User Manual

UMF601V1-1EN

Ultrasonic Flowmeter for Liquids

FLUXUS F601

Firmware V5.xx

Note:

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FLUXUS is a registered trademark of FLEXIM GmbH.

User Manual for
FLUXUS F601
UMF601V1-1EN 18.07.2008
Firmware V5.xx

Die Sprache, in der die Anzeigen auf dem FLUXUS erscheinen, kann eingestellt werden (siehe Abschnitt 5.5).

FLUXUS can be operated in the language of your choice (see section 5.5).

Il est possible de sélectionner la langue utilisée par FLUXUS à l'écran (voir section 5.5).

FLUXUS puede ser manejado en el idioma de su elección (ver sección 5.5).

Table of contents

1 Introduction

1.1 Regarding this Manual

This manual has been written for the personnel operating the ultrasonic flowmeter FLUX-US. It contains important information about the instrument, how to handle it correctly, how to avoid damages. Always keep this manual at hand.

Get acquainted with the safety rules and the handling precautions. Make sure you have read and understood this manual before using the instrument.

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

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

1.2 Safety Precautions

You will find in this manual the following safety information:

Note!	The notes contain important information which help you use the flowmeter optimally.

Attention!	This text contains important instructions which should be respected to avoid damage or destruction of the flowmeter. Proceed with attention!

Respect these safety precautions!

1.3 Warranty

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

This includes:

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

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

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

If any problem appears which can not be solved with the help of this manual (see chapter 19), contact our sales office giving a precise description of the problem. Specify the type, serial number and firmware version of the flowmeter.

2 Handling

2.1 First Inspection

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

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

Type and serial number of the flowmeter are given on the data plate. The transducer type is printed on the transducers.

2.2 General Precautions

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

- Protect the flowmeter from excessive shock.
- Keep the transducers clean. Manipulate the transducer cables cautiously. Avoid excessive cable bend.
- Make sure to work under correct ambient conditions (see annex A, section Technical Data).
- Use a correct external power supply when not using the battery.
- Handle the charging unit and the battery correctly (see section 3.5).
- The power adapter and the battery charging unit are not moisture-proof. Use it only in dry rooms.
- Take the degree of protection into account (see annex A, section Technical Data).

2.3 Cleaning

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

2.4 Storage

- Wipe the transducers clean of traces of acoustic coupling compound.
- Always pack the flowmeter and its accessories into the respective compartments of the transport case after measurements have been performed.
- Avoid excessive cable bends especially when closing the cover of the transport case.
- Observe the notes on the storage of the battery (see section 3.5).

3 Flowmeter

3.1 Measuring Principle

The flow of the medium is measured by ultrasonic signals using the transit time difference method.

Ultrasonic signals are emitted by a first transducer installed on one side of a pipe, reflected on the opposite side and received by a second transducer. The signals are emitted alternatively in and against the flow direction.

As the medium in which the signals propagate is flowing, the transit time in flow direction is shorter than against flow direction.

The transit time difference Δt is measured allowing to determine the average flow velocity on the propagation path of the ultrasonic signals. A flow profile correction is then performed to obtain the area average of the flow velocity, which is proportional to the volume flow.

The received ultrasonic signals will be tested for usefulness for the measurement and the plausibility of the measured values will be evaluated. The complete measuring procedure will be controlled by the integrated microprocessors. Disturbance signals will be eliminated.

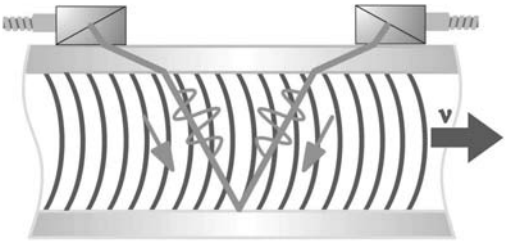


Fig. 3.1: Path of the ultrasonic signal

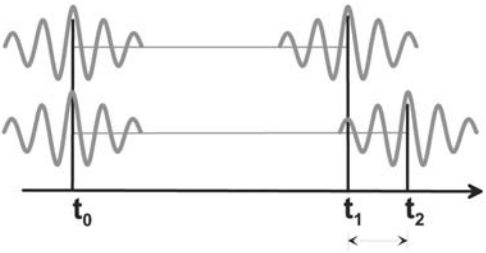


Fig. 3.2: Transit time difference Δt

3.2 Description of the Flowmeter

3.2.1 Design

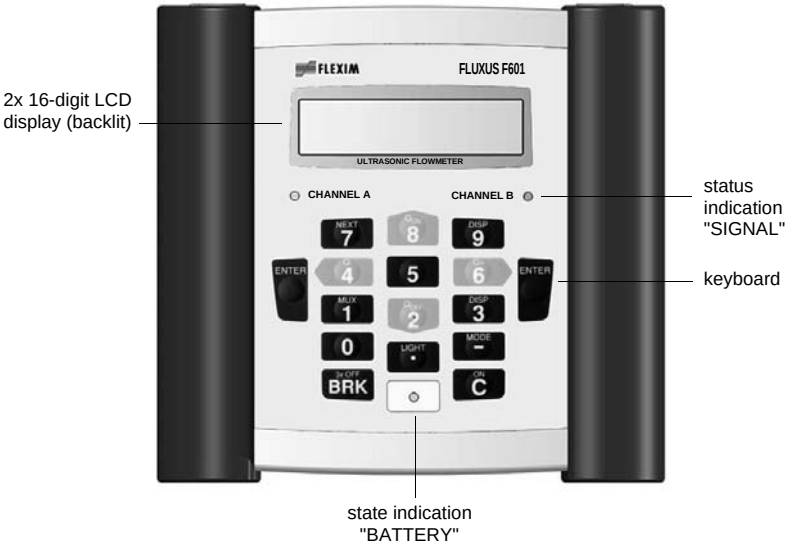


Fig. 3.3: Command panel

A handle is mounted to the back side of the flowmeter which can be used as support (see Fig. 3.4). It will also be used as support. The aperture at the support plate is used to fix the flowmeter to a pipe (see section 3.2.3).

Fig. 3.4: Back side

3.2.2 Connections

The connections are on the upper side of the flowmeter.

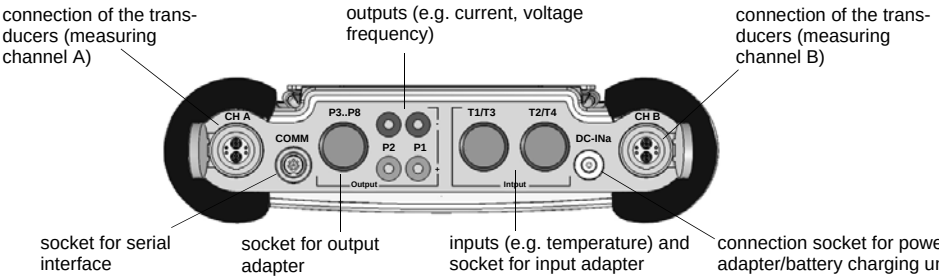


Fig. 3.5: Connections of the flowmeter

The number of outputs can be increased to max. 8 by connecting the output adapter.

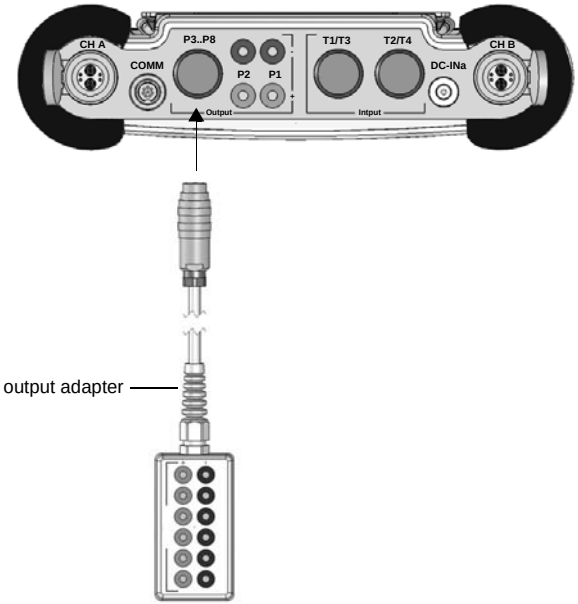


Fig. 3.6: Connection of the output adapter

The number of temperature inputs can be increased to max. 4 by connecting 2 input adapters.

If the flowmeter has current or voltage inputs, the adapter for voltage or current inputs will be used.

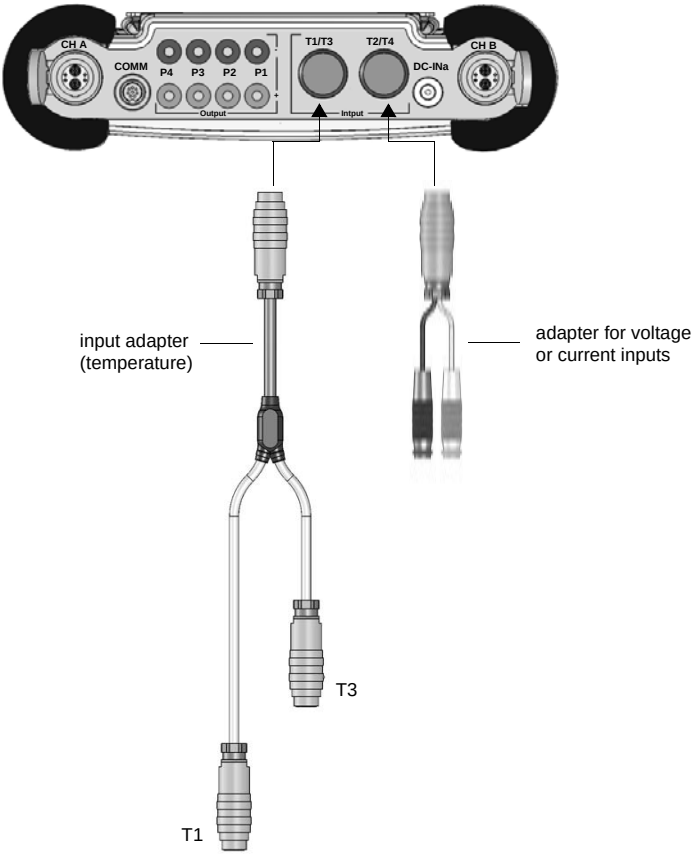


Fig. 3.7: Connection of the input adapter

3.2.3 Installation

Placement

Push the support back to the stop of the support plate.

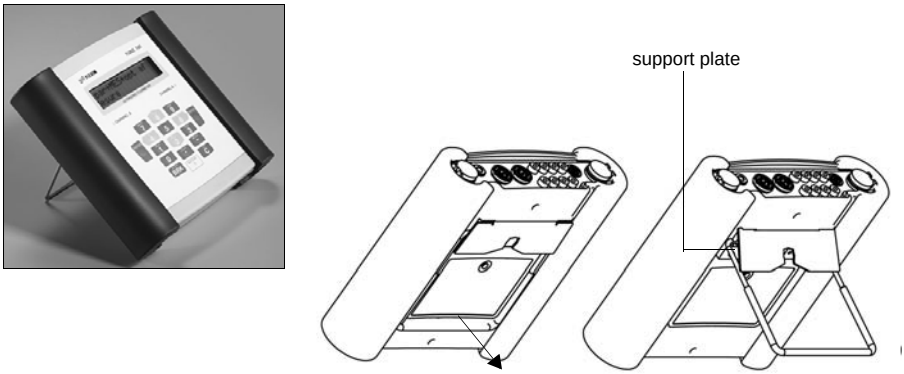


Fig. 3.8: Placing the flowmeter

Hanging

Press both ends of the handle outwards and pass them past the support plate. Turn the handle upwards.

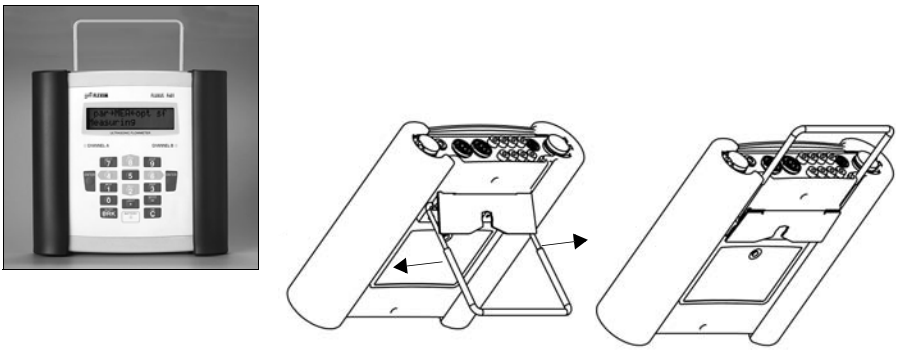


Fig. 3.9: Hanging the flowmeter

Fixing at the Pipe

Attention!	When the flowmeter is fixed to the pipe, the pipe temperature must not exceed the operating temperature of the flowmeter.

Fix the belt with the button to the pipe. Tighten the belt by means of the ratchet. Insert the button into the aperture of the support plate at the back side of the flowmeter.

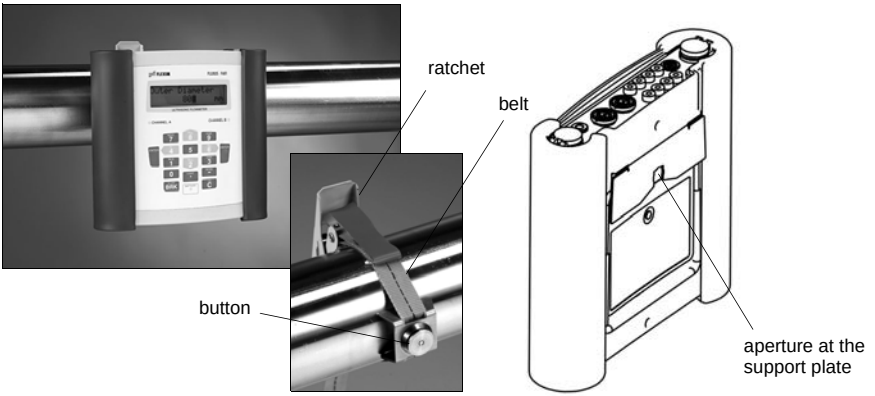


Fig. 3.10: Fixing the flowmeter to the pipe

3.3 Serial Number

Type and serial number are on the data plate on the side of the flowmeter. When contacting FLEXIM, always have both numbers and the number of the firmware version at hand (see section 12.5).

3.4 Keyboard

The keyboard has function keys (ENTER, BRK and C) and numerical keys.

Several keys have double functions. They can be used for data entry and for navigation through scroll lists.

The arrow shaped keys 4, 6, 8 and 2 will be used as cursor keys for scrolling through scroll lists and for input of digits and letters in input mode.

Fig. 3.11: Keyboard

Table 3.1: General functions

C	switching on the flowmeter
LIGHT	switching on/off the backlight of the display
ENTER	confirmation of selection or input
BRK + C + ENTER	RESET: Press simultaneously these three keys to recover from an error. The reset has the same effect as restarting the flowmeter. Stored data will not be affected.
BRK	The flowmeter will be switched off by pressing key BRK three times.
BRK	interruption of the measurement and selection of the main menu **Note:** Be careful not to interrupt a current measurement by inadvertently pressing key BRK!

Table 3.2: Navigation

BRK	selection of the main menu
4 6	scroll to the left or right through a scroll list
8 2	scroll upwards and downwards through a scroll list
ENTER	Confirmation of the selected menu item

Table 3.3: Input of digits

0 … 9	input of the digit shown on the key
−	sign for the input of negative values
.	decimal point
C	delete values. After the value has been deleted, the previous value will be displayed.
ENTER	confirmation of input

Table 3.4: Input of text

4 6	positioning of the cursor
9	changes the currently selected character to an "A"
3	changes the currently selected character to a "Z"
5	changes between small and capital letters
8 2	selection of the previous/next ASCII character
0	deletes the character and inserts a blank
7 … 1	scrolls upwards/downwards through the restricted ASCII character set. The character changes every second. Scrolling will be interrupted by pressing any other key.
ENTER	finishes editing

Table 3.5: Cold start

BRK + C	INIT (cold start): Most parameters and settings are reset to the factory default values. The memory will not be deleted. Keep the two keys pressed while switching on the flowmeter until the main menu is displayed. A cold start during operation is executed as follows: • Press the keys BRK, C and ENTER simultaneously. • Release only key ENTER. A RESET is executed. • Keep the keys BRK and C pressed until the main menu is displayed.

3.5 Power Supply

The flowmeter can be operated by means of the power adapter or the battery.

3.5.1 Operation with Power Adapter

Connect the power adapter with the socket on the upper side of the flowmeter (see Fig. 3.5).

Attention!

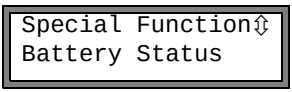
- Use only the power adapter delivered by FLEXIM.
- The power adapter is not moisture proof. Use it only in dry rooms.
- The voltage printed on the power adapter must not be exceeded.
- Do not connect a damaged power adapter with the flowmeter.

3.5.2 Battery Operation

The flowmeter has a Li Ion battery so that it can be operated independently of the power adapter.

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

The charge state of the battery can be displayed during measurement (see section 7.3) and in the program branch SPECIAL FUNCTION:



Select SPECIAL FUNCTION\BATTERY STATUS. Press ENTER.

The current charge state of the battery is displayed (here: 30 %).

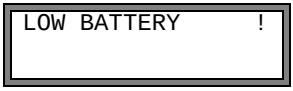
The minus sign "-" indicates that the flowmeter is in battery mode and is being discharged.

The number of cycles the battery has passed is displayed after Cy:.

A cycle corresponds to a charging and discharging process. The life time of the battery can be derived by means of this value.

Note!
If RELEARN in the lower line and a question mark "?" before the current charge state is displayed, a relearn cycle should be started (see section Maintenance below).

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



The capacity is sufficient for the display and storage of the current parameter record. A measurement is impossible.

Charge Battery

Connect the power adapter to the flowmeter. Switch on the flowmeter. Charging starts automatically. The LED "BATTERY" flashes green while charging. The max. charging time is approx. 5 h.

During charging, the ambient temperature should be in the range 0...60 °C.

A measurement can be carried out during charging. Charging will be automatically stopped when the battery is charged completely. The LED "BATTERY" lights green then.

Storing the Battery

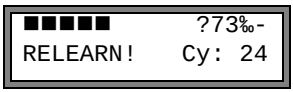
The battery remains in the flowmeter. After storage, the flowmeter can be operated directly with battery.

- charge state: > 30 %
- storing temperature: 12...25 °C

Maintenance (Relearn Cycle)

The accuracy of the displayed value for the charge state will be improved by a relearn cycle. The ambient temperature during a relearn cycle should be in the range 12...30 °C.

Select SPECIAL FUNCTION\BATTERY STATUS. Press ENTER.



The charge state of the battery is displayed (here: 73 %).

The "?" and RELEARN indicate that the value of the displayed charge state is not reliable. A relearn cycle is recommended.

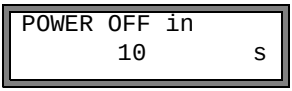
Proceed as follows for a relearn cycle:

- Charge the battery completely. The LED "BATTERY" lights green when charging is finished.
- Discharge the battery completely: Remove the power adapter from the flowmeter. To deactivate the automatic power off during discharging, start a measurement. Discharging takes min. 14 h. The LED "BATTERY flashes red afterwards.

3.5.3 Automatic Power off

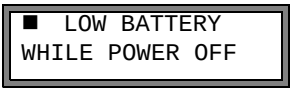
In battery mode, the flowmeter has an automatic power off. The flowmeter will be switched off automatically if

- no measurement is going on and no key is pressed within 10 min or
- the battery is empty



This message will be displayed before the flowmeter is switched off automatically. A countdown with acoustic signal is started.

The countdown can be stopped by pressing any key.



If this message is displayed during switching on, the flowmeter had been switched off automatically due to a too low charge state.

3.6 Status Indication

Table 3.6: LED "SIGNAL"

LED off	flowmeter offline
LED lights green	signal quality of the measuring channel sufficient for measurement
LED lights red	signal quality of the measuring channel insufficient for measurement

Table 3.7: LED "BATTERY"

LED flashes green	battery is being charged
LED lights green	battery is charged
LED off	charge state of the battery > 10 %
LED flashes red	charge state of the battery < 10 %

Note! If the LED "BATTERY" flashes red/green, the power supply has an internal error. Please contact FLEXIM.

4 Selection of the Measuring Point

The correct selection of the measuring point is crucial for achieving reliable measurement results and a high accuracy. A measurement must take place on a pipe in which

- the ultrasound propagates with sufficiently high amplitude (see section 4.1)
- the flow profile is fully developed (see section 4.2)

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.

Because of the variety of applications and the different factors influencing the measurement, there can be no standard solution for the transducer positioning. The correct position of the transducers will be influenced by the following factors:

- diameter, material, lining, wall thickness and form of the pipe
- medium
- presence of gas bubbles in the medium.

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

Avoid locations where deposits are building in the pipe. The ambient temperature at the measuring point must be within the operating temperature range of the transducers.

Select the location of the flowmeter within cable reach of the measuring point. Make sure that the ambient temperature at the location is within the operating temperature range of the flowmeter (see annex A, section Technical Data).

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

4.1 Acoustic Penetration

It must be possible to penetrate the pipe with acoustic signals 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 of pipe and 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 conditions have to be respected at the measuring point:

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

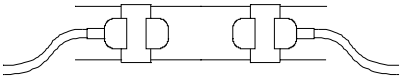
Note!	Even bubble-free media can form gas pockets when the medium expands, e.g. before pumps and after great cross-section extensions.

Table 4.1: Measuring points to be avoided

Horizontal pipe

Select a measuring point where the transducers can be mounted on the side of the pipe, so that the sound waves propagate horizontally in the pipe. Thus, solids deposited on the bottom of the pipe and the gas pockets developing at the top will not influence the propagation of the signal.

correct

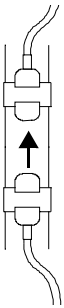


disadvantageous

Vertical pipe

Select the measuring point at a pipe location where the medium flows upwards. The pipe must be completely filled.

correct



disadvantageous

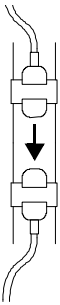
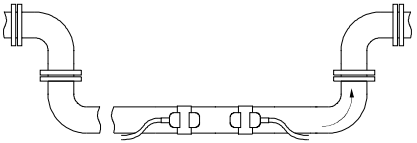


table 4.1: Measuring points to be avoided (continued)

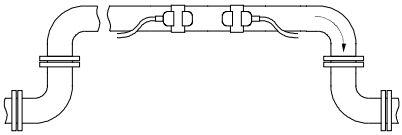
Free supply or return pipe section:

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

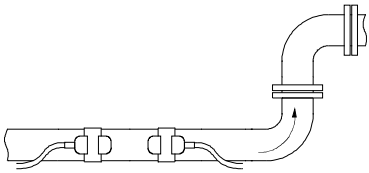
correct



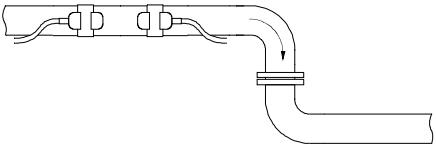
disadvantageous



correct



disadvantageous



4.2 Undisturbed Flow Profile

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

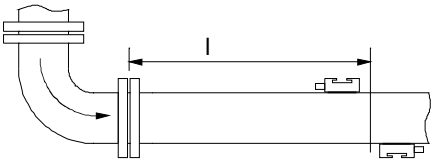
It is most important that the measuring point is selected at a sufficient distance from any disturbance sources. Only then it can be assumed that the flow profile in the pipe is fully developed. However, measuring results can be obtained even if the recommended distance to disturbance sources can not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

Recommended straight inlet and outlet pipe lengths are given for different types of flow disturbance sources in the examples in Table 4.2.

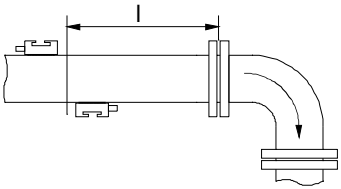
Table 4.2: Recommended distance from disturbance sources
D = nominal pipe diameter at the measuring point, l = recommended distance

disturbance source: 90° elbow

supply: l ≥ 10 D

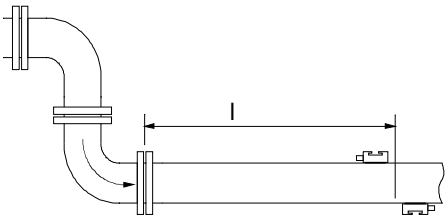


return: l ≥ 5 D

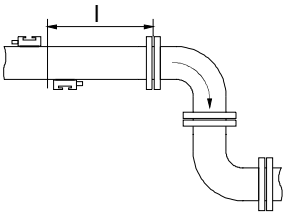


disturbance source: 2x 90 ° elbows in one plane

supply: l ≥ 25 D



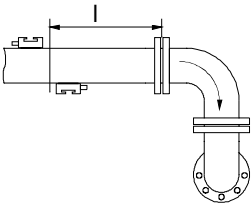
return: l ≥ 5 D



disturbance source: 2x 90 ° elbows in different planes

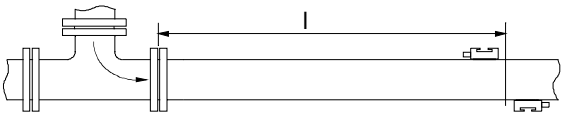
supply: l ≥ 40 D

return: l ≥ 5 D



disturbance source: T piece

supply: l ≥ 50 D



return: l ≥ 10 D

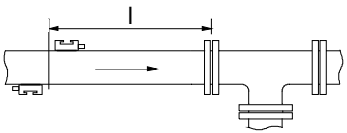
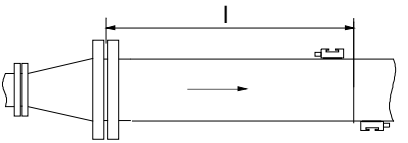


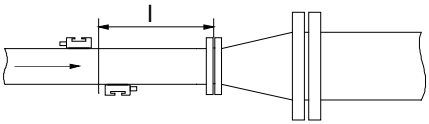
table 4.2: Recommended distance from disturbance sources
D = nominal pipe diameter at the measuring point, l = recommended distance (continued)

disturbance source: diffuser

supply: l ≥ 30 D

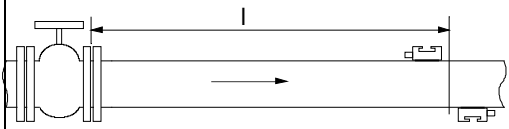


return: l ≥ 5 D

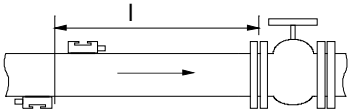


disturbance source: valve

supply: l ≥ 40 D

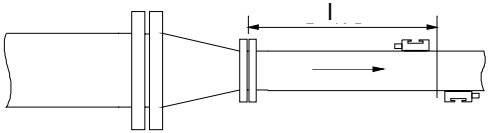


return: l ≥ 10 D

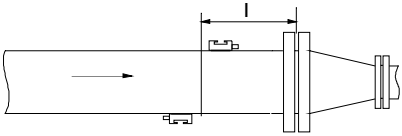


disturbance source: reducer

supply: l ≥ 10 D

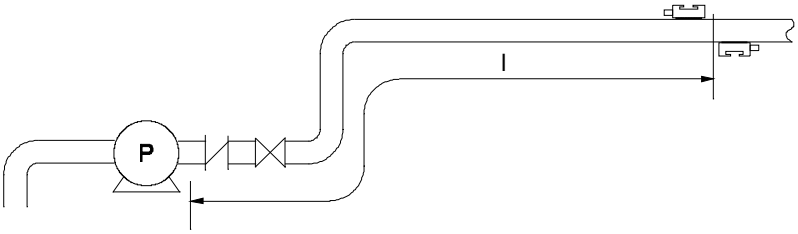


return: l ≥ 5 D



disturbance source: pump

supply: l ≥ 50 D



5 Start-up

5.1 Switching on/off

```
FLEXIM FLUXUS
F601-06010003
```

Press key C to switch on the flowmeter.

After switching on, it is indicated which transducer has been detected on which channel.

Afterwards the serial number of the flowmeter will be displayed for a short time.

Data can not be entered while the serial number is displayed.

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

After initialization, the main menu is displayed in the selected language. The language of the display can be set (see section 5.5).

Press three times BRK to switch off the flowmeter.

5.2 Connection of the Transducers

- Pull up the socket cover.
- Insert the connector of the transducer cable in the socket of the flowmeter. The red point on the connector (a) must face the red marking (b) on the socket (see Fig. 5.1).

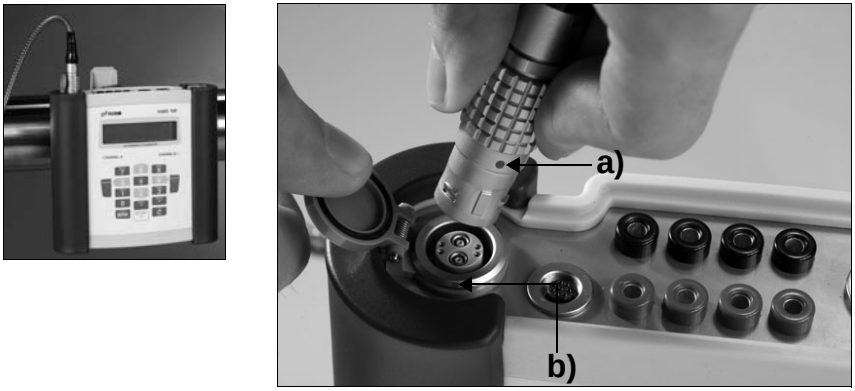
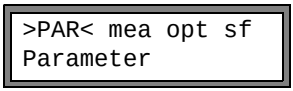


Fig. 5.1: Connection of the transducers to the flowmeter

5.3 Displays

5.3.1 Main Menu



The main menu contains the program branches:

- PAR (parameters)
- MEA (measuring)
- OPT (output options)
- SF (special functions)

The selected program branch is displayed in capital letters between arrows. The full name of the selected program branch is displayed in the lower line.

Select a program branch with key 4 and 6. Press ENTER.

