|---|---|
| **Attention!** | The defined profile bounds are still active after the deactivation of the SuperUser mode. |

### 15.2.2 Correction of the Flow Velocity

After the profile bounds have been defined (see section 15.2.1), it is possible to define a correction of the flow velocity.

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

with

v - measured flow velocity

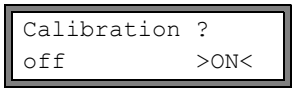
m - slope, range: -2.000...+2.000

n - offset, range: -12.7...+12.7 cm/s

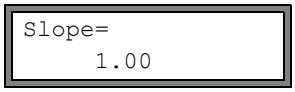
$v_{cor}$ - corrected flow velocity

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. |

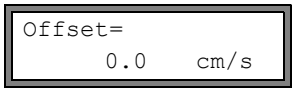



Select `on` to define the correction data, `off` to work without correction of the flow velocity and return to the menu item `SYSTEM settings`.




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<br>`Offset: -10.0 cm/s` = -0.1 m/s<br>If a flow velocity v = 5 m/s is measured, before the calculation of the derived quantities, it will be corrected as follows:<br>$v_{cor} = 1.1 \cdot 5$ m/s - 0.1 m/s = 5.4 m/s |
| **Example 2:** | `Slope`: -1.0<br>`Offset`: 0.0<br>Only the sign of the measured values is changed. |

| | |
|---|---|
| **Note!** | The correction data will only be stored when a measurement is started. If the transmitter is switched off without starting a measurement, the entered correction data will be lost. |

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

## 15.3 Limit of the Signal Amplification

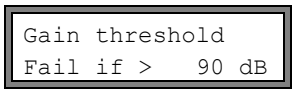
In order to prevent disturbing and/or pipe wall signals (e.g., if the pipe has run empty) from being interpreted as useful signals, it is possible to define a max. signal amplification. If the signal amplification is greater than the max. signal amplification,

- 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).



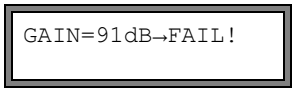
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Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `Gain threshold` is displayed.




Enter 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.

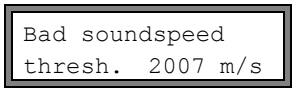
| **Attention!** | The limit of the signal amplification is still active after the deactivation of the SuperUser mode. |
|---|---|

## 15.4 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:

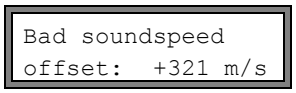
- fixed upper value, default: 1 848 m/s
- value of the sound speed curve of the medium at the operating point plus offset, default offset: 300 m/s

In the SuperUser mode, the values can be defined for media that are not contained in the data set of the transmitter. Select `Special Funct.\SYSTEM settings\Measuring\Miscellaneous`. Press ENTER until the menu item `Bad soundspeed` is displayed.




Enter the fixed upper limit of the sound speed. Enter `0` (zero) to use the default value of 1 848 m/s.

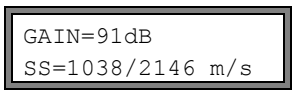
Press ENTER.




Enter 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<br>`offset: 600 m/s`<br>value of the sound speed curve at the operating point: 1 546 m/s<br>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. |
|---|---|



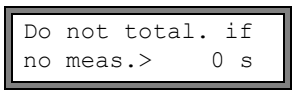

It is possible to display the valid range for the sound speed (`SS=`) in the lower line during the measurement. The second value (here: 2 146 m/s) is the upper limit at the operating point.

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

## 15.5 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.

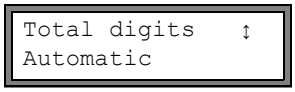


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## 15.6 Number of Decimal Places of the Totalizers

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 |

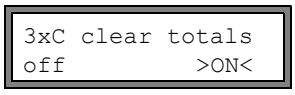
| | |
|---|---|
| **Note!** | The number of decimal places and the max. value defined here only affect the display of the totalizers. |

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

## 15.7 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. |

| | |
|---|---|
| **Note!** | If the manual reset of the totalizers is activated, the manual reset function for the alarm outputs (see section 16.6.4) will be deactivated. In order to be able to reset the alarm outputs during the measurement, it will be necessary to deactivate the manual reset of the totalizers. |

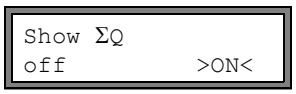


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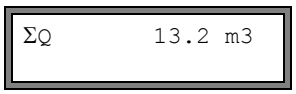
## 15.8 Display of the Sum of the Totalizers

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.

## 15.9 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.

## 15.10 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 medium |



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# 16 Outputs

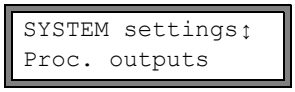
The outputs have to be installed and activated before they can be used:

- 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`

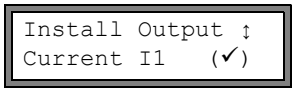
## 16.1 Installation of an Output

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 B, the changes will not be stored. |
|---|---|

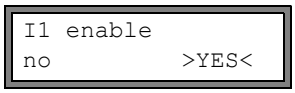



Select `Special Funct.\SYSTEM settings\Proc. outputs`. Press ENTER.

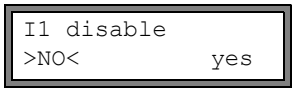



Select the output to be installed. Press ENTER.

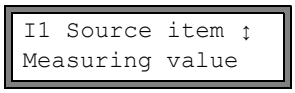
The scroll list contains all available outputs. A tick ✓ after a list item indicates that this output has already been installed.




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 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. 16.1.

Tab. 16.1: 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) |
| `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 medium |
| | `Signal` | signal amplitude |
| | `SCNR` | ratio useful signal to correlated disturbance signal |
| | `VariAmp` | standard deviation of the signal amplitude |
| | `Density` | density of the medium |



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### 16.1.1 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: $I_{MAX} - I_{MIN} \geq 2$ mA for a 4…20 mA current output

### 16.1.2 Error Output

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

Tab. 16.2: 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 16.2): > 0

The volumetric flow rate cannot be measured during the time interval $t_0 ... t_1$ (see Fig. 16.1). The error value will be output.

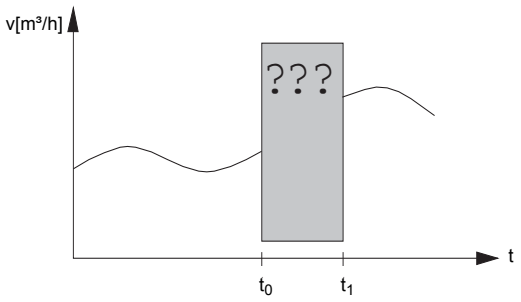
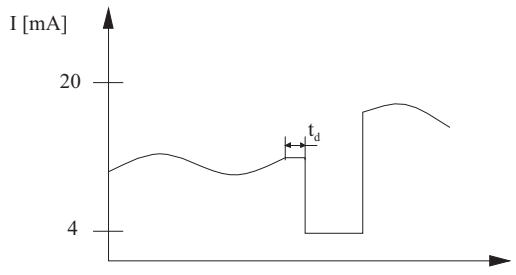
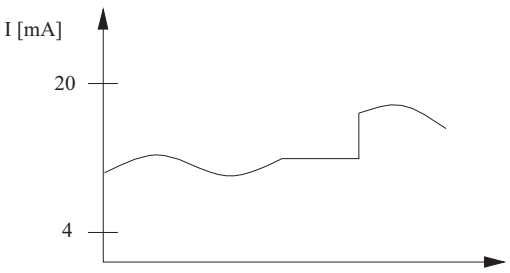
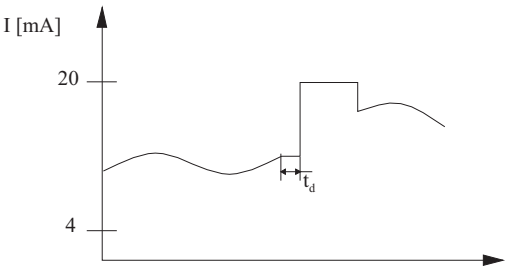
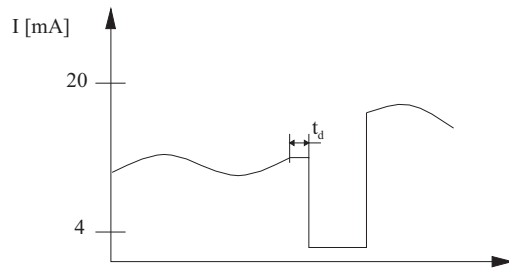



