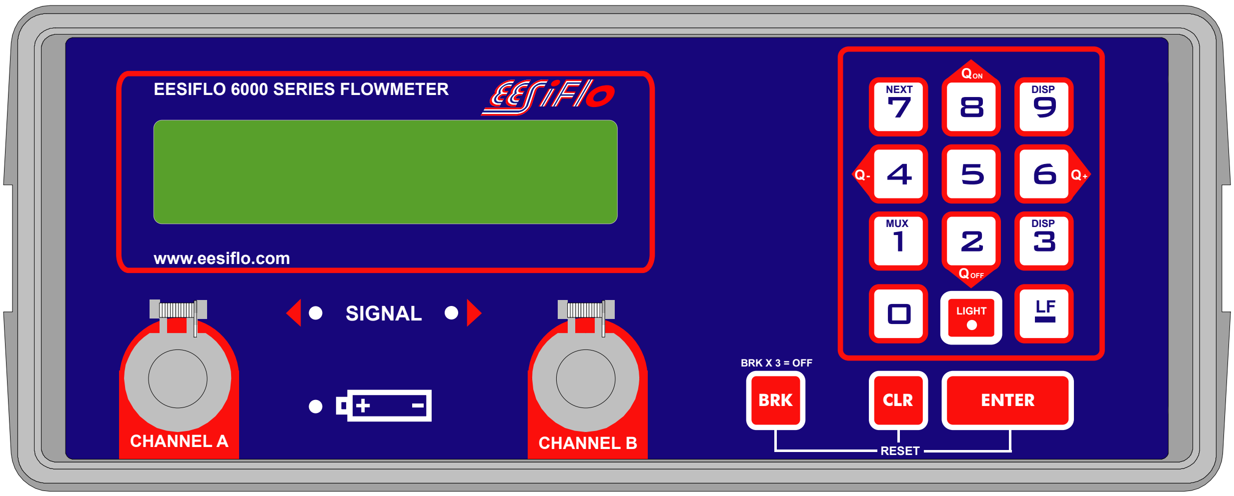
USER'S MANUAL

IM-EESIFLO-6000V3-EN, 02.01.2003



PORTABLE ULTRASONIC FLOWMETER

EESIFLO 6000 Series

Firmware V5.xx

Remarks:

IBM is a protected trademark of International Business Machines Corporation.

MS-DOS, Excel, Windows are trademarks of Microsoft Corporation.

EESIFLO can be operated in the language of your choice. Please refer to section 4.5.

EESIFLO blendet seine Anzeigen in einer durch Sie zu wählenden Sprache ein. (Siehe Abschnitt 4.5).

Il est possible de sélectionner la langue utilisée par EESIFLO à l'écran. Veuillez consulter la section 4.5.

EESIFLO puede ser manejado en el idioma de su elección. Consulte el capítulo 4.5.

Table of Contents

1 Introduction

1.1 Regarding this Manual

This manual has been written for personnel operating a EESIFLO flowmeter. It contains very important information about the instrument, how to handle it correctly, how to avoid damaging it and how to avoid injury. 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. The basic functions of the instrument are explained in chapter 4.

All reasonable effort has been made to ensure the correctness of the content of this manual. Should you however find some erroneous information, please inform us.

Please note that we shall be grateful for any suggestions and comments regarding the EESIFLO 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.

Furthermore, should you have any suggestions about improving the documentation and particularly this User's Manual, please let us know so that we can consider your comments for future reprints.

We also provide special customer solutions and will be pleased to advise you in using EESIFLO for specific applications and finding the most appropriate solution for your measurement problem.

1.2 Safety Precautions

You will find in this manual the following safety information:

Note:	The notes contain important information which help you use your instrument in an optimal way.

Attention!	This text gives you important instructions which should be respected in order to avoid to damage or destroy the instrument. Proceed with attention!

⚠	This text denotes an action which could result in injury or death of personal. Proceed cautiously!

Respect these safety precautions!

1.3 Warranty

The EESIFLO 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 the present User's Manual. Misuse of the EESIFLO will immediately revoke any warranty given or implied. This includes:

- the replacement of a component of EESIFLO by a component that was not authorized by **EESIFLO**,
- unsuitable or insufficient maintenance,
- repair of EESIFLO by unauthorized personnel.

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

EESIFLO is a very reliable instrument. It is manufactured under strict quality control, using modern production techniques. If installed correctly, in an appropriate location and as recommended, used cautiously and taken care of conscientiously, no troubles should appear. If any problem appears which cannot be solved with the help of this manual (see chapter 21), please contact our sales office, giving a precise description of the problem. Don't forget to specify the model, serial number and firmware version of your instrument.

2 The Flowmeter

2.1 Overview

2

EESIFLO 6000 is a flowmeter that uses ultrasonic signals to measure the flow in pipes or conduits. It can measure the following quantities:

-the flow velocity,

-the volume and mass flow rate and their totalization,

-the heat flow rate and its totalization (optional),

-the sound velocity of a medium,

-the concentration of a constituent of a solution (optional).

With a special probe, **EESIFLO 6000** can also measure the thickness of pipe walls.

The transducers can be used at temperatures between -22°F and 266°F. With specially designed high temperature transducers, the operating temperature range can be extended up to 392°F, and, for short periods, up to 572°F. Measurement can be made on all commonly used pipe materials such as steel, synthetic material, glass or copper. Pipe diameters may range from 1/4 up to 256 inches depending on the transducer type. The two clamp-on transducers allow for non-invasive measurement that do not affect the piping or the liquid to be measured. They are small, lightweight and also very robust.

EESIFLO 6000 is a portable, battery operated measuring instrument. It can also be operated from an external power supply of 110 VAC using the supplied power adapter. **EESIFLO 6000** has protection degree IP54 and is therefore suitable for monitoring tasks under difficult environmental conditions.

EESIFLO 6000 can be operated in different languages. A backlit display shows input data and measurements results as well as operational errors. The menus guide the user through the parameter setup, measurement and data storage.

An internal data bank contains the properties of many current materials and media. It is possible to select which of those materials and media will be offered in the selection lists of the program branches and the order in which they will appear. An integrated coefficient storage which can be partitioned according to your needs keeps self-defined properties of materials and media.

EESIFLO 6000 can log up to 100,000 measured values and up to 14 different sets of site parameters. Furthermore, up to 80 memory places for measuring point parameters can be used.

EESIFLO 6000 has a serial interface which allows the transfer of the measured data to a PC or to a printer for visualization, editing and manipulation.

EESIFLO 6000 features an integrated measuring point multiplexer which enables quasi simultaneous measurement on the different channels. Calculation measurement is also possible (channel A - channel B for example).

2.2 Measuring Principle

EESIFLO 6000 uses ultrasonic signals for the measurement of liquid flow, employing the **transit time** 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. These signals are emitted alternatively in the direction of flow and against it.

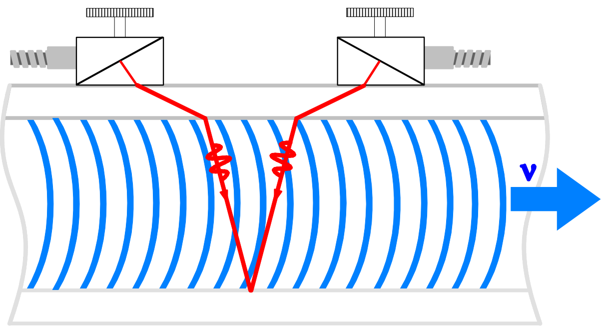


Fig. 2.1: Transit path of the ultrasonic signals

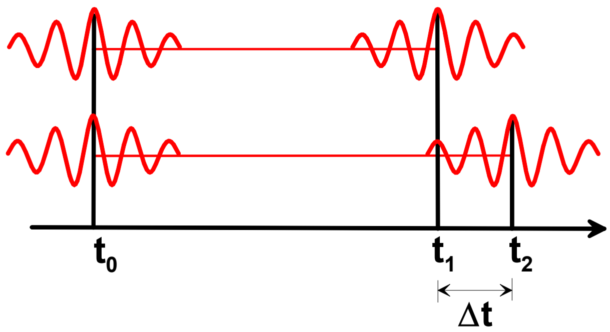


Fig. 2.2: Transit-time difference ΔT

Because the medium in which the signals propagate is flowing, the transit time of the sound signals propagating in the direction of flow is shorter than the transit time of the signal propagating against the direction of flow.

The transit-time difference ΔT is measured and allows the determination of the average flow velocity on the propagation path of the ultrasonic signals. A profile correction is then performed to obtain the average flow velocity on the cross-section of the pipe, which is proportional to the volume flow rate.

EESIFLO 6000 tests the incoming ultrasonic signals for their usefulness for the measurement and evaluates the plausibility of the measured values. The integrated microprocessors control the complete measuring cycle, eliminating disturbance signals by statistical signal processing techniques.

2.3 Applications

EESIFLO can be used everywhere where the pipe wall and the liquid to be measured are sonically conductive. This is true for pipe walls consisting of homogeneous material, and for liquids which carry only small amounts of solid particles or gas bubbles. Since ultrasonic waves also propagate in solid materials, the transducers can be mounted outside the pipe, allowing for non-invasive measurement.

The transit-time difference effect can be observed over the complete range of flow velocities found in technical applications. Furthermore, it is independent of the electrical parameters of the fluid (conductivity, dielectric constant, etc.). EESIFLO **6000** is thus a very versatile instrument.

Advantages:

- Non-invasive methods permits safe measurement on aggressive or high temperature media flowing in closed conduits.
- Flow values can be measured without interruption of the process.
- The installation does not require any alterations to the pipe system.
- Straightforward mounting of the transducers and battery operated portable instrument allow flow measurements at various locations in the plant and on pipes with different diameters. The measurement does not influence the actual flow conditions.

2.4 Description of the Flowmeter

2.4.1 Front Panel

2 x 16-digit backlit LCD

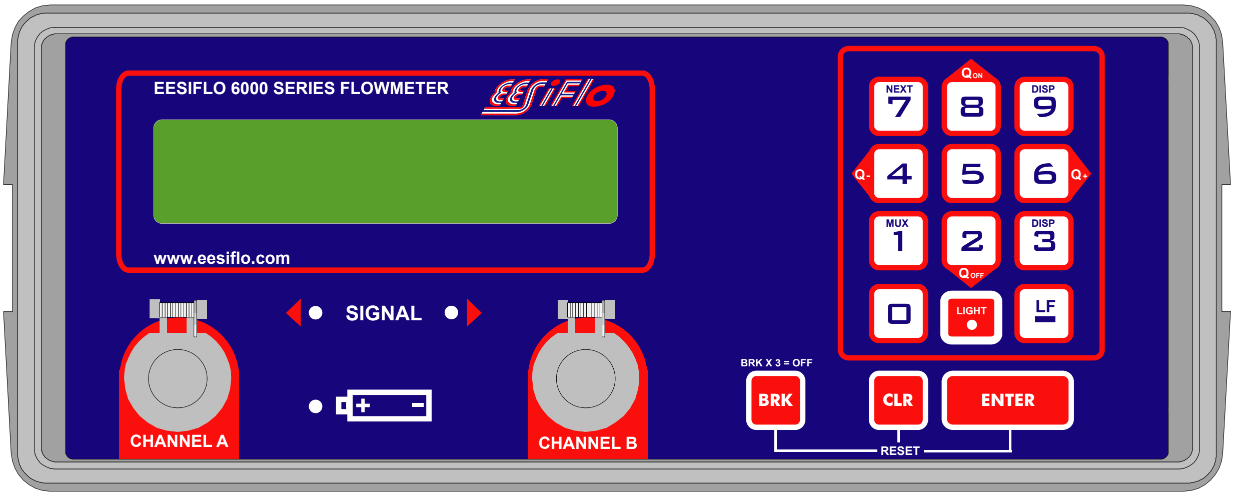


Fig. 2.3: Front panel of EESIFLO 6000

- Connection port for flow transducers of channel A or wall thickness sensor.
- Status indicators (see sections 4.6 and 4.6)
- Connection port for flow transducers of channel B or wall thickness sensor.
- Keypad (see section 4.2)

2.4.2 Rear Panel

Serial interface

Process outputs (optional) (see chapter 20)

Process inputs (optional) (see chapter 19)

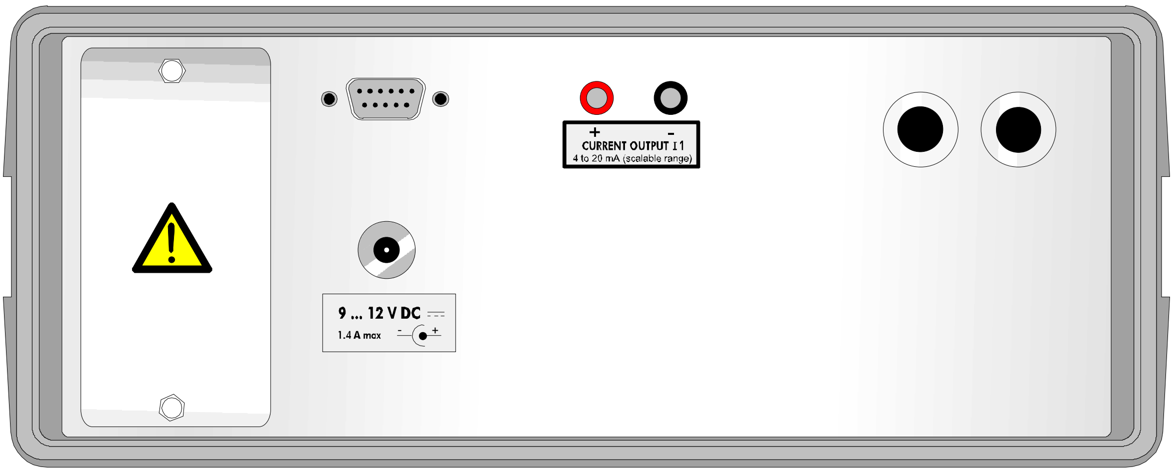


Fig. 2.4: Back panel of EESIFLO 6000

- Battery compartment cover
- Connection socket for power adapter/battery charging unit

2.5 The Transducers

There is a different engraving on the top of each transducer. The transducers are mounted correctly if the engravings on the two transducers are forming an arrow together. The transducer cables should then show in opposite directions.

Later, the arrow, in conjunction with the indicated measured value, will help you to determine the direction of flow.

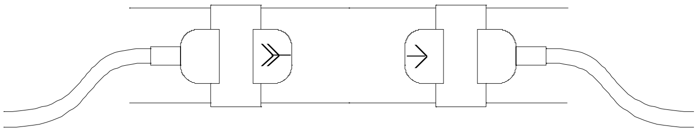


Fig. 2.5: Correct positioning of the transducers

Note:	The engravings should also form an arrow if the two transducers are mounted on opposite sides of the pipe wall.

Connection

- Pull up the socket cover of the channel on which you want to connect the transducers.
- Insert the connector of the transducer cable in the socket. The red point on the connector should face the red marking on the socket.