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

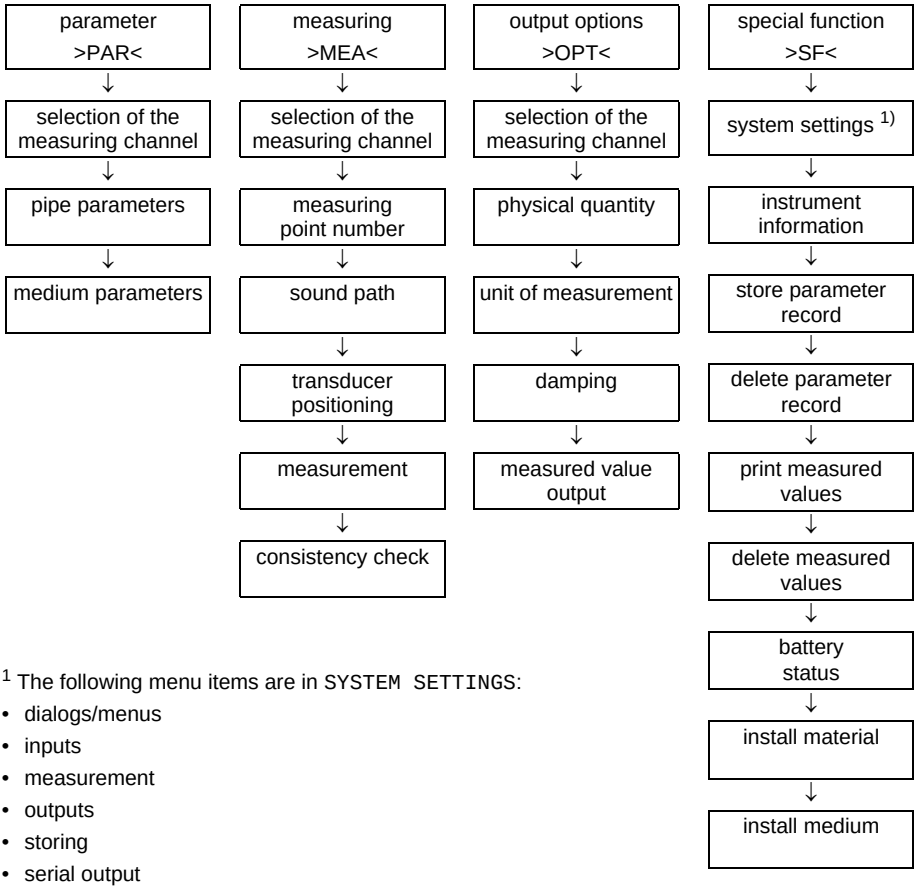
Note!	In this manual, all program entries and keys are indicated in capital letters. Program entries are indicated in typewriter characters (PARAMETER). The menu items will be separated from the main menu by a backslash "\".

5.3.2 The Program Branches and their Menu Items

- The pipe and medium parameters will be input in the program branch PARAMETER.
- The steps for the measurement will be processed in the program branch MEASURING.
- Physical quantity and unit of measurement as well as all parameters necessary for the measured value output will be determined in the program branch OUTPUT OPTIONS.
- All functions that are not directly related with the measurement are in program branch SPECIAL FUNCTION.

For an overview of the program branches see section 5.3.3. For a detailed overview of the menu structure see annex B.

5.3.3 Overview of the Program Branches



[1] The following menu items are in `SYSTEM SETTINGS`:

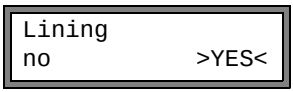
- dialogs/menus
- inputs
- measurement
- outputs
- storing
- serial output
- miscellaneous
- set clock
- libraries

5.3.4 Navigation

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

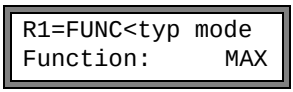
Scroll with key 8 and 2 to select a list item in the lower line. Press ENTER.

In some menu items, there is a horizontal scroll list in the lower line. The selected list item is displayed in capital letters between arrows.



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

In some menu items, there is a horizontal scroll list in the upper line. The selected list item is displayed in capital letters between arrows. The current value of the list item is displayed in the lower line.



Scroll with key 4 and 6 to select a list item in the upper line.

Scroll with key 8 and 2 to select a value for the selected list item in the lower line.

Press ENTER.

5.4 HotCodes

A HotCode is a key sequence activating some settings:

- language selection (see section 5.5)
- switching on the SuperUser mode (see section 14)
- switching on the FastFood mode (see section 8.6)
- manual input of the lower limit for the inner pipe diameter (see section 8.8)

A HotCode can be entered only in the main menu directly after the flowmeter has been switched on. The HotCode will not be displayed during input.

5.5 Language Selection

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

Table 5.1: Language HotCodes

909031	Dutch
909033	French
909034	Spanish
909044	English
909049	German

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

When the last digit is entered, the main menu will be displayed in the selected language. The selected language remains activated after switching the flowmeter off and on again.

Note! After initialization of the flowmeter the default language will be set (key BRK and C when switching on).

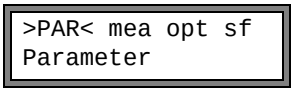
6 Basic Measurement

The pipe and medium parameters will be entered for the selected measuring point (see chapter 4). The pipe and medium parameter range are limited by the characteristics of the transducers and of the flowmeter.

Note!	The transducers have to be connected to the flowmeter during input of the parameters.

Note!	The parameters will be stored only if the program branch PARAMETER is finished completely once.

6.1 Input of the Pipe Parameters



Select the program branch PARAMETER. Press ENTER.

Select the channel for which parameters are to be entered. Press ENTER.

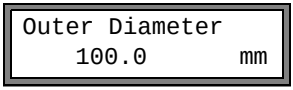
This display will not be indicated, if the flowmeter has only one measuring channel.

If PARAMETER FROM is displayed, at least one parameter record is stored in the flowmeter and can be selected. A parameter set contains all data necessary for a measurement:

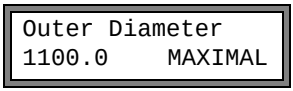
- pipe parameters
- medium parameters
- transducer parameters
- output options

A parameter record can be defined for each measuring task (see chapter 10).

6.1.1 Outer Pipe Diameter/Pipe Circumference



Enter the outer pipe diameter. Press ENTER.



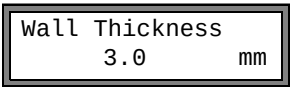
An error message will be displayed if the entered parameter is not within the range. The limit will be displayed.

example: upper limit 1100.0 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 12.2.1). The setting is activated in the program branch SPECIAL FUNCTION. The setting is cold start resistant.

If the input of the pipe circumference is activated and 0 (zero) is entered for the OUTER DIAMETER, the menu item PIPE CIRCUMFER. will be displayed automatically. If the pipe circumference is not to be entered, press BRK to return to the main menu and start the parameter input again.

6.1.2 Pipe Wall Thickness

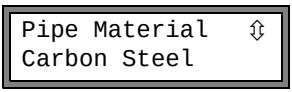


Enter the pipe wall thickness. The range depends on the connected transducers. Default is 3.0 mm. Press ENTER.

Note!	The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness) will be calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed. It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 8.8).

6.1.3 Pipe Material

The pipe material has to be selected to determine the sound velocity. The sound velocity for the materials in the scroll list are stored in the flowmeter.

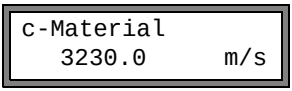


Select the pipe material from the scroll list.

If the material is not in the scroll list, select OTHER MATERIAL. Press ENTER.

The materials to be displayed in the scroll list can be selected (see section 11.5).

When the pipe material is selected, the corresponding sound velocity is set automatically. If OTHER MATERIAL is selected, the sound velocity has to be entered.



Enter the sound velocity of the pipe material.

Values between 600.0 m/s and 6553.5 m/s will be accepted. Press ENTER.

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

For the sound velocity of some materials see annex C, Table C.1.

6.1.4 Pipe Lining

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

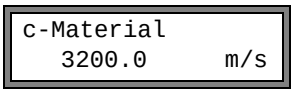
If NO is selected, the next parameter will be displayed (see section 6.1.5).

Select the lining material.

If the material is not in the scroll list, select OTHER MATERIAL. Press ENTER.

The materials to be displayed in the scroll list can be selected (see section 11.5).

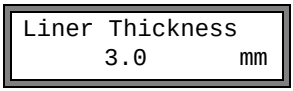
If OTHER MATERIAL is selected, the sound velocity has to be entered.



Enter the sound velocity of the lining material. Values between 600.0 m/s and 6553.5 m/s will be accepted.

Press ENTER.

For the sound velocity of some materials see annex C, Table C.1.



Enter the thickness of the liner. Default is 3.0 mm.

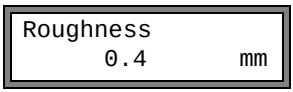
Press ENTER.

Note!	The inner pipe diameter (= outer pipe diameter - 2x pipe wall thickness - 2x liner thickness) will be calculated internally. If the value is not within the inner pipe diameter range of the connected transducers, an error message will be displayed. It is possible to change the lower limit of the inner pipe diameter for a given transducer type (see section 8.8).

6.1.5 Pipe Roughness

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

For the roughness of some materials see annex C, Table C.2. The values are based on experience and measurements.

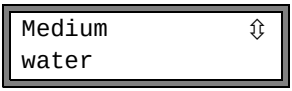


Enter the roughness of the selected pipe or liner material.

Values between 0.0 mm and 5.0 mm will be accepted. Default for steel as pipe material is 0.1 mm.

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

6.2 Input of the Medium Parameters



Select the medium from the scroll list.

If the medium is not in the scroll list, select OTHER MATERIAL. Press ENTER.

The media to be displayed in the scroll list can be selected (see section 11.5).

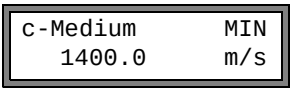
For the programmed parameters of common media see annex C, Table C.3.

If a medium is selected from the scroll list, the menu item for the input of the medium temperature is displayed directly (see section 6.2.4). If OTHER MEDIUM is selected, the medium parameters have to be entered first:

- min. and max. sound velocity
- kinematic viscosity
- density

6.2.1 Sound Velocity

The sound velocity of the medium is used for the calculation of the transducer distance at the beginning of the measurement. However, the sound velocity does not influence the measuring result directly. Often, the exact value of the sound velocity for a medium is unknown. A range of possible values for the sound velocity must therefore be entered. These displays will be indicated only if OTHER MEDIUM has been selected.

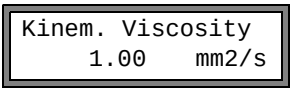


Enter the min. and max. sound velocity of the medium.

Values between 500.0 m/s and 3500.0 m/s will be accepted. Press ENTER after each input.

6.2.2 Kinematic Viscosity

The kinematic viscosity influences the flow profile of the medium. The entered value and other parameters will be used for the profile correction. This display will be indicated only if OTHER MEDIUM has been selected.

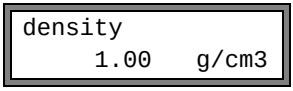


Enter the kinematic viscosity of the medium. Values between 0.01 mm^2/s and 30 000.00 mm^2/s will be accepted. Press ENTER.

6.2.3 Density

The mass flow will be calculated on the base of the density (product of volume flow and density). This display will be indicated only if OTHER MEDIUM is selected.

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



Enter the operating density of the medium.

Press ENTER.

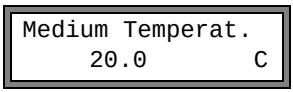
Values between 0.01 g/cm^3 and 20.00 g/cm^3 will be accepted.

6.2.4 Medium Temperature

The medium temperature is used for the interpolation of the sound velocity and for the calculation of the recommended transducer distance at the beginning of the measurement.

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

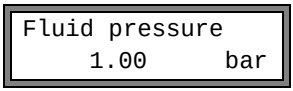
The value entered here will be used for the calculations if the medium temperature is not measured and fed to an input of the flowmeter.



Enter the medium temperature. The value must be within the operating temperature range of the transducers. Default is 20 °C. Press ENTER.

6.2.5 Medium Pressure

The medium pressure is used for the interpolation of the sound velocity. This display will be indicated only if SPECIAL FUNCTIONS\SYSTEM SETTINGS\DIALOGS/ MENUS\FLUID PRESSURE is activated.



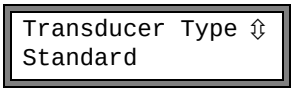
Enter the medium pressure. Values between 1.00 bar and 600.00 bar will be accepted.

6.3 Other Parameters

6.3.1 Transducer Parameters

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

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



Select STANDARD to use the standard transducer parameters stored in the flowmeter.

Select SPECIAL VERSION to enter the transducer parameters. The parameters have to be provided by the transducer manufacturer.

Press ENTER.

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

```
Transd. Data    1
   35.99
```

If SPECIAL VERSION is selected, enter the 6 transducer parameters specified by the manufacturer. Press ENTER after each input.

6.4 Selection of the Channels

The channels on which will be measured can be activated individually. This is only possible if the flowmeter has more than one measuring channel.

```
par >MEA< opt sf
MEASURING
```

Select the program branch MEASURING. Press ENTER.

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

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

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

The channels for the measurement can be activated and deactivated.

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

The symbols mean:

✓: the channel is active

–: the channel is not active

•: the channel can not be activated

Note!	A measuring channel can not be activated if the parameters are not valid, e.g. if the parameters in the program branch PARAMETER of the channel are not complete.

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

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

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

```
Meas. Point No.:
1          (↑↓←→)
```

If arrows are displayed, ASCII text can be entered.

If digits are displayed, only digits, point and hyphen can be entered.

Enter the measuring point number. Press ENTER.

6.5 Define Number of Sound Paths

The number of transits of the ultrasonic waves through the medium depends on the placement of the transducers on the pipe.

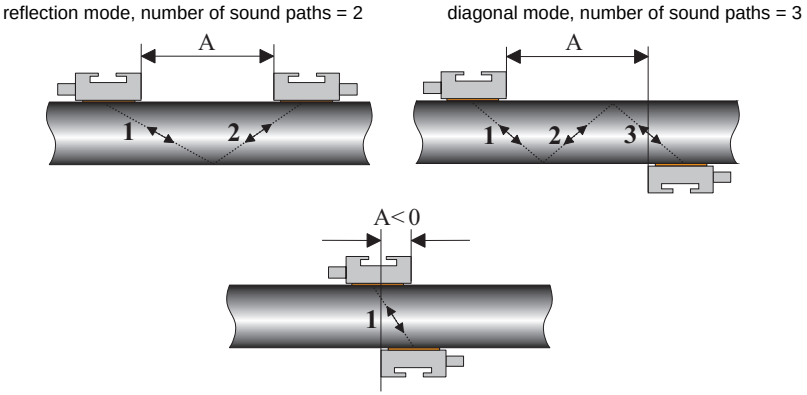


Fig. 6.1: Sound path and transducer distance (A)

At an odd number of transits (diagonal mode), the transducers will be mounted on opposite sides of the pipe.

At an even number of transits (reflection mode), the transducers will be mounted on the same sides of the pipe.

An increased number of transits means increased accuracy of the measurement. However, the increased transit distance leads to a higher attenuation of the signal.

The reflections on the opposite pipe wall and deposits on the inner pipe wall cause additional amplitude losses of the sound signal.

If the signal is attenuated strongly by the medium, the pipe, deposits, etc., the number of sound paths has to be set to 1 if necessary.

```
A: Sound Path
        2        NUM
```

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

6.6 Mounting and Positioning the Transducers

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

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

- Clean the pipe at the transducer positions.
- Remove rust or loose paint. An existing paint layer on the pipe should be smoothed for a better measuring result.
- Use coupling foil or apply a bead of acoustic coupling compound along the center line onto the contact surface of the transducer.
- Air pockets must not be between transducer contact surface and pipe wall.
- Make sure that the transducer mounting fixture applies the necessary pressure on the transducers.

The transducer will be mounted that the engravings on the transducers form an arrow (see Fig. 6.2). The transducer cables show then in opposite directions. The arrow indicates the positive flow direction (see section 6.8).

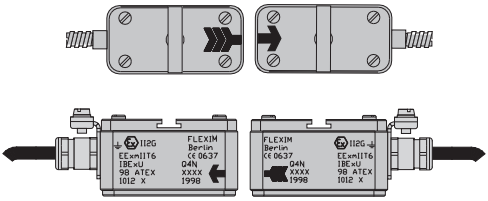


Fig. 6.2: Correct positioning of the transducers

6.6.1 Transducer Distance

```
Transd. Distance
A:54 mm Reflec
```

A value for the transducer distance will be recommended. Mount the transducers on the pipe adjusting this value (see section 6.6). Press ENTER.

A - measuring channel
`REFLEC` - reflection mode
`DIAGON` - diagonal mode

The transducer distance given here is the distance between the inner edges of the transducers. A negative transducer distance is possible for a measurement in diagonal mode on very small pipes (see Fig. 6.1).

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

Select the installation instructions corresponding to the supplied transducer mounting fixture:

6.6.2 Mounting the Transducers with Fastening Shoes and Chains

- Insert the transducers in the fastening shoes. Turn the screw on top of the fastening shoes by 90 ° to engage and lock its end in the groove on the top of the inserted transducer.

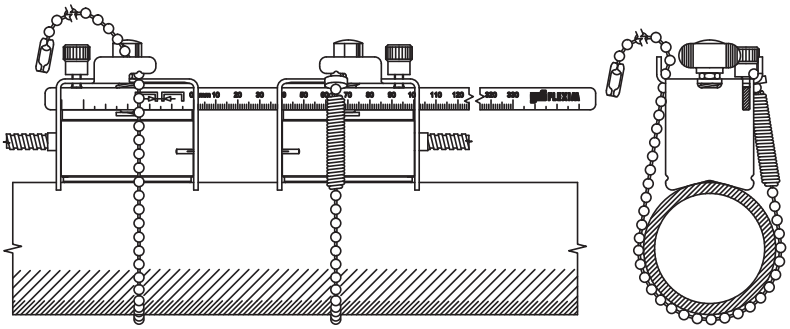


Fig. 6.3: Mounting the transducers with fastening shoes and chains

- Insert the ruler in the lateral slots of the fastening shoes. Adjust the transducer distance to the displayed value (see section 6.6.1). Fix the transducers by the plastic screws on the transducer cable side of the fastening shoe.
- Place the fastening shoes/ruler assembly on the pipe at the measuring point. Insert the last ball in the slot on the top of a fastening shoe.
- Lay the chain around the pipe. When the transducers are mounted to a vertical pipe and the flowmeter is placed lower than the pipe, the cable of the upper transducer should be slipped under the chain to protect the cable from mechanical strain.
- Pull the chain firmly and insert it in the second slot of the fastening shoe. Fix the second transducer in the same way.

Extension of the Ball Chain

To extend the chain, insert the last ball of the extension in the fastening clip of the ball chain. The spare fastening clips supplied with the chain can be used to repair a broken chain.

6.6.3 Mounting the Transducers with Magnetic Fastening Shoes

- Insert the transducers in the fastening shoes. Turn the screw on top of the fastening shoes by 90° in order to engage and lock its extremity in the groove on the top of the inserted transducer. Apply acoustic coupling compound to the contact surface of the transducers.
- Insert the ruler in the lateral slot of the fastening shoes.
- Adjust the transducer distance to the displayed value (see section 6.6.1). Fix the transducers by means of the small plastic screws on the transducer cable side of the fastening shoe.
- Place the fastening shoes/ruler assembly on the pipe at the measuring point. Air pockets must not be between transducer contact surface and pipe wall. Adjust the transducer distance again.

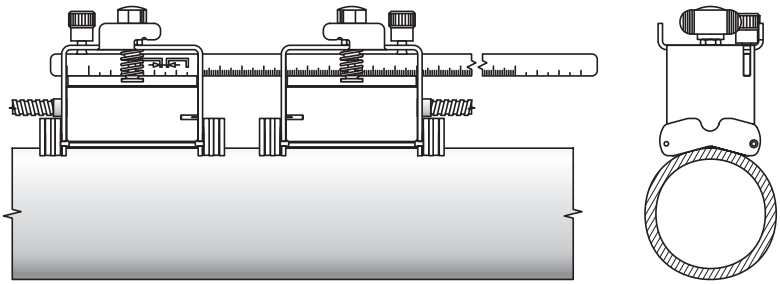
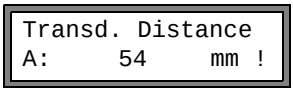


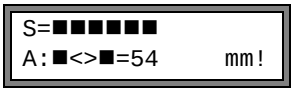
Fig. 6.4: Mounting the transducers with magnetic fastening shoes

6.6.4 Fine Adjustment of the Transducer Distance



If the displayed transducer distance is adjusted, press ENTER.

The positioning procedure is started.

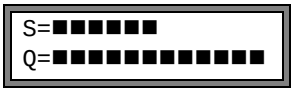


A bar graph S= displays the amplitude of the received signal.

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

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

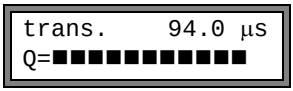
Shift the transducer slightly in the range of the recommended transducer distance until the LED of the measuring channel lights green.



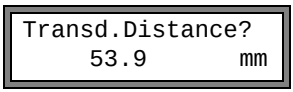
The following can be displayed in the upper line with key 9 DISP and in the lower line with key 3 DISP:

- transducer distance
- bar graph Q= (signal quality), must have max. length
- transit time TRANS. in µs
- bar graph S= (signal amplitude)

If the signal is not sufficient for measurement, Q= UNDEF will be displayed.



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



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

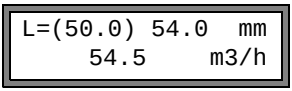
Enter the actual (precise) transducer distance. Press ENTER.

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

6.6.5 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 9.



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

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

If the difference of optimum and entered transducer distance is less than specified in Table 6.1 or Table 6.2, the measurement is consistent and the measured values are valid. The measurement can be continued.

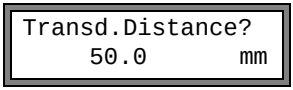
If the difference is greater, adjust the transducer distance to the displayed optimum value. Afterwards, check the signal quality and the signal amplitude bar graph (see section 6.6.4). Press ENTER.

Table 6.1: Standard values for signal optimization of shear wave transducers

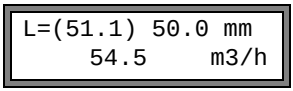
transducer frequency	difference between optimum and entered transducer distance [mm]
S	3
Q	6
P	8
M	10
K	15
G	20

Table 6.2: Standard values for signal optimization of Lamb wave transducers

transducer frequency	difference between optimum and entered transducer distance [mm]
P	- 6...+10
M	-10...+20
K	-25...+40
H	-35...+60
G	-50...+100



Enter the new adjusted transducer distance. Press ENTER.



Scroll with key [9] again until the transducer distance is displayed and check the difference between optimum and adjusted transducer distance. Repeat the steps if necessary.

Note!	Never change the transducer distance during measurement without having restarted the consistency check.

Repeat the steps for all channels on which will be measured.

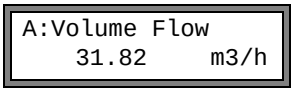
6.6.6 Value of the Sound Speed

The sound velocity of the medium can be displayed during measurement by pressing key [3].

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 6.6.5, it is recommended to note the sound velocity for the next measurement. The optimization procedure does not need to be repeated then.

Also take note of the temperature of the medium as the sound speed depends on the temperature. The value can be entered in the program branch PARAMETER or a user defined medium can be defined for this sound velocity (see section 11.2 and 11.3).

6.7 Start of Measurement



The measured values will be displayed in the lower line. Press ENTER to return to the fine adjustment of the transducer distance (see section 6.6.4).

If more than one measuring channel is available/activated, the flowmeter works with an integrated measuring point multiplexer providing quasi simultaneous measurement on the different measuring channels. The flow is measured on one channel for approx. 1 second, then the multiplexer switches to the next activated channel. The LED of an activated channel lights as the measurement takes place. The measuring time depends on the measuring conditions. If, e.g. the measuring signal can not be detected immediately, the measurement might take longer than 1 s.

The outputs and the serial interface continuously get the measuring results of the assigned channel. The results will be displayed according to the actually selected output options (see chapter 7). The default unit of measurement of the volume flow is m^3/h. For the selection of the values to be displayed and for setting of the output options see chapter 7. For further measuring functions see chapter 8.

6.8 Recognition of Flow Direction

The flow direction in the pipe can be recognized with the help of the displayed volume flow in conjunction with the arrow engraved on the transducers:

- The medium flows in arrow direction if the display shows a positive flow reading (e.g. 54.5 m^3/h).
- The medium flows against the arrow direction if the display shows a negative flow reading (e.g. -54.5 m^3/h).

6.9 Stopping the Measurement

The measurement can be interrupted at any time by pressing key BRK.

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

7 Displaying the Measured Values

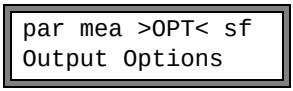
The physical quantity will be set in the program branch OUTPUT OPTIONS (see section 7.1). The designation of the physical quantity will be displayed normally in the upper line, its value in the lower line. The display can be adapted (see section 7.3).

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

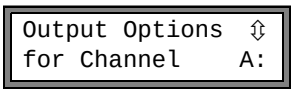
The following quantities can be measured:

- **sound velocity**
- **flow velocity**: is calculated on the basis of the measured transit time difference
- **volume flow**: will be calculated by multiplying the flow velocity by the cross-section of the pipe
- **mass flow**: will be calculated by multiplying the volume flow by the operating density of the medium
- **heat flow (option)**: will be calculated on the basis of the volume flow, the measured temperatures of the supply and return lines and the heat flow coefficients of the medium

The physical quantity will be selected as follows:

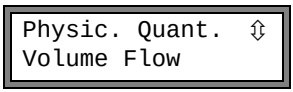


Select the program branch OUTPUT OPTIONS. Press ENTER.

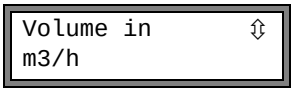


Select the channel for which the output options are to be entered. Press ENTER.

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



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



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

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

Return to the main menu by pressing key BRK. The further menu items of the program branch OUTPUT OPTIONS are for the activation of the measured value output.

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

7.2 Toggling between the Channels

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

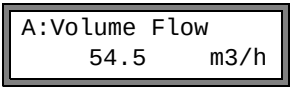
- AutoMux mode
  - all channels
  - only calculation channels
- HumanMux mode

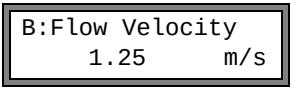
With key [1 MUX] will be toggled between the modes.

7.2.1 AutoMux Mode

In AutoMux mode, the display and the measuring process are synchronized. The channel on which is being measured will be displayed left in the upper line.

The measured values will be displayed as configured in the program branch `OUTPUT OPTIONS` (see section 7.1). When the multiplexer switches to the next channel, the display is actualized.





The AutoMux mode is the default display mode. It will be activated automatically after a cold start.

All Channels

The measured values of all channels (measuring and calculation channels) will be displayed. The next active channel is selected after min. 1.5 s.

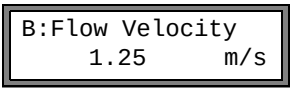
Only Calculation Channels

The measured values of the calculation channels will be displayed only. The next active calculation channel is selected after min. 1.5 s.

Note!	This mode can only be activated if min. two calculation channels are activated.

7.2.2 HumanMux Mode

The measured values of one channel will be displayed in HumanMux mode. The measurement on the other channels will be continued, but not displayed:



The selected channel will be displayed left in the upper line.

Press key [NEXT 7] to display the next activated channel. The measured values of the selected channel will be displayed as configured in the program branch `OUTPUT OPTIONS` (see section 7.1).

7.3 Adjustment of the Display

During measurement, the display can be adjusted as to display two measured values simultaneously (one in each line of the display). This does not have influence on the totalizing, the storing of measured values, the measured value output, etc.

The following information can be displayed in the upper line:

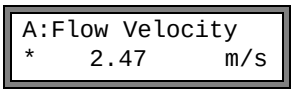
- designation of the physical quantity
- totalizer values, if activated
- linked temperatures and their difference (if the temperature is measured)
- date and time at which the memory will be full
- measuring mode
- transducer distance
- remaining time until the time programmable measurement is automatically stopped
- alarm state indication, if activated (see section 18.7.5) and if alarm outputs are activated
- charge state of the battery

The following information can be displayed in the lower line:

- flow velocity
- sound velocity
- mass flow
- volume flow
- heat flow

The display in the upper line can be changed during measurement with key DISP 9.

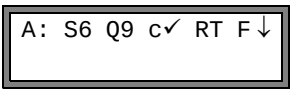
The display in the lower line can be changed during measurement with key 3 DISP.



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

7.4 Status Line

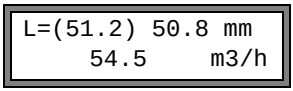
Important data on the current measurement are summarized in the status line. Thus, quality and precision of the current measurement can be estimated.



The status line will be selected by scrolling during measurement with key 9 through the upper line.

	value	explanation
S		**signal amplitude**
	0	< 5 %
	…	…
	9	≥ 90 %
Q		**signal quality**
	0	< 5 %
	…	…
	9	≥ 90 %
c		**sound velocity**: comparison of the measured and expected sound velocity of the medium. The expected sound velocity is calculated on the basis of the medium parameters (medium selected in program branch PARAMETER, temperature dependency, pressure dependency).
	√	ok, corresponds to the expected value
	↑	> 20 % of the expected value
	↓	< 20 % of the expected value
	?	unknown, can not be measured
R		**flow profile** information about the flow profile based on the Reynold's number
	T	fully turbulent flow profile
	L	fully laminar flow profile
	↕	the flow is in the transition range between laminar and turbulent flow
	?	unknown, can not be calculated
F		**flow velocity** comparison of the measured flow velocity with the flow limits of the system
	√	ok, flow velocity is not in a critical range
	↑	the flow velocity is higher than the actual limit
	↓	the flow velocity is lower than the actual 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, can not be measured

7.5 Transducer Distance



By pressing key [DISP 9] it is possible during measurement to scroll to the display of the transducer distance.

The optimum transducer distance will be displayed in parentheses (here: 51.2 mm) followed by the entered transducer distance (here: 50.8 mm).

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

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

Note!	Never change the transducer distance during measurement!