Fig. 16.1: Error output



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Tab. 16.3: Examples for the error output

| list item for the error output | output signal |
|---|---|
| Error-value ↕<br>Minimum (4.0mA) |  |
| Error-value ↕<br>Hold last value |  |
| Error-value ↕<br>Maximum (20.0mA) |  |
| Error-value ↕<br>Other value...<br>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: -D, C+

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

Press ENTER.

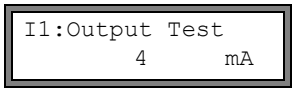


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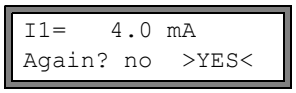
### 16.1.3 Function Test

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.



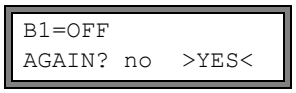

If the multimeter displays the entered value, the output functions correctly.

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

**Test of the binary output**



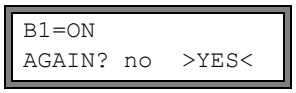

Select `Reed-Relay OFF` to test the de-energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be high ohmic.




Select `yes`. Press ENTER.



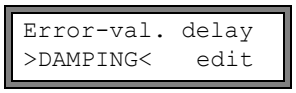

Select `Reed-Relay ON` to test the energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be low ohmic.




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

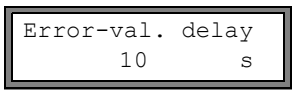
## 16.2 Error Value Delay

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`.



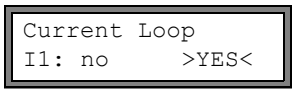

From now on, the error value delay can be entered in the program branch `Output Options`.



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## 16.3 Activation of the Current Output

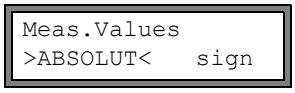
| | |
|---|---|
| **Note!** | An output can only be activated in the program branch `Output Options` if it has previously been installed. |




Select the program branch `Output Options`. Press ENTER until `Current Loop` is displayed. Select `yes` to activate the output. Press ENTER.

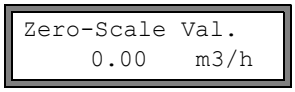
### 16.3.1 Measuring Range of the Analog Outputs

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



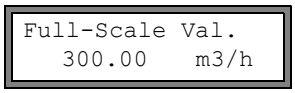

Select `sign` if the sign of the measured values is to be considered for the output.

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 16.1.1.



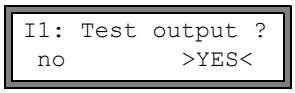

Enter the highest expected measured value.

`Full-Scale Val.` is the measured value that corresponds to the upper limit of the output range as defined in section 16.1.1.

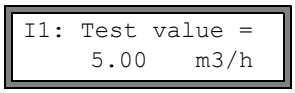
| | |
|---|---|
| **Example:** | output: current output<br>output range: 4…20 mA<br>`Zero-Scale Val.`: 0 m³/h<br>`Full-Scale Val.`: 300 m³/h<br>volumetric flow rate = 0 m³/h, corresponds to 4 mA<br>volumetric flow rate = 300 m³/h, corresponds to 20 mA |

### 16.3.2 Function Test

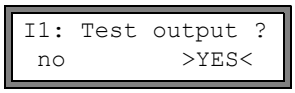
The function of the installed output can now be tested. Connect a multimeter to the installed output.




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




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

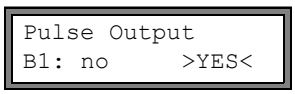



Select `yes` to repeat the test. Press ENTER.

## 16.4 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 medium which has passed the measuring point reaches a given value (`Pulse Value`). The integrated quantity is the selected physical quantity. Integration is restarted as soon as a pulse is emitted.

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




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

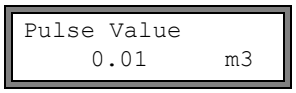



This error message will be displayed if the flow velocity has been selected as the physical quantity.

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

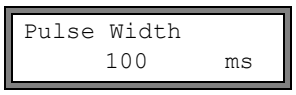


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Enter the pulse value. The unit of measurement will be displayed according to the current physical quantity.

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




Enter the pulse width.

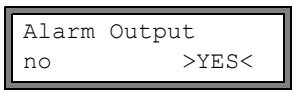
The range of possible pulse widths depends on the specification of the measuring instrument (e.g., counter, PLC) that is to be connected to the output.

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.

## 16.5 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. |
|---|---|

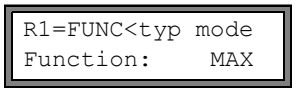



Select the program branch `Output Options`. Press ENTER until the menu item `Alarm Output` is displayed.

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

### 16.5.1 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. 16.4: 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. |

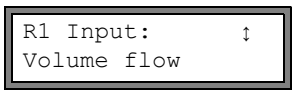
| **Note!** | If no measurement is made, all alarms will be de-energized, independently of the programmed switching function. |
|---|---|



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### 16.5.2 Setting the Limits

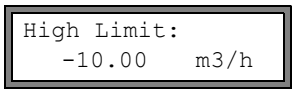
If the switching condition MAX or MIN is selected in the scroll list func, the limit of the output will have to be defined:




Select in the scroll list Input the physical quantity to be used for the comparison. The following list items are available for the alarm output R1:

- selected physical quantity
- signal amplitude
- sound speed of the medium

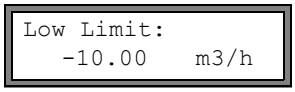
Press ENTER.




switching condition: MAX

Enter the upper limit. Press ENTER.

The alarm will switch if the measured value exceeds the limit.



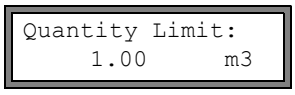

switching condition: MIN

Enter the lower limit. Press ENTER.

The alarm will switch if the measured value falls below the limit.

| | |
|---|---|
| **Example 1:** | High Limit:: -10 m³/h<br>volumetric flow rate = -9.9 m³/h<br>the limit is exceeded, the alarm switches<br>volumetric flow rate = -11 m³/h<br>the limit is not exceeded, the alarm does not switch |
| **Example 2:** | Low Limit:: -10 m³/h<br>volumetric flow rate = -11 m³/h<br>the measured value is below the limit, the alarm switches<br>volumetric flow rate = -9.9 m³/h<br>the measured value is not below the limit, the alarm does not switch |

If the switching condition QUANT. is selected in the scroll list func, the limit of the output will have to be defined:




switching condition: QUANT.