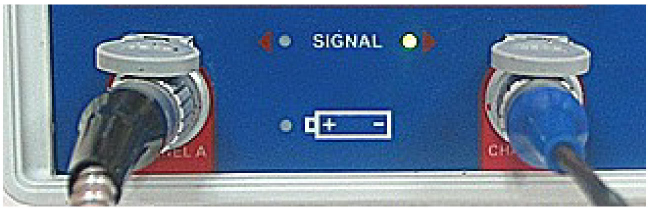


Fig. 2.6: Connection of the transducers

2.6 Power Supply

The chargeable NiCd batteries guarantee an operating time of at least 10 hours. The instrument can also be operated from an external power supply of 110 VAC using the supplied power adapter.

Attention!	The power adapter/battery charging unit is not moisture-proof. Use it only in dry rooms.

3 Handling

3.1 Scope of Delivery

On delivery, please make sure that all items of the following list (standard scope of delivery) are in the package:

1 User's manual
1 Basic instrument, including inserted battery set (fully charged)
1 Power adapter and battery charging unit with integrated cables for connection with instrument and mains
Transducers as per order, with integrated cables
2 Transducer mounting fixture with chains
1 Service set for transducer mounting chains
1 Tube of acoustic coupling compound
1 Serial interface cable
1 Interface adapter 9 pins / 25 pins
1 CD with software for data transmission
1 Transport case

Your package may contain other components according to your particular order. Model designation and serial number are given on the data plate on the rear face of the EESIFLO. When contacting **EESIFLO**, always have both of them at hand, as well as the number of the firmware version (see section 12.5).

3.2 General Precautions

EESIFLO is a precision measuring instrument and it must be handled with care. To obtain good measurement results and in order not to damage the instrument, it is important that great attention is paid to the instructions given in this User's Manual, and particularly to the following points:

- Protect the instrument from excessive shock.
- Do not open the housing without authorization.
- Use a correct external power supply when not using the battery.
- Make sure to work under correct ambient conditions (see specifications in Appendix A).
- Handle the charging unit and the battery correctly (see section 3.6).
- Take the degree of protection into account (see specifications in Appendix A).
- The power adapter/battery charging unit is not moisture-proof. Use it only in dry rooms.
- Keep the transducers clean.
- Manipulate the transducer cables cautiously (avoid excessive cable bends).

3.3 Service

EESIFLO is a very reliable instrument. No service work is necessary. Always respect the handling precautions and the instructions given in this manual. If EESIFLO is installed correctly, in an appropriate location and as recommended, used cautiously and taken care of conscientiously, no troubles should appear.

3.4 Cleaning

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

3.5 Battery Replacement

To replace the battery:

- Unscrew the two cap nuts (5,5 mm) of the battery compartment cover (see picture in section 3.4.2) and remove the cover. Make sure not to lose the screws!
- Unplug the connector.
- Remove the battery pack by pulling the black strap.
- Insert the new battery pack in the instrument with the connector free end first.
- Plug the connector again. Take care to plug the connector correctly, it prevents to reverse the polarity.
- Screw the battery compartment cover back on the instrument.

Attention!

- Use only the battery set authorized by **EESIFLO**.This battery set can be ordered from **EESIFLO** or an authorized dealer.
- The protective degree IP54 of the flowmeter is given only if the battery compartment cover is screwed on the housing.

3.6 Battery Handling

Taking the following precautions will prolong the battery's life expectancy:

- For longer periods of storage, batteries should be kept at low temperatures (0°C to 10°C). Storage in cool conditions will lower the self-discharging by a factor of 1/10.
- Store the battery set only in charged condition.
- To avoid the so-called *Memory Effect* (the charging of the batteries in ever shorter times with a low charging capacity), discharge the batteries fully in a smooth and continuous manner before a new charging cycle is being started.

Attention!

- Use only the battery set authorized by **EESIFLO**.This battery set can be ordered from **EESIFLO** or an authorized dealer.
- The use of non-rechargeable batteries is prohibited.
- Take care to plug correctly the connector which prevents from reversing the polarity.
- Before recharging, discharge the battery set as far as possible in order to avoid over-charging. EESIFLO signalizes that the battery is discharged as follows:

```
LOW BATTERY !
```

3.7 Storage

Always pack the instrument and its accessories into the respective compartments of the transport case after measurements have been performed.

Wipe the transducers clean of traces of acoustic coupling compound.

In order to avoid scratches on the enclosure caused by the instrument handle during transport, tilt the instrument handle towards the upper front face of EESIFLO and not onto the top side of the housing. Avoid excessive cable bends especially when closing the transport case top cover.

4 Getting Started

4

4.1 Switching ON/OFF

Press key ON C to switch EESIFLO ON.

Pressing **BRK** three times will switch EESIFLO OFF.

```
EESIFLO
6000-00000999
```

After EESIFLO has been switched on, a message will appear indicating if a connected transducer has been detected and on which channel. The serial number of the instrument is then displayed for a second or two.

Note!	No data can be entered while the serial number is displayed.

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

After initialization, the main menu in the actually selected language version appears.

EESIFLO can be operated in the language of your choice (see section 4.5).

4.2 The Keyboard

The operator interface of EESIFLO consists of a keyboard and a two-line display (16 digits per line). The keyboard features three function keys and 12 keys for numerical data input.

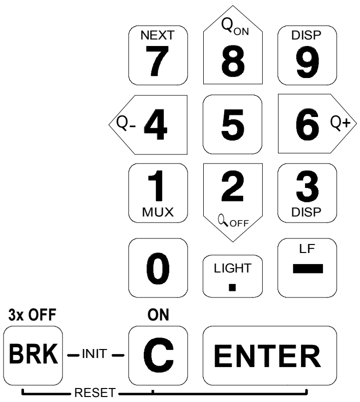


Fig. 4.1: The keyboard

Several keys have double functions. They can be used for INPUT as well as for SELECTION**.**

In SELECTION mode, for example, the arrow-shaped numerical keys operate as cursor keys.

In INPUT mode, they can be used for the input of numbers and characters.

Table 4.1: Key operations

General functions

ON C	Press this key to switch the flowmeter ON.
LIGHT .	Switches the background lighting ON/OFF.
BRK – INIT – C ENTER (RESET)	RESET: Press these keys simultaneously to recover from an error. This has the same effect as restarting the unit. Data will not be affected.

ON BRK – INIT – C	INIT (coldstart): To initialize EESIFLO, press these keys simultaneously **while switching the flowmeter ON** and hold them down until the main menu appears. Most parameters and settings are reset to the factory default values. The memory will not be cleared.
3x OFF BRK	Press 3 times **BRK** to switch the flowmeter OFF.
BRK	Interrupts the measurement and calls the main menu.

Attention!	Be careful not to interrupt an ongoing measurement by inadvertently pressing **BRK**!

Menu selections

BRK	Press on **BRK** to call the main menu.
Q- 4 6 Q+	Selecting the menu entry at the left or at the right of the currently highlighted one.
Q_{ON} 8 2 Q_{OFF}	Scrolling upwards or downwards through the menus.
ENTER	Confirmation of the selected entry. The corresponding program branch appears.

Input of numerical values

0 ... DISP 9	Input of the numerical value shown on the key
LF –	Sign for the input of negative data
LIGHT .	Decimal point
C	Deletion of data. After the deletion of data, the previous value will be displayed.
ENTER	Confirmation of input.

Input of text

Q- 4 6 Q+	Selection of the position of the character to be input.
DISP 9	Changes the currently selected character to an 'A'.
3 DISP	Changes the currently selected character to a 'Z'.
5	Changes between small and capital letters.
2 Q_{OFF} Q_{ON} 8	Moving to the next/previous ASCII character.
0	Deleting the character currently shown and inserts a blank space.

NEXT 7, 1 MUX	To automatically scroll upwards/downwards through the selected restricted ASCII character set. The character changes every second. The scrolling can be interrupted by pressing any other key.
ENTER	Finishes editing.

4.3 The Menus

4.3.1 The Main Menu

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

After switching on and initialization, the main menu appears on the first line of the display. The main menu has following entries: `PAR` (parameter), `MEA` (measuring), `OPT` (output options) and `SF` (special functions), corresponding to the four different program branches. The actually selected program branch is displayed in capital letters between arrows. The full name of the program branch is displayed on the second line.

Use keys Q- 4 and 6 Q+ to select a program branch. Confirm your selection by pressing **ENTER**.

4.3.2 The Program Branches

In the `PARAMETER` program branch, you can enter the parameters of the pipe and of the medium for the different measuring channels.

The `MEASURING` program branch leads you through the different steps of the measuring process.

In the `OUTPUT OPTIONS` branch, you can set all output relevant parameters, such as the physical quantity to be displayed during measurement and the measurement unit used for display for example.

The `SPECIAL FUNCTION` branch contains all functions that are not directly related with the basic measurement.

```
Pipe Material   ⇳
Carbon Steel
```

If a vertical arrow (⇳) is displayed beside a menu option, this menu option contains a scroll list. This list is displayed on the second line.

Use the arrow keys Q_{ON} 8 and 2 Q_{OFF} to scroll through the list, then confirm your selection by pressing **ENTER**.

```
Lining
 no         >YES<
```

EESIFLO sometimes requests a selection on the second line. The actually selected option is displayed in capital letters and between arrows.

Use keys Q- 4 and 6 Q+ to select one of the options, then confirm your selection by pressing **ENTER**.

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

EESIFLO sometime requests an horizontal selection between different menus on the upper line of the display. The selected menu is displayed in capital letters and between arrows. The actually selected options of the menus are displayed on the second line.

Use keys Q- 4 and 6 Q+ to select one of the menus.

Use the arrow keys QON 8 and 2 QOFF to scroll through the selected menu.

Note:	You can return to the main menu at any time by pressing key **BRK.**

Note:	In this manual, all program entries and keys will appear in capital letters. Program entries are in typewriter characters ("`PARAMETER`"). Submenus are separated from the main menu entry by a backslash.

4.4 HotCodes

A HotCode is a specific key sequence which has to be entered to activate some settings. Enter HotCodes in the main menu just after the flowmeter has been turned on. The HotCode itself is not displayed during entry.

4.5 Selecting the Language

EESIFLO can be operated in one of the languages listed below. The language can be selected with the following HotCodes. Depending on the specific technical characteristics of your instrument, some of the languages listed below might not be implemented.

Table 4.2: Language HotCodes

909031	Dutch	**909045**	Danish
909033	French	**909047**	Norwegian
909034	Spanish	**909048**	Polish
909042	Czech	**909049**	German
909044	English	**909090**	Turkish

When the last digit has been entered, the main menu appears in the selected language and EESIFLO greets accordingly. The selected language remain activated even after switching the unit OFF and ON again. A language selection can be made as often as required.

Note:	After initialization of the instrument (BRK – INIT – C while starting), the display will appear in the factory preset language version.

Should you have entered the HotCode for the language version incorrectly, switch the unit off by pressing **BRK** three times, then on again. Enter the HotCode again.

4.6 LEDs

Table 4.3: Function of the Battery LED

LED off:	The flowmeter works under normal operating conditions (battery or external power supply).
LED on:	Battery is being charged.
LED flashes (long intervals):	Battery voltage is insufficient. Measurements are impossible. Battery set must be charged or changed.
LED flashes (short intervals):	Error during battery charging, e.g. no external voltage present.

Table 4.4: Function of the Signal LED

LED off:	The flowmeter works offline.
LED on (green):	The signal received by the channel is sufficient for measurements.
LED on (red):	The signal received by the channel is insufficient for measurements.

4.7 Automatic Power Off

When the flowmeter is battery operated, an automatic power off function is activated. If the flowmeter has been expecting an action (key press) for a period of 10 minutes, an automatic switching off process will be activated. The flowmeter won't be switched off during measurement unless the batteries run low. "During measurement" means here that the measuring process has been started by entering the precise transducer distance and pressing **ENTER** - no matter whether this measuring process is successful or not. Upon activation of the power off process, an acoustic signal is emitted and following warning is displayed:

```
POWER OFF IN
      10       s
```

While the countdown runs, you can press any key to avoid switching off.

```
  LOW BATTERY
WHILE POWER OFF
```

If this information appears after EESIFLO has been switched ON again after automatically switching off, it indicates that the unit has switched itself off because of low batteries.

Note:	The automatic power off function is not activated when the instrument works with an external power supply.

```
LOW BATTERY    !
```

This message appears when the battery is low, but still has enough capacity for the display and keyboard operation necessary to store the current parameter record. However, a low battery will not allow the undertaking of measurements.

5 Selection of the Measuring Point

The correct selection of the measuring point is crucial for achieving reliable measurements and a high accuracy. Basically, measurement must take place on a pipe

- in which sound can propagate (see section 5.1)
- and in which a fully developed rotationally symmetrical flow profile is observed (see section 5.2).

The correct positioning of the transducers is an essential condition for error-free measurement. It guarantees that the sound signal will be received under optimal conditions and evaluated correctly. Because of the variety of applications and the different factors influencing measurement, there can be no standard solution for the positioning of the transducers. The correct position of the transducers will be influenced by the following factors:

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

Avoid the locations described in section 5.2.

Make sure that the temperature at the selected location is within the operating temperature range of the transducers (see Specifications in Appendix A).

Select afterward the location of the instrument within cable reach of the measuring point. Make sure that the temperature at the selected location is within the operating temperature range of the transmitter (see Specifications in Appendix A).

5.1 Acoustic Propagation

Acoustic propagation can be assumed when pipe and medium do not attenuate the sound so strongly that the signals get completely absorbed before reaching the second transducer. How strong the sound attenuation is in a specific system depends on:

- the kinematic viscosity of the liquid,
- the proportion of gas bubbles and solid particles in the liquid,
- the presence of deposits on the inner pipe wall,
- the wall material.

Make sure that following conditions are respected at the measuring point:

- the pipe is always filled,
- no material deposits are building,
- no bubbles accumulate (even bubble-free liquids can form gas pockets at places where the liquid expands, e.g. especially behind pumps and where the cross-sectional area of the pipe extends considerably).

5.2 Undisturbed Flow Profile

Many flow elements (elbows, slide valves, valves, pumps, T-sections, reducers, diffusers, etc.) distort the flow profile in their vicinity. The axi-symmetrical flow profile needed for correct measurement is no longer given. A careful selection of the measuring point makes it possible to reduce the impact of disturbance sources.

It is most important that the measuring point is chosen at a sufficient distance from any disturbance sources. Only then can it be assumed that the flow profile in the pipe is fully developed.

However, EESIFLO will give you meaningful measuring results even under non-ideal measuring conditions, with a liquid containing a certain proportion of gas bubbles or solid particles or if the recommended distances to disturbance sources can not be observed for practical reasons for example.

In the following examples, recommended straight inlet and outlet pipe lengths are given for different types of flow disturbance sources to assist you in selecting the correct measuring point.