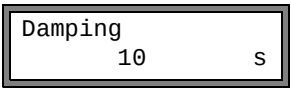
8 Advanced Measuring Functions

8.1 Damping Factor

Each displayed measured value is the floating average of all measured values of the last x seconds, where x is the damping factor. A damping factor of 1 s means that the measured values are not averaged as 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 larger damping factor.

Select the program branch `OUTPUT OPTIONS`. Press ENTER until the menu item `DAMPING` is displayed.



Enter the damping factor. Values between 1 s and 100 s will be accepted. Press ENTER.

Press BRK to return to the main menu.

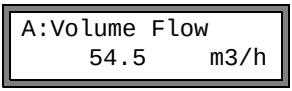
8.2 Totalizers

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

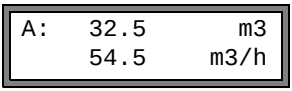
There are two totalizers, one for the positive flow direction, one for the negative flow direction.

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

The value of a totalizer consists of max. 11 digits, including max. 3 decimal places.



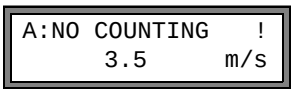
To activate the totalizers, press key  during measurement (see Table 8.1).



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

Table 8.1: Keys for display of the totalizers

activation	press key 8 once during measurement
deactivation	press key 2 three times during measurement
display of the totalizer for the positive flow direction	press key 4 once during measurement
display of the totalizer for the negative flow direction	press key 4 once during measurement
reset the totalizers to zero	press key 8 three times during measurement



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

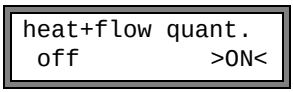
Note! The totalizers can only be activated for the measuring channel whose measured values are just displayed.

Note! A keystroke will influence the totalizers only if the totalizer is displayed in the upper line.

8.2.1 Store the Totalizer Values

During Heat Flow Measurement

It is possible to output and store the values of the heat quantity totalizer and of the volume flow totalizer during heat flow measurement. Select in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING the menu item HEAT+FLOW QUANT. The setting is cold start resistant.

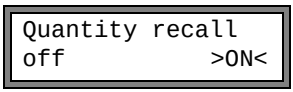


Select ON to store and output the values of heat quantity totalizer and volume flow totalizer during heat flow measurement.

Press ENTER.

When the Measurement is Interrupted

The behavior of the totalizers after an interruption of the measurement or after a RESET of the flowmeter will be set in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING\QUANTITY RECALL. The setting is cold start resistant.



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.

Selection of the Totalizers for Storage

It is possible to store only the value of the totalizer currently displayed or one value for each flow direction. Select in SPECIAL FUNCTION\SYSTEM SETTINGS\STORING the menu item QUANTITY STORAGE. The setting is cold start resistant.

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

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

Press ENTER.

8.2.2 Overflow of the Totalizers

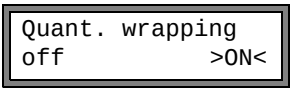
The overflow behavior of the totalizers can be set:

Without overflow: The value of the totalizer increases to the internal limit of 10^{38}.

The values will be displayed as exponential numbers (±1.00000E10), if necessary. The totalizer can only be reset to zero manually.

With overflow: The totalizer will be reset to zero automatically as soon as ±9999999999 is reached.

Select in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING the menu item QUANT. WRAPPING. The setting is cold start resistant.



Select ON to work with overflow. Select OFF to work without overflow.

Independently of the selected list item, the totalizers can be reset manually to zero.

Note!

The overflow of a totalizer influences all output channels, e.g. data memory, online output.

The output of the sum of both totalizers (the throughput ΣQ) via an output will not be valid after the first overflow (wrapping) of one of the respective totalizers.

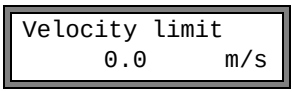
To signalize the overflow of a totalizer, an alarm output with the switching condition QUANTITY and the type HOLD has to be activated.

8.3 Upper Limit of the Flow Velocity

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

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

The upper limit of the flow velocity will be set in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING. The setting is cold start resistant.



Select the menu item VELOCITY LIMIT.

Enter 0 (zero) to switch off the detection of outliers.

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

Values between 0.1 m/s and 25.5 m/s will be accepted.

Press ENTER.

If the flow velocity is higher than the upper limit,

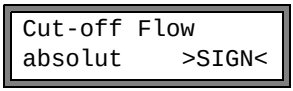
- the flow velocity will be marked as invalid. The physical quantity can not be determined.
- the LED of the measuring channel will light red
- "!" will be displayed after the unit of measurement (in case of a normal error, "?" will be displayed

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

8.4 Cut-off Flow

The cut-off flow function automatically sets all measured flow velocities to zero that are below a preset value. All values derived from this measured value will be also set to zero.

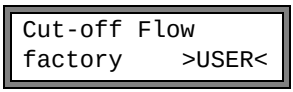
The cut-off flow can depend on the flow direction or not. Default is 2.5 cm/s (0.025 m/s). The max. value is 12.7 cm/s (0.127 m/s). The cut-off value will be set in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING. The setting is cold start resistant.



Select SIGN to define a cut-off flow dependent on the flow direction. There are two independent limits to be set for the positive and negative flow directions.

Select ABSOLUTE to define a cut-off flow independent of the flow direction. There is only one limit to be set.

The absolute value of the measured value will be compared to the cut-off flow.

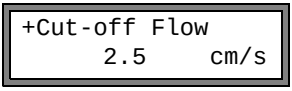


Select FACTORY to use the default value of 2.5 cm/s (0.025 m/s) for the cut-off flow.

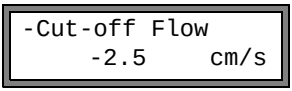
Select USER to enter the cut-off flow.

Press ENTER.

If CUT-OFF FLOW\SIGN and USER are selected, two values have to be entered:

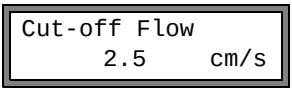


Enter the cut-off flow for positive measured values. All positive values of the flow velocity less than this limit, will be set to zero.



Enter the cut-off flow for negative measured values. 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 has to be entered:

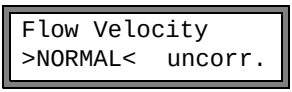


The limit will be compared to the absolute value of the measured flow velocity.

8.5 Uncorrected Flow Velocity

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

The profile correction of the flow velocity will be activated in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING\FLOW VELOCITY. The setting is cold start resistant.

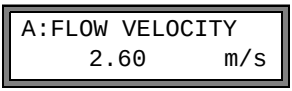


Select NORMAL to display and output the flow velocity with profile correction.

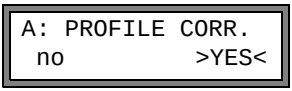
Select UNCORR. to display the flow velocity without profile correction. Press ENTER.

If UNCORR. is selected, it has to be confirmed each time the program branch MEASURING is selected whether to use the profile correction.

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



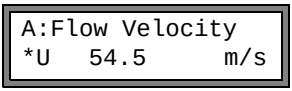
All measured quantities will be calculated with the uncorrected flow velocity. In this case, the designation of the physical quantities will be displayed in capital letters.



If YES is selected, the uncorrected flow velocity will be used only when the flow velocity is selected as physical quantity in the program branch OUTPUT OPTIONS.

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

During measurement, the designation flow velocity will be displayed in capital letters, indicating that the displayed flow velocity is uncorrected. Press ENTER.



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

Scroll with key 3 DISP until the flow velocity is displayed. The uncorrected flow velocity is marked by U.

Uncorrected flow velocities transmitted to a PC will be marked by UNCORR.

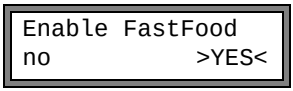
8.6 Measurement of Transient Processes (FastFood Mode)

The FastFood mode allows to measure flows with high dynamics. A storage rate of approx. 70 ms can be reached. The continuous adaptation to changing measuring conditions which takes place in the normal measuring mode is only partially realized in FastFood mode.

The sound velocity of the medium is not measured. The flow velocity stored in the internal database will be used instead, taking into account the medium temperature entered in the program branch PARAMETER (or the measured temperature if the medium temperature is measured).

A change of the measuring channel is not possible. The inputs and outputs can still be used. The measured values will be stored as usual. The FastFood mode has to be enabled and activated.

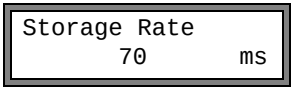
8.6.1 Enabling/Disabling the FastFood Mode



Enter HotCode 007022 directly after the flowmeter has been switched on. The menu item ENABLE FASTFOOD will be displayed.

Select YES to enable the FastFood Mode, NO to disable it.

8.6.2 Storage Rate of the FastFood Mode

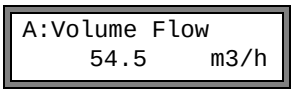


When the FastFood mode is enabled, a STORAGE RATE in ms has to be entered in the program branch OUTPUT OPTIONS.

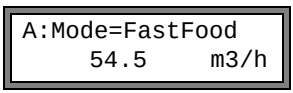
Enter a storage rate. Values ≥ 64 ms will be accepted. Press ENTER.

8.6.3 Activating/Deactivating the FastFood Mode

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



Press key 0 to activate/deactivate the FastFood mode for the measuring channel currently displayed.



Scroll with key DISP 9 in the upper line until the activated measuring mode A:MODE=FASTFOOD or A:MODE=TRANSTIME will be displayed.

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

Note!	The values of the current measuring data set will be deleted when the FastFood mode is deactivated and activated again without interrupting the measurement.

Note!	The values of the current measuring data set is kept if the measurement has been interrupted before the FastFood mode is activated again. A new measuring data set will be created when the next measurement is started.

8.7 Calculation Channels

Additionally to the ultrasonic measuring channels, the flowmeter has two virtual calculation channels Y and Z. The measured values of the measuring channels A and B will be summed up by the calculation channels.

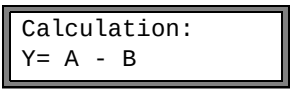
The result of the calculation is the measured value of the selected calculation channel. This measured value is equivalent to the measured values of a measuring channel. All operations with the measured values of a measuring channel (totalizing, online output, storing, outputs, etc.) can be done with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

8.7.1 Characteristics of the Calculation Channels

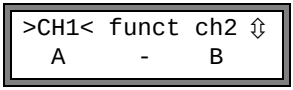
- In the program branch PARAMETER, the measuring channels to be used for the calculation and the calculation function have to be entered.
- A calculation channel can not be attenuated. The damping factor has to be set separately for each of the two measuring channels.
- Two cut-off flows for each calculation channel can be defined. The cut-off flow is not based on the flow velocity as for measuring channels. Instead it will be defined in the unit of measurement of the physical quantity selected for the calculation channel. During measurement, the calculated values are compared to the cut-off flow values and set to zero if necessary.
- A calculation channel provides valid measured values if at least one measuring channel provides valid measured values.

8.7.2 Parameterization of a Calculation Channel

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



The current calculation function will be displayed. Press ENTER to edit the function.



Three scroll lists are displayed in the upper line:

- selection of the first measuring channel (CH1)
- selection of the calculation function (FUNCT)
- selection of the second measuring channel (CH2)

Select a scroll list with keys 4 or 6.

The list items will be displayed in the lower line.

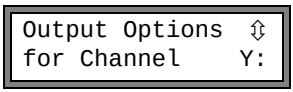
Scroll with keys 8 and 2 through the scroll list. All measuring channels and their absolute values can be used for the calculation.

The following calculation functions are available:

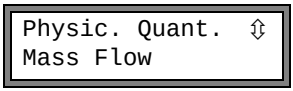
- -: Y = CH1 - CH2
- +: Y = CH1 + CH2
- (+)/2: Y = (CH1 + CH2)/2
- |-|: Y = |CH1 - CH2|

Press ENTER.

8.7.3 Output Options for a Calculation Channel



Select a calculation channel in the program branch OUTPUT OPTIONS. Press ENTER.



Select the physical quantity to be calculated. Press ENTER.

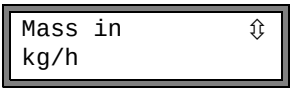
Make sure that the physical quantity selected for the calculation channel can be calculated from the physical quantities of the selected measuring channels. The possible combinations are shown in Table 8.2.

Table 8.2: Physical quantity of the calculation channel

physical quantity of the calculation channel	possible physical quantity of the first measuring channel (CH1)				possible physical quantity of the second measuring channel (CH2)			
	flow velocity	volume flow	mass flow	heat flow	flow velocity	volume flow	mass flow	heat flow
flow velocity	x	x	x	x	x	x	x	x
volume flow		x	x	x		x	x	x
mass flow		x	x	x		x	x	x
heat flow				x				x

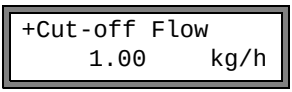
example 1: The difference of the volume flows of the channels A and B has to be determined. The physical quantity of measuring channel A can be the volume flow or the mass flow, but not the flow velocity. The physical quantities of the two measuring channels do not need to be identical (channel A = mass flow, channel B = volume flow).

example 2: To determine the heat flow difference, the physical quantity of both input channels must be the heat flow.

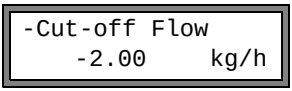


Select the unit of measurement. Press ENTER.

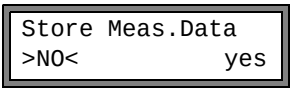
Two cut-off flows for each calculation channel can be defined. They will be defined in the unit of measurement of the physical quantity selected for the calculation channel.



All positive calculated values less than the limit, will be set to 0.

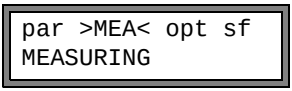


All negative calculated values greater than the limit, will be set to 0.

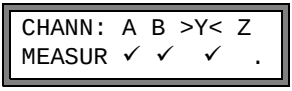


The data memory can be activated/deactivated. Press ENTER.

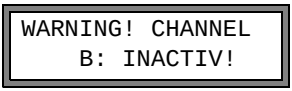
8.7.4 Measuring with Calculation Channels



Select the program branch MEASURING. Press ENTER.

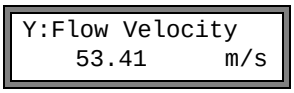


Activate the necessary channels. Calculation channels will be activated or deactivated like a measuring channel. Press ENTER.



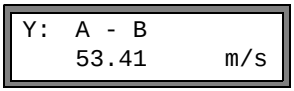
If a measuring channel is not activated although necessary for an activated calculation channel, a warning will be displayed. Press ENTER.

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



If a calculation channel is activated, the HumanMux mode (see section 7.2.2) will be selected at the beginning of the measurement and the values of the calculation channel will be displayed.

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



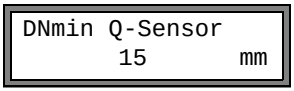
Press key [9] to display the calculation function.

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

8.8 Change of Limit for the Inner Pipe Diameter

It is possible to change the lower limit of the inner pipe diameter for a given transducer type. The setting is cold start resistant.

Enter HotCode 071001 directly after the flowmeter has been switched on.



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

Values between 3 mm and 63 mm will be accepted.

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

9 Storing and Output of Measured Values

Storing and serial output of measured values are available only if the flowmeter has a serial interface.

Storing

The data memory has to be activated for storing measured data (see section 9.1.1). The following data can be stored:

- date
- time
- measuring point number
- pipe parameters
- medium parameters
- transducer parameters
- sound path (reflection or diagonal)
- transducer distance
- damping factor
- storage rate
- physical quantity
- unit of measurement
- measured values
- totalizer values

The available data memory can be checked (see section 9.5).

The storing of each measured value will be signalized acoustically. This signal can be deactivated (see section 9.4.6).

Online Output

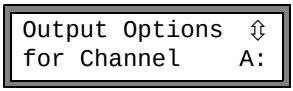
The measured values will be transmitted to a PC directly during the measurement (see section 9.2.2).

Offline Output

The measured values will be stored in the flowmeter and later transmitted to a PC (see section 9.2.3).

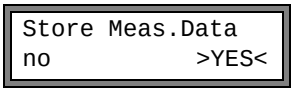
9.1 Data Memory

9.1.1 Activating/Deactivating of the Data Memory



Select in the program branch OUTPUT OPTIONS the channel for which an output has to be activated. Press ENTER.

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



Press ENTER until the menu item STORE MEAS.DATA is displayed.

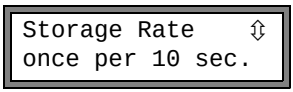
Select YES to activate the data memory. Press ENTER.

9.1.2 Setting the Storage Rate

The storage rate is the frequency at which the measured values are output or stored online. The storage rate will be set separately for each channel.

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

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



Select a storage rate in the scroll list STORAGE RATE.

If another storage rate has to be set, select EXTRA. Press ENTER.

Enter the storage rate. Values between 1 s and 43 200 s (= 12 h) will be accepted. Press ENTER.

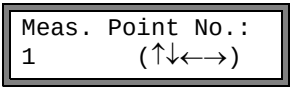
Note: This menu item will not be displayed if the data memory and/or the serial output are not activated.

9.1.3 Measuring Point Number

At the beginning of measurement, the measuring point has to be identified, either

- by ASCII text (e.g. MS.PK20!) or
- by digits, including point, hyphen (e.g. 18.05-06).

The input mode will be set in program branch SPECIAL FUNCTION (see section 12.2.3).



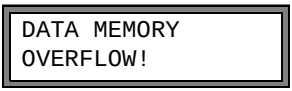
If arrows are displayed, ASCII text can be entered.

If digits are displayed, only digits, point and hyphen can be entered.

Enter the measuring point number. Press ENTER.

Measuring point number and parameters will be stored together with the measured values.

9.1.4 Measurement



If OUTPUT OPTIONS\STORE MEAS.DATA is activated and SPECIAL FUNCTION\SYSTEM SETTINGS\RING-BUFFER is deactivated, this error message will be displayed as soon as the data memory is full. Press ENTER.

If no other measured value output is activated, the measurement will be stopped.

If another measured value output is activated, the measurement will be continued. Only storing of the measured values will be stopped. The error message will be displayed periodically.

9.2 Output of the Measured Values

The measured values can be output via the RS232 interface.

Note!	For the connection of the RS232 interface to the flowmeter see section 3.2.2.

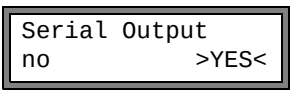
9.2.1 RS232 Interface

- online or offline output of the measured values in ASCII format
- transmission of the stored measured values by means of the program FluxData in binary format

9.2.2 Online Output

The measured values will be transmitted via the serial interface to a PC directly during measurement. If the data memory is activated, the measured values will be stored additionally.

- Select the program branch OUTPUT OPTIONS. Press ENTER.
- Select the channel for which the online output is to be activated. Press ENTER until the menu item SERIAL OUTPUT is displayed.



Select YES to activate the online output. Press ENTER.

- Set the storage rate (see section 9.1.2).

The measuring point number will be requested when the measurement is started (see section 9.1.3).

9.2.3 Offline Output

The measured values will be transmitted from the data memory of the flowmeter via the serial interface:

- to a PC or by means of the program FluxData or
- to a terminal program in ASCII format

Offline Output by Means of the Program FluxData

settings at the flowmeter:

```
par mea opt >SF<
Special Function
```

Press BRK to select the main menu.

Further settings at the flowmeter are not necessary.

Settings in the program FluxData:

- Open the program FluxData on the PC
- Select the serial connection of the PC connected with the flowmeter (e.g. COM1 in Fig. 9.1).
- Open the menu FLUXUS in the program FluxData and select RECEIVE MEASURING VALUES (see Fig. 9.2 and Fig. 9.3).

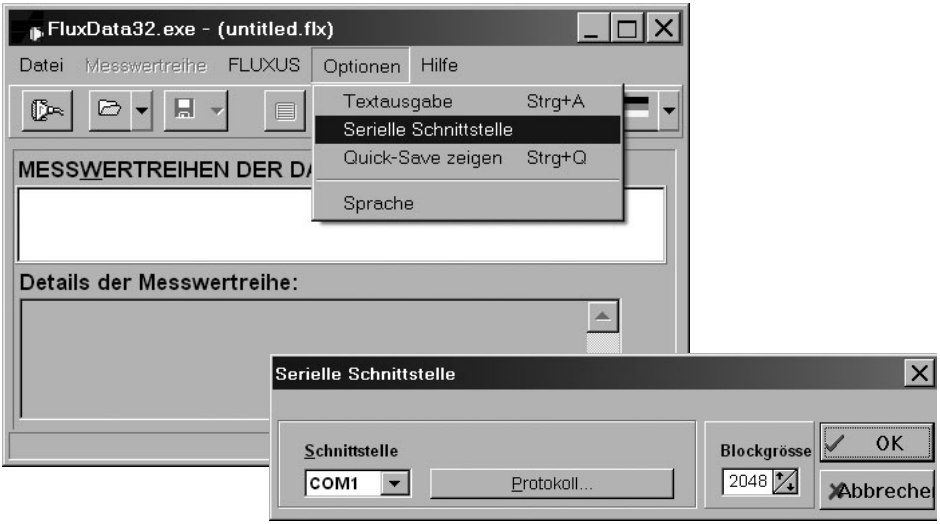


Fig. 9.1: Selection of the serial interface

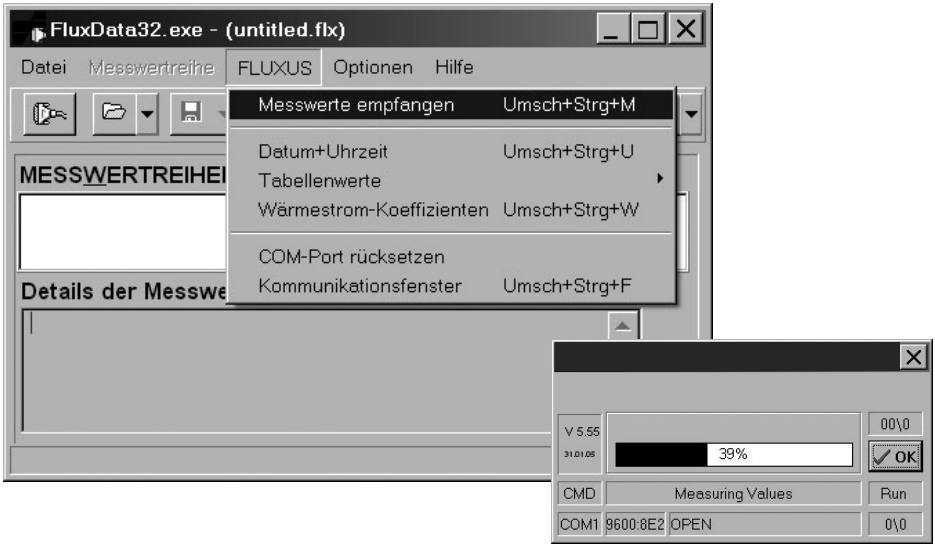
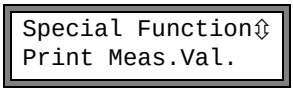


Fig. 9.2: Receive measured values

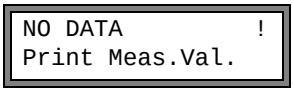
Fig. 9.3: Display of the received measuring data sets

Offline Output to a Terminal Program

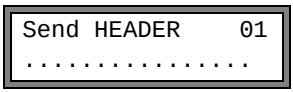
- Select the program branch SPECIAL FUNCTION on the flowmeter. Press ENTER.



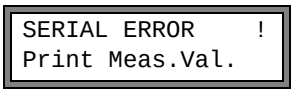
Select the list item PRINT MEAS.VAL. Press ENTER.



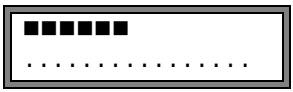
This error message will be displayed, if no measured values are stored. Press ENTER.



Connect the flowmeter to a PC with a serial interface. Press ENTER to transmit the stored measured values. The display indicates that the measured values are being transmitted.



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.



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

9.2.4 Data Format

The header will be transmitted at the beginning of the measurement. The first four lines contain general information about the flowmeter and the measurement. The following lines contain the configuration parameters output for each channel in a data block.

example:

```
\DEVICE             :F601-06010003
\MODE               :ONLINE
\CHAN               :1 (A:)
DATE                :09.01.2008
TIME                :19:56:52
Par.Record
Meas. Point No.     :A:F5050
Pipe
 Outer Diameter     :60.3 mm
 Wall Thickness     :5.5 mm
 Roughness          :0.1 mm
 Pipe Material      :Carbon Steel
 Lining             :NO LINING
```

```
Medium               :water
  Medium Temperature :38 C
  Medium Pressure    :1.00 bar
Transducer Type      :xxx
Sound Path           :3 NUM
Transducer Distance  :-15.6 mm
Damping              :20 s
Full-Scale Val.      :4.50 m3/h
Physic. Quant.       :volume flow
Unit of Measurement  :[m3/h]/[m3]
```

The line \DATA will be transmitted next, followed once by the column titles (see Table 9.1) for the corresponding channel. The measured values will be transmitted afterwards.

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

One data line is transmitted per storage interval and per activated measuring channel. The line "???" will be transmitted if there are no measured values availabe for the storage interval.

example: With a storage rate of 1 s, 10 lines "???" will be transmitted, if the measurement is restarted after an interruption for transducer positioning of 10 s.

The following data columns can be transmitted:

Table 9.1: Format of the Serial Output

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
FQ_POS		totalizer value for the positive flow direction (if HEAT FLOW is selected as physical quantity)
FQ_NEG		totalizer value for the negative flow direction (if HEAT FLOW is selected as physical quantity)
T1	###000.0	temperature T1 (= supply temperature if HEAT FLOW is selected as physical quantity)

Table 9.1: Format of the Serial Output

T2	###000.0	temperature T2 (= return temperature if HEAT FLOW is selected as physical quantity)
...		designation for other inputs
SSPEED		sound velocity of the medium
KNZ		concentration in mass percent
AMP		signal amplitude

Online Output

During online output, columns will be generated for all quantities which appear during measurement. The columns Q_POS and Q_NEG will be empty if the totalizers are deactivated.

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

Offline Output

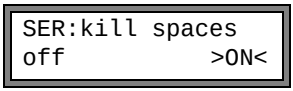
During offline output, columns will only be generated if at least one measured value is stored in the data set. The columns Q_POS and Q_NEG will not be generated if the totalizers are deactivated.

Transmission Parameters

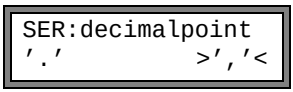
- the flowmeter sends CRLF-terminated ASCII
- max. line length: 255 digits
- RS232: 9600 bits/s, 8 data bits, even parity, 2 stop bits, protocol (RTS/CTS)

9.2.5 Settings of the Serial Output

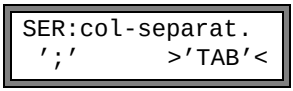
Some format settings of the serial output can be edited in the program branch SPECIAL FUNCTION\SYSTEM SETTINGS\SERIAL TRANSMIS.



If ON is selected, space characters will not be transmitted. The file size will be considerably reduced (shorter transmission time).



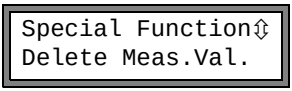
decimal marker to be used for floating point variables (point or comma).



character to be used for separating columns (semicolon or tabulator). This setting depends on the PC program used.

9.3 Delete the Measured Values

Select the program branch SPECIAL FUNCTION. Press ENTER.



Select the list item DELETE MEAS.VAL. Press ENTER.

Select YES or NO. Press ENTER.

9.4 Settings for the Data Memory

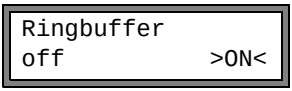
Select SPECIAL FUNCTION\SYSTEM SETTINGS. Press ENTER. Select the list item STORING. It contains the following menu items:

- ring buffer
- sample mode
- storing of the totalizer values
- storing of the signal amplitude
- storing of the sound velocity
- storing of the concentration
- acoustic signal during storing

Note!	All settings of the data memory are cold start resistant.

9.4.1 Ring Buffer

The setting of RINGBUFFER has an influence on the storing of the measured values as soon as the data memory is full:

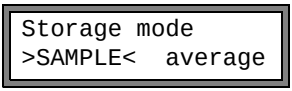


If ON is selected, the data memory will be halved. The oldest measured values will be overwritten.

If OFF is selected, the storing of measured values will be stopped.

Press ENTER.

9.4.2 Sample Mode



Select the sample mode.

If SAMPLE is selected, the displayed measured value will be used for storing and online output.

If AVERAGE is selected, the mean value of all measured values during a storage interval will be use for storage and online output.

Press ENTER.

Note! The sample mode does not have influence on the interfaces working continuously (e.g. current output, voltage output).

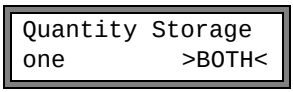
If AVERAGE is selected, all primary physical quantities will be averaged, i.e. also the measured temperatures if the corresponding measuring channel is activated.

Note! If a mean value could not be calculated over the complete storage interval while AVERAGE was activated, the value will be marked as invalid. "???" appears in the ASCII file of the stored measured values for invalid mean values and the corresponding physical quantity and "?UNDEF" for invalid temperatures. There will be no indication of how many momentary measured values a valid mean value consists of.

9.4.3 Storing of the Totalizers

It is possible to store only the value of the totalizer currently displayed or one value for each flow direction. The setting is cold start resistant.

Select in SPECIAL FUNCTION\SYSTEM SETTINGS\STORING the menu item QUANTITY STORAGE.



Select ONE to store only the displayed totalizer.

Select BOTH to store the totalizer of both flow directions.

Press ENTER.

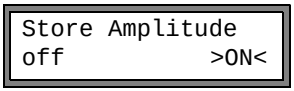
Note! The totalizers will be stored only if they are activated and the data memory is activated.

The storage of a totalizer reduces the total number of measured values to be stored by approx. two thirds.

example: In the program branch SPECIAL FUNCTION will be displayed that 10 000 measured values can still be stored. If the totalizers are activated and only one totalizer is stored, 3 333 data fields will be available for storing. If both totalizers are stored, 2 000 data fields will be available for storing.

9.4.4 Storage of the Signal Amplitude

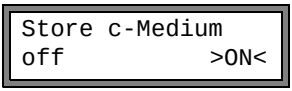
Select SPECIAL FUNCTION\SYSTEM SETTINGS\STORING\STORE AMPLITUDE.