Enter the limit of the totalizer. Press ENTER.

The alarm will switch if the measured value reaches the limit.

A positive limit will be compared to the totalizer value for the positive flow direction.

A negative limit will be compared to the totalizer value for the negative flow direction.

The comparison will also take place if the totalizer of the other flow direction is displayed.

| | |
|---|---|
| **Note!** | The unit of measurement of the limit corresponds to the unit of measurement of the selected physical quantity.<br>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<br>Quantity Limit:: 1 m³ |
| **Example 2:** | physical quantity: volumetric flow rate in m³/h<br>Low Limit:: 60 m³/h<br>The unit of measurement of the physical quantity is changed to m³/min. The new limit to be entered is 1 m³/min. |



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### 16.5.3 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.

```
R1 Hysterese:
     1.00    m3/h
```

switching condition: `MIN or MAX`
Enter the value for `Hysterese`.
or
Enter 0 (zero) to work without a hysteresis.
Press ENTER.

## 16.6 Behavior of the Alarm Output

### 16.6.1 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.

### 16.6.2 Reset and Initialization of the Alarm

After an initialization, the alarm output will be initialized as follows:

Tab. 16.5: 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 the alarm output to the idle state. An alarm output whose switching condition is still met will be activated again after 1 s. This function is used to reset an alarm output of the type `HOLD` if the switching condition is no longer met.

By pressing key B, the measurement will be stopped and the main menu selected. The alarm output will be de-energized, independently of the programmed idle state.

### 16.6.3 Alarm Outputs During Transducer Positioning

At the beginning of the transducer positioning (bar graph display), the alarm output is reset to the programmed idle state.

If the bar graph is selected during the measurement, the alarm output will be reset 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 into the idle state will not be displayed.



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### 16.6.4 Alarm Output 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.

An alarm output with the switching condition QUANT. will be activated if the limit is reached.

An alarm output 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.

An alarm output with the switching condition +→- -→+ and of the type NON-HOLD will be activated with each change of the flow direction for approx. 1 s (see Fig. 16.2).

An alarm output with the switching condition +→- -→+ and of the type HOLD will be active after the first change of the flow direction. It can be reset by pressing key C three times (see Fig. 16.2).

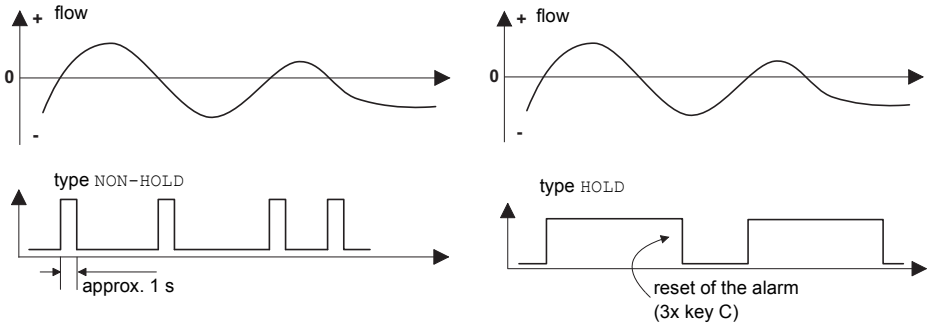



Fig. 16.2: Behavior of a relay when the flow direction changes

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

### 16.6.5 Indication of the Alarm State

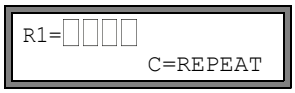
| **Note!** | There is no visual or acoustic indication of alarm output switching. |
|---|---|

After the configuration of the alarm output and during the measurement, the state of the alarm 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 output have to be reconfigured frequently.




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 output will be indicated after the configuration of the alarm output:




The indication of the alarm state is structured as follows:

R1 = □ □ □ □, where □ is a pictogram according to Tab. 16.1.

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

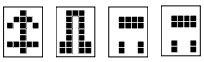
If the indication of the alarm state is activated, it is possible to show the alarm state during the measurement. Press key ▶ to scroll through the upper line and ▼ to scroll through the lower line until the alarm state is indicated.



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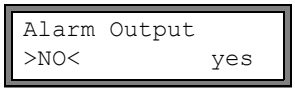
Tab. 16.1: Pictograms for the alarm state indication

| | func<br>**(switching condition)** | typ<br>**(holding behavior)** | mode<br>**(switching function)** | **current state** |
|---|---|---|---|---|
| R1 = | | | | |
| | OFF | NON-HOLD | NO Cont. | closed |
| | MAX | HOLD | NC Cont. | open |
| | MIN | | | |
| | +→- -→+ | | | |
| | QUANT. | | | |
| | ERROR | | | |

**Example:** R1 = 

### 16.6.6 Deactivation of the Output

If the programmed output is no longer required, it 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 the output. Press ENTER.



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# 17 Troubleshooting

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

**Calibration**

Portalok 7S is a very reliable instrument. It is manufactured under strict quality control, using modern production techniques. If installed as recommended in an appropriate location, used cautiously and taken care of conscientiously, no troubles should appear. The transmitter has been calibrated at the factory and, usually, a re-calibration of the transmitter will not be necessary. A re-calibration is recommended if the contact surface of the transducers shows visible wear.

The transmitter has to be sent to EESIFLo for recalibration under reference conditions.

**The display does not work at all or fails regularly**

Check the contrast setting of the transmitter (see section 14.4).

Check if the battery is inserted and charged. Connect the power supply. 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 EESIFLo for repair.

**The message SYSTEM ERROR is displayed**

Press key B 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 EESIFLo.

**The transmitter does not react when key B 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 EESIFLo for repair.

**Date and time are wrong, the measured values are deleted when the transmitter is switched off**

The data backup battery has to be replaced. Send the transmitter to EESIFLo.

**An output does not work**

Make sure that the outputs are configured correctly. Check the function of the output as described in section 16.1.3. If the output is defective, contact EESIFLo.

**It is not possible to manually reset the alarm output by pressing key C three times**

The manual reset of the totalizers by pressing key C three times is activated (see section 15.7). This makes it impossible to manually reset the alarm outputs. Deactivate the manual reset of the totalizers.

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

see section 17.1.

**The values of the totalizer are wrong**

see section 17.6.

## 17.1 Problems with the Measurement

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

- Check if the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound speed of the medium. (Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.)
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point has been selected (see section 17.2).
- Try to establish better acoustic contact between the pipe and the transducers (see section 17.3).
- Enter a lower value for the number of sound paths. The signal attenuation might be too high due to a high medium viscosity or deposits on the inner pipe wall (see section 17.4).



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**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 EESIFLo.
- Wait briefly until acoustic contact is reestablished. The measurement can be interrupted by a temporarily higher proportion of gas bubbles and solids in the medium.

**The measured values substantially differ from the expected values**

- Wrong measured values are often caused by wrong parameters. Make sure that the entered parameters are correct for the measuring point.
- If the parameters are correct, see section 17.5 for the description of typical situations in which wrong measured values are obtained.