Table 5.1: Recommended distance from disturbance source (D = nominal pipe diameter at measuring point, L = recommended distance)

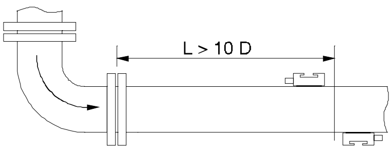
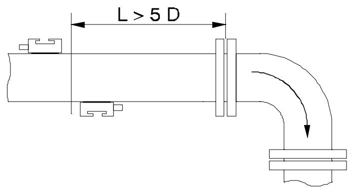
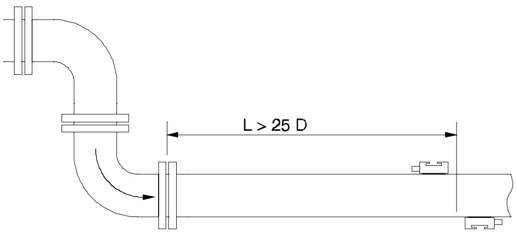
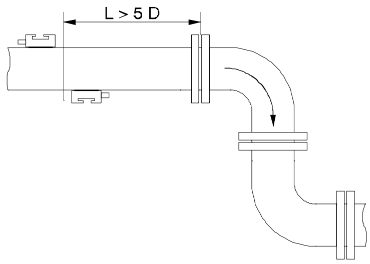
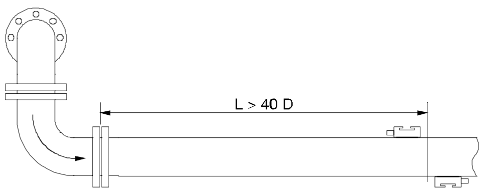
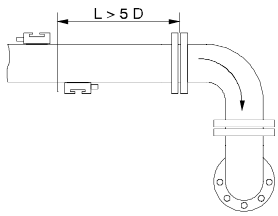
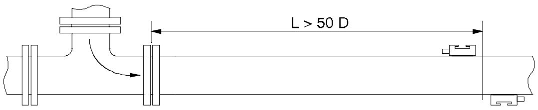
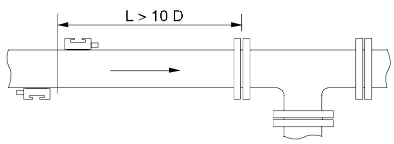
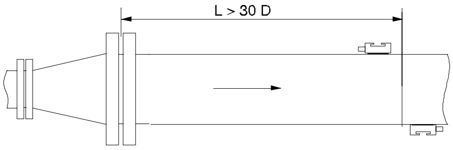
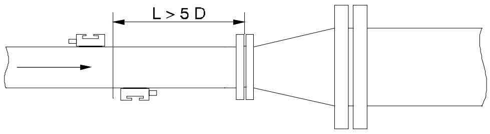
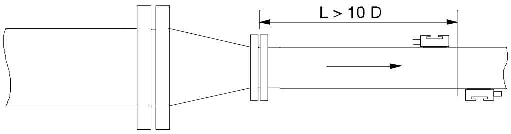
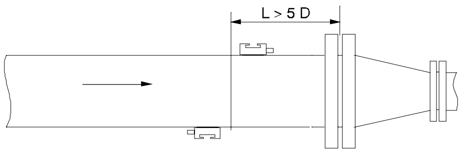
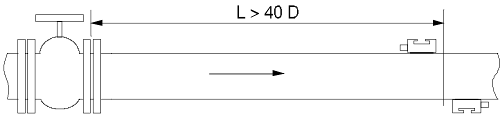
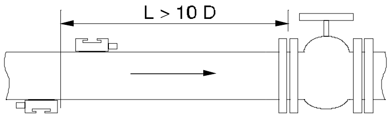
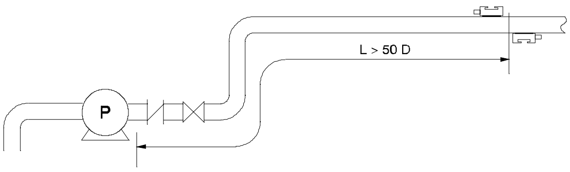
<table>
<tr><td colspan="2">Disturbance source: 90°-elbow</td></tr>
<tr><td>Inlet
L ≥ 10 D

</td><td>Outlet
L ≥ 5 D

</td></tr>
<tr><td colspan="2">Disturbance source: 2 x 90°-elbows in one plane</td></tr>
<tr><td>Inlet
L ≥ 25 D

</td><td>Outlet
L ≥ 5 D

</td></tr>
<tr><td colspan="2">Disturbance source: 2 x 90°-elbows in different planes</td></tr>
<tr><td>Inlet
L ≥ 40 D

</td><td>Outlet
L ≥ 5 D

</td></tr>
<tr><td colspan="2">Disturbance source: T-section</td></tr>
<tr><td>Inlet
L ≥ 50 D

</td><td>Outlet
L ≥ 10 D

</td></tr>
</table>

Table 5.1 (cont'd)

<table>
<tr><td colspan="2">Disturbance source: diffuser</td></tr>
<tr><td>Inlet
L ≥ 30 D

</td><td>Outlet
L ≥ 5 D

</td></tr>
<tr><td colspan="2">Disturbance source: reducer</td></tr>
<tr><td>Inlet
L ≥ 10 D

</td><td>Outlet
L ≥ 5 D

</td></tr>
<tr><td colspan="2">Disturbance source: valve</td></tr>
<tr><td>Inlet
L ≥ 40 D

</td><td>Outlet
L ≥ 10 D

</td></tr>
<tr><td colspan="2">Disturbance source: pump
Inlet
L ≥ 50 D

</td></tr>
</table>

5.3 Points to Avoid

Try to avoid measuring locations:

- in the vicinity of deformations and defects of the pipe
- or in the vicinity of weldings.

Avoid locations where deposits are building in the pipe.

Respect the recommendations given in Table 5.2.

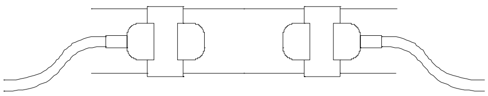
5

Table 5.2: Points to avoid

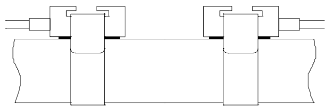
For an horizontal pipe:

Select a location where the transducers can be mounted on the side of the pipe, so that the sound waves emitted by the transducers propagate horizontally in the pipe. Thus, the solid particles deposited on the bottom of the pipe and the gas pockets developing at the top won't influence the propagation of the signal.

Correct



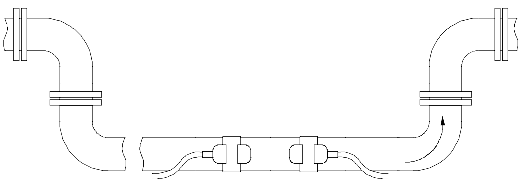
Incorrect



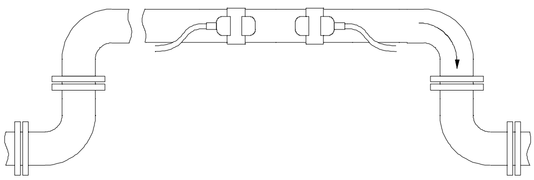
For a free inlet or outlet pipe section:

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

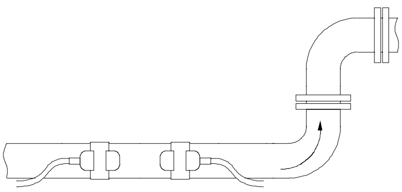
Correct



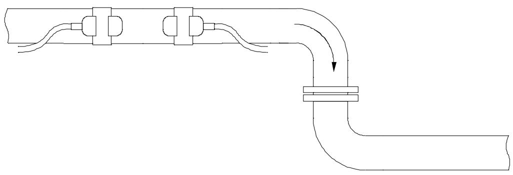
Disadvantageous



Correct



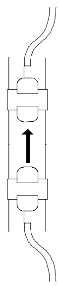
Disadvantageous



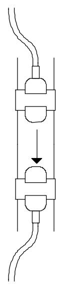
For a vertical pipe:

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

Correct



Incorrect



6 Basic Measurement

Once the measuring point has been selected (see chapter 5), the parameters of the pipe and of the medium can be entered. The parameters must be entered separately for every available measuring channel. They can be modified at any time later by calling the program branch `PARAMETER` again.

6.1 Input of the Pipe's Parameter

Note:	It is recommended to connect the transducers to the flowmeter before turning the flowmeter on.

The parameters of the pipe now have to be entered for every measuring point.

```
Outer Diameter
1100.0 MAXIMUM
```

(Example)

The values that can be given to the parameters of pipe and medium are limited by the characteristics of transmitter and transducers. EESIFLO will warn you if the entered values do not respect these limits (MINIMUM and MAXIMUM plausibility check).

In this example, the entered outer diameter was too big. EESIFLO displays the maximal possible value for this parameter (1100.0 mm in the case of transducers of type Q and a pipe with a wall thickness of 50 mm).

6

Note:	EESIFLO only accepts the parameters for a measuring channel if the program branch `PARAMETER` has been gone through completely once.

The pipe parameters that you will now enter can be modified at any time later by calling the program branch `PARAMETER` again.

Connect the transducers to the flowmeter if they are not already connected. Turn the flowmeter on.

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

In the main menu, select the program branch `PARAMETER` and press **ENTER**.

```
Parameter        ⇕
For Channel   A:
```

Select the channel for which you want to set the parameters and press **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

If the display `PARAMETER FROM` appears at this point, at least a parameter record has been stored and can be recalled now. A parameter record is a set of all the data required to perform a certain measuring task: the pipe parameters, medium parameters, transducer parameters and output options. You can create a parameter record for each of your measuring tasks. For more information on this subject, see chapter 10.

6.1.1 Pipe Outer Diameter / Circumference

```
Outer Diameter
    100.0     mm
```

Enter the outer diameter of the pipe.

Confirm your entry or the displayed value by pressing **ENTER**.

If the entered outer diameter is bigger than 4000 mm, measuring in reflection mode won't be possible (see section 6.5).

It is possible to change this menu in order to enter the pipe circumference instead of the diameter. This setting is coldstart resistant and can be made in the program branch `SPECIAL FUNCTION` (see section 12.2.1).

If the input of the pipe circumference is activated and you inadvertently enter a 0 (zero) in the `OUTER DIAMETER` display, EESIFLO will switch to the `PIPE CIRCUMFER.` display. If you do not wish to enter the pipe circumference, press **BRK** to return to the main menu and start the parameter input again.

6.1.2 Wall Thickness

```
Wall Thickness
      3.0     mm
```

Enter the pipe wall thickness. The range of possible values depends on the transducer specifications. Default value for this parameter is 3.0 mm.

Confirm by pressing **ENTER**.

Note:	EESIFLO calculates the inner diameter (outer diameter - 2 x wall thickness) and checks if this value is within the specified inner diameter range for the transducers used. An error message is displayed if this is not the case. It is possible to modify the value of the minimal pipe inner diameter accepted by EESIFLO for a certain type of transducer. See section 8.8.

6.1.3 Pipe Material

The pipe material now has to be selected in order to determine its sound velocity. The sound velocities of the materials of the selection list are already programmed in the instrument. When the pipe material is selected, EESIFLO sets the sound velocity automatically.

```
Pipe Material    ⇳
Carbon Steel
```

Select the pipe material in the pipe material selection list. If the correct material is not listed, select the entry `OTHER MATERIAL`.

Confirm by pressing **ENTER**.

Note:	It is possible to select which materials are to be displayed in the material selection list. See section 11.1.

```
c-Material
   3230.0    m/s
```

If you have selected `OTHER MATERIAL`, EESIFLO requests the entry of the sound velocity. Enter the sound velocity of the pipe material. Values between 600.0 and 6553.5 m/s are accepted. Confirm by pressing **ENTER**.

(Table B . 1 in Appendix B gives the sound velocity of some selected materials.)

Important!	Enter here that sound velocity of the material (longitudinal velocity or transversal velocity) which is nearer to 2500 m/s.

Note:	The longitudinal sound velocity of the material can be measured with EESIFLO. See chapter 15.

6.1.4 Pipe Lining

```
Lining
 no          >YES<
```

The instrument asks if the pipe is lined. If this is the case, select YES and confirm by pressing **ENTER.**

If you select NO, EESIFLO will ask for the next parameter (section 6.1.5).

```
Lining           ⇳
Bitumen
```

Select the lining material or the entry OTHER MATERIAL if the lining material is not listed.

Confirm by pressing **ENTER**.

6

Note:	It is possible to select which materials are to be displayed in the material selection list. See section 11.1.

```
c-Material
   3200.0    m/s
```

If you have selected OTHER MATERIAL, EESIFLO requests the entry of the sound velocity. Enter the sound velocity for the liner material. Values between 600.0 and 6553.5 m/s are accepted.

Confirm by pressing **ENTER**.

(Table B . 1 in Appendix B gives the sound velocity of some selected materials.)

```
Liner Thickness
      3.0      mm
```

Enter the pipe liner thickness. Default value for this parameter is 3.0 mm.

Confirm by pressing **ENTER**.

Note:	EESIFLO checks the correlation between the entered outer diameter, the pipe wall and liner thickness. The inner diameter (outer diameter - 2 x wall thickness - 2 x liner thickness) should be within the specified inner diameter range for the transducers used. An error message is displayed if this is not the case.

6.1.5 Pipe Roughness

The roughness of the inner pipe wall influences the flow profile of the liquid and is used for the calculation of the profile correction factor. In most cases, the pipe roughness cannot be exactly determined, but must be estimated. For your convenience, we have compiled a list of roughness factors for a number of materials, based on experience and measurements (Table B . 2 in Appendix B). The display ROUGHNESS requests the input of a value for the selected pipe or lining material.

```
Roughness
      0.4     mm
```

Change the suggested value according to the condition of the inner pipe wall. Values between 0.0 mm and 5.0 mm are accepted. Default value is 0.1 mm.

Confirm by pressing **ENTER**.

6.2 Input of the Medium's Parameters

After you have finished entering the pipe parameters, EESIFLO asks for the medium parameters.

The medium parameters required for measurement are:

- the minimum and maximum sound velocity for the medium,
- the kinematic viscosity of the medium,
- the density of the medium (only if the output option `MASS FLOW` is activated),
- the temperature of the medium.

Table B . 3 in Appendix B gives an overview of the pre-programmed parameters for common media.

```
Medium              ⇳
Water
```

Select the medium or the entry `OTHER MEDIUM` if the medium you want to measure is not listed.

Confirm by pressing **ENTER**.

If the medium has been selected, EESIFLO jumps straight to the display for entering the medium temperature (section 6.2.4). If you have selected `OTHER MEDIUM`, EESIFLO requests the entry of the minimal and maximal sound velocity, the kinematic viscosity and the density of the medium.

Note:	It is possible to select which media are to be displayed in the medium selection list. See section 11.1.

6.2.1 Sound Velocity

EESIFLO uses the sound velocity of the medium for the calculation of the distance between the transducers at the beginning of the measurement. However, the sound velocity does not influence the measuring result directly. Often, the accurate value of the sound velocity for a given medium is unknown. A range of possible values for the sound velocity must therefore be entered.

```
c-Medium       MIN
   1400.0     m/s
```

Enter the minimum and maximum values of the sound velocity for the medium you want to measure (in m/s).