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

9.4.5 Storing the Sound Velocity of the Medium

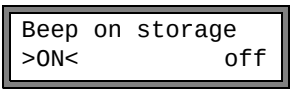
Select SPECIAL FUNCTION\SYSTEM SETTINGS\STORING\STORE C-MEDIUM.



If ON is selected and the data memory is activated, the sound velocity of the medium will be stored together with the measured values. Press ENTER.

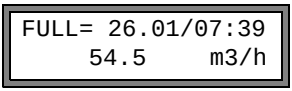
9.4.6 Acoustic Signal

Per default, an acoustic signal will be emitted every time a measured value is stored or transmitted to a PC or printer. The signal can be deactivated in SPECIAL FUNCTION\SYSTEM SETTINGS\BEEP ON STORAGE.



Select OFF to deactivate the acoustic signal, ON to activate it. Press ENTER.

9.5 Available Data Memory

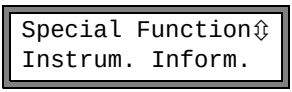


The time on which the memory will be full can be displayed during the measurement.

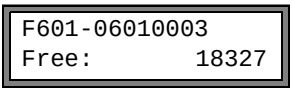
Scroll through the displays of the upper line with key DISP 9 during measurement.

Max. 100 measuring data sets will be stored. The number of measuring data sets depends on the total number of measured values stored in the precedent measuring data sets.

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



Select SPECIAL FUNCTION\INSTRUM. INFORM. Press ENTER.



Type and serial number of the flowmeter will be displayed in the upper line.

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

10 Working with Parameter Records

10.1 Introduction

Parameter records are data sets that contain all information necessary to perform a certain measurement task:

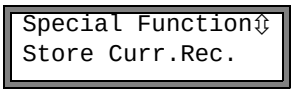
- pipe parameters
- transducer parameters
- medium parameters
- output options

Working with parameter records will make repeated measurement tasks easier and faster. The flowmeter can store max. 14 parameter records.

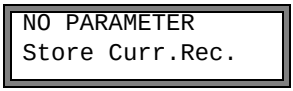
Note!	No parameter records are stored in the delivery state. Parameter records will be entered manually.

10.2 Storing of a Parameter Record

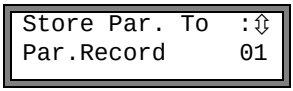
The parameters must first be entered in the program branch PARAMETER. Afterwards, they can be stored in a parameter record.



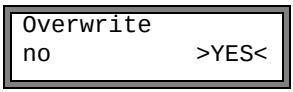
Select SPECIAL FUNCTION\STORE CURR.REC. Press ENTER.



If this error message is displayed, a complete parameter record is not available. Storing is impossible. Enter the missing parameters in the program branch PARAMETER.



14 parameter records (PAR.RECORD 01 to PAR.RECORD 14) can be stored. Select a parameter record. Press ENTER.

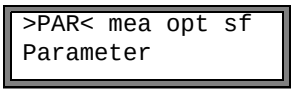


If parameters are already stored in the selected parameter record, they can be overwritten.

Select YES to overwrite the parameters, or NO to select another parameter record. Press ENTER.

10.3 Loading of a Parameter Record

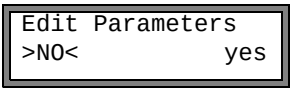
Stored parameter records can be loaded and used for measurement.



Select the program branch PARAMETER. Press ENTER.

Select the channel for which the parameter record is to be loaded. Press ENTER.

Select the parameter record to be loaded. Press ENTER.

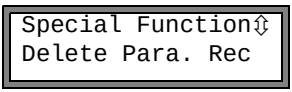


Select YES to edit the parameters of a parameter record.

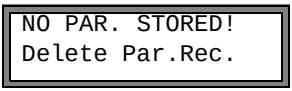
Select NO to return to the main menu and to start the measurement.

Press ENTER.

10.4 Deleting Parameter Records



Select SPECIAL FUNCTION\STORE CURR.REC. Press ENTER.



This error message will be displayed if parameter records are not stored. Press ENTER.

If parameter records are stored, DELETE: will be displayed.

Select the parameter record to be deleted. Press ENTER.

Confirm whether to delete the parameter record. Press ENTER.

11 Libraries

The internal material database of the flowmeter contains parameters for pipe and lining materials as well as for media. It can be extended cold start resistant by user defined materials or media. User defined materials and media will be always 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 11.1).

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

- as constants without the extended library (see section 11.2)
- as constants or temperature and pressure dependent functions by means of the extended library (see section 11.3).

The material and media scroll lists displayed in the program branch PARAMETER can be arranged here (see section 11.5). The shorter scroll lists make the work more efficient.

11.1 Partitioning of the Coefficient Memory

The coefficient memory can be arbitrarily parted among the following material data:

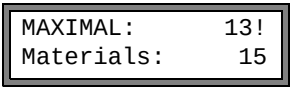
- material properties:
  - transversal and longitudinal sound velocity
  - typical roughness
- medium properties:
  - min. and max. sound velocity
  - kinematic viscosity
  - density
- heat flow coefficients (additional medium property)
- steam coefficients (additional medium property)
- concentration coefficients (additional medium property)

The max. number of data sets for each category of these material data is indicated in Table 11.1.

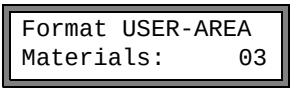
Table 11.1: Capacity of the coefficient memory

	max. number of data sets	occupancy of the coefficient memory in %
materials	13	97
media	13	97
heat flow coefficients	29	98
steam coefficients	19	95
concentration coefficients	14	98

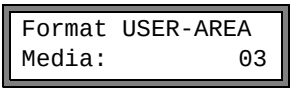
Select in the program branch SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES the list item FORMAT USER-AREA. Press ENTER.



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



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



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

Enter the number of user defined data sets of the heat flow coefficients. Press ENTER.

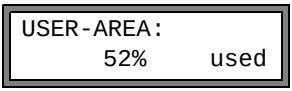
Heat flow coefficients can be entered only if the flowmeter is equipped with temperature inputs.

Enter the number of user defined data sets of the steam coefficients. Press ENTER.

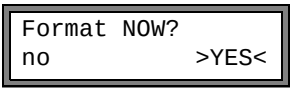
Steam coefficients can be entered only if the flowmeter is equipped with temperature inputs.

Enter the number of the user defined data sets of the concentration coefficients. Press ENTER.

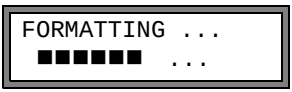
The input of concentration coefficients is reasonable only if the flowmeter is equipped with temperature inputs.



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



Confirm the selected partition. Select YES to start partitioning. Press ENTER.



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

After partitioning, FORMAT USER-AREA will be displayed again.

11.1.1 Keeping Data during Formatting of the Coefficient Memory

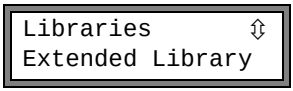
When the coefficient memory is repartitioned, max. 8 data sets of each type can be kept.

example 1: The number of user defined materials will be reduced from 5 to 3. The data sets #01 to #03 will be kept. The data sets #04 and #05 will be deleted.

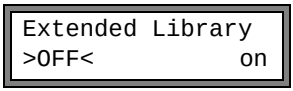
example 2: The number of user defined materials will be increased from 5 to 6. All 5 data sets will be kept.

11.2 Input of Material/Medium Properties without the Extended Library

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



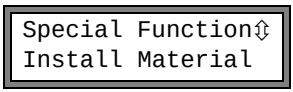
Select in SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES the list item EXTENDED LIBRARY. Press ENTER.



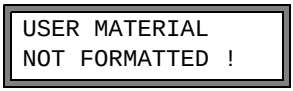
Select OFF to deactivate the extended library. Press ENTER.

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

The steps to input a material or a medium are almost identical. Thus, displays for a medium will be shown and described only in case of differences.

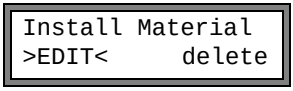


Select in the program branch SPECIAL FUNCTION the menu item INSTALL MATERIAL or INSTALL MEDIUM. Press ENTER.

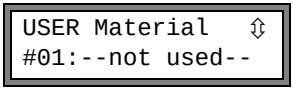


An error message will be displayed if the coefficient memory does not contain space for user defined materials/media.

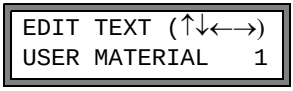
Partition the coefficient memory accordingly (see section 11.1).



Select EDIT. Press ENTER.



Select a user defined material/medium. Press ENTER.



Change the designation of the material/medium.

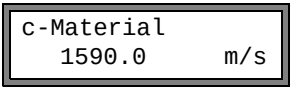
The default name for a user defined material/medium is USER MATERIAL N or USER MEDIUM N with N an integer.

Note!

There are 95 ASCII characters available (letters, capital letters, numbers, special characters [!? " + - ( ) > < % * etc.]

A designation can have max. 16 characters. The input of text is described in section 3.4.

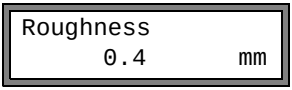
Material Properties



Enter the sound velocity of the material.

For the sound velocity of some materials see annex C, Table C.1.

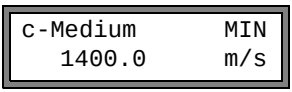
Values between 600.0 m/s und 6553.5 m/s will be accepted. Press ENTER.



Enter the roughness of the material. Press ENTER.

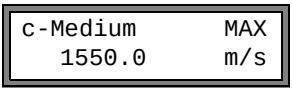
For the typical roughness of some materials see annex C, Table C.2.

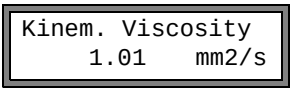
Medium Properties



Enter the min. and max. value of the sound velocity for the medium in m/s.

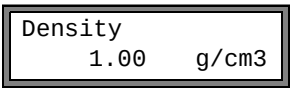
Values between 800.0 m/s und 3500.0 m/s will be accepted. Press ENTER.





Enter the kinematic viscosity of the medium.

Values between 0.01 mm^2/s und 30 000.00 mm^2/s will be accepted. Press ENTER.



Enter the density of the medium. Press ENTER.

11.3 Extended Library

11.3.1 Introduction

If the extended library is activated, material and medium properties as function of the temperature or of the pressure and additional medium properties (heat flow coefficients, steam coefficients and concentration coefficients) can be entered to the flowmeter directly or by means of the program FluxKoef.

For an overview of the material properties to be entered and of the measuring processes they are needed for see Table 11.2.

Table 11.2: Material and medium properties that can be stored

property	property is necessary for...
material property	
transversal sound velocity	flow measurement
longitudinal sound velocity	wall thickness measurement and/or flow measurement
type of sound wave	flow measurement
typical roughness	profile correction of the flow velocity

Table 11.2: Material and medium properties that can be stored

property	property is necessary for...
medium property	
sound velocity	start of Measurement
viscosity	profile correction of the flow velocity
density	mass flow calculation
additional properties of a medium	
heat flow coefficients	heat flow measurement
steam coefficients	heat flow measurement with steam in supply line
concentration coefficients	concentration measurement

Enter only the properties needed for the measuring task.

example: The density of a medium is unknown. If the mass flow is not measured, any constant value can be selected for the density.

The measurement of the flow velocity and of the volume flow will not be affected. However, the value of the mass flow will be wrong.

The dependency of certain material properties from the temperature and pressure can be described

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

Constants or a linear function are sufficient in most cases

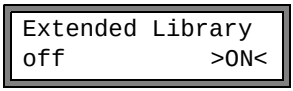
If e.g. the temperature fluctuations at the measuring point are small compared to the temperature dependencies of the material properties, the linearization or the complete neglect of the temperature dependency will not result in an considerable additional measuring error.

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

Customized Interpolation Functions

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

11.3.2 Activation of the Extended Library



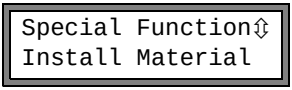
Select `ON` to activate the extended library. Press ENTER.

11.3.3 Input of Material/Medium Properties

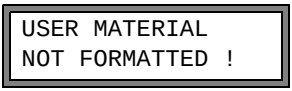
The properties of a user defined material/medium can be entered now.

The steps to input a material or a medium are almost identical. Thus, displays for a medium will be shown and described only in case of differences.

Select in SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES the list item EXTENDED LIBRARY. Press ENTER.

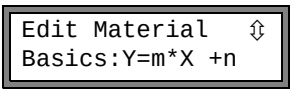


Select in the program branch SPECIAL FUNCTION the menu item INSTALL MATERIAL or INSTALL MEDIUM. Press ENTER.



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

Partition the coefficient memory accordingly (see section 11.1).



Select the function for the temperature or pressure dependency of the material/medium properties:

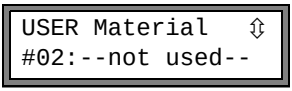
Y=CONST.: constants

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

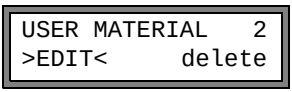
Y=POLYNOM:
$y = k_0 + k_1 \cdot x + k_2 \cdot x^2 + k_3 \cdot x^3 + k_4 \cdot x^4$

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

... GO BACK: return to the previous menu item

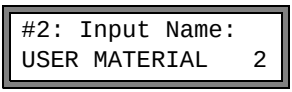


Select a user defined material/medium.



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

Select EDIT to edit the material/medium properties or DELETE to delete the material/medium and to return to the scroll list EDIT MATERIAL or EDIT MEDIUM.



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 an integer.

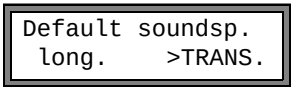
Material Properties

Enter for the material:

- transversal sound velocity (in m/s)
- longitudinal sound velocity (in m/s)

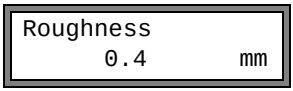
One to five values depending on the selected function have to be entered. Press ENTER after each input.

If an already defined material is edited, for each property will be requested whether to edit it. Select YES or NO. Press ENTER. Change the values if necessary.

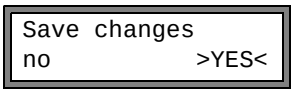


Select the type of sound wave to be used for the flow measurement. Press ENTER.

A transversal sound wave has to be selected in most cases.



Enter the typical roughness of the material. Press ENTER.



Select YES to store the entered properties or NO to leave the menu item without storing. Press ENTER.

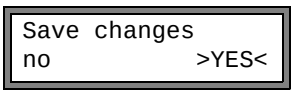
Medium Properties

Enter for the medium:

- longitudinal sound velocity (in m/s)
- kinematic viscosity [mm^2/s]
- density (in g/cm^3)

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

If an already defined medium is edited, for each property of some of the functions will be requested whether to edit it. Select YES or NO. Press ENTER. Change the values if necessary.

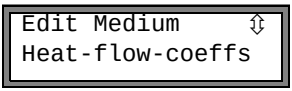


Select YES to store the entered properties or NO to leave the menu item without storing. Press ENTER.

11.3.4 Input of Heat Flow Coefficients

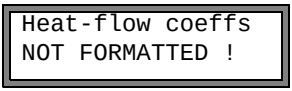
Note! The heat flow coefficients can also be edited with the programs FluxData and FluxKoef.

Note! The entered coefficients will not be checked. Absurd values can result in wrong measured values or in permanent system errors.



Select in the program branch SPECIAL FUNCTION the list item INSTALL MEDIUM. Press ENTER.

The scroll list EDIT MEDIUM will be displayed. Select the list item HEAT-FLOW COEFFS. Press ENTER.

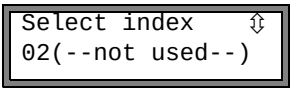


An error message will be displayed if the coefficient memory does not contain space for heat flow coefficients.

Partition the coefficient memory accordingly (see section 11.1).

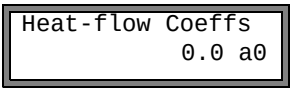
Select the medium for which the heat flow coefficients have to be entered.

User defined media will be displayed first, followed by the media of the internal database.

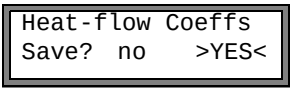


Select an index for storing the heat flow coefficients of the selected medium. Press ENTER.

If the coefficient memory is partitioned so that heat flow coefficients for two media can be entered, indices 01 and 02 are available.



Enter the 10 heat flow coefficients: a0...a4, r0...r4. Press ENTER after each input.



The values can be stored now. Press ENTER.

11.3.5 Input of Steam and Concentration Coefficients

Use the program FluxKoef (option).

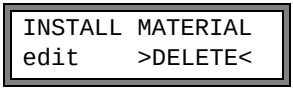
Note! The entered coefficients will not be checked. Absurd values can result in wrong measured values or in permanent system errors.

11.4 Deleting a User Defined Material/Medium

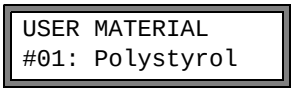
To delete a user defined material or medium, proceed as follows:

Select in the program branch SPECIAL FUNCTION either 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.



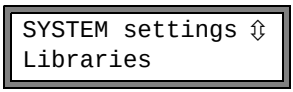
Select the material/medium to be deleted. Press ENTER.

Select YES or NO. Press ENTER.

11.5 Arrangement of the Material/Medium Scroll List

The materials and media to be displayed in the program branch PARAMETER will be arranged in the material scroll list and medium scroll list.

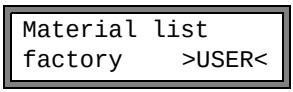
Note! User defined materials and media will be always displayed in the scroll lists of the program branch PARAMETER.



Select SPECIAL FUNCTION\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. A user defined scroll list already existing will not be deleted but only deactivated.

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

If USER is selected, the material or medium scroll list can be edited (see section 11.5.1 to 11.5.3).

Finish editing with END OF EDIT. Press ENTER.

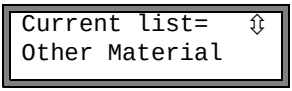
Select YES to store all changes of the scroll list or NO to leave the menu item without storing. Press ENTER.

Note! If the material scroll list is quit with BRK before storing, all changes will be lost.

11.5.1 Displaying a Scroll List

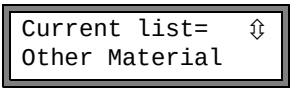
Select SHOW LIST. Press ENTER to display the scroll list as in the program branch PARAMETER.

The current scroll list is displayed in the lower line. User defined materials/media are always part of the current scroll list.

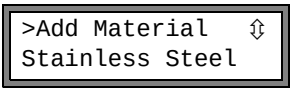


Press ENTER to return to the scroll list MATERIAL LIST.

11.5.2 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.

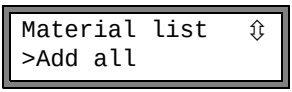


All materials/media not being in the current scroll list will be displayed in the lower line.

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

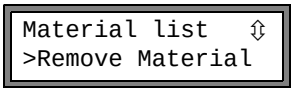
Note! The materials/media are displayed in the order in which they have been added.

11.5.3 Adding all Materials/Media to the Scroll List

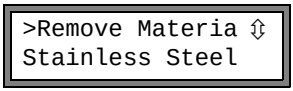


Select ADD ALL. Press ENTER to add all materials/media of the internal database to the current scroll list.

11.5.4 Removing a Material/Medium from the Scroll List



Select REMOVE MATERIAL or REMOVE MEDIUM to remove a material/medium from the scroll list.

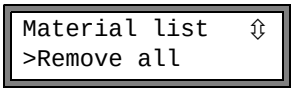


All materials/media of the current scroll list will be displayed in the lower line.

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

Note!	User defined materials/media are always part of the current scroll list. They can not be removed.

11.5.5 Removing all Materials/Media from the Scroll List



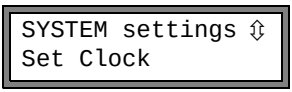
Select REMOVE ALL. Press ENTER to remove all materials/media from the current scroll list. User defined materials/media will not be removed.

12 Settings

12.1 Time and Date

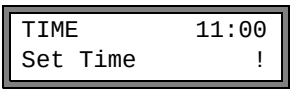
The flowmeter has a battery buffered clock. Measured values will be automatically stored with date and time.

12.1.1 Time



Select in SPECIAL FUNCTION\SYSTEM SETTINGS the list item SET CLOCK. Press ENTER.

The actual time is displayed. Select OK to confirm the time or NEW to set the time. Press ENTER.



Select the digit to be edited with key 4 and 6.

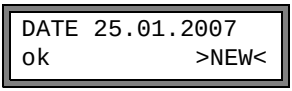
Edit the selected digit with key 8 and 2.

Press ENTER.

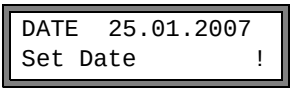
The new time will be displayed. Select OK to confirm the time or NEW to set the time again. Press ENTER.

12.1.2 Date

After the time has been set, DATE will be displayed.



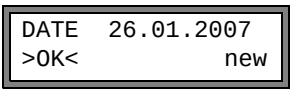
Select OK to confirm the date or NEW to set the date. Press ENTER.



Select the digit to be edited with key 4 and 6.

Edit the selected digit with key 8 and 2.

Press ENTER.



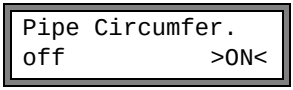
The new date will be displayed. Select OK to confirm the date or NEW to set the date again. Press ENTER.

12.2 Dialogs and Menus

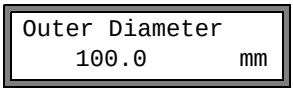
Select SPECIAL FUNCTION\SYSTEM SETTINGS. Select the list item DIALOGS/MENUS. Press ENTER.

Note! The settings of the menu item DIALOGS/MENUS will be stored at the end of the dialog. If the menu item is left before the end of the dialog, the settings will not be effective.

12.2.1 Pipe Circumference

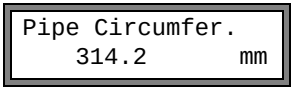


Select ON if the pipe circumference has to be entered instead of the pipe diameter in the program branch PARAMETER. The setting is cold start resistant. Press ENTER.



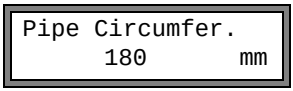
If ON is selected for PIPE CIRCUMFER., the outer pipe diameter will be requested in the program branch PARAMETER nevertheless.

To select the menu item PIPE CIRCUMFER., enter 0 (zero). Press ENTER.

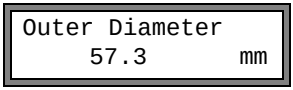


The value displayed in PIPE CIRCUMFER. is calculated on the basis of the last displayed value of the outer pipe diameter.

example: 100 mm * π = 314.2 mm



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



During the next scroll through the program branch PARAMETER, the outer pipe diameter corresponding to the entered pipe circumference will be displayed.

example: 180 mm : π = 57.3 mm

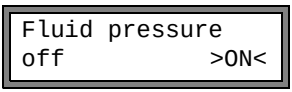
Note! The pipe circumference is edited temporarily only. When the flowmeter switches back to the display of the pipe circumference (internal recalculation), slight rounding errors may occur.

example: entered pipe circumference: 100 mm
displayed outer pipe diameter: 31.8 mm

When the flowmeter switches back to the display of the pipe circumference (internal recalculation), 99.9 mm will be displayed.

12.2.2 Medium Pressure

The dependency of the properties of a medium on the pressure can be taken into account.

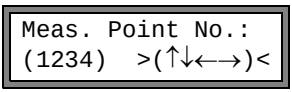


If ON is selected, the medium pressure will be requested in the program branch PARAMETER.

If OFF is selected, 1 bar will be used for all calculations.

Note!	It is reasonable for documentation purpose to enter the medium pressure even if no pressure dependent characteristics are stored in the flowmeter.

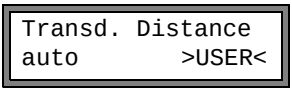
12.2.3 Measuring Point Number



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

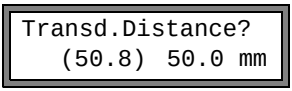
Select ↑↓←→ if the measuring point is to be identified by the ASCII editor.

12.2.4 Transducer Distance

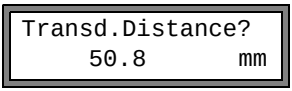


recommended adjustment: USER

- USER will be selected if the measuring point is always the same.
- AUTO can be selected if the measuring point often changes.



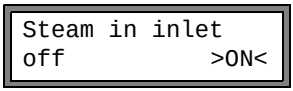
In the program branch MEASURING, the recommended transducer distance will be displayed in parentheses, followed by the entered transducer distance if the recommended and the entered transducer distance are not identical.



During transducer positioning in the program branch MEASURING

- only the entered transducer distance will be displayed if TRANSD. DISTANCE\USER is selected and the recommended and the entered transducer distances are identical
- only the recommended transducer distance will be displayed if TRANSD. DISTANCE\AUTO is selected.

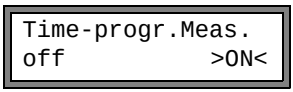
12.2.5 Steam in the Supply Line



Select ON if the supply pressure is to be entered in the program branch PARAMETER.

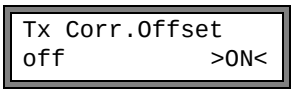
For further information on STEAM IN INLET of the heat flow measurement see section 16.7.

12.2.6 Time Programmable Measurement



Select ON to enable TIME-PROGR.MEAS., OFF to disable it.

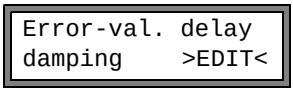
12.2.7 Temperature Offset



Select ON to enter an offset for each temperature channel (see section 16.6).

12.2.8 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 error value delay.

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

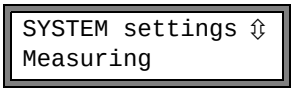
12.2.9 Alarm State Indication

Select ON to display the alarm state during measurement.

Fur further information on alarm outputs see section 18.6.

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

12.3 Measurement Settings



Select in SPECIAL FUNCTION\SYSTEM SETTINGS the list item 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 left before the end of the dialog, the settings will not be effective.

```
Enable Concentr.
no          >YES<
```

Select YES to activate the concentration measurement, NO to deactivate it.

```
Wave Injector
off          >ON<
```

This menu item will be displayed only, if a WaveInjector is in the scope of supply (see user manual of the WaveInjector).

```
Compare c-fluid
no          >YES<
```

Select YES if the actually measured sound velocity is to be compared to the theoretical or expected value. The difference

$\Delta = c_{mea} - c_{stored}$

between the two sound velocities will be displayed during measurement. c_{stored} is the sound velocity stored in the database. Scroll with key [9] to display Δ.

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

Select NORMAL to display and output the profile corrected flow values, UNCORR. to display and output the flow values without flow profile correction. Press ENTER.

The setting is cold start resistant.

Fur further information see section 8.5.

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

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

A lower limit for the flow velocity can be entered (see section 8.4).

```
Velocity limit
     24.0      m/s
```

An upper limit for the flow velocity can be entered (see section 8.3).

Values between 0.1 m/s and 25.5 m/s will be accepted. Enter 0 (zero) to switch off the flow velocity check.

```
Heat Quantity
>[J]<        [Wh]
```

The heat quantity is the totalizer of the heat flow. Select the unit of measurement for the heat flow (J or Wh).

```
heat+flow quant.
 off          >ON
```

Select ON to store and output the values of the heat quantity totalizer and volume flow totalizer during the heat quantity measurement.

```
Quant. wrapping
off          >ON<
```

Select the overflow behavior of the totalizers (see section 8.2.2).

```
Quantity recall
off          >ON<
```

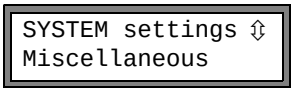
Select ON to keep the previous totalizer values after restart of the measurement.

Select OFF to reset to zero the totalizers after restart of the measurement.

Note! All changes are stored now at the end of the dialog.

12.4 Setting the Contrast

The contrast of the display of the flowmeter can be set in SPECIAL FUNCTION\SYSTEM SETTINGS\MISCELLANEOUS.



Select SPECIAL FUNCTION\SYSTEM SETTINGS\MISCELLANEOUS. Press ENTER.

The contrast of the display will be adjusted by the following keys:

6 increases the contrast

4 decreases the contrast

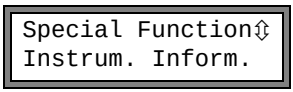
2 = minimum contrast

5 = medium contrast

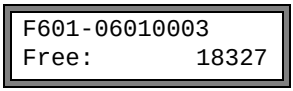
8 = maximum contrast

Note! The display will be reset to medium contrast after a cold start.

12.5 Instrument Information



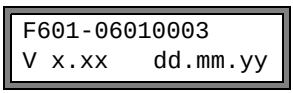
Select SPECIAL FUNCTION\INSTRUM. INFORM. to obtain information about the flowmeter. Press ENTER.



Type and serial number of the flowmeter will be displayed in the upper line.

The available data memory will be displayed in the lower line (here: 18 327 measured values can be stored).

Press ENTER.



Type and serial number of the flowmeter will be displayed in the upper line.

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

Press ENTER.

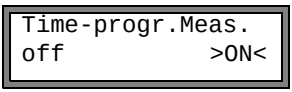
13 Time Programmable Measurement

The beginning and the end of a measurement will be programmed in the mode Time Programmable Measurement. The measurement, storing and output of the measured values will be started automatically when the programmed start time is reached and stopped when the programmed stop time is reached.

The measured values can be stored with a high storage rate at a particular time (instead of with a low storage rate continuously).

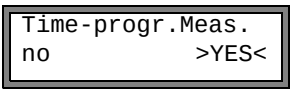
13.1 Enabling/Disabling

The mode Time Programmable Measurement can be enabled and disabled in the program branch SPECIAL FUNCTION\SYSTEM SETTINGS/DIALOGS/MENUS. The setting is cold start resistant.



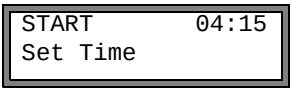
Select the menu item TIME-PROGR.MEAS. Select ON to enable the mode Time Programmable Measurement, OFF to disable it.

13.2 Input of the Start Time



Select YES in MEASURING\TIME-PROGR.MEAS. to program the start time. Press ENTER.

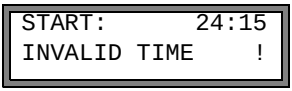
Note!	The menu item TIME-PROGR.MEAS. will be displayed only if the data memory, the serial output or an output has been activated.