## 17.2 Selection of the Measuring Point

- Make sure that the recommended min. distance to any disturbance source is observed (see chapter 5, Tab. 5.2).
- Avoid measuring points with deposit formation in the pipe.
- Avoid measuring points in the vicinity of deformations and defects on the pipe and in the vicinity of welds.
- Measure the temperature at the measuring point and make sure that the transducers are suitable for this temperature.
- Make sure that the outer pipe diameter is within the measuring range of the transducers.
- When measuring on a horizontal pipe, the transducers have to be mounted on the side of the pipes.
- A vertical pipe always has to be filled at the measuring point and the medium should flow upward.
- No gas bubbles should form (even bubble-free media can form gas bubbles when the medium expands, e.g., upstream of pumps and downstream of great cross-section enlargements).

## 17.3 Maximum Acoustic Contact

Observe the instructions in chapter 7.

## 17.4 Application Specific Problems

**The entered sound speed of the medium is wrong**

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

**The entered pipe roughness is not appropriate**

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

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

Contact EESIFLo.

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

Try measuring on a liner free section of the pipe.

**Highly viscous media strongly attenuate the ultrasonic signal**

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

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

A measurement is impossible if the value is ≥ 6 %. If the proportion is high but < 6 %, 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. Contact EESIFLo.



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## 17.5 Large Deviations of the Measured Values

**The entered sound speed of the medium is wrong**

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

**There is gas in the pipe**

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

**The 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 medium is outside the measuring range of the transmitter**

**The measuring point is not appropriate**

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

## 17.6 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.

## 17.7 Data Transmission

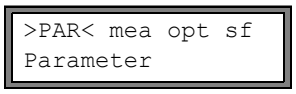
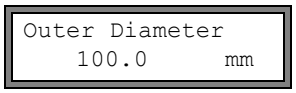
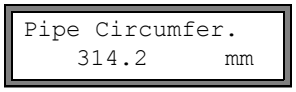
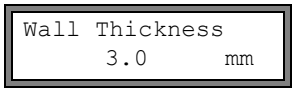
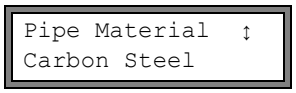
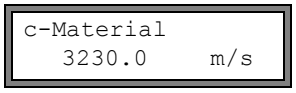
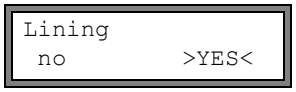
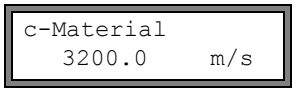
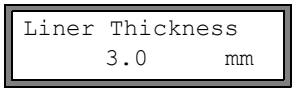
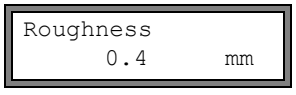
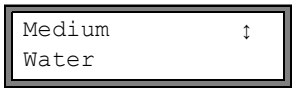
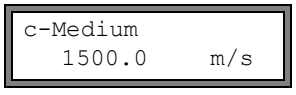
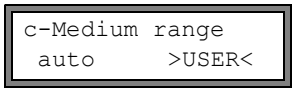
**The file with the transmitted measuring data contains meaningless strings**

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



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# 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<br>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<br>range: depends on the connected transducers<br>default: 3 mm | |
|  selection of the pipe material | |
|  input of the sound speed of the pipe material<br>range: 600...6553.5 m/s<br>This display will only be indicated if `Other Material` has been selected. | |
|  selection whether the pipe is lined | |
|  selection of the lining material<br>This display will only be indicated if `Lining` = `yes` has been selected. | |
|  input of the sound speed of the lining material<br>range: 600...6553.5 m/s<br>This display will only be indicated if `Other Material` has been selected. | |
|  input of the liner thickness<br>default: 3 mm | |
|  input of the roughness of the inner pipe wall<br>range: 0...5 mm<br>default: 0.1 mm (for steel as pipe material) | |
|  selection of the medium | |
|  input of the average sound speed of the medium<br>range: 500...3500 m/s<br>This display will only be indicated if `Other Medium` has been selected. | |
|  selection of the range of the sound speed<br>`auto`: The area around the average sound speed is defined by the transmitter.<br>`user`: The area around the average sound speed has to be entered. | |



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| | INIT-resistant |
|---|---|
| c-Medium=1500m/s<br>range +-150m/s<br>input of the range around the average sound speed of the medium<br>This display will only be indicated if `Other Medium` has been selected. | |
| Kinem.Viscosity<br>1.00 mm2/s<br>input of the kinematic viscosity of the medium<br>range: 0.01...30 000 mm²/s<br>This display will only be indicated if `Other Medium` has been selected or no data set for the selected medium is stored in the transmitter. | |
| Density<br>1.00 g/cm3<br>input of the operating density of the medium<br>range: 0.01...20 g/cm³<br>This display will only be indicated if `Other Medium` has been selected. | |
| Medium Temperat.<br>20.0 C<br>input of the medium temperature<br>default: 20 °C (68 °F) | |
| Transducer Type↕<br>Standard<br>selection of the transducer type | |
| Additional cable<br>65.0 m<br>input of the length of an extension cable | |
| **Program Branch `Measuring`** | |
| par >MEA< opt sf<br>Measuring<br>main menu: selection of the program branch `Measuring` | |
| Meas.Point No.:<br>xxx (↑↓← →)<br>input of the measuring point number<br>This display will only be indicated if `Output Options\Store Meas.Data` and/or `Serial Output` are activated. | |
| PROFILE CORR.<br>>NO< yes<br>activation/deactivation of the flow profile correction<br>This display will only be indicated if `Special Funct.\SYSTEM settings\Measuring\Flow Velocity` = `uncorr.` has been selected. | |
| Transd. Distance<br>54 mm Reflex<br>display of the transducer distance to be adjusted between the inner edges of the transducers | |
| **Program Branch `Output Options`** | |
| par mea >OPT< sf<br>Output Options<br>main menu: selection of the program branch `Output Options` | |
| Physic. Quant. ↕<br>Volume flow<br>selection of the physical quantity | |
| Volume in: ↕<br>m3/h<br>selection of the unit of measurement for the physical quantity | |
| Damping<br>10 s<br>input of the duration over which a floating average of the measured values has to be determined<br>range: 1...600 s | |
| Store Meas.Data<br>no >YES<br>activation of the data logger | |

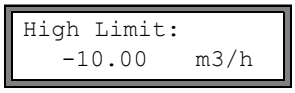
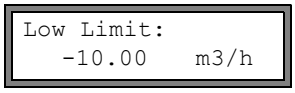
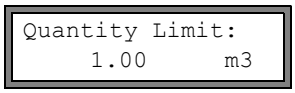
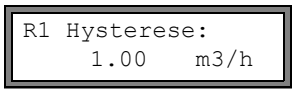
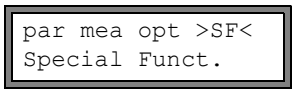
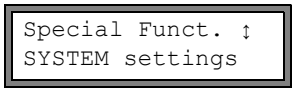
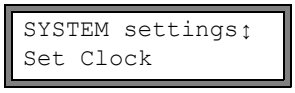
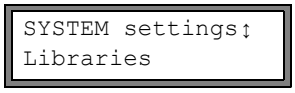
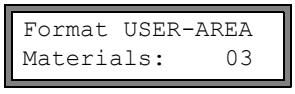