Values between 500.0 m/s and 3500.0 m/s are accepted.

Confirm your entries by pressing **ENTER**.

Note:	With older versions of the firmware, the lowest sound velocity that can be entered is 800.0 m/s.

6.2.2 Kinematic Viscosity

The kinematic viscosity influences the flow profile of the liquid. EESIFLO uses the value of the kinematic viscosity as well as other parameters for the profile correction.

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

Enter the kinematic viscosity of the medium. Values between 0.01 and 30,000.00 mm^2/s are accepted.

Confirm by pressing **ENTER**.

6.2.3 Density

EESIFLO now asks for the density of the medium. This value is needed for calculating the mass flow rate (= volume flow rate multiplied with the entered density).

Note:	If you are not interested in measuring the mass flow rate, just confirm the displayed value by pressing **ENTER**. This will not influence your results.

```
Density
      1.00 g/cm3
```

Enter the density of the medium. Values between 0.10 g/cm^3 and 20.00 g/cm^3 are accepted.

Confirm by pressing **ENTER**.

6.2.4 Medium Temperature

EESIFLO needs the medium temperature for the calculation of the distance between the transducers (distance suggested at the beginning of measurement) and for correcting the sound velocity and the viscosity which both depend on temperature. If temperature measurement takes place, EESIFLO interpolates the sound velocity of the medium and the viscosity using the measured medium temperature (a temperature input or a current input measuring temperature must first be assigned to the measuring channel, see chapter 19). Otherwise, it uses the static temperature that has been entered here.

```
Medium Temperat.
     20        C
```

Enter the medium temperature. The value must be within the operating range of the transducer. The default value is 20°C.

Confirm by pressing **ENTER**.

Note:	The range of possible medium temperature depends on the operating range of the selected transducers.

6.3 Other Parameters

6.3.1 Transducer Parameters

If no transducers are connected, if you have connected special transducers which EESIFLO cannot automatically recognize, or if the connected transducers are defective, following display will appear at the end of parameter input:

```
TransducerType  ⇳
Standard
```

Select `STANDARD` to work with standard transducer parameters or `SPECIAL VERSION` to edit the transducer parameters (manufacturer's data must be available).

Confirm by pressing **ENTER**.

Attention!	EESIFLO cannot guarantee for the precision of values obtained when working with standard parameters. Measurement might be impossible.

6

```
Transd. Data   1
    35.99
```

If you have selected SPECIAL VERSION, EESIFLO will ask for the transducer data. Enter the value of the 6 transducer parameters as given by the manufacturer, confirming each entry by pressing **ENTER**.

6.4 Selection of the Measuring Channels

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

In the main menu, select the program branch MEASURING, then press **ENTER**.

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

If this error message appears, no complete parameter set exists. Return to the program branch PARAMETER and enter the missing parameters.

```
CHANN: A B>Y>Z
Measur √ - . .
```

In the first display of the program branch MEASURING, activate the channels on which you want to measure and deactivate the others.

Note: This display does not appear if your instrument has only one measuring channel.

"√" means that the measuring channel is activated, "–" that the measuring channel is deactivated and "•" that the measuring channel cannot be activated (you did not enter parameters for that channel).

- Use the keys Q- 4 and 6 Q+ to select a measuring channel.
- Press key Q_ON 8 to activate or deactivate the selected channel.

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

Press **ENTER** when finished.

Note:	A measuring channel cannot be activated if its parameters are not valid (for example if the program branch PARAMETER of the channel has not been worked through completely).

At this point, EESIFLO asks for the measuring point number if the storage or the serial output of the measuring data has been activated. See chapter 9.

6.5 Selection of the Sound Path Factor

EESIFLO now asks for the **sound path factor**, which is the number of transits of the ultrasonic waves through the medium in the pipe.

A sound path factor of "0" (zero) is nonsense in terms of physics. An **odd** number of transits (diagonal mode) requires mounting of the transducers on opposite sides of the pipe (see illustration below). An **even** number of transits (reflection mode) requires mounting of the transducers on the same side of the pipe (see illustration below).

An increased number of transit path means increased accuracy of the measurement. However, the increased transit distance also leads to a higher attenuation of the signal. The reflections on the opposite pipe wall and eventual deposits on the inner pipe wall cause additional amplitude losses of the sound signal. In the case of a measurement on a system where both the pipe and the medium are strongly attenuating and where deposits can be found on the inner pipe wall, it is possible that the amplitude of the signal is already insufficient for measuring after two transit paths.

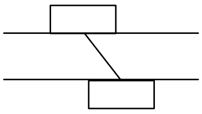
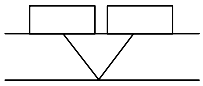
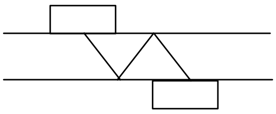
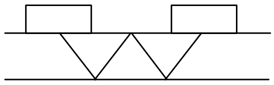
Transducer installation in diagonal mode		**Transducer installation in reflection mode**	
number of transits	**sound path**	**number of transits**	**sound path**
1		2	
3		4	
etc.		etc.	

Fig. 6.1: Sound path

Note:	Correct positioning of the transducer is easier for an even number of transit paths as for an odd number.

```
A:Sound Path
       5      NUM
```

Enter the sound path factor.

Confirm by pressing **ENTER**.

6.6 Mounting and Positioning the Transducers

6.6.1 Distance between the Transducers

Once the number of transit paths has been entered, following display appears.

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

(Letter A = Measuring channel A)

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

If you have entered the sound path factor numerically, '`Refle`' (reflection mode) or '`Diago`' (diagonal mode) appears behind '`mm`'.

The display indicates at which distance from another the transducer should be mounted (here: 54 mm). The transducer distance given here is the distance between the inner edges of the transducers. For very small pipes, a negative transducer distance is possible, as illustrated in Fig. 6.2.

Note:	The accuracy of the distance suggested by EESIFLO depends on the accuracy of both the pipe and medium parameters entered.

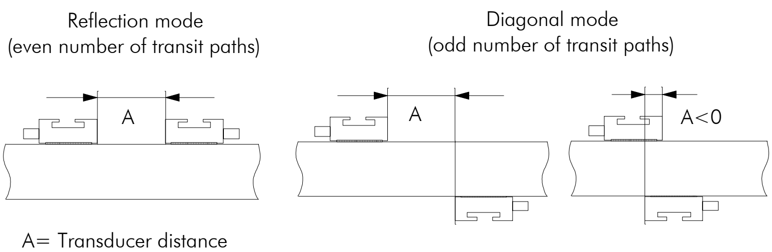


Fig. 6.2: Transducer distance

6.6.2 Mounting the Transducers

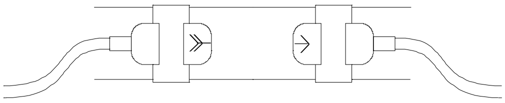


Fig. 6.3: Correct positioning of the transducers

Always mount the transducers so that the front edges are opposite to each other. The engravings on the top of the transducers should form an arrow, as illustrated in Fig. 6.3.

Important!	In order to obtain maximal acoustic contact between the pipe and the transducers, pay attention to the following points:
	• Rust or other deposits absorb the sound signals! Clean the pipe at the emplacement where you plan to mount the transducers. Remove rust or loose paint. Grind off any thick layer of paint. • Always apply a bead of acoustic coupling compound lengthwise down the center of the contact surface of the transducers. • There should be no air or air pockets between transducer surface and pipe wall. Make sure that the mounting fixture applies the necessary pressure on the transducers.

6.6.2.1 Mounting with Chains

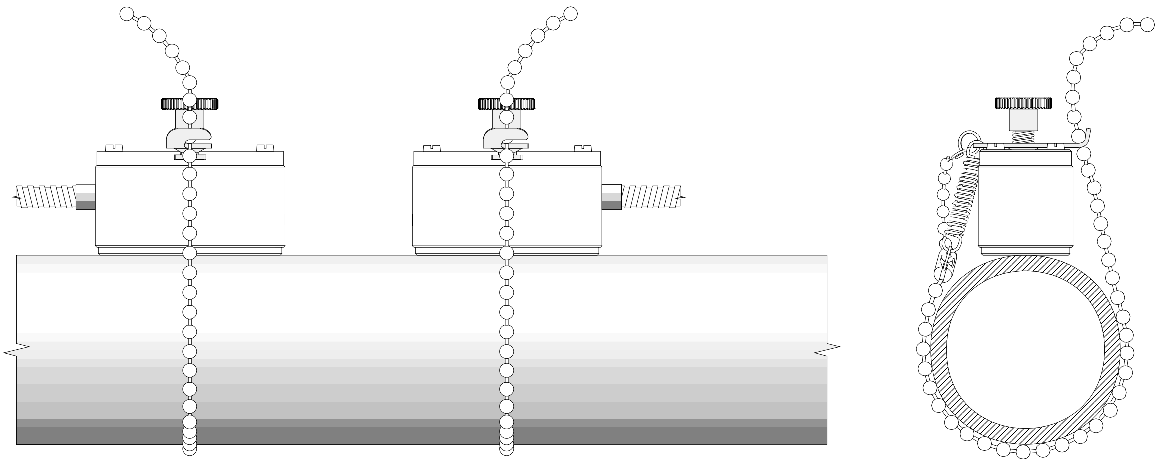


Fig. 6.4: Side view and sectional view of a pipe with transducers fastened with chains and retaining clip

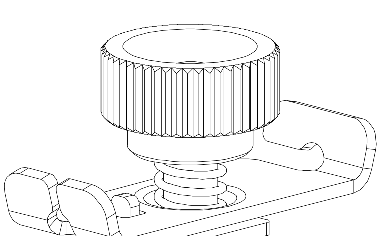


Fig. 6.5: Side view of the retaining clip

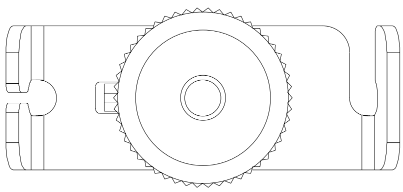


Fig. 6.6: Top view of the retaining clip

- Insert the retaining clip into the groove on the top of the transducer and secure it using the knurled screw.
- Apply some acoustic coupling compound to the contact surface of the transducer. Place the transducer on the pipe and press it firmly.
- Take the spring end of the chain in the hand and insert the ball at its extremity in the vertical slot of the retaining clip. Lay the chain around the pipe. When mounting the transducers on a vertical pipe

and EESIFLO is placed lower than the pipe, it is recommended to slip the cable of the upper transducer under the chain in order to free it from mechanical strain.

- Pull the chain firmly and insert it in the lateral slot of the retaining clip. There should be no air or air pockets between transducer surface and pipe wall.
- Mount the second transducer in the same way. Using a ruler, adjust the transducer distance to the distance suggested by EESIFLO.

6.6.2.2 Mounting with Runners and Chains

- Insert the transducers in the runners. Turn the screw on top of the runners by 90° in order to engage and lock its extremity in the groove of the inserted transducer.
- Insert the ruler in the lateral slots of the runners (see Fig. 6.7). Adjust the transducer distance to the distance suggested by EESIFLO and fix the transducers with the small plastic screws on the transducer cable side of the runner.

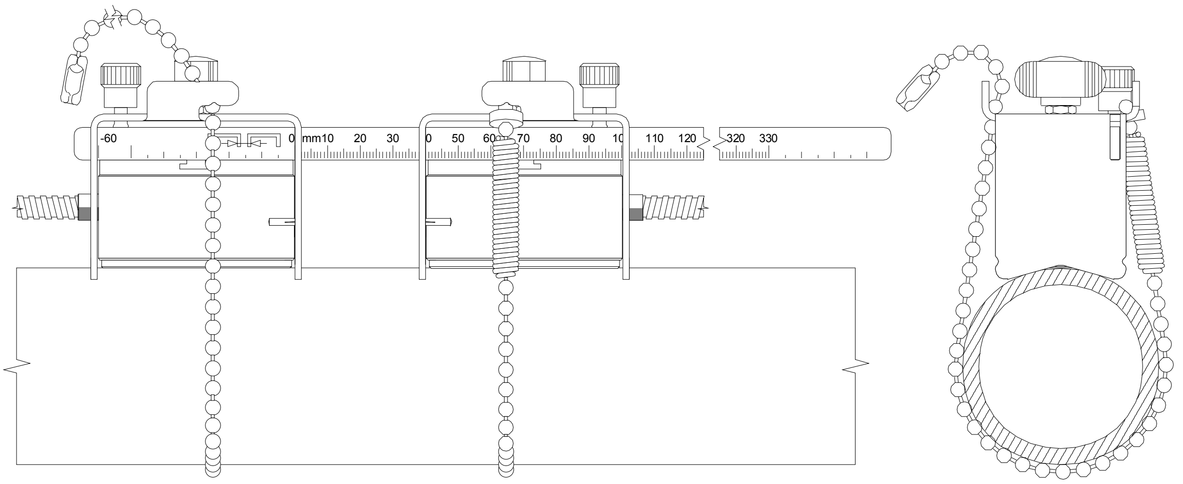


Fig. 6.7: Transducers mounted with runners and chains

- Place the runners/ruler assembly on the pipe at the measuring point.
- Take the spring end of one of the ball chains, insert the last ball in the slot on the top of one of the runner.
- Lay the chain around the pipe.

Note:	When mounting the transducers on a vertical pipe with EESIFLO situated lower than the pipe, it is recommended to slip the cable of the upper transducer under the tension strap in order to free it from mechanical strain.

- Pull the chain firmly and insert it in the second slot on the top of the runner.
- Fix the other transducer in the same way.

6.6.2.3 Extension of the Ball Chain

To extend the chain, insert the last ball of the spring end 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

6.6.2.4 Mounting with Magnetic Runners

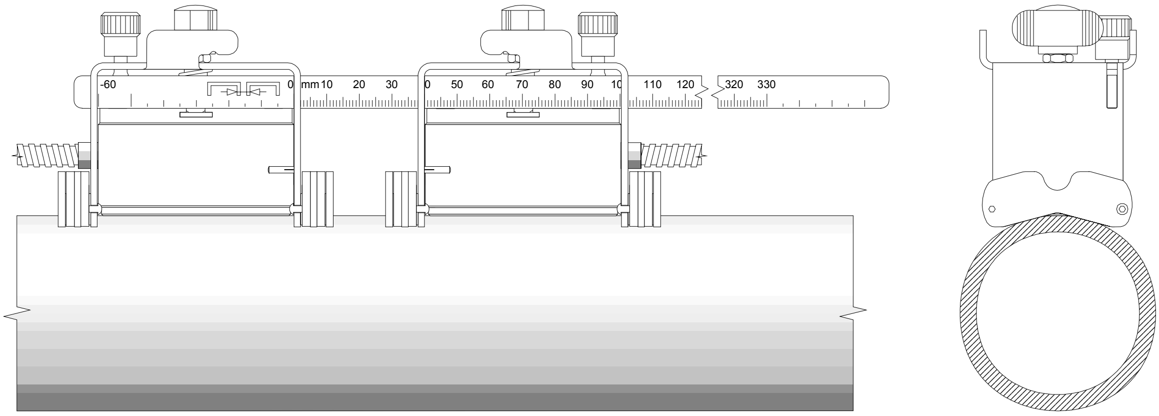


Fig. 6.8: Side view and sectional view of a pipe with transducers fastened with magnetic runners

- Insert the transducers in the runners. Turn the screw on top of the runners 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 slots of the runners (see Fig. 6.8). Adjust the transducer distance to the distance suggested by EESIFLO and fix the transducers with the small plastic screws on the transducer cable side of the runner.
- Place the runners/ruler assembly on the pipe at the measuring point. There should be no air or air pockets between transducer surface and pipe wall.
- Adjust transducer distance again.