Select the digit you want to edit with the keys 4 und 6.

Set the hours or minutes with the keys 2 und 8.

Press ENTER.

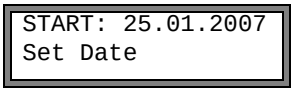


If an error message is displayed, an invalid time has been entered.

The start time must be set between 00:00 and 23:59. Press ENTER to return to the menu item SET TIME.

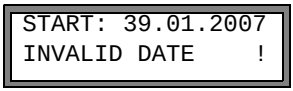
Note!	The internal clock of the flowmeter works with a 24-hours clock. The time has to be entered accordingly, e.g. 02:35 p.m. = 14:35.

If a valid start time has been entered, the menu item for setting the start date is displayed.



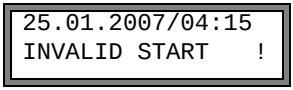
Set the day, the month and the year. Press ENTER.

If the entered date exists and is in the future, the stop time can be entered (see section 13.3).



If an error message is displayed, the date does not exist (leap years will be recognized).

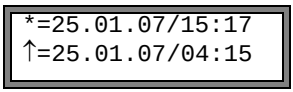
Press ENTER to return to the menu item SET DATE.



This error message will be displayed if the entered start time is in the past.

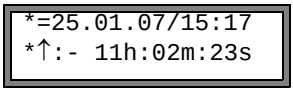
Press ENTER.

Note! The seconds of the start time are set to zero automatically. Therefore, the entered start time must be at least one minute later than the actual time.



The actual time will be displayed in the upper line (*=) and the programmed start time in the lower line (↑=).

The programmed start time is invalid in this display as it is in the past (↑=).

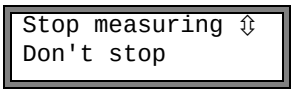


The display in the lower line can be changed between the start time and the difference between start time and actual time (*↑: -) by pressing key 9 or 3.

Press ENTER to return to the menu item SET TIME.

13.3 Input of the Stop Time

A time programmable measurement can be stopped automatically. Shortly afterwards, the flowmeter will be switched off if it is in battery mode. The menu item STOP MEASURING will be displayed after the input of the start time.



Select one of the list items described below. Press ENTER.

Note! The charge state of the battery will be reduced by 2 % with every hour waiting for the start time. The operating time left for the measurement will be reduced accordingly.

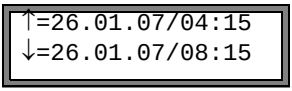
Table 13.1: List items for the automatic stop of the measurement

list item	result
DON'T STOP	The measurement will not be stopped automatically unless • the battery is empty • or the data memory is full and no other measured value output has been selected.
STOP: DATE/TIME	Date and time of the automatic stop of the measurement can be set
STOP: DURATION	The measurement duration can be set. The stop time will be calculated internally (START + DURATION = STOP).

13.3.1 Date/Time

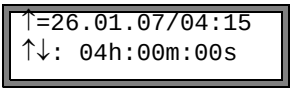
If the list item STOP: DATE AND TIME has been selected in the precedent step, enter the stop time (date and time) in the same way as the start time. Press ENTER after each input.

The validity of the entered date and time will be checked. A stop time that is before the start time will not be accepted.



If a valid stop time is entered, the start time (↑=) and the stop time (↓=) will be displayed again.

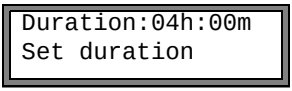
example: The measurement will be started on 26.01.2007, 4:15 a.m., takes 4 h and will be automatically stopped at 8:15 a.m.



The display in the lower line can be changed between the stop time and the measurement duration (↑↓:) by pressing key 9 DISP or 3 DISP.

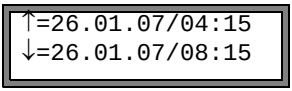
Press ENTER to select the next menu item of the program branch MEASURING.

13.4 Measurement Duration

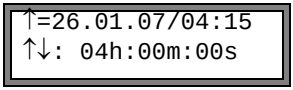


If the list item STOP: DURATION has been selected in the precedent step, enter the measurement duration in the same way as the start time. Press ENTER.

The max. measurement duration is 999 h and 59 min, corresponding to approx. 41 days.



The start time (↑=) and the stop time (↓=) calculated from the entered duration will be displayed after the measurement duration has been entered.



The display in the lower line can be changed between the stop time and the measurement duration (↑↓:) by pressing key 9 DISP or 3 DISP.

Press enter to select the next menu item of the program branch MEASURING.

13.5 Measuring in Mode Time Programmable Measurement

If the mode Time Programmable Measurement is activated, the output options are defined and the start time and the stop time are set, proceed as follows:

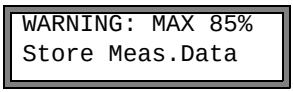
- Start the measurement as usual. The measured values are displayed, stored and/or transmitted depending on the selected measured value output.
- Activate all settings needed for the time-programmable measurement (totalizers, etc.).
- Press ENTER to start the countdown. The current measurement will be interrupted and the countdown started.

Note!	The countdown can be stopped by pressing any key.

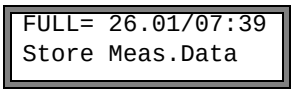
The memory requirement for the measurement can now be calculated.

If a stop time or a measurement duration has been set and the data memory is activated, it will be checked whether the available memory is sufficient for the storage of the measured values for the complete measurement duration.

If not, the following error message will be displayed:



In the example, the available memory only covers 85 % of the expected measured values.



Press key 9 DISP or 3 DISP to display in the upper line the time at which the memory is expected to be full.

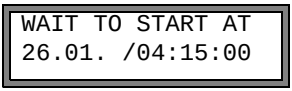
If storing is the only active measured value output, the measurement will be stopped as soon as the memory is full, even if the stop time is not reached.

If another measured value output is activated, the measurement will be continued until the defined stop time is reached, even if the memory is full. If the available memory is not sufficient, proceed as follows:

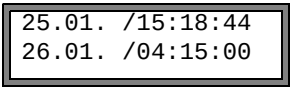
- Delete all stored measured values in the menu item SPECIAL FUNCTION\DELETE MEAS.VAL.
- Reduce the storage rate in OUTPUT OPTIONS\STORAGE RATE. If the storage rate is halved from e.g. EVERY SECOND to EVERY TWO SECONDS the memory requirement is halved.

- Deactivate the totalizer if possible. Storing of one totalizer value triples the memory requirement.
- Check the totalizer storage mode. Select ONE in SPECIAL FUNCTION\SYSTEM SETTINGS\STORING\QUANTITY STORING if it is sufficient to store the totalizer of one flow direction.

The Countdown

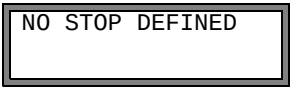


It is indicated that the countdown is running. The current status (waiting for the start time) or the current time is displayed in the upper line.

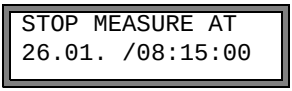


The display in the lower line can be changed between the start time and the remaining time until the measurement is started (*↑:) with key 3 DISP.

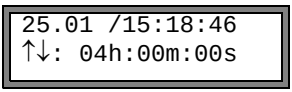
During the countdown, it can be checked whether a stop time has been programmed. Press key DISP 9 to display further information in the upper line.



This message is displayed when no stop time has been programmed.



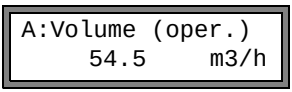
This message indicates that the measurement will be stopped at the displayed time.



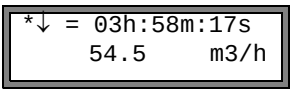
Press key 3 DISP to display the stop time or the measurement duration (↑↓:).

Measurement

When the start time is reached, the previously interrupted measurement will be continued. It can be checked during measurement whether a stop time has been programmed.



Press key DISP 9 once or several times during measurement.



Additional information will be displayed in the upper line, e.g. the time remaining until the automatic stop of the measurement(*↓:).

If this message is missing, no stop time has been programmed.

Note!	The measurement will be interrupted by pressing key BRK.

The time programmable measurement will be stopped automatically if:

- the stop time is reached
- the data memory is full and no other measured value output is activated
- the battery is empty

13.6 Storing Measured Values

If the data memory is activated, the measured values will be stored after the start of the measurement. The stored values will be kept when the measurement is interrupted (key BRK) to start or interrupt the countdown.

However, when the measurement is started automatically after the countdown, all measured values stored before the countdown will be deleted. The first measured value stored after the automatic start is the first value of the current measuring data set. The start time will be stored as reference for the current measuring data set.

13.7 Online Output

When the online output via the serial interface is activated, the header will be transmitted or printed at the start of the measurement. As long as the countdown has not started, the current measured values and totalizer values will be output.

When the countdown is started, a message will be displayed that the start time is waited for. The measurement will be interrupted.

When the start time is reached, date, time and measuring point number will be transmitted or printed.

After the character string `\DATA`, the measured values will be printed as usual.

If the flowmeter is operated in battery mode or the battery has discharged during countdown or measurement, the error message `\LOWBAT 29.04. /01:30:46` will be displayed.

When the stop time is reached, the automatic stop of the measurement will be displayed as follows: `\STOP MEASURE AT: 30.04. /08:15:00`.

14 SuperUser-Mode

The SuperUser mode allows 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 limit determined by physical laws and technical data.
- The cut-off flow is not active.
- A value for the number of sound paths has to entered.

It is possible to change the lower limit of the inner pipe diameter for a given transducer type without the activation of the Super User mode.

14.1 Activating/Deactivating

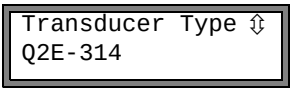
Enter HotCode 071049 directly after the flowmeter has been switched on.

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

The SuperUser mode will be deactivated by switching off the flowmeter.

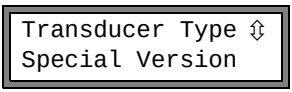
14.2 Transducer Parameters

In SuperUser mode, the menu item TRANSDUCER TYPE will be displayed at the end of parameter input even if the transducers are detected by the flowmeter.

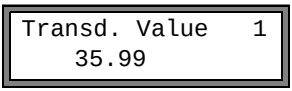


Press ENTER.

or:



Select SPECIAL VERSION to edit the transducer parameters. Press ENTER.



If SPECIAL VERSION is selected, the transducer parameters have to be entered.

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

14.3 Malfunctions in SuperUser Mode

As the SuperUser mode operates without any plausibility check, absurd entries may result in an automatic switching-off of the flowmeter or in a crash of the internal software. An absurd input is e.g. 0 (zero) for the number of sound paths or 0.1 mm for the outer pipe diameter.

Switch on the flowmeter again and reactivate the SuperUser mode. Use RESET, if necessary by pressing keys BRK, C and ENTER simultaneously.

15 Wall Thickness Measurement

If the flowmeter has the option wall thickness measurement, the wall thickness and the longitudinal sound velocity of the pipe can be measured. A wall thickness probe to be connected directly with the transducer connection socket is delivered then. The wall thickness probe will be detected automatically when being connected to the flowmeter. The wall thickness can be transmitted into the current parameter record of the flow measurement.

A modified transit time method to determine the wall thickness or the sound velocity of the pipe will be used.

- The probe emits a ultrasonic pulse which propagates in the pipe.
- The pulse is reflected by the boundary layer of the pipe and will be received by the probe.
- The time difference between emitting and receiving the signal is a measure of the wall thickness of the pipe (if the sound velocity of the material is known) or of the longitudinal sound velocity (if the wall thickness is known).

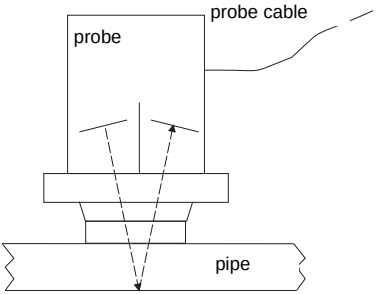


Fig. 15.1: Measuring Principle

Note!	With some exceptions, the transversal sound velocity of a material is approx. 30...60 % of the longitudinal sound velocity.

15.1 Activation of Wall Thickness Measurement

Push the probe cable in the socket of measuring channel A or B to activate the wall thickness measurement. The wall thickness measurement mode is selected automatically.

```
*WALL THICKNESS*
*DETECTED ON A:*
```

A message is displayed that the probe has been detected.

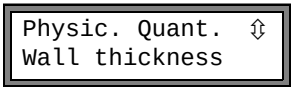
The main menu of the wall thickness measurement will be displayed. The menu structure is similar to the flow measurement. The program branches are adapted to the wall thickness measurement.

Note!	The wall thickness measurement is activated as long as the probe is connected with the measuring channel.

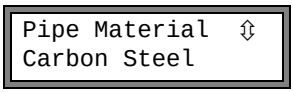
15.2 Parameter Input

15.2.1 Parameter Input for Wall Thickness Measurement

The sound velocity of the pipe material has to be entered to measure the wall thickness.



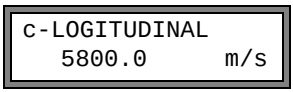
Select WALL THICKNESS in the scroll list OUTPUT OPTIONS\PHYSIC. QUANT. for the selected measuring channel



Select the pipe material in the scroll list PARAMETER\PIPE MATERIAL.

If the material is not in the scroll list, select OTHER MATERIAL.

Press ENTER.



A value for the longitudinal sound velocity of the selected material will be recommended.

If OTHER MATERIAL is selected, 0.0 m/s will be displayed.

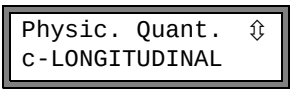
Edit the sound velocity, if necessary. The max. value is 20 000 m/s. Press ENTER.

Note!	The measurement can be started only if the entered sound velocity is > 0. Compared to the flow measurement, the sound velocity has a great, approximately linear influence on the measuring result. The input of a 10 % too high sound velocity will result in a wall thickness approx. 10 % too high. The actual sound velocity of a material often differs substantially from the values published in the literature as it depends on the composition, the manufacturing process and the temperature. The sound velocities given in annex C, Table C.1 only serve as orientation values.

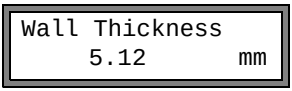
Note!	The longitudinal sound velocity of a material can be measured precisely using a comparative block of known thickness (see section 15.3.2).

15.2.2 Parameter Input for the Sound Velocity Measurement

The thickness of the pipe has to be entered to determine the longitudinal sound velocity of a material.



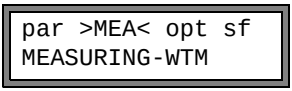
In the program branch OUTPUT OPTIONS, select the physical quantity c-LONGITUDINAL for the measuring channel on which the probe is connected.



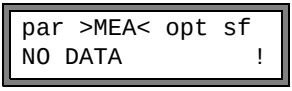
Enter the wall thickness of the pipe in the program branch PARAMETER.

Values between 0.8 mm and 200 mm will be accepted.

15.3 Measurement



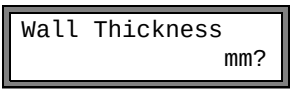
Select the program branch MEASURING in the main menu. Press ENTER.



If this error message is displayed,

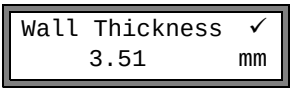
- the required parameters are not entered completely or
- the sound velocity for the material was set to 0.0 m/s.

15.3.1 Measurement of Wall Thickness



This display will be indicated if the wall thickness is selected as physical quantity for the measuring channel connected with the probe.

As long as there is no valid measured value, the unit of measurement and a question mark will be displayed in the lower line.



Apply a film of acoustic coupling compound on the pipe wall. Firmly press the probe against the pipe wall on this spot.

As soon as a valid measured value is obtained, it will be displayed in the lower line. A tick will be displayed right in the upper line.

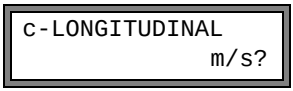
The measured value remains on the display when the probe is removed from the pipe.

To minimize errors when measuring the wall thickness, measure the longitudinal sound velocity of the material on a comparative block of the same material with known dimensions.

- The comparative block should be even and smooth.
- The thickness of the comparative block should be comparable to the max. thickness of the pipe.

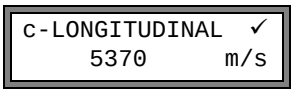
Note! The sound velocity of the material depends on the temperature. The sound velocity of a comparative block should be measured at the location where the flow will be measured later to obtain the sound velocity at the right temperature.

15.3.2 Measurement of Sound Velocity



This display will be indicated if the sound velocity is selected as physical quantity for the measuring channel connected with the probe.

As long as there is no valid measured value, the unit of measurement and a question mark will be displayed in the lower line.



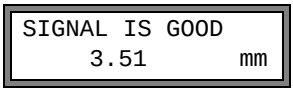
Apply a film of acoustic coupling compound on the pipe wall. Firmly press the probe against the pipe wall on this spot.

As soon as a valid measured value is obtained, it will be displayed in the lower line. A tick will be displayed right in the upper line.

The measured value remains on the display when the probe is removed from the pipe.

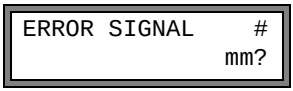
Note! For pipe materials that can be used with the longitudinal sound velocity see annex C, table C.1.

15.3.3 Further Information on the Measurement

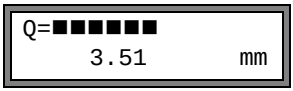


Press key [DISP 9] to obtain information on the measuring signal.

This message will be displayed if the measuring signal is sufficient. The LED of this channel lights green.

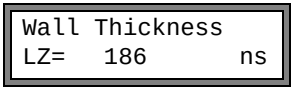


This message will be displayed if the measuring signal is not sufficient (# = number). The LED of this channel lights red.



Press key [DISP 9] again. The bar graph of the signal quality (Q=) will be displayed.

If the signal is not sufficient for a measurement, UNDEF will be displayed. The LED of this channel lights red. Displace the probe slightly on the pipe until the LED of the channel lights green.



Press key [3 DISP] to display the transit time (TRANS).

15.3.4 Errors during Measurement

If no valid wall thickness can be measured,

- remove the probe from the pipe wall
- clean the probe and the spot on the pipe where the measurement takes place
- apply a film of acoustic coupling compound on the pipe wall
- firmly press the probe against the pipe wall on this spot
- try measuring again.

Note!	Use a small amount of coupling compound. Press evenly with the probe on the pipe wall.

15.3.5 Possible Reasons for Incorrect Measuring Results

- **temperature fluctuations**:
  The sound velocity is temperature dependent.
- **doubling effect**:
  When measuring the wall thickness using ultrasonic signals, a phenomena called doubling effect can be observed when the thickness of the pipe is lower than the min. measuring range of the probe. The measured value is then twice (or sometimes three times) as high as the actual wall thickness because of repeated reflections of the ultrasonic signal.
- **the measured value is too low**:
  The ultrasonic signal was reflected by a defect and not by the boundary layer, resulting in a shorter transit time and thus a lower wall thickness.
- **warped surfaces**:
  The probe has to be pressed centrally against the pipe or cylindrical vessel. The applied pressure must be constant. The acoustic partition boundary of the probe must be perpendicular to the longitudinal axis of the pipe.
- **surface conditions**:
  Regular unevenness (e.g. small grooves) at the surface of the pipe can result in wrong measured values. Normally, this problem can be avoided by turning the probe so that the acoustic partition boundary of the pipe is perpendicular to the orientation of the grooves (see Fig. 15.2).

When measuring on a rough surface applying of too high amount of acoustic coupling compound can result in wrong measured values. Measurement on very rough surfaces might be impossible (message NO COUPLING will be displayed). In this case, the surface has to be smoothed.

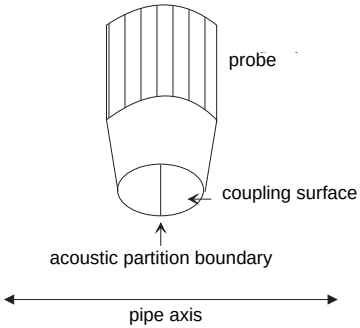


Fig. 15.2: Acoustic partition boundary

15.3.6 Store/Transmit the Wall Thickness

Press ENTER to stop the measurement and to store or output the measured value. This display appears if a valid wall thickness has been measured and a measured value output is activated.

```
Transfer Data
no           >YES<
```

Select YES to store and/or output the measured value.

- The wall thickness can be transmitted into the current parameter record of the flow measurement.
- The pipe material will be replaced by the material used for the wall thickness measurement.

If the serial output is activated, the measured value will be transmitted.

15.3.7 Finishing Wall Thickness Measurement

To leave the wall thickness measurement mode, disconnect the probe from the flowmeter.

16 Heat Flow and Heat Quantity

When the flowmeter has the option heat quantity measurement and two temperature inputs, the heat flow and the heat quantity can be measured.

16.1 Measuring Setup

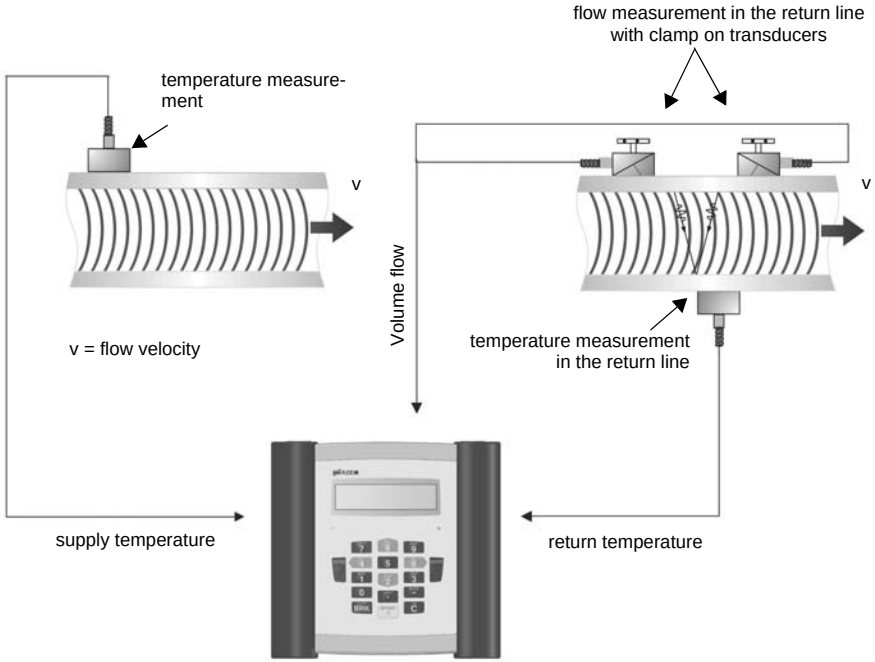


Fig. 16.1: Measurement of heat flow and heat quantity

Clamp on transducers and clamp on temperature probes will be used which allow a non-invasive measurement.

Note!	As the volume flow is measured always in the return line, the return temperature corresponds to the medium temperature at the selected measuring point.

16.2 Calculation of Heat Flow and Heat Quantity

The following physical quantities are used for the calculation:

- supply temperature
- return temperature (medium temperature)
- volume flow in the return line
- density, temperature and pressure of the medium.

Note!	If the supply or return temperature is known and constant during the whole measuring period, this temperature can be entered in the flowmeter and the corresponding temperature probe does not need to be connected.

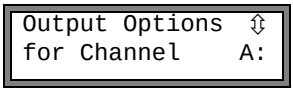
10 medium dependent heat flow coefficients are needed for the heat flow measurement. The heat flow coefficients of a few media are already stored in the internal database of the flowmeter. The heat flow coefficients of the other media have The heat flow coefficients of the other media have to be entered before the start of the measurement.

A temperature correction value (offset) can be defined for each temperature input (see section 16.6).

If the supply pressure is constant or can be measured with an additional input, heat flow and heat quantity can be determined for a medium that is vaporous in the supply line (see section 16.7).

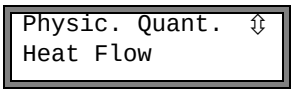
16.3 Settings

- Configure the temperature inputs in `SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS` (see section 17.1).
- Enter the heat flow coefficients of the medium if necessary (see section 11.3.4).
- Select the program branch `OUTPUT OPTIONS`.



Select the measuring channel on which the heat flow is to be measured (the channel to which the temperature inputs were linked). Press ENTER.

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



Select `HEAT FLOW` as physical quantity. Press ENTER.

- Select `SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING`. Press ENTER until the list item `HEAT QUANTITY` is displayed.

Heat Quantity
>[J]< [Wh]

Select the unit of measurement (Joule [J] or Watt-hour [Wh]). The setting is cold start resistant. Press ENTER.

heat+flow quant.
off >ON<

Select ON to output both the volume flow totalizer and the heat quantity totalizer. Press ENTER.

16.4 Installation of the Temperature Probe

- Fix the temperature probe (see Fig. 16.1 to Fig. 16.3).

Note!	The temperature probe has to be mounted on a clean area of the pipe! Remove rust, insulation material and loose paint to get a good thermal contact.

- Protect the temperature probe by the protection plate and by isolation foam (see Fig. 16.2).

a) b)

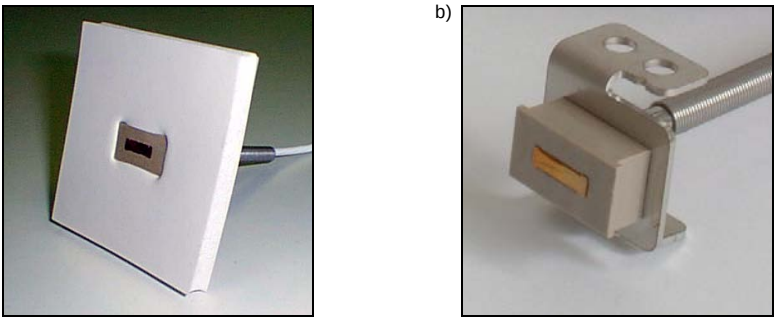


Fig. 16.2: Temperature probe (a)with and (b) without protection plate and isolation foam

- Apply a film of thermal conductivity paste (no FLEXIM supply) onto the contact surface of the temperature probe.
- Take the spring end of the ball chain and insert the last ball in one of the slots on the top of the temperature probe.
- Place the chain around the pipe. Pull the chain firmly and insert it in the second slot of the temperature probe (see Fig. 16.3).
- Connect the temperature probe with the flowmeter.

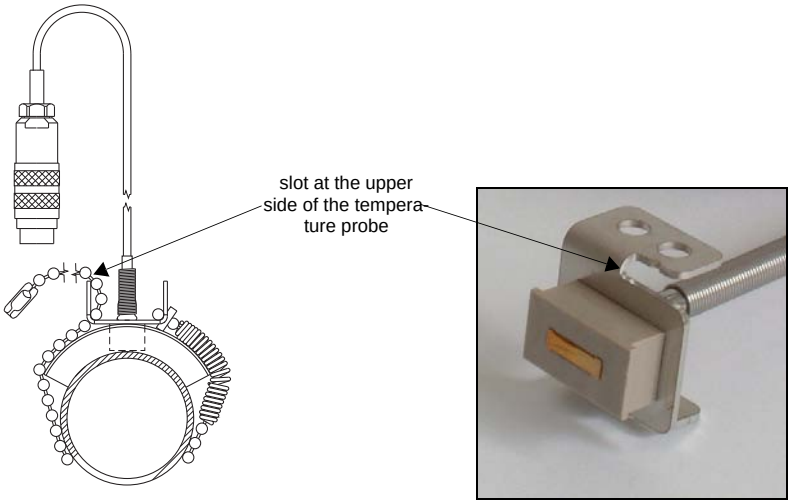


Fig. 16.3: Mounted temperature probe

For the installation of the transducers see Fig. 16.1 and section 6.6.

Note!	The volume flow has always to be measured at the return line, i.e the transducers will be mounted on the return line.

16.5 Measurement

Start the measurement as usual.

```
Heatflow
*INVALID MEDIUM*
```

If no heat flow coefficients are available for the selected medium, an error message will be displayed.

```
T1= 90.2 C
T2= 70.4 C
```

The two temperature inputs will be checked and the measured temperatures will be displayed. Press ENTER.

```
T1=?UNDEF C
T2= 70.4 C
```

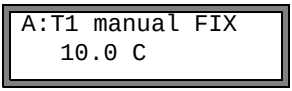
If a temperature can not be measured (the temperature probe is not connected or is defective), the error message ?UNDEF will be displayed. In the example, T1 can not be measured.

```
A:T1 manual FIX
    0.0 C
```

If FIXED INPUT VALUE was selected during the configuration of the temperature input, the value has to be entered now.

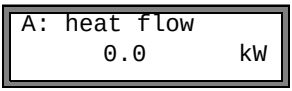
Enter the medium temperature. Press ENTER.

Note! A fixed temperature should be entered if e.g. the temperature can be measured only with difficulties on the supply line but the supply temperature is known and constant.



For simulations, it is possible to enter supply and return temperatures as constants.

In this case, do not connect the temperature probes with the flowmeter. The temperatures have to be entered (MANUAL).



As soon as all necessary values are entered, the measured heat flow will be displayed.

If the heat quantity has to be measured too, the heat flow totalizer has to be activated (see section 8.2).

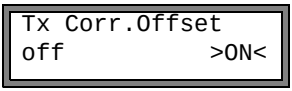
16.6 Temperature Correction

A correction value (offset) for the temperature can be defined for each temperature input. If a correction value is defined, it will be automatically added to the measured temperature. This function is useful if e.g.:

- the characteristic curves of the two temperature probes differ considerably one from another
- a known and constant temperature gradient exists between the measured temperature and the actual medium temperature.

16.6.1 Activating/Deactivating the Temperature Correction

The temperature correction can be activated/deactivated in SPECIAL FUNCTIONS\SYSTEM SETTINGS\DIALOGS/MENUS.

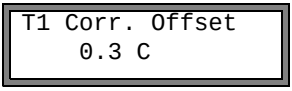


Select ON in TX CORR.OFFSET to activate the temperature correction, OFF to deactivate it.

Note! If OFF is selected, the temperature correction will be deactivated for all inputs. However, the entered correction values for each temperature input will be stored and displayed when the temperature correction is activated again.

16.6.2 Input of the Correction Value

During the flow transducer positioning, the correction values will be requested for each input which is activated and where the temperature can be measured.