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| | | INIT-resistant |
|---|---|---|
| Serial Output<br>no >YES< | activation of the measured value transmission to a PC or a printer via the serial interface | |
| Storage Rate ↕<br>Once per 10 sec. | selection of the storage rate for storing measured values in the data logger<br>This display will only be indicated if `Output Options\Store Meas.Data` and/or `Serial Output` are activated. | |
| Storage Rate<br>1 s | Input of the storage rate if `Storage Rate` = `EXTRA` has been selected<br>range: 1...43 200 s (= 12 h) | |
| **Current Loop** | | |
| Current Loop<br>I1: no >YES< | activation of a current output<br>This display will only be indicated if the current output has been installed in `Special Funct.\SYSTEM settings\Proc. outputs`. | |
| Meas.Values<br>>ABSOLUT< sign | selection whether the sign of the measured values is to be considered for the output<br>This display will only be indicated if `Current Loop` is activated. | |
| Zero-Scale Val.<br>0.00 m3/h | input of the lowest/highest measured value to be expected for the current output<br>The values are assigned to the lower/upper limit of the output range.<br>These displays will only be indicated if `Current Loop` is activated. | |
| Full-Scale Val.<br>300.00 m3/h | | |
| Error-val. delay<br>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<br>This display will only be indicated if `Special Funct.\SYSTEM settings\Dialogs/Menus\Error-val. delay` = `EDIT` has been selected. | |
| **Pulse Output** | | |
| Pulse Output<br>B1: no >YES< | Activation of a Pulse Output<br>This display will only be indicated if a pulse output has been installed in `Special Funct.\SYSTEM settings\Dialogs/Menus\Proc. outputs`. | |
| Pulse Value<br>0.01 m3 | input of the pulse value (value of the totalizer at which a pulse will be emitted)<br>This display will only be indicated if `Pulse Output` is activated. | |
| Pulse Width<br>100 ms | input of the pulse width<br>range: 80...1000 ms<br>This display will only be indicated if `Pulse Output` is activated. | |
| **Alarm Output** | | |
| Alarm Output<br>no >YES< | activation of an alarm output<br>This display will only be indicated if an alarm output has been installed in `Special Funct.\SYSTEM settings\Proc. outputs`. | |
| R1=FUNC<typ mode<br>Function: MAX | Selection of the switching condition (`func`), the holding behavior (`typ`) and the switching function (`mode`) of the alarm output.<br>This display will only be indicated if `Alarm Output` is activated. | |
| R1 Input: ↕<br>Volume flow | selection of the physical quantity to be monitored<br>This display will only be indicated for R1 if `Alarm Output` is activated. | |

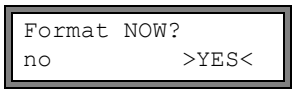
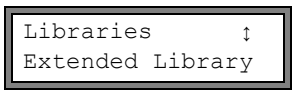
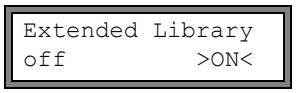
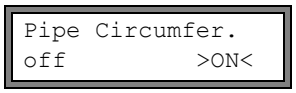
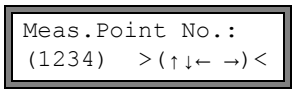
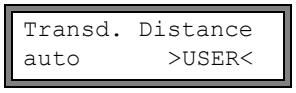
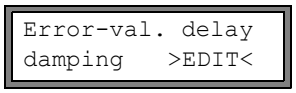
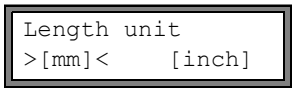
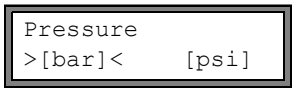


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| | INIT-resistant |
|---|---|
|  input of the upper limit of the physical quantity to be monitored<br>This display will only be indicated if `Alarm Output` has been activated and `MAX` has been selected as the switching condition. | |
|  input of the lower limit of the physical quantity to be monitored<br>This display will only be indicated if `Alarm Output` has been activated and `MIN` has been selected as the switching condition. | |
|  input of the limit for the totalizer of the physical quantity to be monitored<br>This display will only be indicated if `Alarm Output` has been activated and `QUANT.` has been selected as the switching condition. | |
|  input of the hysteresis for the lower or upper limit<br>This display will only be indicated if `Alarm Output` has been activated and `MIN` or `MAX` has been selected as the switching condition. | |
| **Program Branch `Special Funct.`** | |
|  main menu: selection of the program branch `Special Funct.` | |
| **`SYSTEM settings`** | |
|  selection of `Special Funct.\SYSTEM settings` | |
| **`SYSTEM settings\Set Clock`** | |
|  selection of the displays for the input of the date and the time | |
| **`SYSTEM settings\Libraries`** | |
|  selection of the displays for the management of the material and medium scroll lists | |
| **`SYSTEM settings\Libraries\Material list`** | |
|  selection of the displays for the arrangement of the material scroll list (pipe and lining materials) | |
| **`SYSTEM settings\Libraries\Medium list`** | |
|  selection of the displays for the arrangement of the medium scroll list | |
| **`SYSTEM settings\Libraries\Format USER-AREA`** | |
|  selection of the displays for the partitioning of the coefficient memory for the storing of user defined material and medium properties | |
|  input of the number of user defined materials | |
|  input of the number of user defined media | |



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| | | INIT-resistant |
|---|---|---|
|  | display of the occupancy of the coefficient memory | |
|  | confirmation of the selected partition | |
|  | the coefficient memory is being partitioned | |
| **SYSTEM settings\Libraries\Extended Library** | | |
|  | selection of the displays for the activation of the extended library | |
|  | activation of the extended library | x |
| **SYSTEM settings\Dialogs/Menus** | | |
|  | selection of the displays for the activation/deactivation or setting of the menu items in the other program branches | |
|  | activation of the menu item for the input of the pipe circumference in the program branch `Parameter` | x |
|  | selection of the input mode for the measuring point number in the program branch `Measuring`:<br>`(1234)`: digits, point, hyphen<br>`(↑↓← →)`: ASCII editor | x |
|  | setting for the display for the input of the transducer distance in the program branch `Measuring`:<br>• `user`: only the entered transducer distance will be displayed if the recommended and the entered transducer distances are identical<br>• `auto`: only the recommended transducer distance will be displayed<br>recommended setting: `user` | x |
|  | selection of the error value delay<br>• `damping`: The damping factor will be used.<br>• `edit`: The menu item for the input of the error value delay in the program branch `Output Options` will be activated. | x |
|  | activation of the display of the alarm state during the measurement | x |
|  | selection of the unit of measurement for the length | x |
|  | selection of the unit of measurement for the temperature | x |
|  | selection of the unit of measurement for the pressure | x |