6.6.3 Positioning of the Transducers

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

When the transducers are mounted, confirm the transducer distance by pressing **ENTER**. The positioning procedure is started.

```
S= ■■■■■■
A: ■< >■ =54 mm!
```

A bar graph ("S=") informs you of the amplitude of the received signal.

Adjust the transducers by moving them slightly in order to obtain a maximal length of the bar graph.

If the signal received by the channel is sufficient for measurement, the corresponding LED shows green; if not, it shows red. In the last case, adjust the transducers by moving them slightly until the LED shows green.

```
S= ■■■■■■
Q= ■■■■■■■■
```

Press key 3 DISP to switch on the lower line between the display of the transducer distance and the bar graph of the quality of the signal ("Q="). If the signal is not sufficient for measurement, `UNDEF` is displayed.

```
trans.  94.0   µs
Q= ■■■■■■■■■
```

Press key **9** (DISP) to scroll on the upper line between the display of the bar graph of the signal amplitude ("S="), the bar graph of the quality of the signal ("Q=") and the display of the transit time ("trans.") in microseconds.

Note:	It is important for the flow measurement that the signal maximum with the shortest transducer distance (shortest transit time) is used. However, this signal maximum should not deviate from the suggested distance by more than ± 0.5 cm. In case of bigger deviations, check if the entered parameter inputs are correct or repeat measurement at a different location on the pipe.

```
Transd.Distance?
     53.9     mm
```

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

Enter the actual (precise) transducer distance and press **ENTER** or just confirm the displayed value by pressing **ENTER**.

6

Note:	It is possible to have EESIFLO remind you of the last entered precise transducer distance in this display. See section 12.2.4.

6.7 Starting the Measurement

Repeat the steps described in sections 6.5 and 6.6 for all channels on which you want to measure. When the precise transducer distance has been entered for all these channels, the measurement will be automatically activated.

```
A: Volume Flow
    54.5    m3/h
```

You can press **ENTER** to return to the bar graph display.

EESIFLO works with an integrated measuring point multiplexer which enables quasi simultaneous measurement on the different channels. The flow is measured on one channel, which takes approx. 1 second, then the multiplexer switches to the next activated channel. The SIGNAL LED of an activated channel flashes as the measurement takes place. The measuring time depends on the measuring conditions. If for some reason the signal cannot be immediately detected, the measurement might take longer than 1 second.

Note:	The measurement of flow processes with high flow dynamics (transients) might be impossible in normal measuring mode. For such measurements, activate the FastFood mode (see section 8.6).

All process outputs as well as the serial interface continuously get the measuring results of the assigned channel.

The results are displayed and output according to the actually selected output options (see chapter 7.1). Default setting is the display of volume flow rate in m^3/h.

Chapter 7 describes the selection of the values to be displayed and the setting of the output options. Advanced measuring functions are described in chapter 8.

6.8 Recognition of Flow Direction

The direction of flow in the pipe can be recognized with the help of the displayed "Volume Flow" in conjunction with the arrow formed by the engravings on the transducers:

The medium flows in direction of the arrow if the display shows a positive flow reading (example: 54.5 m^3/h).

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

6.9 Stopping the Measurement

You can stop the measurement on all activated measuring channels at any time by pressing **BRK**.

Attention!	Be careful not to interrupt an ongoing measurement by inadvertently pressing **BRK**!

7 Displaying the Measured Values

The physical quantity to be measured and used for storage and output can be set in the `OUTPUT OPTIONS` program branch as described in section 7.1. Default display setting is that the designation of the quantity of measurement selected in the `OUTPUT OPTIONS` is displayed on the first line and its value on the second line. It is possible to temporary adapt the display to your requirements by selecting which quantity should be shown on the first and second line of the display (see section 7.3).

It is possible to have the measured values of only one selected channel displayed, or to switch between the activated channels every second (see section 7.2).

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

EESIFLO can measure the following quantities:

- flow velocity
- volume flow rate
- mass flow rate
- heat flow rate
- sound velocity of the medium,

EESIFLO measures the flow velocity directly. The volume flow is calculated by multiplying the flow velocity with the cross-sectional area of the pipe, the mass flow by multiplying the volume flow with the density of the medium.

```
par mea >OPT< sf
Output Options
```

In the main menu, select the program branch `OUTPUT OPTIONS`.

```
Output Options  ⇳
For Channel   A:
```

Select the measuring channel for which you want to set the output options.

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
Physic. Quant.  ⇳
Volume Flow
```

Select the desired quantity of measurement in the scroll list.

Confirm by pressing **ENTER**.

The selection of the physical quantity `SOUND VELOCITY` immediately ends the program branch `OUTPUT OPTIONS`, because the process outputs, the serial interface and the data logger are not active during the measurement of the sound velocity and there are thus no more settings to be made. The measurement of the sound velocity is described in chapter 16.

```
Volume in:      ⇳
m3/h
```

For all quantities of measurement other than `SOUND VELOCITY`, a scroll list of the available measurement units is displayed. Select the unit of measurement in which you want to have the chosen physical quantity displayed and output.

Confirm by pressing **ENTER**.

You can now return to the main menu by pressing **BRK**. The next displays of the program branch `OUTPUT OPTIONS` are for the activation of the different output options (process outputs, data logger, output to a PC, etc...).

7.2 Toggling between the Channels

EESIFLO can display the measuring values of the activated channels in 4 different modes.

Use key 1 MUX to toggle between the modes described below.

7.2.1 AutoMux Mode

In AutoMux mode, the display is synchronized with the measuring process. The channel where measurement actually takes place is displayed on the upper left corner of the display (A:, B:, ...). For this channel, EESIFLO displays the measured values as configurated in the `OUTPUT OPTIONS` program branch (see section 7.1). When the multiplexer switches to the next channel, the display is actualized.

```
A: Volume Flow
    54.5    m3/h
```

```
B: Flow Velocity
    1.25     m/s
```

7.2.2 HumanMux Mode

In HumanMux mode, EESIFLO displays the measured values of only one measuring channel. Measurement still takes place on all other activated channels - without display of the results.

```
A: Volume Flow
    54.5    m3/h
```

EESIFLO shows the selected measuring channel on the upper left corner of the display (A, B, ...).

Press key NEXT 7 to select the next activated channel for displaying.

EESIFLO displays the measuring values as configured in the `OUTPUT OPTIONS` program branch (see section 7.1) for the selected channel.

7.2.3 Calculation Channels Mode

(This mode is available only in firmware versions V5.30 and higher.)

In this mode, EESIFLO displays the measuring results of the calculation channels only. It switches to the next activated calculation channel every 1.5 seconds. This mode can only be activated if at least 2 calculation channels are activated.

7.2.4 All Channels

(This mode is available only in firmware versions V5.30 and higher.)

In this mode, EESIFLO displays the measuring results of all channels (calculation and measuring channels). It switches to the next activated measuring channel every 1.5 seconds.

7.3 Configuration of the Display

EESIFLO gives the option of displaying two of the measured values (one on each line of the display) and of configuring the display readings according to your requirements.

You can change the displayed values independently and without interfering with the ongoing measurement. The changes have no influence on the totalizers, the storage of measured values, the operation of the process interfaces etc..

Following information can be displayed on the first line of the display:

- Designation of the quantity of measurement actually being measured and recorded
- Totalizer values (if activated)
- Linked temperatures and their difference (if any temperatures are measured)
- the date and time at which the memory will be full
- the measuring mode
- the transducer distance (see section 7.4)
- the calculation function if activated
- the time remaining until the automatic stop of a programmed measurement
- the state of the alarms if any alarm outputs are activated and the display of the alarm's state is enabled (see section 20.6).

Following information can be displayed on the second line in addition to the selected quantity of measurement:

- Flow velocity
- Mass flow rate
- Volume flow rate
- Heat flow rate
- Linked temperatures and their difference (if any temperatures are measured).

Use key DISP 9 to scroll through the different displays of the first line while measurement is going on.

Use key 3 DISP to scroll through the different displays of the second line while measurement is going on.

```
A: Volume Flow
*     2.47   m/s
```

The asterisk "*" indicates that the displayed value (here: the flow velocity) is not the selected quantity of measurement (here: the volume flow).

Note:	
	• "(`FIX`)" is displayed when a temperature was entered manually.
	• If a temperature cannot be measured and its value has not been entered as a constant, "`?UNDEF`" will be displayed instead of the temperature value or the temperature difference T1-T2. At the same time, the calculations for heat flow rate and heat quantity cannot be made and the displayed values are marked by "`_UNDEF_`".
	• The indication of the temperature difference does not show whether one or both of the temperatures are constants.

7.4 Transducer Distance

```
L=(51.2) 50.8 mm
    54.5    m3/h
```

During measurement, it is possible to scroll to the display of the transducer distance by pressing the key DISP 9.

The actual optimal transducer distance is given first in parenthesis (here: 51.2 mm), then the entered transducer distance (here: 50.8 mm). The optimal transducer distance might change during measurement due to temperature fluctuations for example. An eventual mispositioning of the transducers (here: -0.4 mm) will be internally compensated by EESIFLO.

Attention!	Never change the transducer distance during measurement!

8 Advanced Measuring Functions

8.1 The Damping Factor

Each measured value displayed by the instrument is actually the average of the 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, since the measuring rate is of approx 1 value per second. The default value is 10 s. This is appropriate for normal flow conditions. Strongly fluctuating readings caused by high flow dynamics require a larger damping factor.

Select the `OUTPUT OPTIONS` program branch of the channel for which you want to set the damping factor. Work yourself through the scroll list, confirming the already selected options by pressing **ENTER**, until you reach the `DAMPING` option.

```
Damping
      30       s
```

Enter the damping factor. Values between 1 s and 100 s are accepted.

Confirm by pressing **ENTER**.

You can now return to the main menu by pressing **BRK**.

8.2 Flow Totalizers

EESIFLO can totalize the **volume** or the **mass** of medium or the **heat quantity** passing through the pipe at the measuring point.

- There are two built-in flow totalizers, one for totalizing in positive flow direction, the other for totalizing in negative flow direction.
- The unit of measurement used for totalization corresponds to the volume, heat or mass unit used in the quantity of measurement (see section 7.1).
- Every numerical value of the totalizer consists of up to 11 characters, with a maximum of 3 figures to the right of the decimal point.

```
A: Volume Flow
    54.5    m3/h
```

The two flow totalizers can be activated simultaneously during measurement when the display of the measuring quantity that should be totalized is activated.

To activate the flow totalizers:	Press key Q_{ON} **8** during measurement.
To have the totalizer for positive flow direction displayed:	Press key **6** Q+.
To have the totalizer for negative flow direction displayed:	Press key Q- **4**.
To reset the two flow totalizers to zero:	Press 3 times key Q_{ON} **8** while a totalizer is displayed.
To deactivate flow totalizing:	Press 3 times key **2** Q_{OFF} while a totalizer is displayed.

Note: With firmware version 5.41 and lower, you only have to press the keys 8 or 2 once to reset or deactivate the totalizers.

```
A: NO COUNTING !
     3.5     m/s
```

This error message appears if you try to activate the totalizers on a channel where the flow velocity is selected as quantity of measurement. The flow velocity cannot be totalized.

Note: The flow totalizers can only be activated for the measuring channel which measured values are actually displayed.

Note: A keystroke which has influence on the totalizers will only be active if the upper line of the display shows the total value. If the upper line of the display shows something other than the totalizer, you need to press the key twice. The first keystroke will display the totalizer. The second stroke will perform the actual function.

```
A:  32.5    m3
    54.5    m3/h
```

Once the totalizers are activated, the totalized value is shown on the first line of the display (here: the volume which has passed the measuring point in positive flow direction since the activation of the totalizers).

8.2.1 Settings of the Totalizers

Note: All totalizer settings are coldstart resistant.

It is possible to output and store both the heat totalizer and the volume flow totalizer during heat flow measurement. This setting can be activated in the program branch `SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ MEASURING`.

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

In the `MEASURING` scroll list, select the `HEAT+FLOW QUANT.` option. Select `ON` to output and store the heat quantity and the volume flow totalizer during heat flow measurement.

The behavior of the totalizer after a measurement has been stopped or after a reset can also be set in the program branch `SPECIAL FUNCTION \ SYSTEM SETTINGS \ MEASURING`.

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

In the `MEASURING` scroll list, select the `QUANTITY RECALL` option.

If you select `ON`, the numerical values of the totalizers will be memorized and used for the next measurement or when the measurement is continued after a reset. If you select `OFF`, the totalizers will be reset to zero in both cases.

It is possible to store the value of the currently displayed totalizer only or one value for each flow direction. In the `SPECIAL FUNCTION \ SYSTEM SETTINGS \ STORING` program branch, select the `QUANTITY STORAGE` entry.