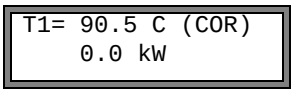
Enter the correction value for the temperature input.

Press ENTER.

Note! Only measured temperatures can be corrected.

For a zero adjustment, measure the same reference temperature with the two temperature probes, then enter the difference between the two measured values as correction value for one of the temperature inputs. The difference can also be distributed on the correction values of both channels.

The temperature difference display T1-T2 does not indicate if one or both temperatures are constants or if the temperatures are corrected.



During measurement, a corrected temperature value is marked by COR.

16.7 Steam in the Supply Line

If the supply pressure is constant or can be measured by an additional input, heat flow and heat quantity can be determined for a medium that is vaporous in the supply line.

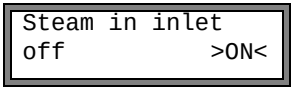
The state of aggregation of the medium will be determined by means of the supply pressure and the supply temperature.

Note! The measurement of the volume flow, and thus of the heat flow, is only possible when the medium is liquid in the return line.

The steam coefficients of water and ammonia are stored in the internal database of the flowmeter. The steam coefficients of the other media must be entered with the program FluxKoef.

16.7.1 Activating/Deactivating

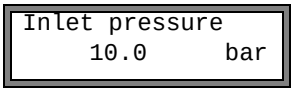
Select SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS\STEAM IN INLET.



Select ON to activate STEAM IN INLET. The state of aggregation of the medium will be determined by means of the supply pressure and the supply temperature.

Select OFF to deactivate STEAM IN INLET. The medium is then always considered to be liquid in the supply line.

The setting is cold start resistant.



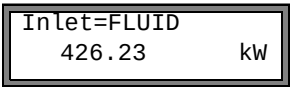
If STEAM IN INLET is activated, the supply pressure has to be entered in the program branch PARAMETER.

Enter the supply pressure. Press ENTER.

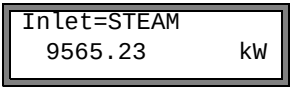
Note!	The menu item STEAM IN INLET will be always displayed independently of the selected physical quantity. However, the supply pressure will be used only for heat flow measurement.

16.7.2 Displays

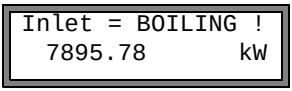
During heat flow measurement, the calculated state of aggregation will be displayed in the upper line by pressing key 9 .



This message will be displayed if the medium in the supply line is completely liquid.



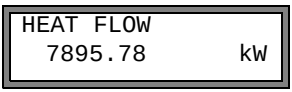
This message will be displayed if the medium in the supply line is completely vaporous.



This message will be displayed if the medium in the supply line is in the phase transition (critical range).

An exact measurement of the heat flow is not possible in this case as the proportion of medium in liquid phase in the supply line has to be known for calculating the enthalpy of the supply.

The critical range of water of is considered ±3 °C around the boiling temperature. For this range, the heat flow will be calculated with the steam saturation enthalpy.



If the medium is in the critical range, the measured value will be displayed in capital letters.

17 Inputs

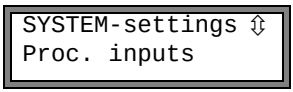
External transducers can be connected to the inputs (if available) to measure the following physical quantities:

- temperature
- density
- pressure
- kinematic viscosity
- dynamic viscosity

The values of the current, voltage or temperature inputs can be used by all measuring channels.

An input has to be linked to a measuring channel (see section 17.1 and 17.3) and has to be activated (see section 17.4) before it can be used for the measurement or for storing of measured values.

Note!	If a new input is installed, the flowmeter has to be restarted (RESET or off/on) to identify the new inputs.



Select SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS.

Depending on the configuration of the flowmeter, one or several of the following list items will be displayed:

Table 17.1: List items of the scroll list PROC. INPUTS

list item	function
LINK TEMPERATURE	linking temperature inputs to measuring channels
LINK OTHERS	linking other inputs to measuring channels
PT100/PT1000	selection of a temperature probe
...GO BACK	return to the precedent menu item

17.1 Linking the Temperature Inputs to the Measuring Channels

17.1.1 Temperature Inputs and Heat Flow Measurement

For the heat flow measurement, the supply and return temperature have to be linked as T-INLET and T-FLUID/OUTLET to the corresponding measuring channel (see section 17.1.2). These temperatures are usually measured, but can also be entered as constants.

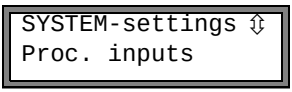
With the configuration in Table 17.2, two independent heat flows can be measured simultaneously. The temperature measured by T2 can not be used for heat flow measurement on measuring channel B, but can be displayed and output.

Note! The physical quantity HEAT FLOW is displayed in the program branch OUTPUT OPTIONS only if a supply and return temperature have been linked to this channel.

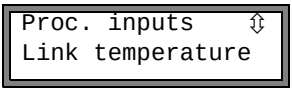
Table 17.2: Example of configuration of the temperature inputs for heat flow measurement

measuring channel A	temperature input
supply temperature T_V	T1
return temperature T_R	T2
heat quantity measurement	possible
measuring channel B	temperature input
supply temperature T_V	constant value
return temperature T_R	T4
heat quantity measurement	possible

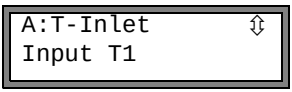
17.1.2 Linking the Temperature Inputs



Select SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS. Press ENTER.



Select the list item LINK TEMPERATURE.



Select the temperature input to be linked to measuring channel A as supply temperature.

Select the list item FIXED INPUT VALUE if the temperature will be entered manually before the measurement.

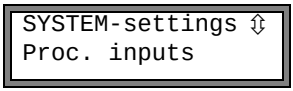
Select the list item NO MEASURING if a supply temperature is not to be linked to measuring channel A.

Press ENTER.

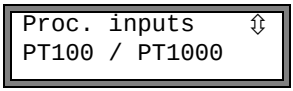
Select the list items for T-FLUID/OUTLET, T(3) and T(4) of measuring channel A and the other activated channels accordingly. Press ENTER after each input.

Note! The configuration of a measuring channel will be stored when the next channel is selected. The configuration dialog of a channel has to be finished to save the changes.

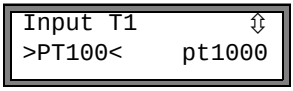
17.2 Selection of the Temperature Probe



Select SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS. Press ENTER.



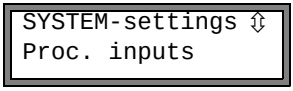
Select the list item PT100/PT1000.



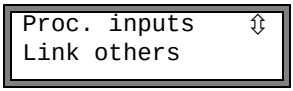
Select the temperature probe.

If necessary, select the temperature probe for input T2, T3 and T4 accordingly.

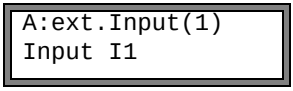
17.3 Linking Other Inputs to the Measuring Channels



Select SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS. Press ENTER.



Select the list item LINK OTHERS.



Select the first input to be linked to measuring channel A. Only the installed inputs are displayed in the scroll list.

Select the list item NO MEASURING if an input is not to be linked to measuring channel A.

Press ENTER.

Select the list items for EXT. INPUT(2)...(4) of measuring channel A and the other activated channels accordingly.

Note!	The configuration of a measuring channel will be stored when the next channel is selected. The configuration dialog of a channel has to be finished to save the changes.

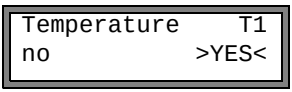
17.4 Activation of the Inputs

Note!	The activation of the inputs in program branch OUTPUT OPTIONS will be displayed only if the flowmeter has inputs of the corresponding type and they are linked to a measuring channel.

17.4.1 Activation of Temperature Inputs

Note!	If HEAT FLOW is selected as physical quantity, the corresponding temperature inputs will be automatically activated. The steps described below are only necessary if the measured temperatures are to be displayed or output.

Temperature inputs have to be activated if the measured temperatures have to be displayed, stored and/or output with the other measured values or if the measured temperature is to be used for the interpolation of the medium viscosity and density.



Select in the program branch OUTPUT OPTIONS the channel for which a temperature input has to be activated.

The temperature inputs linked to the channel will be displayed one after another. Select YES for the temperature inputs to be activated.

Note!	The total number of measured values that can be stored will be reduced if a temperature input is activated.

17.4.2 Activation of Other Inputs

Attention!	Observe the polarity to avoid damaging the current source. The current input might be destroyed by a permanent short circuit.

Inputs have to be activated if the measured values are to be displayed, stored and/or output together with the other measured values.

Select in the program branch OUTPUT OPTIONS the channel for which an input has to be activated.

The inputs linked to the channel will be displayed one after another. Select YES for the inputs to be activated.

Note!	The total number of measured values that can be stored will be reduced if an input is activated.

17.5 Connection of a Current Input

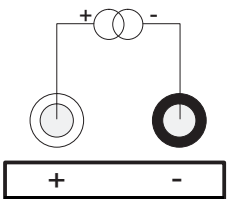
17.5.1 Connection with a Passive Current Input

Table 17.3: Technical data of the passive current input

measuring range	-20...+20 mA
accuracy	0.1 % of reading ±10 µA
input impedance	50 Ω/0.6 W
max. permanent overcurrent	100 mA

Connection of an Active Current Source

Connect an active current source to a passive current input as follows:

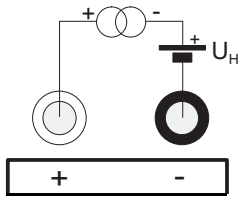


If the polarity of the current source is inversed, only the sign of the measured current will change.

Fig. 17.1: External active current source with passive current input

Connection of a Passive Current Source

- An external power supply is required for the connection of a passive current source.



The power supply U_H must be able to supply the passive current source as well as to cover the voltage drop over the measurement resistance (max. 1 V) and over all other voltage drops (e.g. cable resistance) in the circuit.

A current of min. 20 mA has to be provided.

Fig. 17.2: External passive current source with passive current input

example: A passive current source (e.g. a pressure sensor 4...20 mA) is connected to a passive current input.

Technical Data of the pressure sensor:

auxiliary power supply: U_S = 11...30 V DC
output signal: 4...20 mA

The required auxiliary power supply of the pressure sensor will be calculated as follows:

$U_{H\text{-}MIN}$ = $U_{S\text{-}MIN} + I_{MAX} \cdot R_{MEA} + I_{MAX} \cdot R_{CAB}$

= 11 V + 20 mA · 50 Ω + 2 0 mA · 2 Ω

= 12.04 V

R_{MEA} = input impedance, R_{CAB}= cable resistance

$U_{H\text{-}MAX}$ = 30 V (according to the technical data of the pressure sensor)

18 Outputs

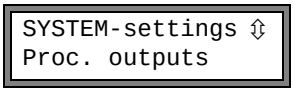
If the flowmeter is equipped with outputs, they have to be installed and activated before they can be used:

- assigning a measuring channel (source channel) to the output (if the flowmeter has more than one measuring channel)
- assigning the physical quantity (source item) to be transmitted to the output by the source channel and the properties of the signal
- defining the behavior of the output in case no valid measured value is available
- activation of the installed output in the program branch `OUTPUT OPTIONS`

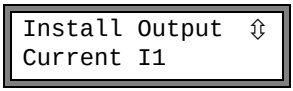
18.1 Installation of an Output

The outputs will be installed in the program branch `SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. OUTPUTS`.

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

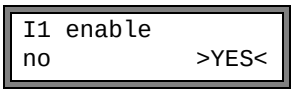


Select `SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. OUTPUTS`. Press ENTER.

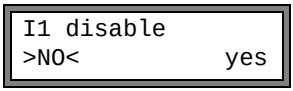


Select the output to be installed. The scroll list contains all actually available outputs.

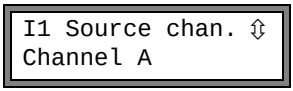
A tick ✓ after a list item indicates that this output has already been installed. Press ENTER.



This display is indicated if the output has not been installed yet. Select `YES`. Press ENTER.

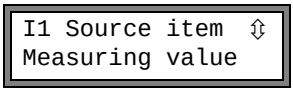


If the output is already installed, select `NO` to reconfigure it or `YES` to uninstall the output and to return to the precedent menu item to select another output. Press ENTER.



Select in the scroll list the measuring channel to be assigned as source channel to the output. Press ENTER.

This display will not be indicated, if the flowmeter has only one measuring channel or only one measuring channel is active.



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

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

The source items and their scroll lists are described in Table 18.1.

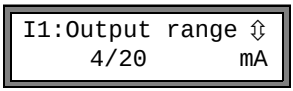
Table 18.1: Configuration of the outputs

source item	list item	output
MEASURED VALUE	ACTUAL MEASURE	physical quantity selected in the program branch OUTPUT OPTIONS
	FLOW	flow independently of the physical quantity selected in the program branch OUTPUT OPTIONS
	HEAT FLOW	heat flow independently of the physical quantity selected in the program branch OUTPUT OPTIONS
QUANTITY	Q+	totalizer for the positive flow direction
	* ACTUAL MEASURE	totalizer for the physical quantity selected in the program branch OUTPUT OPTIONS
	* FLOW	flow totalizer
	* HEAT FLOW	heat flow totalizers
	Q-	totalizer for the negative flow direction
	* ACTUAL MEASURE	totalizer for the physical quantity selected in the program branch OUTPUT OPTIONS
	* FLOW	flow totalizer
	* HEAT FLOW	heat flow totalizers
	ΣQ	sum of the totalizers (positive and negative flow direction)
	* ACTUAL MEASURE	totalizer for the physical quantity selected in the program branch OUTPUT OPTIONS
	* FLOW	flow totalizer
	* HEAT FLOW	heat flow totalizers
LIMIT	R1	limit message (alarm output R1)
	R2	limit message (alarm output R2)
	R3	limit message (alarm output R3)
TEMPERATURE		Is available only if a temperature input has been assigned to the channel.
	T-INLET (T1)	supply temperature for the heat flow measurement
	T-OUTLET (T2)	return temperature for the heat flow measurement
	T(3)=INPUT T3	further temperature input
	T(4)=INPUT T4	further temperature input
	TV(=T1)-TR(=T2)	difference between supply and return temperature
	TV(=T1)-T3	difference between supply temperature and T(3)
	TR(=T2)-T3	difference between return temperature and T(3)
	TV(=T1)-T4	difference between supply temperature and T(4)
	TR(=T2)-T4	difference between return temperature and T(4)
	T3-T4	difference between T(3) and T(4)

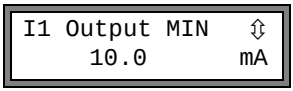
Table 18.1: Configuration of the outputs

source item	list item	output
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	SOUNDSPEED FLUID	sound velocity of the medium
	CONCENTRATION K	Concentration
	SIGNAL	signal amplitude of a measuring channel

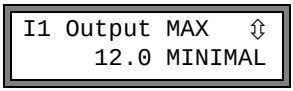
18.1.1 Output Range



When configuring an analog output, the output range will be defined now. Select a list item or OTHER RANGE.. to enter the output range manually.



If OTHER RANGE.. is selected, enter the values OUTPUT MIN and OUTPUT MAX. Press ENTER after each input.



This error message will be displayed if the output range is not min. 10 % of the max. output range. The next possible value will be displayed. Repeat the input.

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

18.1.2 Error Output

In the further dialog, an error value can be defined which is to be output if the source item can not be measured e.g. when gas bubbles are in the medium.

Table 18.2: 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: The volume flow is selected as source item for a current output, the output range is 4...20 mA, the error value delay is $t_d > 0$.

The volume flow can not be measured in the time interval $t_0...t_1$ (see Fig. 18.1). The error value will be output.

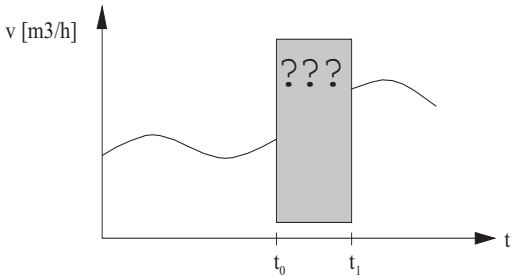


Fig. 18.1: Error output

Table 18.1: Examples for the error output

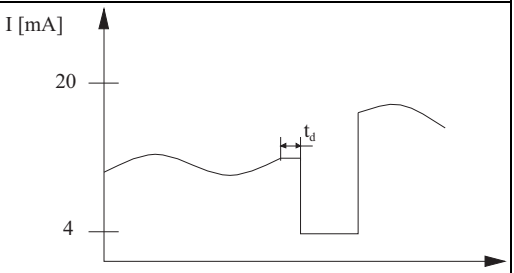
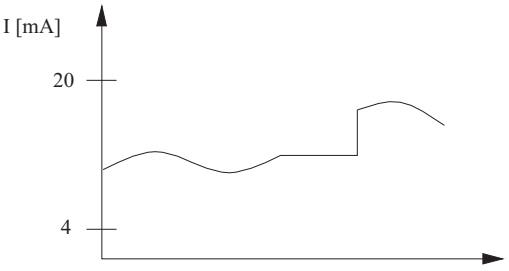
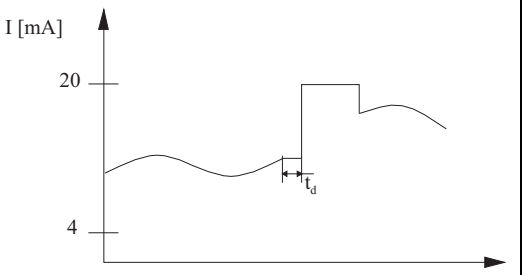
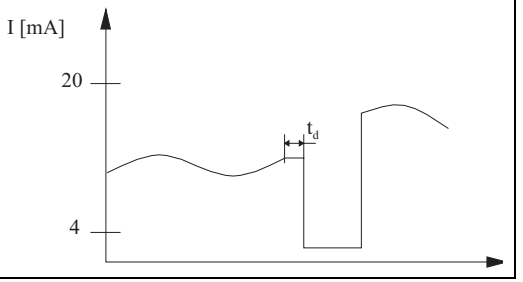
list item for the error output	output signal
Error-value ⇳ Minimum (4.0mA)	
Error-value ⇳ Hold last value	

Table 18.1: Examples for the error output

list item for the error output	output signal
Error-value ⇳ Maximum (20.0mA)	
Error-value ⇳ Other value ... error output = 2.00 mA	

Error-value ⇳
Minimum (4.0mA)

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

Error-value
3.5 mA

If OTHER VALUE ... is selected, enter an error value. It has to be within the limits of the output.

Press ENTER.

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

I1 active loop
Terminal:P1+,P1-

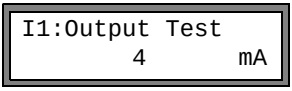
The terminals to be used for the connection of the output are now displayed (here: P1+ and P1- for the active current loop).

Press ENTER.

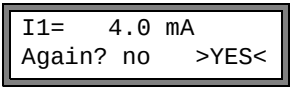
18.1.3 Function Test

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

Test of the Analog Outputs



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

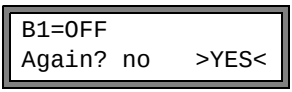


If the multimeter displays the entered value, the output functions correctly.

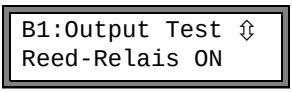
Select YES to repeat the test, NO to return to SYSTEM SETTINGS. Press ENTER.

Test of the Binary Outputs

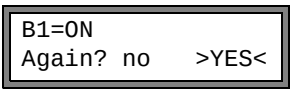
Select REED-RELAIS OFF or OPEN COLLECTOR OFF in the scroll list OUTPUT TEST to test the de-energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be high ohmic.



Select YES. Press ENTER.



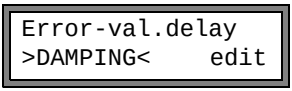
Select REED-RELAIS ON or OPEN COLLECTOR ON in the scroll list OUTPUT TEST to test the energized state of the output. Press ENTER. Measure the resistance at the output. The value has to be low ohmic.



Select YES to repeat the test, NO to return to SYSTEM SETTINGS. Press ENTER.

18.2 Error Value Delay

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



Select in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS the menu item ERROR-VAL. DELAY.

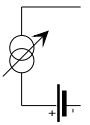
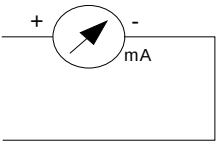
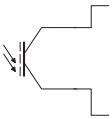
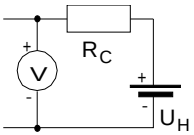
Select DAMPING if the damping value is to be used as error value delay. Select EDIT to activate the error value delay request.

```
Error-val. delay
      10         s
```

From now on, the error value delay can be entered in the program branch OUTPUT OPTIONS. The setting is cold start resistant.

18.3 Circuits of the Outputs

Table 18.2: Circuits of the outputs

output	FLUXUS	circuits	
active current loop			$R_{LOAD} < 500\ \Omega$
binary output (optorelay)			$U_H \leq 32$ V $I_C \leq 100$ mA

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

18.4 Activation of an Analog Output

Note!	An output can only be activated in the program branch OUTPUT OPTIONS if it has been previously installed.

```
Output Options  ⇳
for Channel     A:
```

Select in the program branch OUTPUT OPTIONS the channel for which an output has to be activated. Press ENTER.

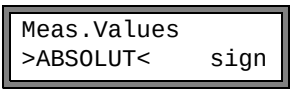
This display will not be indicated, if the flowmeter has only one measuring channel.

```
Current Loop
I1: no        >YES<
```

Press ENTER until CURRENT LOOP is displayed. Select YES to activate the output. Press ENTER.

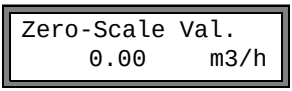
18.4.1 Measuring Range of the Analog Outputs

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



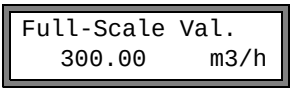
Select SIGN if the sign of the measured values has to be considered for the output.

Select ABSOLUT if the sign does not need to be considered.



Enter in ZERO-SCALE VAL. the lowest measured value expected. The unit of measurement of the source item will be displayed.

ZERO-SCALE VAL. is the measured value corresponding to the lower limit of the output range as defined in section 18.1.1.



Enter in FULL-SCALE VAL. the highest measured value expected.

FULL-SCALE VAL. is the measured value corresponding to the upper limit of the output range as defined in section 18.1.1.

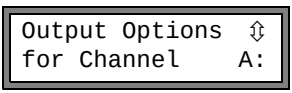
example: The output range 4…20 mA was selected for a current loop, the zero-scale value was set to 0 m^3/h and the full-scale value to 300 m^3/h.

If the volume flow is 300 m^3/h, a 20 mA signal is transmitted to the output. If the volume flow is 0 m^3/h, a 4 mA signal is transmitted to the output.

18.5 Activation of a Pulse Output

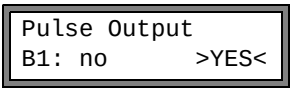
A pulse output is an integrating output which emits a pulse when the medium volume or the medium mass which has passed the measuring point reaches a given value (PULSE VALUE). The integrated quantity is the selected physical quantity. Integration is restarted when a pulse is emitted.

Note! The menu item PULSE OUTPUT will be displayed in the program branch OUTPUT OPTIONS only if a pulse output has been installed.

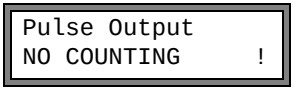


Select in the program branch OUTPUT OPTIONS the channel for which a pulse output has to be activated. Press ENTER.

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

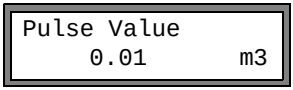


Select YES to activate the output. Press ENTER.



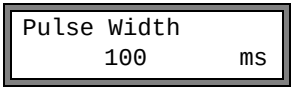
This error message will be displayed if the flow velocity is selected as physical quantity.

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



Enter the PULSE VALUE. The unit of measurement will be displayed corresponding to the current physical quantity.

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



Enter the PULSE WIDTH. Values between 1 ms and 1000 ms will be accepted.

The range of possible pulse widths depends on the specifications of the instrument (e.g. counter, PLC) to be connected with the pulse output.

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

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

18.6 Activation of an Alarm Output

Note! The menu item ALARM OUTPUT will be displayed in the program branch OUTPUT OPTIONS only if an alarm output is installed.

Max. 3 alarm outputs R1, R2, R3 per channel operating independently of each other can be configured. The alarm outputs can be used to output information on the current measurement or to start and stop pumps, motors, etc.

18.6.1 Alarm Properties

The switching condition, the holding behavior and the switching function can be defined for an alarm output:

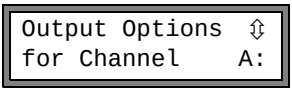
Table 18.3: Alarm properties

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).
	QUANTITY	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.

Table 18.3: Alarm properties

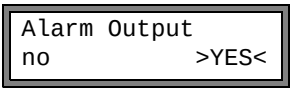
alarm property	setting	description
TYP (holding behavior)	NON-HOLD	If the switching condition is not true any more, the alarm returns to idle state after approx. 1 s.
	HOLD	The alarm remains activated even if the switching condition is not true any more.
MODE (switching function)	NO CONT.	The alarm is energized when the switching condition is true and de-energized when idle.
	NC CONT.	The alarm is de-energized when the switching condition is true and energized when idle.

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

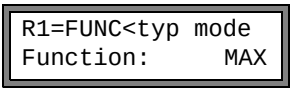


Select in the program branch OUTPUT OPTIONS the channel for which an alarm output has to be activated. Press ENTER.

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



Select YES to activate the alarm output. Press ENTER.



Three scroll lists will be displayed:

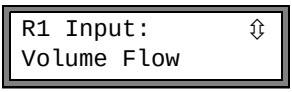
- FUNC for the switching condition
- TYP for setting the holding behavior
- MODE for the switching function

A scroll list will be selected in the upper line with keys 4 and 6. A list item will be selected in the lower line with keys 8 and 2.

Press ENTER to store the settings.

18.6.2 Setting the Limits

If MAX or MIN is selected in the scroll list FUNC, the limit of the output has to be defined:



Select in the scroll list INPUT the physical quantity to be used for comparison. The following list items are available:

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

Press ENTER.

Enter the limit:

table 18.4: Limits MAX and MIN

switching condition	display	comparison
MAX	High Limit -10.00 m3/h	measured value > limit The alarm will switch if the measured value exceeds the upper limit.
MIN	Low Limit -10.00 m3/h	measured value < limit The alarm will switch if the measured value falls below the lower limit.

example 1: upper limit = -10.0 m^3/h

A measured value of e.g. -9.9 m^3/h. exceeds the limit. The alarm switches.

A measured value of e.g. -11.0 m^3/h does not exceed the limit. The alarm does not switch.

example 2: lower limit = -10.0 m^3/h

A measured value of e.g. -11.0 m^3/h falls below the limit. The alarm switches.

A measured value of e.g. -9.9 m^3/h does not fall below the limit. The alarm does not switch.

If QUANTITY has been selected in the scroll list FUNC, the limit of the output has to be defined:

Table 18.5: Limit of totalizer

switching condition	display	comparison
QUANTITY	Quantity Limit 1.00 m3	totalizer ≥ limit The alarm will switch if the totalizer reaches the limit.

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

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

The comparison will also be made if the totalizer of the other flow direction is displayed.

Note! The unit of measurement of the limit corresponds to the unit of measurement of the selected physical quantity.

If the unit of measurement of the physical quantity is changed, the limit has to be converted and input again.

Example 1: physical quantity volume flow in m^3/h, quantity limit = 1.0 m^3

example 2: physical quantity volume flow in m^3/h, lower limit = 60.0 m^3/h

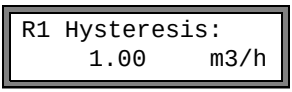
The unit of measurement of the physical quantity will be changed to m^3/min. The new limit to be entered is 1.0 m^3/min.

18.6.3 Defining the Hysteresis

A hysteresis can be defined for alarm output R1 preventing a constant triggering of the alarm by measured values fluctuating marginally around the limit.

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

example: The limit is 30 m^3/h and the hysteresis 1 m^3/h. The alarm will be triggered for values > 30.5 m^3/h and deactivated for values < 29.5 m^3/h.



Enter the hysteresis or 0 (zero) to work without hysteresis. Press ENTER.

18.7 Behavior of the Alarm Outputs

18.7.1 Apparent Switching Delay

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

18.7.2 Reset and Initialization of the Alarms

After a cold start, all alarm outputs will be initialized as follows:

Table 18.6: Alarm state after initialization

FUNC	OFF
TYPE	NON-HOLD
MODE	NO CONT.
LIMIT	0.00

Press three times key C during measurement to reset all alarm outputs to the idle state. Alarm outputs whose switching condition is still met will be reactivated after 1 s. This function is used to reset alarm outputs of type HOLD if the switching conditions is not met anymore.

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

18.7.3 Alarm Outputs during Transducer Positioning

When the positioning of the transducers begins (bar graph display), all alarms outputs switch back to the programmed idle state.

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

An alarm output of type HOLD being activated during the previous measurement remains in the idle state after transducer positioning if the switching condition is not met anymore.

Switching of the alarms into the idle state will not displayed.

18.7.4 Alarm Outputs during Measurement

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

An alarm output of type NON-HOLD will be activated if the switching condition is met. It will be deactivated if the switching condition is not met anymore. The alarm remains activated min. 1 s even if the switching condition is met shorter.

Alarm outputs with switching condition QUANTITY will be activated when the limit is reached.

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

Alarm outputs with switching condition +⇨- -⇨+ and of type NON-HOLD will be activated with each change of the flow direction for approx. 1 s (see Fig. 18.2).

Alarm outputs with switching condition +⇨- -⇨+ and of type HOLD will be activated after the first change of the flow direction. They can be switched back by pressing key C three times (see Fig. 18.2).