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| | | INIT-resistant |
|---|---|---|
| `Pressure absolut`<br>` off >ON<` | selection if the absolute pressure $p_a$ or the relative pressure $p_g$ is to be used | x |
| `Soundspeed unit`<br>`>[m/s]< [fps]` | selection of the unit of measurement for the sound speed | x |
| `Density [lb/ft3]`<br>` no >YES<` | selection if `lb/ft`$^3$ is to be used as the unit of measurement for the density | x |
| `Density unit`<br>` g/cm3 >kg/m3<` | selection of the unit of measurement for the density<br>This display will only be indicated if `lb/ft`$^3$ has not been selected as the unit of measurement for the density | x |
| `Viscosity unit`<br>` mm2/s >cSt<` | selection of the unit of measurement for the kinematic viscosity | x |
| **SYSTEM settings\Measuring** | | |
| `SYSTEM settings↕`<br>`Measuring` | selection of the displays for the settings of the measurement | |
| **SYSTEM settings\Measuring\Miscellaneous** | | |
| `Compare c-fluid`<br>`no >YES<` | activation of the display for the difference between the measured and the expected sound speed of a selected reference medium during the measurement | x |
| `Flow Velocity`<br>`normal >UNCORR.<` | selection whether the flow velocity is displayed and transmitted with or without profile correction | x |
| `Velocity limit`<br>`0.0 m/s` | input of an upper limit of the flow velocity<br>range: 0.1...25.5 m/s<br>0 m/s: no detection for outliers<br>All measured values that are greater than the limit will be marked as outliers. | x |
| `Cut-off Flow`<br>`absolut >SIGN<` | selection of the input of a lower limit for the flow velocity:<br>• `absolut`: independent of the flow direction<br>• `sign`: dependent on the flow direction | x |
| `Cut-off Flow`<br>`factory >USER<` | activation of the input of a lower limit of the flow velocity:<br>• `factory`: the default limit of 2.5 cm/s will be used<br>• `user`: input of a limit | x |
| `+Cut-off Flow`<br>`2.5 cm/s` | input of the cut-off flow for positive measured values<br>range: 0...12.7 cm/s (0.127 m/s)<br>default: 2.5 cm/s (0.025 m/s)<br>This display will only be indicated if `Cut-off Flow` = `sign` and `Cut-off Flow` = `user` has been selected. | x |
| `-Cut-off Flow`<br>`-2.5 cm/s` | Input of the cut-off flow for negative measured values<br>range: -12.7...0 cm/s<br>default: -2.5 cm/s<br>This display will only be indicated if `Cut-off Flow` = `sign` and `Cut-off Flow` = `user` has been selected. | x |



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| | | INIT-resistant |
|---|---|---|
| Cut-off Flow<br>2.5 cm/s | Input of the cut-off flow for the absolute value of the measured values<br>range: 0...12.7 cm/s<br>default: 2.5 cm/s<br>This display will only be indicated if `Cut-off Flow` = `absolut` and `Cut-off Flow` = `user` has been selected. | x |
| Gain threshold<br>Fail if > 90 dB | Input of the max. signal amplification.<br>range: 0...255<br>0: no limit of the signal amplification<br>This display will only be indicated if the SuperUser mode is activated. | x |
| Bad soundspeed<br>thresh. 2007 m/s | Input of the fixed upper limit of the sound speed.<br>range: 0...3 000 m/s<br>0: the default value 1 848 m/s is used<br>This display will only be indicated if the SuperUser mode is activated. | x |
| Bad soundspeed<br>offset: +321 m/s | Input of the offset.<br>range: 0...900 m/s<br>0: the default value 300 m/s is used<br>This display will only be indicated if the SuperUser mode is activated. | x |
| Quant. wrapping<br>off >ON< | activation of the overflow of the totalizers | x |
| Quantity recall<br>off >ON< | activation of the taking-over of the totalizer values after a restart of the measurement | x |
| Do not total. if<br>no meas.> 0 s | input of the time interval without any valid measured values after which the transmitter recognizes a long measurement failure<br>0: the default value 30 s is used<br>This display will only be indicated if the SuperUser mode is activated. | x |
| Total digits ↕<br>Automatic | input of the number of decimal places for the totalizers:<br>`Automatic`: dynamic adjustment<br>`Fixed to x digit`: 0...4 decimal places<br>This display will only be indicated if the SuperUser mode is activated. | x |
| 3xC clear totals<br>off >ON< | Activation of the manual reset of the totalizers.<br>This display will only be indicated if the SuperUser mode is activated. | x |
| Show ΣQ<br>off >ON< | Activation of the display of the sum of the totalizers.<br>This display will only be indicated if the SuperUser mode is activated. | x |
| Keep display val<br>off >ON< | activation of the display of the last valid measured value<br>This display will only be indicated if the SuperUser mode is activated. | x |
| **Special Funct.\SYSTEM** | **settings\Measuring\Calibration** | |
| Profile bounds<br>factory >USER< | definition of the profile bounds<br>`factory`: the default profile bounds is used<br>`user`: the profile bounds can be defined<br>This display will only be indicated if the SuperUser mode is activated. | |



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| | | INIT-resistant |
|---|---|---|
| Laminar flow<br>if R*< 0 | Input of the max. Reynolds number at which the flow is laminar.<br>range: 0...25 500 (rounded to hundreds)<br>0: the default value 1 000 is used<br>This display will only be indicated if the SuperUser mode is activated and `Profile bounds` = `user` is selected. | |
| Turbulent flow<br>if R*> 0 | input of the min. Reynolds number at which the flow is turbulent.<br>range: 0...25 500 (rounded to hundreds)<br>0: the default value 3 000 is used<br>This display will only be indicated if the SuperUser mode is activated and `Profile bounds` = `user` is selected. | |
| Calibration ?<br>>OFF< on | request if an additional correction of the flow velocity is to be defined<br>`on`: the correction data can be defined<br>`off`: no correction of the flow velocity will be used<br>This display will only be indicated if the SuperUser mode is activated. | |
| Slope=<br>1.00 | input of the slope for the correction formula.<br>range: -2.000...+2.000<br>0: no correction<br>This display will only be indicated if the SuperUser mode is activated and `Calibration` = `on` is selected. | |
| Offset=<br>0.0 cm/s | input of the offset.<br>range: -12.7...+12.7 cm/s<br>0: no offset<br>This display will only be indicated if the SuperUser mode is activated and `Calibration` = `on` is selected. | |
| **SYSTEM settings\Proc. outputs** | | |
| SYSTEM settings↕<br>Proc. outputs | selection of the displays for the setting of the outputs of the transmitter | |
| Install Output ↕<br>Current I1 | selection of the output to be installed | |
| **SYSTEM settings\Storing** | | |
| SYSTEM settings↕<br>Storing | selection of the displays for the storing of measured values in the data logger | |
| Start logger ↕<br>Promptly | selection the starting time of the storing of measured values | x |
| Ringbuffer<br>off >ON< | setting of the overflow behavior of the data logger | x |
| Storage mode<br>sample >AVERAGE< | selection of the sample mode<br>• `sample`: storing and online transmission of the displayed measured value<br>• `average`: storing and online transmission of the average of all measured values of a storage interval | x |
| Quantity Storage<br>one >BOTH< | setting of the storing behavior of the totalizers<br>• `one`: the value of the totalizer that is currently displayed will be stored<br>• `both`: one value for each flow direction will be stored | x |

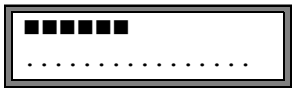
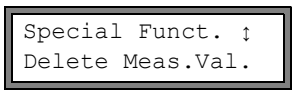
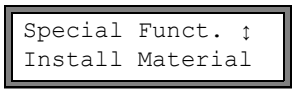
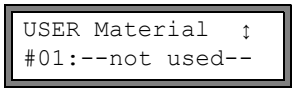
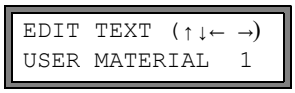
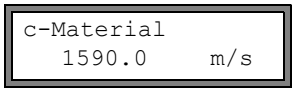
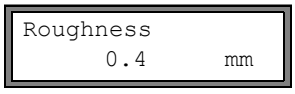
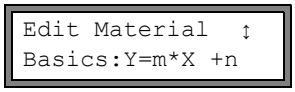
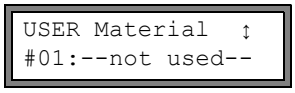
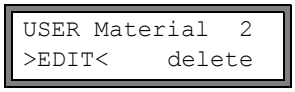
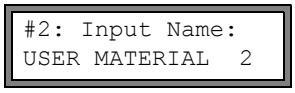
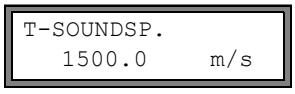