```
Quantity Storage
 one      >BOTH<
```

Select ONE if EESIFLO should only store the value of the displayed totalizer. Select BOTH to enable storage of the totalizer value in function of the flow direction.

Confirm by pressing **ENTER**.

Note:	All totalizer settings are coldstart resistant.

8.2.2 Overflow of the Flow Totalizers

The flow totalizers can work in two different modes:

- Without overflow: The numerical value of the respective totalizer increases up to the internal limit of 10^{38}. The values are displayed as exponential numbers (±1.00000E10) if necessary. The totalizer can only be reset to zero manually.
- With overflow: The totalizer resets automatically to zero as soon as ±9999999999 is reached (as for a water-clock).

Independently of the selected option, it is always possible to reset the totalizers manually.

The totalizer wrapping mode can be set in the program branch SPECIAL FUNCTION \ SYSTEM SETTINGS \ MEASURING. This setting is cold start resistant.

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

Select the QUANT. WRAPPING option.

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

Note:

- The overflow of a totalizer influences all output channels, e.g. storage of measured values, online output, etc.
- The output of sum of both totalizer (the throughput 'ΣQ') via a process output will not be valid after the first overflow (wrapping) of one of the respective totalizers.
- To signalize the overflow of a totalizer, activate an alarm output with the switching condition QUANTITY and the type HOLD.

8.3 Upper Limit for Flow Velocities

A single outlier caused by heavily disturbed surroundings can appear in flow measured values. Such a measured value will, when not ignored, affect all derived quantities, which will then be unsuitable for integration (pulse outputs, e.g.).

It is possible for the instrument to ignore all measured flow velocities bigger than a preset upper limit and mark them as outlier ("invalid measured value"). This upper limit for the flow velocity can be set in the program branch SPECIAL FUNCTION \ SYSTEM SETTINGS \ MEASURING. This setting is cold start resistant.

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

In the program branch SPECIAL FUNCTION \ SYSTEM SETTINGS \ MEASURING, select the VELOCITY LIMIT option. Enter the upper velocity limit. Values between 0.1 and 25.5 m/s are accepted. Entering "0" switches off the test for outliers.

Confirm by pressing **ENTER**.

When the test is activated (velocity limit > 0.0 m/s), every measured flow velocity will be compared with the entered upper velocity limit. If the flow velocity is bigger than the limit:

- The flow velocity is marked as "invalid"; the measuring quantity cannot be determined.
- The LED of the channel shows red.
- The display shows a '!' behind the unit of measurement. (In case of a 'normal' error, a '?' appears.)

Attention!	If the defined velocity limit is too small, measurement might be impossible - most measured values are declared invalid.

8.4 Cut-off Flow

The cut-off flow function automatically sets all measured flow velocities falling below a certain value to zero. All values derived from this flow velocity are equally set to zero. The cut-off can depend on the sign identifying the direction of flow or not. The default cut-off value is 5 cm/s. The largest cut-off value which can be set is 12.7 cm/s.

The cut-off value can be set in the program branch `SPECIAL FUNCTION \ SYSTEM SETTINGS \ MEASURING`. This setting is cold start resistant.

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

If you select `ABSOLUTE`, the user defined cut-off value will not depend on the sign identifying the direction of flow. There is only one limit to be set. The absolute value of the measured value will be compared with the cut-off value.

If you select `SIGN`, the user defined cut-off value will depend on the sign identifying the direction of flow. Two independent limits can be entered for positive and negative flow velocities.

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

If you select `FACTORY`, EESIFLO will use the factory default setting of 5 cm/s for the cut-off value.

Select `USER` to define you own cut-off.

Confirm by pressing **ENTER**.

If you have previously selected `CUT-OFF FLOW \ SIGN`, two cut-off values must be entered:

```
+Cut-off Flow
     5.0    cm/s
```

Enter here the cut-off flow for positive measured values. When a positive value falls below this threshold, the flow velocity is set to 0 cm/s. All derived values are equally set to zero.

```
-Cut-off Flow
    -5.0    cm/s
```

Enter here the cut-off flow for negative measured values. When a negative value rises above this threshold, the flow velocity is set to 0 cm/s. All derived values are equally set to zero.

If you have previously selected `CUT-OFF FLOW \ ABSOLUTE`, only one cut-off value has to be entered :

```
Cut-off Flow
     5.0    cm/s
```

The limit comparison will be performed using the absolute numerical value of the measured flow velocity.

8.5 Uncorrected Flow Velocity

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

In the program branch SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ MEASURING, you may enable or disable the flow profile correction for the flow velocity. This setting is coldstart resistant.

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

In the FLOW VELOCITY display, select NORMAL to have the profile corrected flow velocity displayed and output. Select UNCORR. to enable the display of flow velocities without flow profile correction.

Confirm by pressing **ENTER**.

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

From now on, when the program branch MEASURING is selected, EESIFLO will ask explicitly whether to use the profile correction for the selected channel or not.

```
A: FLOW VELOCITY
     2.60    m/s
```

If you select NO, the profile correction will be completely disabled. All measuring quantities will be calculated with the uncorrected flow velocity. The designations of the measuring quantities will be displayed in capital letters to indicate this.

```
A: PROFILE CORR.
 no        >YES<
```

If you select YES, EESIFLO uses the uncorrected flow velocity only if the physical quantity FLOW VELOCITY is selected in the OUTPUT OPTIONS. EESIFLO determines all other physical quantities (volume flow, mass flow, etc.) with the corrected flow velocity. During measurement, FLOW VELOCITY will be displayed in capital letters, indicating that the displayed flow velocity is uncorrected.

Confirm by pressing **ENTER**.

```
A: Volume Flow
*U  54.5     m/s
```

However, in both cases, the corrected flow velocity can still be displayed by scrolling on the second line of the display (key 3 DISP). The uncorrected flow velocity is preceded by "U".

Uncorrected flow velocities stored in the memory of the instrument or transmitted to a PC will be marked as uncorrected ("UNCORR" appears near the unit of measurement).

8.6 Measurement of Transient Processes (FastFood mode)

The FastFood mode allows the measurement of flow processes with high dynamics. A storage rate of approx. 70 ms can be reached (for example if the storage of the measured values, a temperature measurement and a current output are activated). The continuous adaptation to changing measuring conditions which takes place in the normal measuring mode is only partially realized in the FastFood mode.

The sound velocity of the medium is not measured. EESIFLO uses for the calculation of the flow rate the sound velocity memorized in the internal data bank, taking into account the medium temperature entered in program branch PARAMETER (or the measured temperature if the instrument is equipped with a temperature input).

A change of measuring channel is not possible. The process inputs and outputs can still be used and the measured values stored as usual.

The FastFood Mode has to be enabled and activated.

8.6.1 Enabling/Disabling the FastFood Mode

```
Enable FastFood
 no        >YES<
```

Enter the HotCode **007022** to open the FastFood mode screen.

Select `YES` to enable the FastFood mode, `NO` to disable it. Confirm by pressing **ENTER**. This setting is coldstart resistant.

8.6.2 Storage Rate for the FastFood Mode

```
Storage Rate
      70    ms
```

When the FastFood mode has been enabled, EESIFLO asks in the `OUTPUT OPTIONS` program branch for the input of a storage rate in ms.

Enter a storage rate from 64 ms onwards.

Confirm by pressing **ENTER**.

8.6.3 Activating / Deactivating the FastFood Mode

Even if the FastFood mode is enabled and a measurement has been started, EESIFLO is still in the normal measuring mode (i.e. multi-channel measurement with permanent adaptation to the measuring conditions).

```
A: Volume Flow
    30.5    m3/h
```

To activate the FastFood mode on a given measuring channel, press key **0** during measurement while the measuring values of the channel are displayed.

```
A:Mode=FastFood
    30.5    m3/h
```

EESIFLO activates the FastFood mode. The activated measuring mode is displayed on the first line.

Measurement can be interrupted at any time by pressing **BRK**.

If the storage of measured values is activated, a new data set is created and the storing of the measured values is started. The storing ends with the deactivation of the FastFood mode or with the interruption of the measurement (key **BRK**).

```
A:Mode=TransTime
    30.5    m3/h
```

When you press **0** again, EESIFLO deactivates the FastFood mode and switches back to the previous measuring mode.

Attention!	• The values of the current measuring data set will be deleted when you deactivate the FastFood mode and activate it again without stopping the measurement. • The values of the current measuring data set will be kept if you deactivate the FastFood mode and stop the measurement before activating the FastFood mode again. A new measuring data set will be created when the next measurement is started.

8.7 Calculation Channels

Note:	Calculation channels are only available if your instrument has more than one measuring channel.

In addition to the physically existing ultrasonic measuring channels, EESIFLO offers two virtual calculation channels (channels Y and Z). These two 'virtual' channels allows you to combine numerically the measuring results of the two measuring channels (measured value of channel A *minus* measured value of channel B for example).

The result of the numerical operation is the 'measured value' of the selected calculation channel. This 'measured value' is equivalent to the measured values of a measuring channel. Everything that can be done with the measured values of an ultrasonic measuring channel (totalization, online output, storing, process outputs, etc.) can also be done with the values furnished by a calculation channel.

8.7.1 Characteristics of the Calculation Channels

- In the program branch `PARAMETER`, you now have to specify the channels to be used for the calculation (**input channels**) and the calculation function.
- A calculation channel cannot be attenuated. You have to set up the required damping factor separately for each of the two implied measuring channels.
- You can define two cut-off values for each calculation channel. These cut-off values are not based on the flow velocity as for measuring channels, but are defined in the unit of that quantity of measurement which was selected for the respective calculation channel. During measurement, the calculated values are compared with the set cut-off values and set to zero if necessary.
- A calculation channel provides a valid measured value if both input channels provide valid measured values.

8

8.7.2 Parameterization of a Calculation Channel

```
Parameter        ⇳
For Channel    Y:
```

In the program branch `PARAMETER`, select a calculation channel (Y or Z) and confirm by pressing **ENTER**.

```
Calculation:
    Y= A - B
```

EESIFLO displays the actual calculation function. Press any key to edit the function.

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

Three configuration scroll lists are displayed on the first line of the display:

- `CH1` for the selection of the first input channel,
- `FUNCT` for the selection of the calculation function,
- `CH2` for the selection of the second input channel.

Select a configuration scroll list using keys Q- **4** and **6** Q+ .

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

The options of the selected list are displayed on the second line. Use the keys 8 and 2 to scroll through this list. All measuring channels of the flowmeter as well as their absolute value can be used for the calculation.

```
ch1>FUNCT<ch2
|A |(+)/2 |B |
```

The following calculation functions are available:

- Difference: `Y = CH1 – CH2`
- Sum: `Y = CH1 + CH2`
- (+)/2: `Y= (CH1 + CH2)/2`

Confirm your selection by pressing **ENTER**.

8.7.3 Output Options for a Calculation Channel

```
Output Options
For Channel   Y:
```

In the program branch `OUTPUT OPTIONS`, select a calculation channel.

Confirm by pressing **ENTER**.

```
Physic. Quant.
Mass Flow
```

Select the physical quantity to be calculated.

Confirm by pressing **ENTER**.

Make sure that the selected quantity of measurement can be calculated out of the quantities of measurement of the two input channels selected for the calculation function. Table 8.1 shows which combinations are possible.

Table 8.1: Measuring quantity for the calculation channel

Measuring quantity of the calculation channel	**Possible physical quantity of the first input channel (CH1)**				**Possible physical quantity of the second input 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: *You wish to determine the difference of the volume flow rates of the channels A and B. The physical quantity of measurement of channel A can be the volume flow or the mass flow, but not the flow velocity. The physical quantity of measurement of channel B can also be the volume flow or the mass flow. The quantities of measurement of the two input channel do not have to be identical (channel A = mass flow; channel B = volume flow).*

Example 2: *For determining the heat flow difference, the physical quantity of measurement must be the heat flow for both input channels A and B.*

```
Mass in:
kg/h
```

Select the measuring units.

Confirm by pressing **ENTER**.

```
+Cut-off Flow
     1.00   kg/h
```

Two cut-off values can be defined for each calculation channel. The cut-off value is defined in the unit selected for the quantity of measurement of the calculation channel.

```
-Cut-off Flow
    -2.00   kg/h
```

`+CUT-OFF FLOW`: All positive calculated values falling below this threshold will be set to zero.

`-CUT-OFF FLOW`: All negative calculated values rising above this threshold will be set to zero.

```
Store Meas. Data
>NO<       yes
```

If you wish, you can now activate the storage of measuring data.

Confirm your selection by pressing **ENTER**.

8.7.4 Measuring with Calculation Channels

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

Select the program branch `MEASURING`.

Confirm by pressing **ENTER**.


```
CHANN: A B>Y>Z
Measur √ √ √ -
```

Activate the desired channels. Calculation channel can be activated and deactivated in the same way as physical channels (see section 6.1).

Confirm by pressing **ENTER**.

```
WARNING! CHANNEL
     B:INACTIVE!
```

If you didn't activate a certain physical channel although you had selected it as input channel of an activated calculation channel, a warning appears.

Confirm this message by pressing **ENTER**.

Proceed to positioning of the transducers for all activated physical channels. The measurement will automatically start after this procedure.

```
Y: Volume Flow
   -53.41   m3/h
```

When a calculation channel has been activated, EESIFLO automatically switches to HumanMux mode at the beginning of the measurement (see section 7.2) and displays the values of the calculation channel. If you switch to AutoMux mode, the measured values of the different physical channels (and not of the calculation channels) will be displayed alternately.

```
Y: A - B
   -53.41   m3/h
```

To display the calculation function, press on key DISP 9.

Press on key NEXT 7 to display the measuring results of the different channels.

8.8 Limit Values for the Transducer Parameters

It is possible to modify the value of the minimal pipe inner diameter accepted by EESIFLO for a certain type of transducer. This setting is cold-start resistant.

```
DNmin Q-Sensor
      25      mm
```

Enter the HotCode **071001**.

Enter for the different sensor types (S, Q, M) the minimal pipe inner diameter EESIFLO should accept. Values between 3 mm and 63 mm are accepted.

Confirm each value by pressing **ENTER**.

9 Storage and Output of Measured Values

To have the data measured by the instrument stored in the internal data logger, activate the storage function as described in section 9.1.1. Following data will be stored:

- Date
- Time
- Identification of the measuring point
- Pipe parameters
- Medium parameters
- Transducer parameters
- Sound path (reflection or diagonal)
- Transducer distance
- Damping factor
- Storage rate
- Quantity of measurement
- Unit of measurement
- Measured values
- Values of the totalizers
- Values of the activated process inputs (if any)

The stored data can be transmitted to a PC later (**offline output**, see section 9.2.1).

It is also possible to send the measured data to a PC (**online output**) directly during the measurement, without saving it. This function is described in section 9.2.2.

You will find information about the memory's capacity in section 9.5.

Note!	Per default, EESIFLO emits an acoustic signal every time a measured value is stored. This signal can be deactivated, see section 9.4.6.

9

9.1 Measuring with the Storage Function

9.1.1 Activating/Deactivating the Storage Function

```
Output Options ⇳
For Channel   A:
```

Select the `OUTPUT OPTIONS` program branch of the channel for which you want to activate the storage function.

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
Store Meas. Data
 no        >YES<
```

Confirm the already selected options of the program branch by pressing **ENTER** until you reach the `STORE MEAS. DATA` display.

Select `YES` to activate the storage function.

Confirm by pressing **ENTER**.

You must now set the storage rate as described in section 9.1.2.

9.1.2 Setting the Storage Rate

The storage rate is the frequency at which EESIFLO outputs or stores the measured values. It is used for storing the measured data and for the serial output in online mode, and can be set for each measuring channel independently.

Note:	If you don't set the storage rate, the default rate or the last rate selected will be used.

Note:	If whether the storage of measured values nor the serial output is activated, EESIFLO will omit the display group `OUTPUT OPTIONS` \ `STORAGE RATE`.

Note:	The storage interval in seconds should be at least equal to the number of activated measuring channels. (When 2 measuring channels are activated, the storage rate for a channel should be at least 2 seconds.)

```
Output Options  ⇳
For Channel   A:
```

Select the `OUTPUT OPTIONS` program branch of the channel for which you want to set the storage rate.