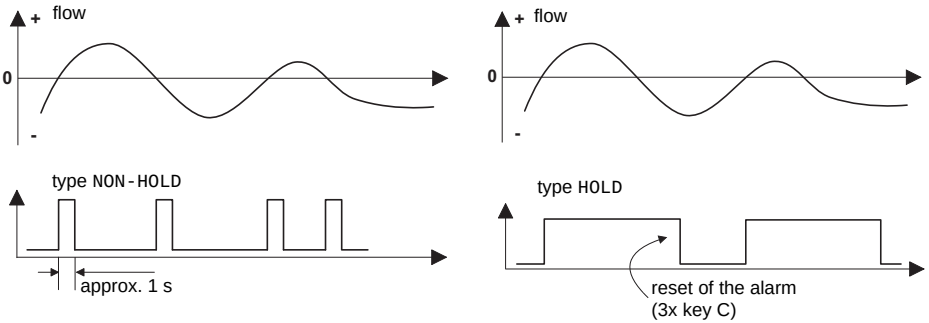


Fig. 18.2: Behavior of a relay when the flow direction changes

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. Alarm outputs with switching condition OFF will be set automatically to the switching function NO CONT.

18.7.5 Alarm State Indication

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

The alarm state can be displayed during measurement. This function will be activated in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS. The setting is cold start resistant.

Select the menu item SHOW RELAIS STAT. Select ON to activate the display of the alarm state.

Scroll during measurement with key 9 until the alarm state is displayed in the upper line.

RX = □ □ □ □, where □ is a pictogram according to Table 18.1.

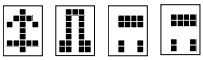
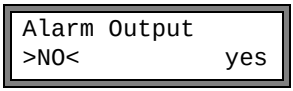
example: R1 = 

Table 18.1: Pictograms for the alarm state indication

	no.		switching condition (FUNC)	holding behavior (TYPE)	switching function (MODE)	actual state
R	□	=	□	□	□	□
	1		OFF	NON-HOLD	NO CONT.	closed
	2		MAX	HOLD	NC CONT.	open
	3		MIN			
			+ → - - → +			
			QUANTITY			
			ERROR			

18.8 Deactivating the Outputs

If the programmed outputs are no longer required, they can be deactivated. The configuration of the deactivated output is stored and will be available when the output is activated again.



To deactivate an output, select NO in OUTPUT OPTIONS\ALARM OUTPUT. Press ENTER.

19 Troubleshooting

If any problem appears which can not be solved with the help of this manual, contact our sales office giving a precise description of the problem. Specify the type, serial number and firmware version of the flowmeter.

Calibration

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

- the contact surface of the transducers show visible wear or
- the transducers were used for a prolonged period at a high temperature (several months at >130 °C for normal transducers or > 200 °C for high temperature transducers).

The flowmeter has to be sent to FLEXIM for recalibration under reference conditions.

The display does not work at all or always fails

Check that the battery is inserted and charged. Connect the power supply. If the power supply is ok, the transducers or an internal component of the flowmeter are defective. Transducers and flowmeter have to be sent for repair to FLEXIM.

The message SYSTEM ERROR is displayed

Press BRK to return to the main menu.

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

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

The backlight is defective. This problem has no influence on the other functions of the display. Send the flowmeter to FLEXIM for repair.

Date and time are wrong, the measured values will be deleted when the flowmeter is switched off

The data backup battery has to be replaced. Send the flowmeter to FLEXIM.

An output does not work

Make sure that the outputs are configured correctly. Check the function of the output as described in section 18.1.3. If the output is defective, contact FLEXIM.

Measurement is impossible or the measured values substantially differ from the expected values

see section 19.1.

The totalizer values are wrong

see section 19.6.

19.1 Problems with the Measurement

A measurement is impossible as no signal is received. A question mark will be displayed at the right side of the lower line

- Make sure that the entered parameters are correct, especially the outer pipe diameter, the pipe wall thickness and the sound velocity of the medium. (Typical errors: The circumference or the radius was entered instead of the diameter. The inner pipe diameter was entered instead of the outer pipe diameter.
- Make sure that the recommended transducer distance was adjusted when mounting the transducers.
- Make sure that an appropriate measuring point has been selected (see section 19.2).
- Try to obtain better acoustic contact between the pipe and the transducers (see section 19.3).
- Enter a lower value for the number of sound paths. The signal attenuation might be too high due to a high medium viscosity or of deposits on the inner pipe wall (see section 19.4).

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

- An exclamation mark "!" right in the lower line indicates that the defined upper limit of the flow velocity is exceeded and, thus, the measured values will be marked invalid. The limit has to be adapted to the measuring conditions or the check has to be deactivated (see section 8.3).
- If no exclamation mark "!" is displayed, a measurement at the selected measuring point is not possible.

Loss of signal during measurement

- If the pipe had been run empty and then has filled up again: Was there no measuring signal afterwards? Contact FLEXIM.
- Wait briefly until the acoustic contact is established again. The measurement can be prevented by a temporarily higher proportion of gaseous or solid particles in the medium.

The measured values substantially differ from the expected values

- Wrong measured values are often caused by false parameters. Make sure that the parameters entered are correct for the measuring point.
- If the parameters are correct, see section 19.5 for the description of typical situations in which wrong measured values are obtained.

19.2 Correct Selection of the Measuring Point

- Make sure that the recommended min. distance to any disturbance source is respected (see Table 4.2 in chapter 4).
- Avoid locations where deposits are building in the pipe.
- Avoid measuring points in the vicinity of deformations and defects of the pipe and in the vicinity of welds.
- Measure the temperature at the measuring point and make sure that the transducers are appropriate for this temperature.
- Make sure that the outer pipe diameter is within the measuring range of the transducers.
- When measuring on horizontal pipes, the transducers have to be mounted to the side of the pipes.
- A pipe vertically mounted has always to be filled at the measuring point, and the medium should flow upward.
- Bubbles should be avoided (even bubble-free media can form gas pockets when the medium expands, e.g. before pumps and after great cross-section extensions).

19.3 Maximum Acoustic Contact

Observe the points in section 6.6.

19.4 Application Specific Problems

The sound velocity of the medium is wrong

The entered sound velocity will be used to calculate the transducer distance and, thus, is very important for the transducer positioning. The sound velocities programmed in the flowmeter only serve as orientation values.

The entered pipe roughness is not appropriate

Reconsider the entered value, taking into account the state of the pipe.

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

Contact FLEXIM.

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

Try measuring on a liner free section of the pipe.

Media with high viscosity strongly attenuate the ultrasonic signal

Measurements on media with a viscosity > 1000 mm^2/s are only possible under certain conditions.

Higher proportions of gas or solids in the medium scatter and absorb ultrasounds and therefore attenuate the measuring signal

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

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

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

19.5 High Measuring Deviations

The entered sound velocity of the medium is wrong

A wrong sound velocity can lead to the ultrasonic signal reflected on the pipe wall being mistaken for the measuring signal passing the medium. The flow calculated from the wrong signal by the flowmeter is very small or fluctuates around zero.

There is gas in the pipe

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

The entered upper limit of the flow velocity is too low

All measured flow velocities that are greater than the upper limit will be ignored and marked as invalid. All quantities derived from the flow velocity are marked as invalid, too. 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 values are set to zero as well. The cut-off flow (default 2.5 cm/s) has to be set to a low value to be able to measure at low flow velocities.

The entered pipe roughness is inappropriate

The flow velocity to be measured is outside the measuring range of the flowmeter

The measuring point is not appropriate

Select another measuring point to check whether the results are better. The cross-section of the pipe is never perfectly circular, thus influences the flow profile. Change the transducer position according to the pipe deformation.

19.6 Problems with the Totalizers

The totalizer values are too high

See SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING\QUANTITY RECALL. If this menu item is activated, the totalizer values will be stored. The totalizer will take this value at the start of the next measurement.

The totalizer values 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 output sum of both totalizers is not valid after the overflow (wrapping) of one of the totalizers.

A Technical Data

Subject to modifications without prior notice.

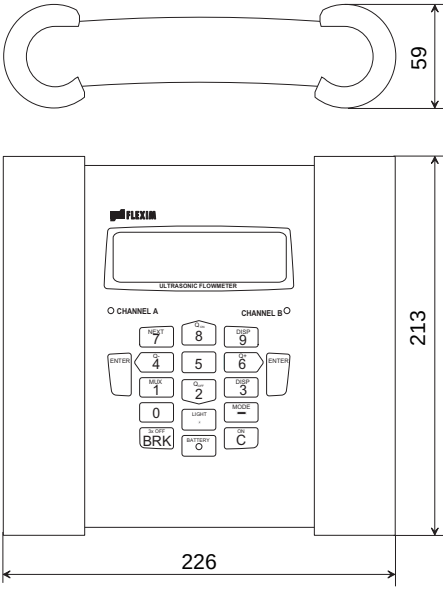
Flowmeter

FLUXUS	F601
measurement	
measuring principle	transit time difference correlation principle, automatic NoiseTrek selection for measurements with high gaseous or solid content
flow velocity	0.01...25 m/s
repeatability	0.15 % of reading ±0.01 m/s
accuracy[1]	
with standard calibration	±1.6 % of reading ±0.01 m/s
with extended calibration (option)	±1.2 % of reading ±0.01 m/s
with field calibration[2]	±0.5 % of reading ±0.01 m/s
medium	all acoustically conductive liquids with < 10 % gaseous or solid content in volume (transit time difference principle)
flowmeter	
power supply	100...230 V/50...60 Hz (power supply), 10.5...15 V DC (socket at flowmeter) or battery
battery	Li-Ion, 7.2 V/4.5 Ah operating time (without outputs, inputs and backlight): > 14 h
power consumption	< 6 W
number of flow measuring channels	2
signal damping	0...100 s, adjustable
measuring cycle (1 channel)	100...1000 Hz
response time	1 s (1 channel), option: 70 ms
material	polyamid
degree of protection according to EN 60529	IP 65
weight	1.9 kg
fixation	QuickFix pipe mounting fixture
operating temperature	-10...+60 °C
display	2 x 16 characters, dot matrix, backlit
menu language	English, German, French, Dutch, Spanish
measuring functions	
physical quantities	volume flow, mass flow, flow velocity, heat flow (if temperature inputs are installed)
totalizers	volume, mass, option: heat quantity
calculation functions	average, difference, sum
data logger	
loggable values	all physical quantities and totalized values
capacity	> 100 000 measured values

[1] for transit time difference principle, reference conditions and v > 0.15 m/s
[2] reference uncertainty < 0.2 %

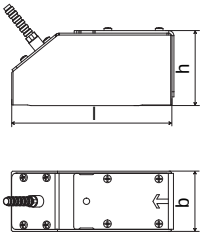
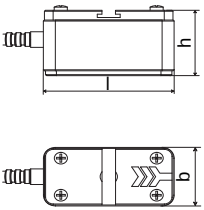
FLUXUS	F601
communication	
interface	RS232/USB
serial data kit	
software (all Windows™ versions)	- FluxData: download of measured data, graphical presentation, conversion to other formats (e.g. for Excel™) - FluxKoeff: creating medium data sets
cable	RS232
adapter	RS232 - USB
outputs	
	The outputs are galvanically isolated from the flowmeter.
number	on request
accessories	output adapter (if number of outputs > 4)
	current output
range	0/4...20 mA
accuracy	0.1 % of reading ±15 µA
active output	R_{ext} < 200 Ω
passive output	U_{ext} = 4...16 V, dependent on R_{ext}, R_{ext} < 500 Ω
	frequency output
range	0...10 kHz
open collector	24 V/4 mA
	binary output
optorelay	32 V/100 mA
binary output as alarm output	
- functions	limit, change of flow direction or error
binary output as pulse output	
- pulse value	0.01...1000 units
- pulse width	1...1000 ms
inputs	
	The inputs are galvanically isolated from the flowmeter.
number	on request , max. 4
accessories	input adapter (if number of inputs > 2)
	temperature input
designation	Pt100/Pt1000
connection	4-wire
range	-150...+560 °C
resolution	0.01 K
accuracy	±0.01 % of reading ±0.03 K
	current input
range	passive: -20...+20 mA
accuracy	0.1 % of reading ±10 µA
passive input	R_i = 50 Ω, P_i < 0.3 W
	voltage input
range	0...1 V
accuracy	0.1 % of reading ±1 mV
internal resistance	R_i = 1 MΩ

Dimensions of FLUXUSF601 (in mm):

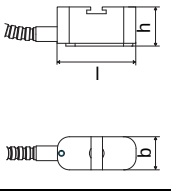
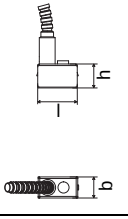


Transducers

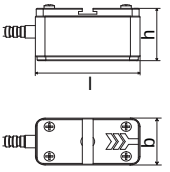
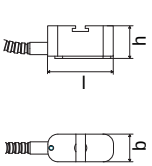
Shear Wave Transducers

technical type		CDG1NZ7	CDK1NZ7	CDM1NZ7
order code		**FSG-NNNNL**	**FSK-NNNNL**	**FSM-NNNNL**
transducer frequency	MHz	0.2	0.5	1
outer pipe diameter				
min. extended	mm	400	100	50
min. recommended	mm	500	200	100
max. recommended	mm	6500	3600	2500
max. extended	mm	6500	4500	3400
material				
housing		PEEK with stainless steel cap	PEEK with stainless steel cap	stainless steel
contact surface		PEEK	PEEK	PEEK
degree of protection according to EN 60529		IP 65	IP 65	IP 65 option: IP 68
dimensions				
length l	mm	129.5	126.5	60
depth b	mm	47	47	30
height h	mm	66.4	55.9	33.5
dimensional drawing				
operating temperature				
min.	°C	-40	-40	-40
max.	°C	+130	+130	+130

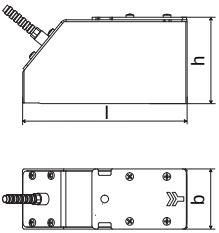
Shear Wave Transducers

technical type		CDQ1NZ7	CDS1NZ7
order code		**FSQ-NNNNL**	**FSS-NNNNL**
transducer frequency	MHz	4	8
outer pipe diameter			
min. extended	mm	10	6
min. recommended	mm	25	10
max. recommended	mm	400	70
max. extended	mm	400	70
material			
housing		stainless steel	stainless steel
contact surface		PEEK	PEI
degree of protection according to EN 60529		IP 65	IP 65
dimensions			
length l	mm	42.5	25
depth b	mm	18	13
height h	mm	21.5	17
dimensional drawing			
operating temperature			
min.	°C	-30	-30
max.	°C	+130	+130

Shear Wave Transducers (High Temperature)

technical type		CDM1EZ7	CDQ1EZ7
order code		**FSM-ENNNL**	**FSQ-ENNNL**
transducer frequency	MHz	1	4
outer pipe diameter			
min. extended	mm	50	10
min. recommended	mm	100	25
max. recommended	mm	2500	400
max. extended	mm	3400	400
material			
housing		stainless steel	stainless steel
contact surface		Sintimid	Sintimid
degree of protection according to EN 60529		IP 65	IP 65
dimensions			
length l	mm	60	42.5
depth b	mm	30	18
height h	mm	33.5	21.5
dimensional drawing			
operating temperature			
min.	°C	-30	-30
max.	°C	+200	+200

Lamb Wave Transducers

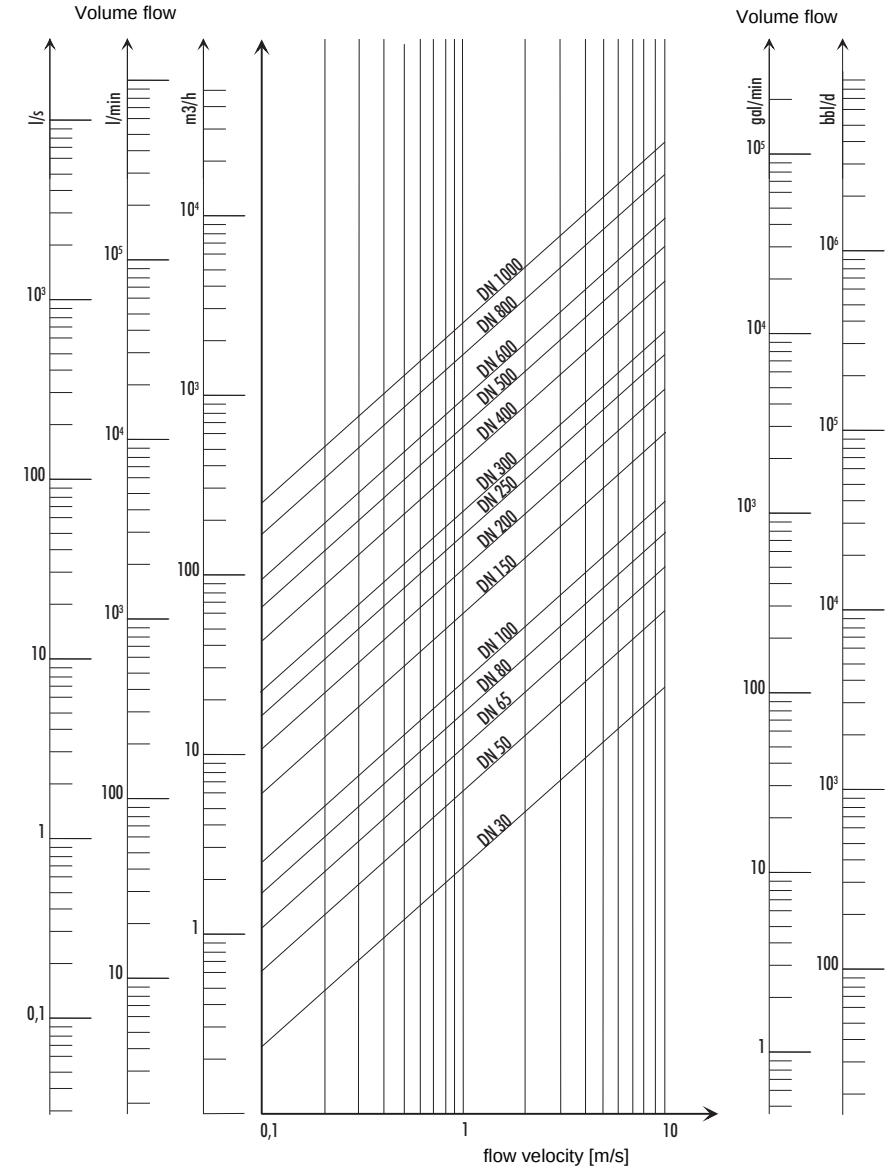
technical type		CRG1NC3	CRH1NC3	CRK1NC3
order code		**FLG-NNNNL**	**FLH-NNNNL**	**FLK-NNNNL**
transducer frequency	MHz	0.2	0.3	0.5
outer pipe diameter				
min. extended	mm	500	400	220
min. recommended	mm	600	450	250
max. recommended	mm	5000	3500	2100
max. extended	mm	6500	5000	4500
pipe wall thickness				
min.	mm	14	9	5
max.	mm	27	18	11
material				
housing		PPSU with stainless steel cap	PPSU with stainless steel cap	PPSU with stainless steel cap
contact surface		PPSU	PPSU	PPSU
degree of protection according to EN 60529		IP 65	IP 65	IP 65
dimensions				
length l	mm	128.5	128.5	128.5
depth b	mm	47	47	47
height h	mm	69.9	69.9	69.9
dimensional drawing				
operating temperature				
min.	°C	-40	-40	-40
max.	°C	+170	+170	+170

Units of Measurement

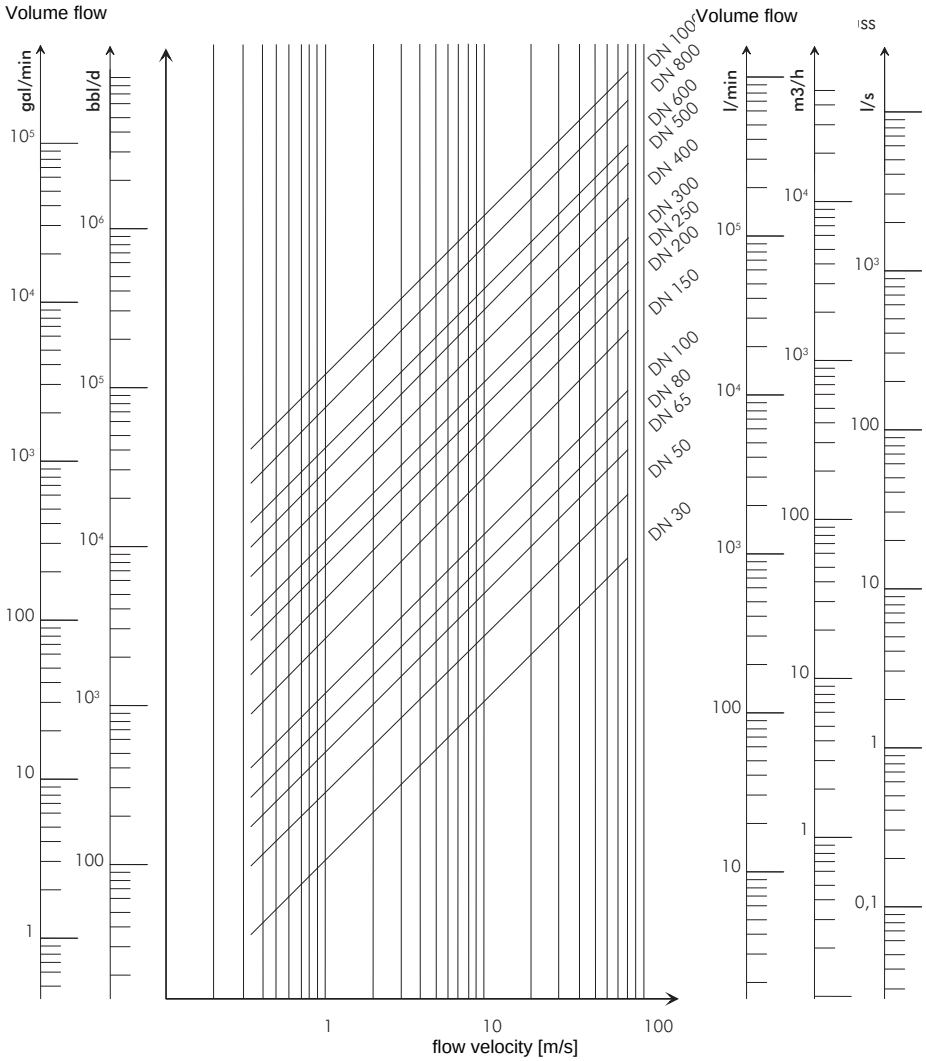
operating volume flow	flow velocity	mass flow	totalizers		sound velocity	heat quantity	heat flow
			volume	mass			
m^3/d	m/s	kg/h	m^3	g	m/s	J	kW
m^3/h	cm/s	kg/min	l	kg		Wh	
m^3/min	inch/s	g/s	gal	t			
m^3/s	fps	t/d					
ml/min		t/h					
l/h		lb/d					
l/min		lb/h					
l/s		lb/min					
hl/h		lb/s					
hl/min							
hl/s							
Ml/d							
bbl/d							
bbl/h							
bbl/m							
USgpd							
USgph							
USgpm							
USgps							
MGD							
CFD							
CFH							
CFM							
CFS							

1 US gallon = 3.78 l
1 barrel = 42 US gallons = 158.76 l

Flow Nomogram (metrical):

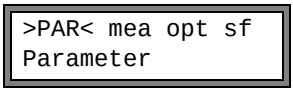


Flow Nomogram (imperial)



B Menu Structure

Program Branch PARAMETER



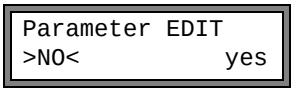
main menu: selection of the program branch PARAMETER

Selection of a measuring channel (A, B) or of a calculation channel (Y, Z)

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

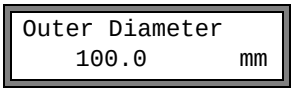
selection of a parameter record.

This display will be indicated only if at least one parameter record has been defined.

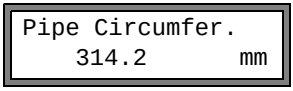


selection if the the parameters of a parameter record are to be edited.

when a measuring channel is selected (A, B):

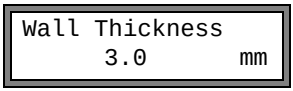


input of the outer pipe diameter

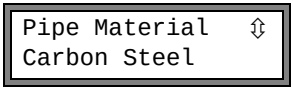


input of the pipe circumference

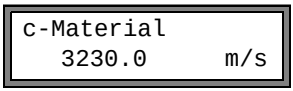
This display will be indicated only, if PIPE CIRCUMFER. is activated in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS and OUTER DIAMETER = 0 has been entered.



input of the pipe wall thickness

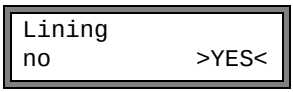


selection of the pipe material



input of the sound velocity of the pipe material

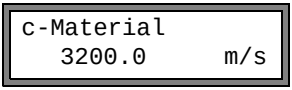
This display will be indicated only if OTHER MATERIAL has been selected.



selection, whether the pipe is lined

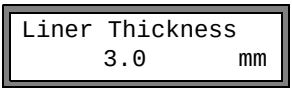
selection of the lining material

This display will be indicated only if LINING = YES has been selected.

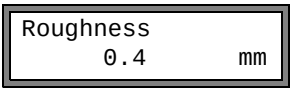


input of the sound velocity of the lining material

This display will be indicated only if OTHER MATERIAL has been selected.

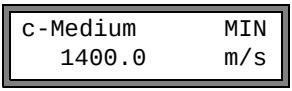


input of the liner thickness



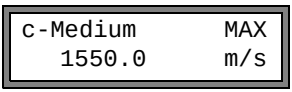
input of the roughness of the inner pipe wall

selection of the medium.



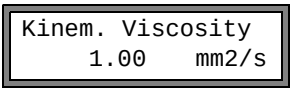
input of the min. sound velocity of the medium

This display will be indicated only if OTHER MEDIUM has been selected.



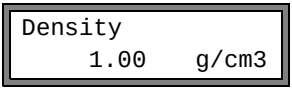
input of the max. sound velocity of the medium

This display will be indicated only if OTHER MEDIUM has been selected.



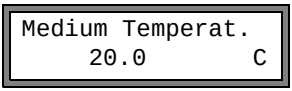
input of the kinematic viscosity of the medium

This display will be indicated only if OTHER MEDIUM has been selected.

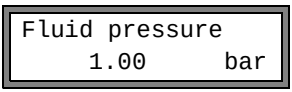


input of the operational density of the medium

This display will be indicated only if OTHER MEDIUM has been selected.

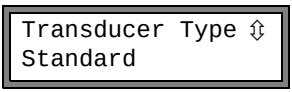


input of the medium temperature



input of the medium pressure

This display will be indicated only if the MEDIUM PRESSURE in SPECIAL FUNCTIONS\DIALOGS/MENUS is activated.

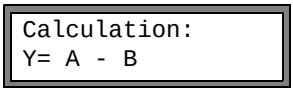


selection of the transducer type

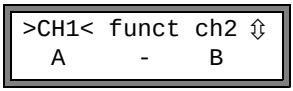
This display will be indicated only if no or special transducers are connected.

When a calculation channel is selected (Y, Z):

Calculation channels are only available if the flowmeter has more than one measuring channel.

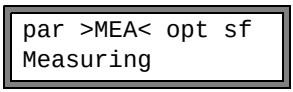


display of the current calculation function

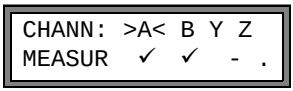


selection of the calculation function

Program Branch MEASURING

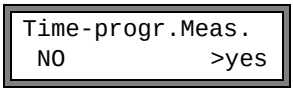


main menu: selection of the program branch MEASURING



activation of the channels

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

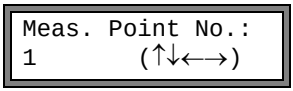


selection whether the measurement is to be started at a later time

This display will be indicated only if

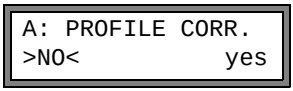
- TIME-PROGR.MEAS. has been activated in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS and
- OUTPUT OPTIONS\STORE MEAS.DATA and/or SERIAL OUTPUT

are activated.



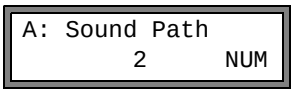
input of the measuring point number

This display will be indicated only if OUTPUT OPTIONS\STORE MEAS.DATA and/or SERIAL OUTPUT is activated.



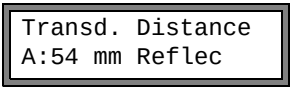
activation/deactivation of the flow profile correction

This display will be indicated only if UNCORR. has been selected in SPECIAL FUNCTION\SYSTEM SETTINGS\MEASURING\FLOW VELOCITY.



input of the number of sound paths

This display will be indicated only if USER is selected in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS\SOUND PATH.

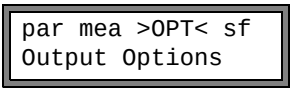


display of the transducer distance to be adjusted between the inner edges of the transducers

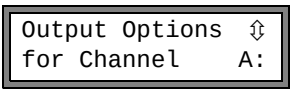
This display will be indicated only if USER is selected in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/ MENUS\SOUND PATH.

bar graph S=, display of the amplitude of the received signal

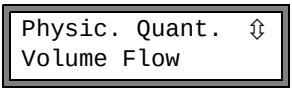
Program Branch OUTPUT OPTIONS



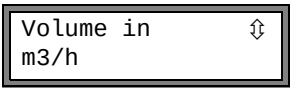
main menu: selection of the program branch OUTPUT OPTIONS



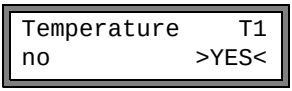
selection of the channel whose output options are to be defined



selection of the physical quantity



selection of the unit of measurement for the physical quantity

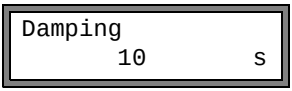


activation of a temperature input

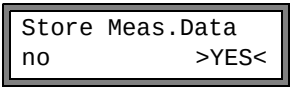
This display will be indicated only if the temperature input T1 has been assigned to the channel in SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS\LINK TEMPERATURE.

activation of a current input for an external temperature probe

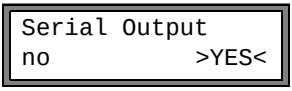
This display will be indicated only if input I1 has been assigned to the channel in SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. INPUTS\LINK OTHER INP.



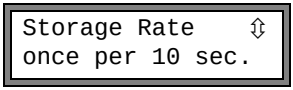
input of the duration over which a floating average of the measured values has to be determined



activation of the data memory



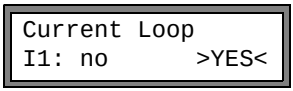
activation of the measured value output via the serial interface to a PC or a printer



selection of the storage rate for storing measured values in the data memory

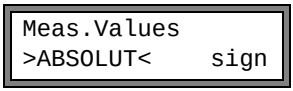
This display will be indicated only if STORE MEAS.DATA and/or SERIAL OUTPUT are activated.