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| | | INIT-resistant |
|---|---|---|
| Store Amplitude<br>off >ON< | activation of the storing of the signal amplitude<br>The value will only be stored if the data logger is activated. | x |
| Store c-Medium<br>off >ON< | activation of the storing of the sound speed of the medium<br>The value will only be stored if the data logger is activated. | x |
| Store diagnostic<br>off >ON< | activation of the storing of diagnostic values | x |
| **SYSTEM settings\serial transmis.** | | |
| SYSTEM settings↕<br>serial transmis. | selection of the displays for the formatting of the serial transmission of measured values | |
| SER:kill spaces<br>off >ON< | activation of the serial transmission of data with/without blanks | x |
| SER:decimalpoint<br>'.' >','< | selection of the decimal marker for floating point numbers | x |
| SER:col-separat.<br>';' >'TAB'< | selection of the character for column separation | x |
| **SYSTEM settings\Miscellaneous** | | |
| SYSTEM settings↕<br>Miscellaneous | selection of the display for the setting of the contrast and input of a HotCode | |
| Input a HOTCODE<br>no >YES< | confirmation that a HotCode has to be entered | |
| Please input a<br>HOTCODE: 000000 | input of a HotCode | |
| SETUP DISPLAY<br>← CONTRAST → | setting of the contrast of the display | |
| **Instrum. Inform.** | | |
| Special Funct. ↕<br>Instrum. Inform. | selection of the displays for information about the transmitter | |
| EESXXXX-XXXXXXXX<br>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. ↕<br>Print Meas.Val. | selection of the displays for the transmission of stored measured values to a PC | |
| Send Header 01<br>..... | start of the transmission of measured values<br>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. | |



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| | INIT-resistant |
|---|---|
|  display of the data transmission progress | |
| **Delete Meas.Val.** | |
|  selection of the displays for the deleting of stored measured values | |
|  confirmation for the deleting of measured values<br>This display will only be indicated if measured values are stored in the data logger. | |
| **Install Material** | |
|  selection of the displays for the input of the pipe and lining materials | |
| **Install Material with Special Funct.\SYSTEM settings\Libraries\Extended Library = off** | |
|  selection whether a user defined material is to be edited or deleted | |
|  selection of a user defined material | |
|  input of a designation for the selected material | |
|  input of the sound speed of the material<br>range: 600...6553.5 m/s | |
|  input of the roughness of the material | |
| **Install Material with Special Funct.\SYSTEM settings\Libraries\Extended Library = on** | |
|  selection of the function for the temperature and pressure dependence of the material properties | |
|  selection of a user defined material | |
|  selection whether the user defined material is to be edited or deleted<br>This display will only be indicated if the selected material already exists. | |
|  input of a designation for the selected material | |
|  input of the constants for the transversal sound speed of the material<br>The number of constants depends on the function selected above. | |



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| | INIT-resistant |
|---|---|
| L-SOUNDSP.<br>1500.0 m/s<br>input of the constants for the longitudinal sound speed of the material<br>The number of constants depends on the function selected above. | |
| Default soundsp.<br>long. >TRANS.<<br>selection of the sound wave type for the flow measurement | |
| Roughness<br>0.4 mm<br>input of the roughness of the material | |
| Save changes<br>no >YES<<br>confirmation that the changes are to be stored<br>This display will only be indicated if a new material has been entered or the properties of an existing material have been changed. | |
| **Install Medium** | |
| Special Funct. ↕<br>Install Medium<br>selection of the displays for the input of media | |
| **Install Medium with Special Funct.\SYSTEM settings\Libraries\Extended Library = off** | |
| Install Medium<br>>EDIT< delete<br>selection whether a user defined medium is to be edited or deleted | |
| USER Medium ↕<br>#01:--not used--<br>selection of a user defined medium | |
| EDIT TEXT (↑↓← →)<br>USER MEDIUM 1<br>input of a designation for the selected medium | |
| c-Medium<br>1500.0 m/s<br>input of the sound speed of the medium<br>range: 500.0...3500.0 m/s | |
| c-Medium=1500m/s<br>range +-150m/s<br>input of the range around the average sound speed of the medium<br>range: 50...999 m/s | |
| Kinem.Viscosity<br>1.01 mm2/s<br>input of the kinematic viscosity of the medium<br>range: 0.01...30 000.00 mm²/s | |
| Density<br>1.00 g/cm3<br>input of the operating density of the medium | |
| **Install Medium with Special Funct.\SYSTEM settings\Libraries\Extended Library = on** | |
| Edit Medium ↕<br>Basics:Y=m*X +n<br>selection of the function for the temperature and pressure dependence of the medium properties | |
| USER Medium ↕<br>#01:--not used--<br>selection of a user defined medium | |
| USER MEDIUM 2<br>>EDIT< delete<br>selection whether the user defined medium is to be edited or deleted<br>This display will only be indicated if the selected medium already exists. | |



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| | | INIT-resistant |
|---|---|---|
| `#2: Input Name:`<br>`USER MEDIUM 2` | input of a designation for the selected medium | |
| `SOUNDSPEED`<br>`1500.0 m/s` | input of the constants for the longitudinal sound speed of the medium<br>The number of constants depends on the function selected above. | |
| `VISCOSITY`<br>`1.0 mm2/s` | input of the kinematic viscosity of the medium | |
| `DENSITY`<br>`1.0 g/cm3` | input of the operating density of the medium | |
| `Save changes`<br>`no >YES<` | confirmation that the changes are to be stored<br>This display will only be indicated if a new medium has been entered or the properties of an existing medium have been changed. | |
| **`Program Code`** | | |
| `Special Funct. ↕`<br>`set program code` | selection of the displays for the input of a program code | |
| `set program code`<br>`------` | defining a program code | |
| `INPUT BREAK_CODE`<br>`CODE: 000000` | input of the break code (= program code) | |
| `INP. ACCESS CODE`<br>`CODE: 000000` | input of the access code (= the first three digits of the program code) | |



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# 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 |



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| 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