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
Storage Rate    ⇳
once per 10 sec.
```

In the `STORAGE RATE` display, select one of the suggested storage rate. If the desired rate doesn't appear, select `EXTRA`, press **ENTER** and enter the storage rate manually. Values between 1 and 43200 seconds (12 hours) are accepted.

Confirm by pressing **ENTER**.

9.1.3 Identification of the Measuring Point

At the beginning of measurement, EESIFLO will now ask you to identify the measuring point. There are two input modes: text mode (example: ´MS.PK20!´) and numerical mode (decimal point and/or slash are also permitted, example: 18.05-06). The input mode can be set in the program branch `SPECIAL FUNCTION` (see section 12.2.3).

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

Enter the measuring point designation.

If the arrows appear, the ASCII input mode has been selected. If not, only numbers, decimal point and dash can be entered.

Confirm by pressing **ENTER**.

When the measurement is started, EESIFLO will store the designation and the parameters of the measuring point together with the measured values.

9.1.4 Measurement

```
DATA MEMORY
OVERFLOW       !
```

When measuring with activated storage function, this error message will appear in case of a memory overflow. Confirm the message by pressing **ENTER**.

Attention:	EESIFLO will interrupt measurement if the internal memory is full and no other output option as storing has been activated! If another output option (serial output, process output, etc.) has been activated, EESIFLO won't interrupt measurement. Only the storage of measured data will be stopped. The error message `DATA MEMORY OVERFLOW` appears periodically.

9.2 Output of the Measured Values

9.2.1 Offline Output

Offline output is the output of the measured values stored in the memory. The data can be transmitted:

- to a printer connected with the serial interface of EESIFLO
- or as ASCII-file to a terminal program (e.g. *HyperTerminal* under *Windows*).

Select the `SPECIAL FUNCTION` program branch. Confirm this by pressing **ENTER**. Scroll through the list until you reach the `PRINT MEAS VAL` option.

```
Special Funct.  ⇳
Print Meas.Val.
```

Confirm your selection by pressing **ENTER**.

```
NO DATA        !
Print Meas.Val.
```

This error message appears if no measured values are stored.

Confirm by pressing **ENTER**.

```
Send HEADER   01
................
```

Connect EESIFLO with a PC or a serial printer. Press **ENTER** to start the output of the stored measured values. The display indicates that the measured values are being transmitted.

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

This error message indicates that there is a problem with the serial communication.

Confirm by pressing **ENTER**. Check connections and make sure that the connected instrument is ready to receive data.

```
■■■■■■
................
```

The displayed bar graph informs you of the progress of the data output.

EESIFLO transfers the data in the format described in section 9.2.3.

9.2.2 Online Output

The output of measured values may also be realized directly (online) during measurement. The measured data won't be stored unless you additionally activate the storage function.

Connect EESIFLO with a PC or a serial printer. Select the `OUTPUT OPTIONS` program branch. Confirm this by pressing **ENTER**. Select the channel for which you want to activate the online output. Work yourself through the scroll list, confirming the already selected options by pressing **ENTER**, until you reach the `SERIAL OUTPUT` option.

```
Serial Output
 no        >YES<
```

Select `YES` to activate the online output of the measured data. Confirm by pressing **ENTER**. If you don't set the storage rate (see section 9.1.2), the default rate or the last rate selected will be used.

EESIFLO transfers the measured data via the serial interface in the format described in section 9.2.3. The measuring point query is activated (see section 9.1.1). An acoustic signal is emitted every time a measured value is transmitted (this signal can be deactivated, see section 9.4.6).

9.2.3 Format of the Output

The parameter record is transmitted at the beginning of measurement, then the line "/DATA", followed by a line describing the contents of the columns of the table to come. The measured values are transmitted afterwards.

One data line is transmitted per storage interval (the storage rate can be set individually for each channel) and per activated measuring channel. The dummy line '???' will be transmitted in case no measured values are available for that storage interval.

Example: With a storage rate of 1 s, 10 dummy lines will be transmitted when the measurement is restarted after an interruption of 10 seconds for positioning the transducers.

EESIFLO can transmit the columns given in the table below.

Table 9.1: Format of the serial output

Column title	Column format	Contents
...		Measuring channel
*MEASURE	###000000.00	Quantity of measurement selected in OUTPUT OPTIONS
Q_POS	+00000000.00	Value of the totalizer for the positive flow direction
Q_NEG	-00000000.00	Value of the totalizer for the negative flow direction
FQ_POS		Value of the volume flow totalizer for the positive flow direction (if HEAT FLOW is selected as quantity of measurement)
FQ_NEG		Value of the volume flow totalizer for the negative flow direction (if HEAT FLOW is selected as quantity of measurement)
T1	###000.0	Temperature T1 (if HEAT FLOW is selected as quantity of measurement, this will be the inflow temperature)
T2	###000.0	Temperature T2 (if HEAT FLOW is selected as quantity of measurement, this will be the outflow temperature)
...		Name of other process inputs
SSPEED		Sound velocity of the medium
KNZ		Concentration in mass percent
AMP		Signal amplitude

Online output (output during measurement)

In ONLINE mode, columns will be generated for all quantities which may be output during measurement. The columns Q_POS and Q_NEG will be empty if the totalizer function has not been activated. Since no totalizer can be enabled for the measuring quantity ‘flow velocity’, no columns for total values will be generated.

Offline output (output of stored measured values)

In OFFLINE mode, columns will only be generated if at least one measured value was stored in the respective data set. The columns Q_POS and Q_NEG are not generated if the totalizer function was not enabled.

Transmission parameters

RS232: 9600 bits per second, 8 data bits, even parity, 2 stop bits, protocol (RTS/CTS)

EESIFLO sends CRLF-terminated ASCII.

Maximal line length: 255 characters.

9.2.4 Settings of the Output

Some format settings of the serial output can be edited in the program branch SPECIAL FUNCTION \ SYSTEM SETTINGS \ SERIAL TRANSMIS. This makes it possible for you to adapt the output depending on whether the data is being sent to a PC or transmitted to a serial printer.

Table 9.2: Settings of the serial output

	TARGET: PC	TARGET: External printer
SER:kill spaces off >ON<	When ON is selected, space characters will not be transmitted. In this way, the file size can be considerably reduced (i.e. shorter transmission time).	Select OFF in order to have all values of a column printed below another.
SER:decimalpoint '.' >','<	Decimal separation to be used for floating point variables (point or comma). Country-specific setting.	Country-specific setting.
SER:col-separat. ';' >'TAB'<	Character to be used for separating columns (semicolon or tabulator). Setting depends on the requirements of the PC program.	TAB increases the total width of a line depending on how the tabulator is set on the printer.

9.3 Deletion of the Stored Data

With this special function, the stored measured values can be deleted. Select the SPECIAL FUNCTION program branch. Confirm this by pressing **ENTER**.

```
Special Funct.  ⇳
Delete Meas.Val.
```

Scroll through the list until you reach the DEL MEAS VAL option.

Confirm by pressing **ENTER**.

```
Really Delete?
 no        >YES<
```

To avoid accidental deletion of data, EESIFLO asks for confirmation to make sure you really want to delete the stored measured values.
Confirm your selection by pressing **ENTER**.

9.4 Settings of the Storage Function

Available options are the storage mode, storage of both totalizers, storage of the measured sound velocity, of the concentration and of the amplitude.

Select the SPECIAL FUNCTION program branch. Confirm this by pressing **ENTER**. Select the SYSTEM SETTINGS in the scroll list. Press **ENTER**. Select the STORING option in the scroll list.

Note:	All settings of the storage function are coldstart resistant.

9.4.1 Storage Mode

```
Storage Mode
>SAMPLE< average
```

Select the storage mode (SAMPLE or AVERAGE).

In SAMPLE mode, EESIFLO uses the instantaneous measured value for storage and online output.

In AVERAGE mode, EESIFLO will use the calculated mean of the measured values of a storage interval for storage and online output.

Confirm your selection by pressing **ENTER**.

Important

- The storage mode does not influence the continuously operating process interfaces (e.g. current loop, voltage output...).
- In AVERAGE mode, all primary measuring quantities are averaged, i.e. also the measured temperatures if the respective measuring channel are activated.
- In case no mean value could be calculated over the complete storage interval while the unit was in AVERAGE mode, the mean value for this interval will be marked as invalid. In the ASCII file with the stored measured values, ´???´ will appear for invalid mean values and the associated quantity of measurement, and ´?UNDEF´ for invalid temperatures. There will be no indication of how many momentary measured values a valid mean value consists of.

9.4.2 Storage of the Totalizers

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

In the SPECIAL FUNCTION \ SYSTEM SETTINGS \ STORING program branch, select the QUANTITY STORAGE entry.

```
Quantity Storage
 one      >BOTH<
```

Select ONE if EESIFLO should only store the displayed totalizer. Select BOTH to enable storage of the totalizer value in function of the flow direction.

Confirm by pressing **ENTER**.

Important:

- EESIFLO will store the totalizers only if they are activated and the storage function enabled.
- The storage of one totalizer approx. reduces by two thirds the total number of measured values which can be internally logged.

  Example:
  In the program branch SPECIAL FUNCTION, EESIFLO shows that 10,000 measured values can still be stored. If the totalizers are activated and only one total value is logged, 3,333 data fields are available for storage. If both total values are saved, 2,000 data storage operations can be made.

9.4.3 Storage of the Amplitude

In the SPECIAL FUNCTION \ SYSTEM SETTINGS \ STORING program branch, select the STORE AMPLITUDE entry.

```
Store Amplitude
 off         >ON<
```

If you select ON, EESIFLO will store the amplitude of the measured signal with the measured flow values when the storage of the measured values is activated.

Confirm by pressing **ENTER**.

9.4.4 Storage of the Sound Velocity of the Medium

In the SPECIAL FUNCTION \ SYSTEM SETTINGS \ STORING program branch, select the STORE C-MEDIUM entry.

```
Store c-Medium
 off         >ON<
```

If you select ON, EESIFLO will store the measured sound velocity of the medium with the measured flow values when the storage of the measured values is activated.

Confirm by pressing **ENTER**.

9.4.5 Storage of the Measured Concentration

In the SPECIAL FUNCTION \ SYSTEM SETTINGS \ STORING program branch, select the STORE CONCENTR. entry.

```
Store Concentr.
 off         >ON<
```

If you select ON, EESIFLO will store the measured concentration with the measured flow values when the storage of the measured values is activated.

Confirm by pressing **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. This signal can be deactivated in the BEEP ON STORAGE display of the SPECIAL FUNCTION \ SYSTEM SETTINGS \ STORING program branch.

```
Beep on storage
>OFF<          on
```

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

Confirm by pressing **ENTER**.

9

9.5 Available Memory

```
FULL=26.01/07:39
    54.5    m3/h
```

The date and time at which the memory will be full can be displayed during the measurement.

Press key DISP **9** one or several time to scroll through the different displays of the first line while measurement is going on.

EESIFLO can store a **maximum of 100 measuring data sets**. The number of data sets that can be created depends on the total number of measured values stored in the precedent data sets.

When all stored measured values have been deleted and a new measurement is started with only one quantity of measurement on one channel and no totalization, **approx. 27,000 measured values** can be stored in the data set of that measurement.

Proceed as follows to find out how much memory is still available for storage.

```
Special Funct.  ⇕
Instrum. Inform.
```

Select SPECIAL FUNCTION \ INSTRUM. INFORM. Confirm by pressing **ENTER**.

```
EESXXXX-00000999
FREE:      18327
```

The type designation and the factory number of your instrument are given on the first line.

The memory still available for data storage is given on the second line. Here: 18,327 measured values can still be stored.

Press two times **ENTER** to return to the SPECIAL FUNCTION program branch.

10 Working with Parameter Records

10.1 Introduction

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

- the pipe parameters,
- the transducer parameters,
- the medium parameters
- and the output options.

Working with parameter records will make repeated measurement tasks easier and faster. EESIFLO can store up to 14 different parameter records. The use of these records is described in section 10.2.

The software option **ParaPool** described in section 10.3 enables you to store up to 80 short records in an independent memory location under a specific name and ID number. A short records contains the main pipe and media parameters.

Note:	A new instrument contains no parameter records. Parameter records must be entered manually.

```
Parameter from: ⇳
Par.Record    01
```

When at least a long parameter record has been created, this display will appear after selection of the `PARAMETER` program branch of a measuring channel.

```
Measur.Params.
load from Nr  #03
```

If the ParaPool option is activated and no long parameter record has been created, the opposite display will appear.

If the ParaPool option is not activated, you can:

- select a parameter record to be loaded and edited or
- select `CURRENT RECORD` to edit the current parameters as usual.

If the ParaPool option is activated, you can:

- select a parameter record to be loaded and edited or
- select `CURRENT RECORD`, select a short record to be loaded and edited or
- select `CURRENT RECORD`, press key **0** or **–** and confirm with **ENTER** to edit the current parameters as usual.

10.2 Working with Long Parameter Records

10.2.1 Saving Parameters in a Parameter Record

The parameters that you wish to save in a parameter record must first be entered in the `PARAMETER` program branch. Afterwards, the parameters can be stored in a parameter record.

```
Special Funct.  ⇳
Store Curr.Rec.
```

In the program branch SPECIAL FUNCTION, select the STORE CURRENT RECORD option.

Confirm by pressing **ENTER**.

```
NO PARAMETER
Store Curr.Rec.
```

If this error message appears, no complete parameter set exists. Storing is impossible. Return to the program branch PARAMETER and enter the missing parameters.

```
Store Par. to:  ⇳
Par.Record    01
```

The display STORE PAR. TO: appears and offers a choice of 14 parameter records (PAR.RECORD 01 to PAR.RECORD 14). Select a parameter record.

Confirm by pressing **ENTER**.

```
Overwrite
 no        >YES<
```

If parameters are already saved in the selected parameter record, EESIFLO asks if you want to overwrite them. Select YES to overwrite the parameters or NO to select another parameter record.

Confirm by pressing **ENTER**.

10.2.2 Loading Parameter Records

Parameter records stored in memory can be easily loaded and used for measurement.

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

Select the program branch PARAMETER and press **ENTER**.

```
Parameter       ⇳
For Channel   A:
```

Select the channel on which you want to load a parameter record.

Confirm by pressing **ENTER**.

```
Parameter from: ⇳
Par.Record    01
```

In the next display, select the parameter record to be loaded.

Confirm by pressing **ENTER**.

```
Edit Parameters
>NO<         yes
```

Select YES if you wish to edit the parameters of the selected record.

If you select NO, the main menu is displayed and you can start measuring.

Confirm by pressing **ENTER**.

10.2.3 Deletion of Parameter Records

```
Special Funct.  ⇕
Delete Par.Rec.
```

In the program branch `SPECIAL FUNCTION`, select the `DELETE PAR. REC.` option and press **ENTER**.

```
NO PAR. STORED !
Delete Par.Rec.
```

If no parameter records have been stored, an error message will appear.

Confirm by pressing **ENTER**.

```
Delete:         ⇕
Par.Record    01
```

If parameter records have been stored, the display `DELETE` appears. Scroll through the list of parameter records and select the one you wish to delete.

Confirm by pressing **ENTER**.