CURRENT LOOP



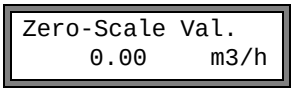
activation of a current output

This display will be indicated only if the current output has been installed in SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. OUTPUTS.



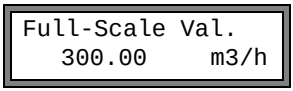
selection whether the sign of the measured values is to be considered for the output.

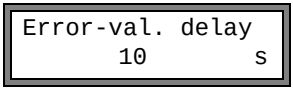
This display will be indicated only if CURRENT LOOP has been activated.



input of the lowest/highest measured value to be expected for the current output. This value will be assigned to the lower/upper limit of the output range.

These displays will be indicated only if CURRENT LOOP has been activated.

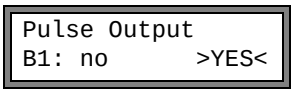




input of the error value delay, i.e. of the time interval after which the value entered for the error output will be transmitted to the output if no valid measured values are available

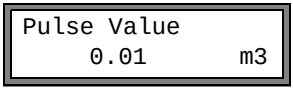
This display will be indicated only if ERROR-VAL. DELAY is activated in SPECIAL FUNCTION\SYSTEM SETTINGS\DIALOGS/MENUS (= EDIT).

PULSE OUTPUT



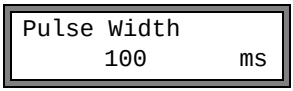
activation of a pulse output

This display will be indicated only if a pulse output has been installed in SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. OUTPUTS.



input of the pulse value (value of the totalizer at which a pulse will be emitted).

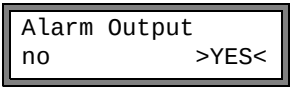
This display will be indicated only if PULSE OUTPUT has been activated.



input of the pulse width

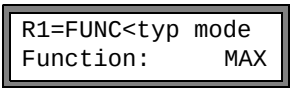
This display will be indicated only if PULSE OUTPUT has been activated.

ALARM OUTPUT



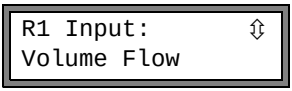
activation of an alarm output

This display will be indicated only if an alarm output has been installed in SPECIAL FUNCTION\SYSTEM SETTINGS\PROC. OUTPUTS.



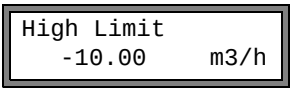
selection of the switching condition (FUNC), of the holding behavior (TYP) and of the switching function (MODE) of the alarm output

This display will be indicated only if ALARM OUTPUT has been activated.



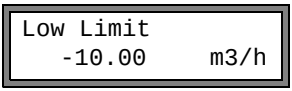
selection of the physical quantity to be monitored

This display will be indicated only for R1 if ALARM OUTPUT is activated.



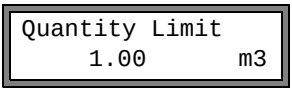
input of the upper limit of the physical quantity to be monitored

This display will be indicated only if ALARM OUTPUT has been activated and MAX has been selected as switching condition.



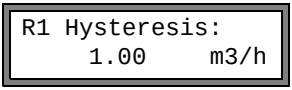
input of the lower limit of the physical quantity to be monitored

This display will be indicated only if ALARM OUTPUT has been activated and MIN has been selected as switching condition.



input of the limit for the totalizer of the physical quantity to be monitored

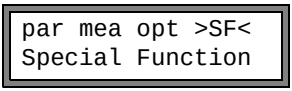
This display will be indicated only if ALARM OUTPUT has been activated and QUANTITY has been selected as switching condition.



input of the hysteresis for the lower or upper limit

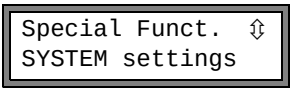
This display will be indicated only if ALARM OUTPUT has been activated and MIN or MAX has been selected as switching condition.

Program branch SPECIAL FUNCTION



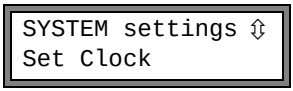
main menu: selection of the program branch SPECIAL FUNCTION

SYSTEM SETTINGS



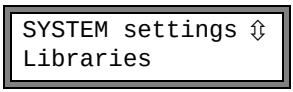
selection of SPECIAL FUNCTION\SYSTEM SETTINGS

SYSTEM SETTINGS\SET CLOCK

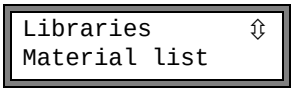


selection of the displays for the input of date and time

SYSTEM SETTINGS\LIBRARIES



selection of the displays for the management of the material and media scroll lists



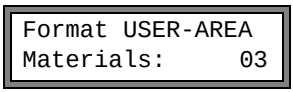
selection of the displays for the arrangement of the scroll list for the pipe and lining materials

SYSTEM SETTINGS\LIBRARIES\MEDIUM LIST

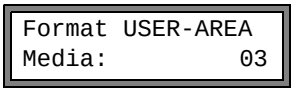
selection of the displays for the arrangement of the media scroll list

SYSTEM SETTINGS\LIBRARIES\FORMAT USER-AREA

selection of the displays for the partitioning of the coefficient memory for storing of user defined material and medium properties



input of the number of user defined materials

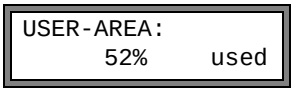


input of the number of user defined media

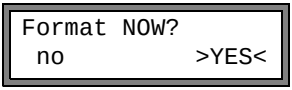
input of the number of user defined data sets of the steam flow coefficients

input of the number of user defined data sets of the steam coefficients

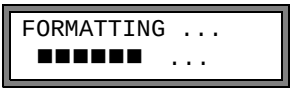
input of the number of user defined data sets of the concentration coefficients



display of the occupancy of the coefficient memory

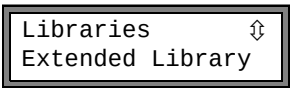


confirmation of the selected partition

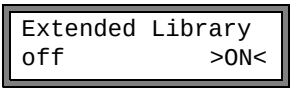


coefficient memory is being partitioned

SYSTEM SETTINGS\LIBRARIES\EXTENDED LIBRARY



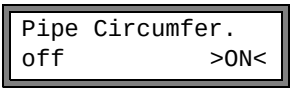
selection of the displays for the activation of the extended library



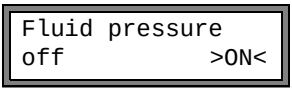
activation of the extended library

SYSTEM SETTINGS\DIALOGS/MENUS

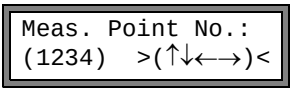
selection of the displays for activation/deactivation or setting of menu items in the other program branches



activation of the menu item for the input of the pipe circumference in the program branch PARAMETER

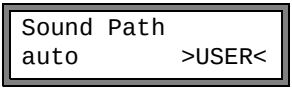


activation of the menu item for the input of the medium pressure in the program branch PARAMETER



selection of the input mode for the measuring point number in the program branch MEASURING:

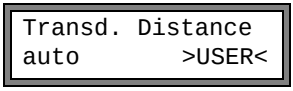
- (1234): digits, point, hyphen
- (↑↓← →): ASCII editor



setting of the display for the input of the sound path in the program branch MEASURING:

- USER: a value for the number of sound paths will be recommended. This value can be changed.
- AUTO: selection between reflection mode or diagonal mode.

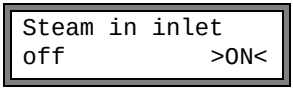
recommended adjustment: USER



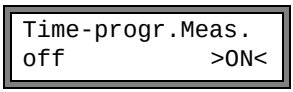
setting for the display for the input of the transducer distance in the program branch MEASURING:

- USER: only the entered transducer distance will be displayed if the recommended and the entered transducer distances are identical
- AUTO: only the recommended transducer distance will be displayed

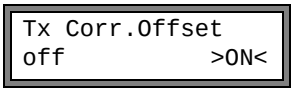
recommended adjustment: USER



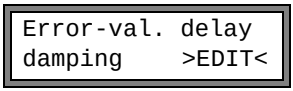
activation of the menu item for the input of the supply pressure in the program branch PARAMETER for a heat flow measurement where the medium in the supply line can be a liquid or a gas



activation of a time programmable measurement, i.e. start of the measurement at a later time



activation of the menu item for the input of a correction value (offset) for each temperature input in the program branch MEASURING

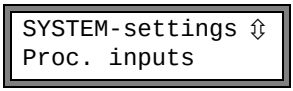


selection of the error value delay

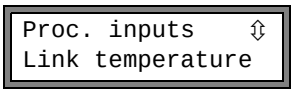
- DAMPING: the damping value will be used.
- EDIT: The menu item for the input of the error value delay in the program branch OUTPUT OPTIONS will be activated.

activation of the indication of the alarm state during measurement

SYSTEM SETTINGS\PROC. INPUTS

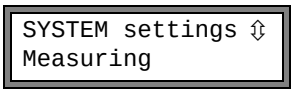


selection of the displays for the setting of the inputs of the flowmeter

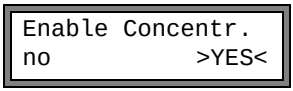


assignment of temperature inputs and other inputs to measuring channels

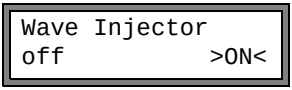
SYSTEM SETTINGS\MEASURING



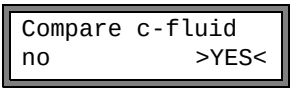
selection of the displays for the settings of the measurement



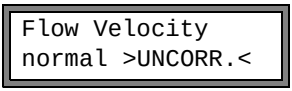
activation of the concentration measurement (option)



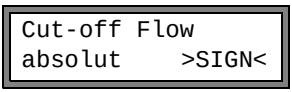
activation of the WaveInjector (option)



activation of the display for the difference between measured and expected sound velocity of a selected reference medium during measurement

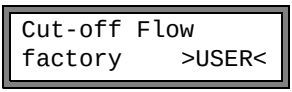


selection whether the flow velocity is displayed and output with or without profile correction



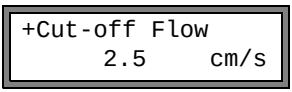
selection of the input of a lower limit for the flow velocity:

- ABSOLUT: independent of the flow direction
- SIGN: dependent on the flow direction



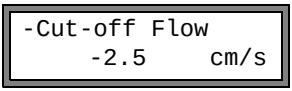
activation of the input of a lower limit of the flow velocity:

- FACTORY: the default 2.5 cm/s will be used
- USER: input of a limit



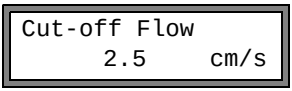
input of the cut-off flow for positive measured values

This display will be indicated only if CUT-OFF FLOW\SIGN and USER have been selected before.



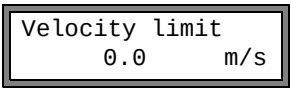
Input of the cut-off flow for negative measured values

This display will be indicated only if CUT-OFF FLOW\SIGN and USER have been selected before.



Input of the cut-off flow for the absolute value of the measured values

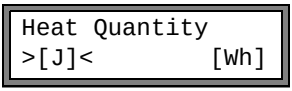
This display will be indicated only if CUT-OFF FLOW\ABSOLUT and USER have been selected before.



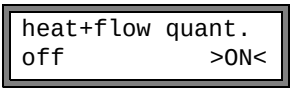
input of an upper limit of the flow velocity

All measured values exceeding the limit will be marked as outliers.

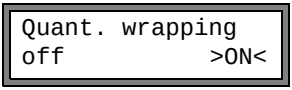
Input of 0 (zero) switches off the detection of outliers



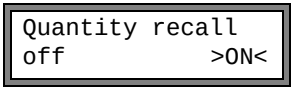
selection of the unit of measurement for the heat quantity



activation of output and storing of the heat quantity totalizer values during heat flow measurement

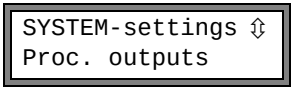


activation of the overflow of the totalizers

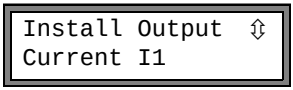


activation of the taking-over of the totalizer values after re-start of the measurement

SYSTEM SETTINGS\PROC. OUTPUTS

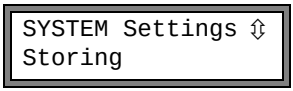


selection of the displays for the setting of the outputs of the flowmeter

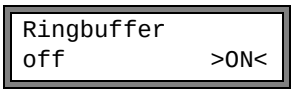


selection of the output to be installed

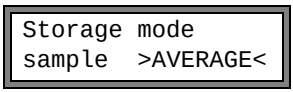
SYSTEM SETTINGS\STORING



selection of the displays for storing of measured values in the data memory

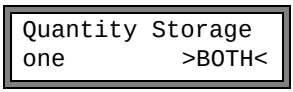


setting of the overflow behavior of the data memory



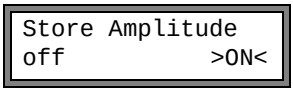
selection of the sample mode

- SAMPLE: storing and online output of the displayed measured value
- AVERAGE: storing and online output of the average of all measured values of a storage interval



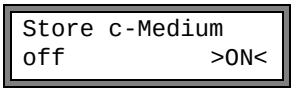
setting of the storage behavior of the totalizers

- ONE: the value of the totalizer currently displayed will be stored
- BOTH: one value for each flow direction will be stored



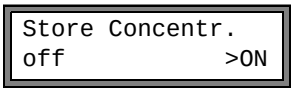
activation of storing of the signal amplitude

This value will be stored only if the data memory is activated.



activation of storing of the sound velocity of the medium

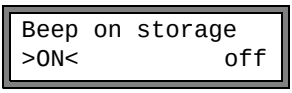
This value will be stored only if the data memory is activated.



activation of storing of the concentration of the medium

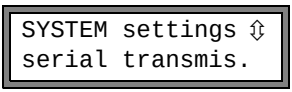
This display will be indicated only if SYSTEM SETTINGS\MEASURING\ENABLE CONCENTR. (option) has been activated.

The value will be stored only if the data memory is activated.

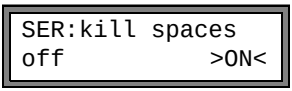


activation of an acoustic signal for each storing or transmission of a measured value

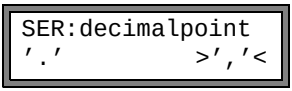
SYSTEM SETTINGS\SERIAL TRANSMIS.



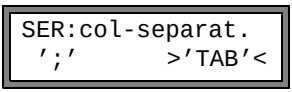
selection of the displays for the formatting of the serial transmission of measured values



activation of the serial transmission with blanks

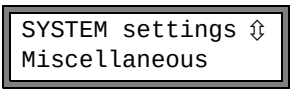


selection of the decimal marker for floating point numbers



selection of the character for column separation

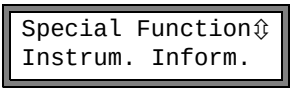
SYSTEM SETTINGS\MISCELLANEOUS



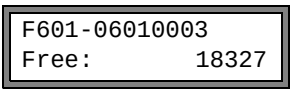
selection of the display for the setting of the contrast

setting of the contrast of the display

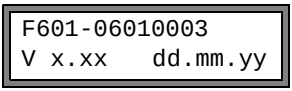
INSTRUM. INFORM.



selection of the displays for the information about the flowmeter

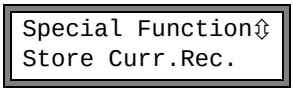


display of type, serial number and available data memory



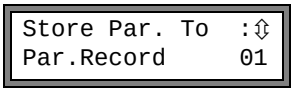
display of type, serial number and firmware version with date (dd - day, mm - month, yy - year)

STORE CURR.REC.

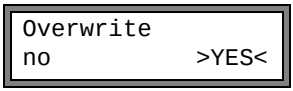


selection of the displays for storing of a parameter record

This menu item can be selected only if the parameters have been entered in the program branch PARAMETER.



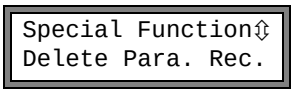
selection of the number of a parameter record



confirmation of overwriting of an existing parameter record

This display will be indicated only if the selected number already contains a parameter record.

DELETE PARA.REC.



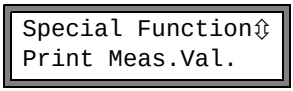
selection of the displays for deleting of a parameter record

selection of the number of the parameter record to be deleted

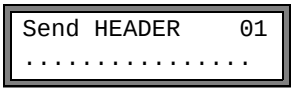
This display will be indicated only if a parameter set already exists.

confirmation for the deleting of a parameter record

PRINT MEAS.VAL.

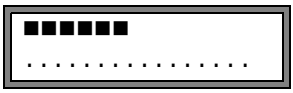


selection of the displays for the transmission of stored measured values to a PC



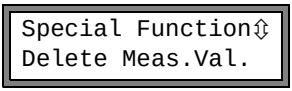
start of the measured values transmission

This display will be indicated only if measured values are stored in the data memory and the flowmeter is connected with the PC by a serial cable.



display of the data transmission progress

DELETE MEAS.VAL.

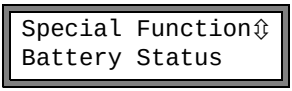


selection of the displays for deleting of stored measured values

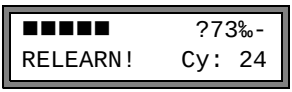
confirmation for deleting of measured values

This display will be indicated only if measured value are stored in the data memory.

BATTERY STATUS



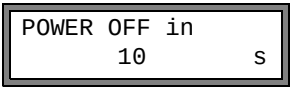
selection of the displays for charging the battery



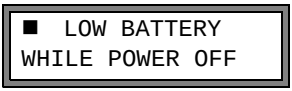
display of the charge state of the battery

If RELEARN! is displayed, a relearn cycle is recommended.

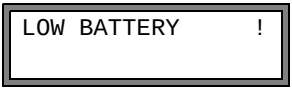
indication of the charge state of the battery



message that the flowmeter will be switched off soon

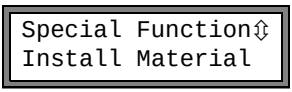


message during switching on that the flowmeter had been switched off automatically due to a too low charge state



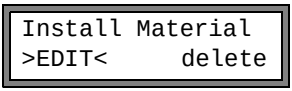
message that the battery is almost empty

INSTALL MATERIAL

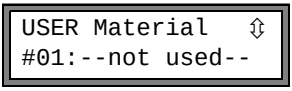


selection of the displays for the input of pipe and lining materials

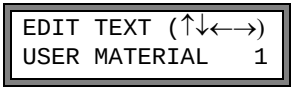
INSTALL MATERIAL with SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES\EXTENDED LIBRARY = OFF



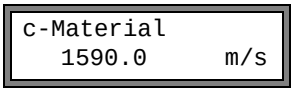
selection whether a user defined material is to be edited or deleted



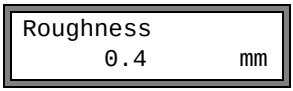
selection of a material data set



input of a designation for the selected material

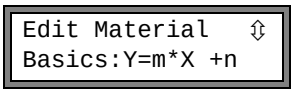


input of the sound velocity of the material

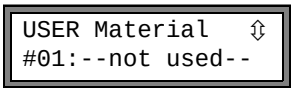


input of the roughness of the material

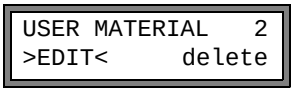
INSTALL MATERIAL with SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES\EXTENDED LIBRARY = ON



selection of the function for temperature and pressure dependency of the material properties

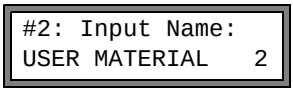


selection of a material data set

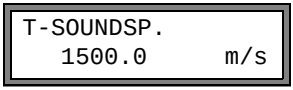


confirmation that the properties of the selected material are to be edited

This display will be indicated only if the selected material already exists.

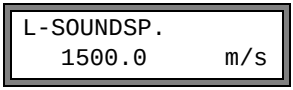


input of a designation for the selected material



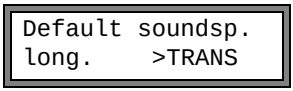
input of the constants for the transversal sound velocity of the material

The number of constants depends on the function selected above.

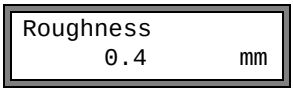


input of the constants for the longitudinal sound velocity of the material

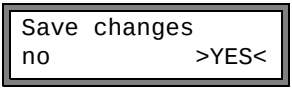
The number of constants depends on the function selected above.



selection of the sound wave type for the flow measurement



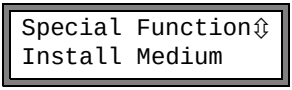
input of the roughness of the material



confirmation that the changes are to be stored

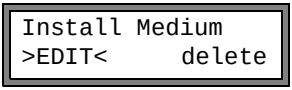
This display will be indicated only if a new material has been entered or the properties of an existing material have been changed.

INSTALL MEDIUM

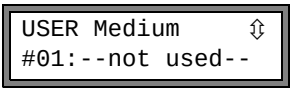


selection of the displays for the input of media

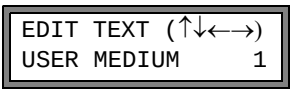
INSTALL MEDIUM with SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES\EXTENDED LIBRARY = OFF



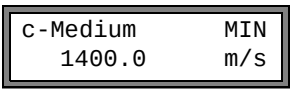
selection whether a user defined medium is to be edited or deleted



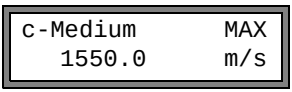
selection of a medium data set



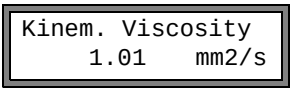
input of a designation for the selected medium



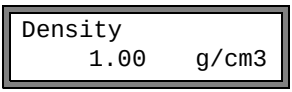
input of the min. sound velocity of the medium



input of the max. sound velocity of the medium

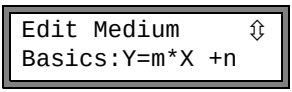


input of the kinematic viscosity of the medium

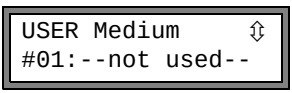


input of the operational density of the medium

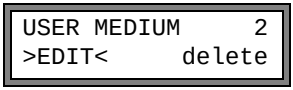
INSTALL MEDIUM with SPECIAL FUNCTION\SYSTEM SETTINGS\LIBRARIES\EXTENDED LIBRARY = ON



selection of the function for temperature and pressure dependency of the medium properties

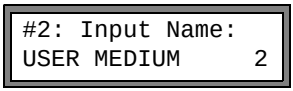


selection of a medium data set

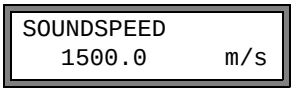


confirmation that the properties of the selected medium are to be edited

This display will be indicated only if the selected medium already exists.



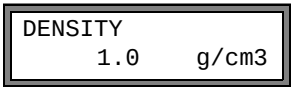
input of a designation for the selected medium



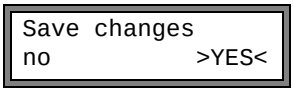
input of the constants for the longitudinal sound velocity of the medium

The number of constants depends on the function selected above.

input of the kinematic viscosity of the medium



input of the operational density of the medium



confirmation that the changes are to be stored

This display will be indicated only if a new medium has been entered or the properties of an existing medium have been changed.

C Reference

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

Table C.1: Sound Velocity of Selected Pipe and Lining Materials at 20 °C

The values of some of these materials are stored in the internal database of the flowmeter. In the column c_{flow}, the sound velocity (longitudinal or transversal) used for flow measurement is indicated.

material	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}	material	c_{trans} [m/s]	c_{long} [m/s]	c_{flow}
aluminum	3100	6300	trans	platinum	1670		trans
asbestos cement	2200		trans	polyethylene	925		trans
lead	700	2200	trans	polystyrene	1150		trans
bitumen	2500		trans	PP	2600		trans
brass	2100	4300	trans	PVC		2395	long
carbon steel	3230	5800	trans	PVC (hard)	948		trans
copper	2260	4700	trans	PVDF	760	2050	long
Cu-Ni-Fe	2510		trans	quartz glass	3515		trans
ductile iron	2650		trans	rubber	1900	2400	trans
glass	3400	4700	trans	silver	1590		trans
grey cast iron	2650	4600	trans	Sintimid		2472	long
PE		1950	long	stainless steel	3230	5790	trans
Perspex	1250	2730	long	Teka PEEK		2537	long
PFA		1185	long	Tekason		2230	long
plastics	1120	2000	long	titanium	3067	5955	trans

Take into consideration for the measuring task that the sound velocity depends on the composition and the processing of the material.

The sound velocity of alloys and cast materials strongly fluctuates. The values serve only as orientation.

Table C.2: Typical Roughness Values 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 and 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

Table C.3: Typical Properties of Selected Media at 20 °C and 1 bar

medium	sound velocity [m/s]	kinematic viscosity [mm^2/s]	density [g/cm^3]
acetone	1190	0.4	0.7300
ammonia (NH_3)	1386	0.2	0.6130
gasoline	1295	0.7	0.8800
beer	1482	1.0	0.9980
BP Transcal LT	1365	20.1	0.8760
BP Transcal N	1365	94.3	0.8760
diesel	1210	7.1	0.8260
ethanol	1402	1.5	0.7950
hydrofluoric acid 50 %	1221	1.0	0.9980
hydrofluoric acid 80 %	777	1.0	0.9980
glycol	1665	18.6	1.1100
20 % glycol/H_2O	1655	1.7	1.0280
30 % glycol/H_2O	1672	2.2	1.0440
40 % glycol/H_2O	1688	3.3	1.0600
50 % glycol/H_2O	1705	4.1	1.0750
ISO VG 100	1487	314.2	0.8690
ISO VG 150	1487	539.0	0.8690
ISO VG 22	1487	50.2	0.8690
ISO VG 220	1487	811.1	0.8690
ISO VG 32	1487	78.0	0.8690
ISO VG 46	1487	126.7	0.8730
ISO VG 68	1487	201.8	0.8750
methanol	1119	0.7	0.7930
milk	1482	5.0	1.0000
Mobiltherm 594	1365	7.5	0.8730
Mobiltherm 603	1365	55.2	0.8590
NaOH 10 %	1762	2.5	1.1140
NaOH 20 %	2061	4.5	1.2230
paraffin 248	1468	195.1	0.8450
R134 Freon	522	0.2	1.2400
R22 Freon	558	0.1	1.2130
crude oil, light	1163	14.0	0.8130
crude oil, heavy	1370	639.5	0.9220
sulphuric acid 30 %	1526	1.4	1.1770
sulphuric acid 80 %	1538	13.0	1.7950
sulphuric acid 96 %	1366	11.5	1.8350
juice	1482	1.0	0.9980
hydrochloric acid 25 %	1504	1.0	1.1180
hydrochloric acid 37 %	1511	1.0	1.1880
sea water	1522	1.0	1.0240
Shell Thermina B	1365	89.3	0.8630
silicone oil	1019	14746.6	0.9660
SKYDROL 500-B4	1387	21.9	1.0570
SKYDROL 500-LD4	1387	21.9	1.0570
water	1482	1.0	0.9990

Table C.4: Properties of Water at 1 bar and at Saturation Pressure

medium temperature [°C]	medium pressure [bar]	density [kg/m^3]	specific heat* [kJ/kg/K^{-1}]
0	1	999.8	4.218
10	1	999.7	4.192
20	1	998.3	4.182
30	1	995.7	4.178
40	1	992.3	4.178
50	1	988.0	4.181
60	1	983.2	4.184
70	1	977.7	4.190
80	1	971.6	4.196
90	1	965.2	4.205
100	1.013	958.1	4.216
120	1.985	942.9	4.245
140	3.614	925.8	4.285
160	6.181	907.3	4.339
180	10.027	886.9	4.408
200	15.55	864.7	4.497
220	23.20	840.3	4.613
240	33.48	813.6	4.769
260	46.94	784.0	4.983
280	64.20	750.5	5.290
300	85.93	712.2	5.762
320	112.89	666.9	6.565
340	146.05	610.2	8.233
360	186.75	527.5	14.58
374.15	221.20	315.5	∞

* at constant pressure

Table C.5: Chemical Resistance of Autotex

Autotex (keyboard) is resistant according to DIN 42115, part 2 against the following chemicals for a contact time of more than 24 h without visible modification:

- ethanol
- cyclohexanol
- diacetone alcohol
- glycol
- isopropanol
- glycerine
- methanol
- triacetin
- Dowandol DRM/PM
- acetone
- methyl-ethyl-ketone
- Dioxan
- cyclohexanone
- MIBK
- isophorone
- ammonia <40 %
- soda lye <40 %
- potassium hydroxide 30 %
- alcalicarbonate
- bichromate
- potassium hexacyanoferrates
- acetonitrile
- sodium bisulfate
- formaldehyde 37…42 %
- acetaldehyde
- aliphatic hydrocarbons
- Toluol
- Xylol
- diluent (white spirit)
- formic acid <50 %
- acetic acid <50 %
- phosphoric acid <30 %
- hydrochloric acid <36 %
- nitric acid <10 %
- trichloroacetic acid <50 %
- sulphuric acid <10 %
- drilling emulsion
- diesel oil
- varnish
- paraffin oil
- castor oil
- silicone oil
- turpentine oil substitute
- Dccon
- plane fuel
- gasoline
- water
- saltwater
- 1,1,1-trichlorethane
- ethyl acetate
- diethyl ether
- N-butyl acetate
- amyl acetate
- butylcellosolve
- ether
- chlornatron <20 %
- hydrogen peroxide <25 %
- potash soft soap
- detergent
- tensides
- softener
- iron chloride ($FeCl_2$)
- iron chloride ($FeCl_3$)
- dibutyl phthalate
- dioctyl phthalate
- sodium carbonate

Autotex is resistant according to DIN 42115, part 2 to acetic acid for a contact time <1 h without visible damage.

Autotex is not resistant to following chemicals:

- concentrated mineral acids
- concentrated alkaline solutions
- high pressure steam >100 °C
- benzyl alcohol
- methylene chloride

D Certificates