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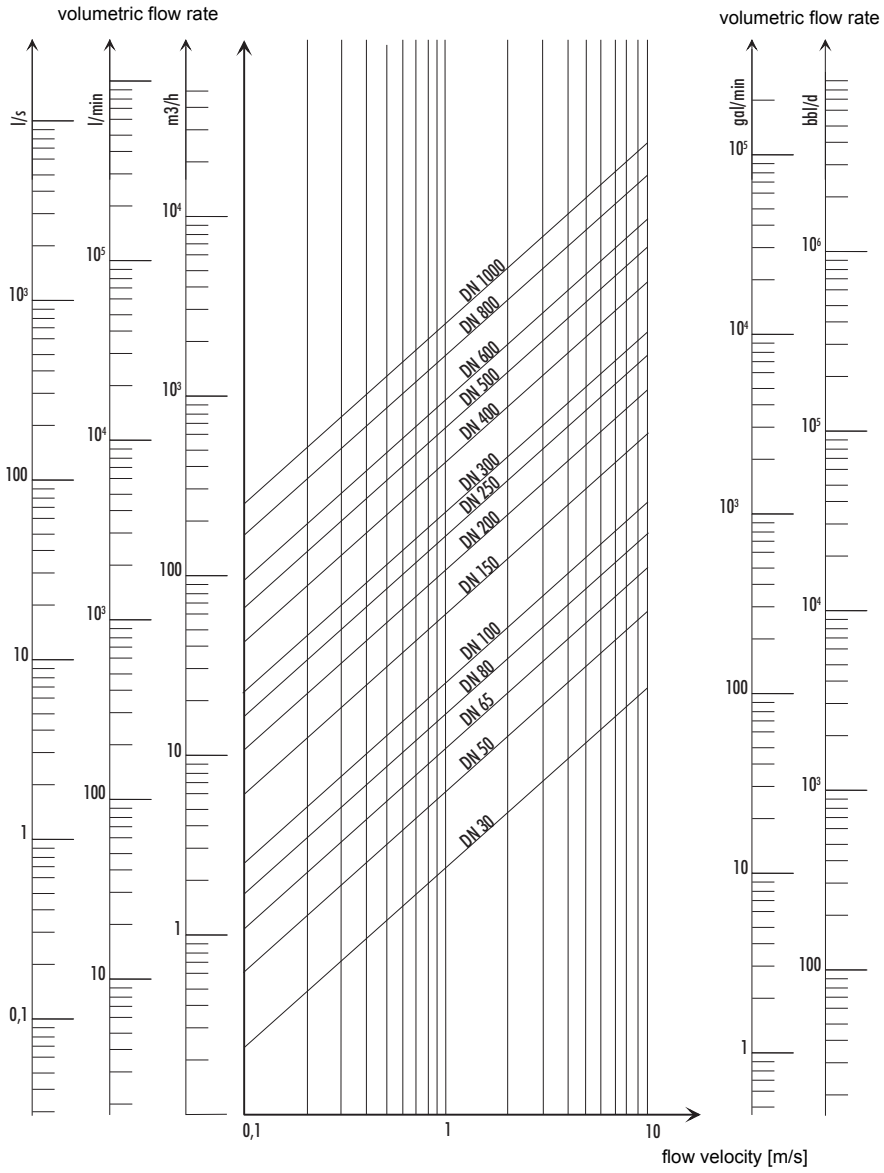
| Mass flow rate | | Mass (totalized) |
|---|---|---|
| unit of measurement | description | unit of measurement |
| t/h | metric ton per hour | t |
| t/d | metric ton per day | t |
| kg/h | kilogram per hour | kg |
| kg/min | kilogram per minute | kg |
| kg/s | kilogram per second | kg |
| g/s | gram 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



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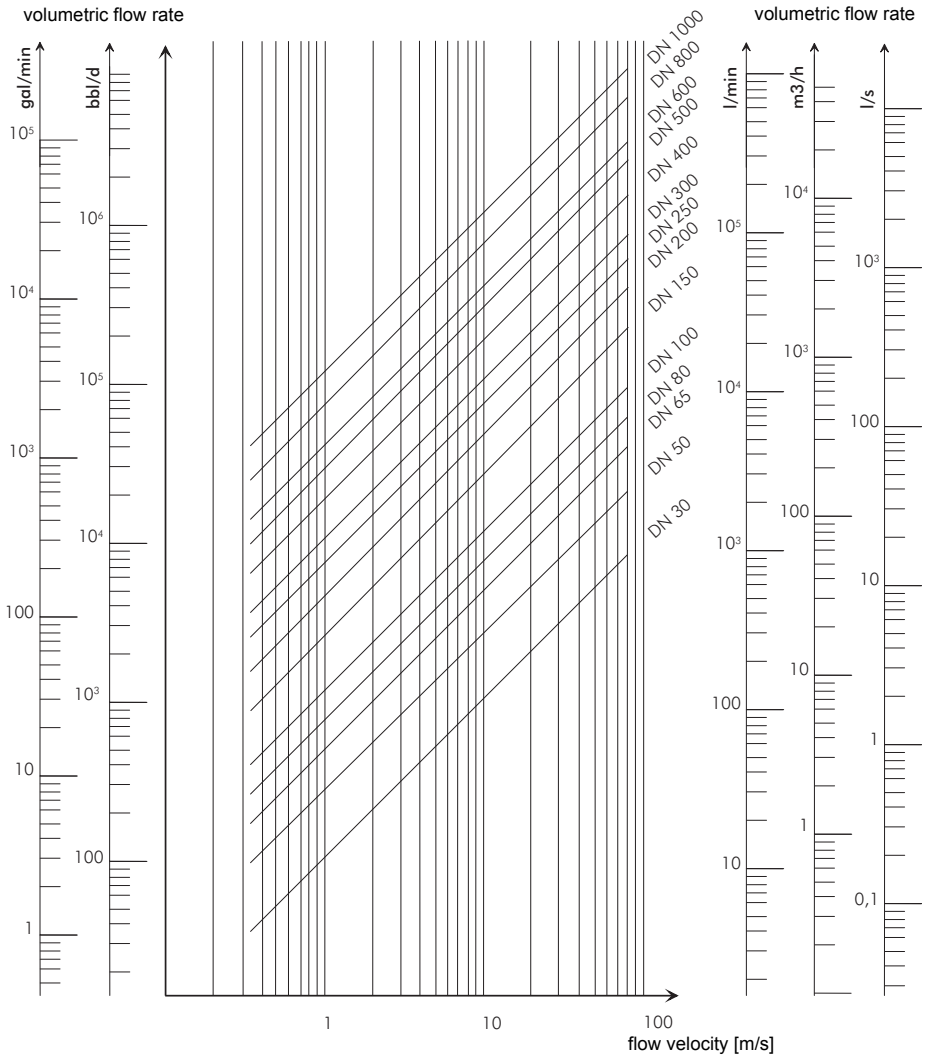
## Flow Nomogram (Metrical)






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## Flow Nomogram (Imperial)






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# 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. EESIFLo does not assume liability for any inaccuracies.

## C.1 Sound Speed of Selected Pipe and Lining Materials at 20 °C (68 °F)

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 | 4 600 | 2 300 | 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.



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## 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 |



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

| medium temperature [°C] | medium temperature [°F] | medium pressure [bar] | density [kg/m$^3$] |
|---|---|---|---|
| 0 | 32 | 1 | 999.8 |
| 10 | 50 | 1 | 999.7 |
| 20 | 68 | 1 | 998.3 |
| 30 | 86 | 1 | 995.7 |
| 40 | 104 | 1 | 992.3 |
| 50 | 122 | 1 | 988.0 |
| 60 | 140 | 1 | 983.2 |
| 70 | 158 | 1 | 977.7 |
| 80 | 176 | 1 | 971.6 |
| 90 | 194 | 1 | 965.2 |
| 100 | 212 | 1.013 | 958.1 |
| 120 | 248 | 1.985 | 942.9 |
| 140 | 284 | 3.614 | 925.8 |
| 160 | 320 | 6.181 | 907.3 |
| 180 | 356 | 10.027 | 886.9 |
| 200 | 392 | 15.55 | 864.7 |
| 220 | 428 | 23.20 | 840.3 |
| 240 | 464 | 33.48 | 813.6 |
| 260 | 500 | 46.94 | 784.0 |
| 280 | 536 | 64.20 | 750.5 |
| 300 | 572 | 85.93 | 712.2 |
| 320 | 608 | 112.89 | 666.9 |
| 340 | 644 | 146.05 | 610.2 |
| 360 | 680 | 186.75 | 527.5 |
| 374.15 | 705 | 221.20 | 315.5 |

* at constant pressure



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