```
Really Delete?
 no        >YES<
```

To avoid accidental deletion of data, EESIFLO asks for confirmation to make sure you really want to delete the selected parameter record.

Confirm your selection by pressing **ENTER**.

10.3 The ParaPool Option

10.3.1 Features

If the ParaPool option is enabled, 80 memory locations are available for saving a selection of the measuring point parameters (short record). Each short record can get a 12-digit name. The stored data can be recalled by entering the identification number of the short record in the program branch `PARAMETER`.

10

A short record contains the following data for a measuring point:

- the name of the measuring point,
- the outer diameter of the pipe,
- the wall thickness of the pipe,
- the pipe material,
- the lining material (if existing),
- the liner thickness (if existing),
- the inner roughness of the pipe,
- the medium flowing in the pipe,
- the approximate temperature of the medium.
- Stored parameters can be transferred into the actual parameter record (see section 10.3.3). The parameters of the actual parameter record can be stored in ParaPool (see section 10.3.4).

10.3.2 Enabling/Disabling ParaPool

Enter HotCode **007021** to enable the ParaPool query.

```
Enable ParamPool
 no        >YES<
```

In the `ENABLE PARAMPOOL` display, select `YES` to enable the ParaPool option, `NO` to disable it.

Confirm by pressing **ENTER**.

This setting is coldstart resistant.

The measuring point parameters saved in ParaPool are not affected by the disabling of the ParaPool option. They will be ready for access as soon as the ParaPool option is enabled again.

10.3.3 Loading and Editing Short Records

The parameters saved in short records must be loaded before they can be edited and used for measurement.

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

Select the program branch `PARAMETER`.

Confirm by pressing **ENTER**.

```
Parameter       ⇕
For Channel   A:
```

Select the channel on which you want to load a short record, then press **ENTER**.

```
Parameter from: ⇕
Current Record
```

This display will only appear if parameter records have been stored. In this case, select `CURRENT RECORD`.

Confirm by pressing **ENTER**.

```
Measur.Params.
load from Nr  #03
```

Enter the ID number (1 to 80) of the short record to be loaded.

Confirm by pressing **ENTER**.

```
#03:INVALID DATA
>AGAIN<  contin
```

If this display appears, the selected short record is empty or contains invalid data. Select `AGAIN` to repeat the input of an identification number.

Confirm by pressing **ENTER**..

```
#01:ABC(41)
 edit  >MEASURE<
```

Select `EDIT` if you wish to edit the loaded parameters or select `MEASURE` to start measurement immediately.

Confirm by pressing **ENTER**.

If you have selected `EDIT`, edit the parameters now.

```
Save Meas.Params
as Nr. #01
```

At the end of the edition of the loaded parameters, EESIFLO asks you under which ID number the edited parameters must be stored.

Enter an ID number (1 to 80).

Confirm by pressing **ENTER**.

```
#01:Overwrite
 no         >YES<
```

If parameters are already saved in the selected short record, EESIFLO asks if you want to overwrite them. Select `YES` to overwrite the parameters or `NO` to enter another ID number.

Confirm by pressing **ENTER**.

```
Input name
#01: _
```

Enter a name for the short record.

Confirm by pressing **ENTER**.

The parameters are saved under the selected ID number.

Note:	The record name can be entered in alphanumerical mode or in numerical mode. See section 12.2.3.

10.3.4 Saving Parameters in a Short Record

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

Select the program branch PARAMETER.

Confirm by pressing **ENTER**.

```
Parameter       ⇕
For Channel   A:
```

Select the channel which parameters you want to save in ParaPool.

```
Parameter from: ⇕
Par.Record    09
```

This display will only appear if long parameter records have been stored.

If you want to load the parameters stored in a long parameter record and save them in a short record, select that parameter record now.

Otherwise, select CURRENT RECORD and press **ENTER**.

```
Edit parameters
 no        >YES<
```

This display will appear if you have selected a parameter record in the previous step. Select YES to edit the loaded parameters before saving, or NO to save without edition.

```
Measur.Params.
load from Nr  #03
```

If the parameters you want to save in a new record are already saved in a short record, enter the ID number of that record now, then press **ENTER**. The parameters of the selected record will be loaded.

If you wish to save the current parameters of the previously selected channel in a short record, press **0** and confirm with **ENTER**, then edit the current parameters.

```
#03:INVALID DATA
>AGAIN<  contin
```

If this display appears, the selected short record is empty or contains invalid data.

Select AGAIN to repeat the input of an identification number.

If you select CONTIN., the current parameters are displayed for edition and can later be saved in a short record.

Confirm by pressing **ENTER**.

10

```
Save Meas.Params
as Nr. #03
```

At the end of the edition of the loaded parameters, EESIFLO asks you under which ID number the edited parameters must be stored.

Enter an ID number (1 to 80).

Confirm by pressing **ENTER**.

```
#01:Overwrite
 no        >YES<
```

If parameters are already saved in the selected short record, EESIFLO asks if you want to overwrite them. Select `YES` to overwrite the parameters or `NO` to enter another ID number.

Confirm by pressing **ENTER**.

```
Input name
#01: _
```

Enter a name for the short record.

Confirm by pressing **ENTER**.

The parameters are saved under the selected ID number.

Note:	The record name can be entered in alphanumerical mode or in numerical mode. See section 12.2.3.

11 Libraries

The internal data bank of the instrument contains the properties of more than 20 different materials (pipe material, lining) and more than 40 different media. It is possible to select the materials and fluids displayed in the selection lists of the program branch PARAMETER (pipe material, lining, medium). You can thus adapt the list to your specific measuring tasks and the shorter selection lists make your work more efficient (see section 11.1.1).

An integrated coefficient storage (user area) allows you to define new materials and media. If necessary, the properties of these new materials and media can be defined as temperature-dependent or pressure-dependent polynomials. The coefficient storage can be partitioned as you like. For more information about user materials and media, see section 11.2.

11.1 Editing the Selection Lists

The procedures for the edition of the material and of the media selection list are the same. We describe here the edition of the material selection list.

Note:	User materials and media are always displayed in the selection lists of the program branch PARAMETER.

```
Special Funct.  ⇳
SYSTEM settings
```

In the program branch SPECIAL FUNCTION, select the option SYSTEM SETTINGS and press **ENTER**.

```
SYSTEM settings ⇳
Libraries
```

In the SYSTEM SETTINGS scroll list, select the option LIBRARIES and press **ENTER**.

```
Libraries       ⇳
Material list
```

Select MATERIAL LIST to edit the material selection list or MEDIUM LIST to edit the medium selection list.

Select GO BACK to return to the SYSTEM SETTINGS.

Confirm you selection by pressing **ENTER**.

```
Material list
 factory  >USER<
```

Select FACTORY if all materials/media of the internal data bank should appear in the selection lists. An already existing selection list will not be deleted but only deactivated.

Select USER to activate the user-defined selection list.

Confirm by pressing **ENTER**.

```
Material list   ⇳
>Show list
```

If USER has been selected, you now have the possibility to edit the selection list. The options of the scroll list are described in section 11.1.1 to 11.1.5.

```
Material list   ⇳
>End of Edit
```

After edition, select END OF EDIT and press **ENTER**.

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```
Save list      ?
 no        >YES<
```

Select YES to save all changes made in the selection list or NO to leave the edition menu without saving.

Confirm by pressing **ENTER**.

Note:	If you quit the edition menu with **BRK** before saving, all changes will be lost.

11.1.1 Displaying a Selection List

```
Material list  ⇳
>Show list
```

Select SHOW LIST and press **ENTER** to display the selection list as it would appear in the program branch PARAMETER.

```
Current list=  ⇳
>Carbon Steel
```

The current selection list is displayed as a scroll list on the second line of the screen. User materials/media are always part of the current user-defined selection list.

```
Current list=  ⇳
>Other Material
```

Press **ENTER** to leave the current selection list and return to the selection list edition menu.

11.1.2 Adding a Material/Medium to the Current List

```
Material list  ⇳
>Add Material
```

To add a material/medium to the current selection list, select ADD MATERIAL or ADD MEDIUM.

Confirm by pressing **ENTER**.

```
>Add Material  ⇳
Rubber
```

EESIFLO displays as a scroll list on the second line all materials/media which are not in the current selection list.

Select the material/medium to be added and press **ENTER**. The material/medium is added to the selection list.

Note:	The materials/media will appear in the list in the order in which they have been added.

11.1.3 Deleting a Material/Medium from the Current List

```
Material list  ⇳
>Remove Material
```

To remove a material or a medium from the selection list, select REMOVE MATERIAL or REMOVE MEDIUM.

```
>Remove Materia ⇳
Rubber
```

EESIFLO displays as a scroll list on the second line all materials/media of the current selection list.

Select the material/medium to be removed and press **ENTER**. The material/medium is deleted from the selection list.

Note:	User materials/media are always part of the current user-defined selection list. They cannot be deleted.

11.1.4 Deleting all Materials/Media from the Current List

```
Material list   ⇳
>Remove all
```

Select `REMOVE ALL` and press **ENTER** to remove all materials/media from the current selection list. Used-defined materials and media will not be removed.

Note:	User materials/media are always part of the current user-defined selection list. They cannot be deleted.

11.1.5 Adding all Materials/Media to the Current List

```
Material list   ⇳
>Add all
```

Select `ADD ALL` and press **ENTER** to add all materials/media of the internal data bank to the current selection list.

11.2 Defining New Materials and Media

It is possible to add self-defined materials or media ("user materials" or "user media") to the internal data bank. These entries are stored in the coefficient storage ("user area").

The number of user materials/media that can be defined depends on the partitioning of the user area (see section 11.2.1). The user materials/media will appear in the selection lists of the program branch `PARAMETER`. The storage of user defined materials and media is cold-start resistant and remains active even if the unit has been switched off.

The basic properties of a medium are its maximal and minimal sound velocities, its viscosity and its density. The basic properties of a material are its transversal and longitudinal sound velocities and its typical roughness. If the Extended Library function is activated, you can additionally define the heat flow coefficients, steam coefficients and concentration coefficients as additional properties of a medium as well as temperature or pressure dependent properties for materials or media. You will find more information about the Extended Library function in section 11.2.2.

Note:	The user area must be partitioned before any data can be stored.

11.2.1 Partitioning the User Area

The capacity of the user area can be parted as you like among the following data set types:

- Basic data of a material (sound velocity, typical roughness)
- Basic data of a medium (sound velocities, kinematic viscosity, density)
- Heat flow coefficients

- Steam coefficients
- Concentration coefficients

The maximal number of data sets for each of these categories are given in Table 11.1.

Table 11.1: Capacity of the user area

	Maximal number of data sets	Corresponding occupancy of the user area in %
Materials	13	97
Media	13	95
Heat flow coefficients	29	98
Steam coefficients	19	95
Concentration coefficients	14	98

Table 11.2: Examples for different partitions of the user area

	Number of data sets					
Materials	3	3	5	5	5	2
Media	3	5	4	3	3	8
Heat flow coefficients	3	12	2	2	3	2
Steam coefficients	3	0	2	2	3	2
Concentration coefficients	3	0	2	3	2	1
% of user area used	**96**	**100**	**98**	**97**	**99**	**97**

```
Libraries          ⇳
Format USER-AREA
```

In the `SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ LIBRARIES` program branch, select the entry `FORMAT USER-AREA`.

Confirm by pressing **ENTER**.

```
MAXIMAL   : 13   !
Materials:     15
```

In the following, a message will be displayed if the selected number of data sets for a certain type of data would overflow the capacity of the user area.

```
Format USER-AREA
Materials:      03
```

Enter the wanted number of user materials.

Confirm by pressing **ENTER**.

```
Format USER-AREA
Media:          03
```

Enter the wanted number of user media.

Confirm by pressing **ENTER**.

```
Format USER-AREA
Heat-Coeffs:    03
```

Enter the wanted number of data sets for heat flow coefficients. Heat flow coefficients can only be defined when your instrument is equipped with temperature inputs.

Confirm by pressing **ENTER**.

```
Format USER-AREA
Steam-Coeffs:  03
```

Enter the wanted number of data sets for steam coefficients. Steam coefficients can only be defined when your instrument is equipped with temperature inputs.

Confirm by pressing **ENTER**.

```
Format USER-AREA
Concentrat.:   03
```

Enter the wanted number of data sets for concentration coefficients. Concentration coefficients can only be defined when your instrument is equipped with temperature inputs.

Confirm by pressing **ENTER**.

```
USER-AREA:
       96% used
```

EESIFLO displays for a few seconds the occupancy of the user area for the selected partition.

```
Format NOW?
 no        >YES<
```

EESIFLO asks for confirmation of the selected partition. Select `YES` to proceed to partitioning.

Confirm by pressing **ENTER**.

```
FORMATTING...
■■■■■■...
```

EESIFLO formats the user area according to your inputs. This procedure takes a few seconds.

```
Libraries       ⇳
Format USER-AREA
```

Once the formatting is finished, EESIFLO will return to the `FORMAT USER-AREA` display.

Keeping Data during Formatting of the User Area

When reformatting the user area, EESIFLO can keep up to 8 data sets of each type.

Example 1: You reduce the number of user materials from 5 to 3. The data sets #01 to #03 are kept. The last two data sets #04 and #05 are deleted.

Example 2: You increase the number of user materials from 5 to 6. All 5 data sets are kept.

11.2.2 Extended Library Function

The Extended Library function allows you to enter heat flow coefficients, steam coefficients and concentration coefficients as additional property of a media as well as temperature or pressure dependent properties. The function has to be activated in the `SPECIAL FUNCTIONS` program branch before defining a material or medium with such properties.

User-defined data can be entered either using the keyboard or using the software ***FluxKoef*** for editing and transferring the data from your PC to the flowmeter (possible only if the latter is equipped with a RS232 or RS485 interface).

The following table gives an overview of the properties that can be entered and what they are needed for.

Table 11.3: Medium and material properties that can be stored

Property	Property is necessary for...
Basic data of a medium	
sound velocity (MIN and MAX)	start of measurement
viscosity	profile correction of the flow velocity
density	mass flow rate calculation
Additional data for a medium	
heat flow coefficients	heat flow rate measurement
steam coefficients	heat flow rate measurement when steam in inflow
concentration coefficients	concentration measurement
Basic data of a material	
transversal sound velocity	flow measurement
longitudinal sound velocity	wall thickness measurement and/or flow measurement
type of sound wave to be used	flow measurement
typical roughness	profile correction of the flow velocity

Enter only those properties which are relevant for your measuring task.

Example: The density of a medium is unknown. If the mass flow rate is not of interest, you may set the density to any constant value. The measurement of flow velocity and volume flow rate is not affected by this. However, the value of the mass flow rate will be wrong.

The dependency of certain properties on process quantities (temperature, pressure) can be described by polynomials of grade 0 to 4 or by other specialized interpolation functions. In most cases although, constant values or a linear dependency are quite sufficient. For instance, if the temperature fluctuations at the measuring point are small compared with the temperature dependencies of the properties, considering a linear dependency or completely neglecting the temperature dependency will not result in a considerable additional measuring error. If the process conditions fluctuate strongly and the properties of the involved materials/media have a pronounced temperature dependency (as the viscosity of hydraulic oils for example), polynomials or other specialized functions should be used for the interpolation.

In case of doubt, consult EESIFLO to find the best solution for your specific measuring task.

Specialized Interpolations

Some dependencies are approximated in an unsatisfactory way by polynomials. EESIFLO offers some specialized interpolation functions (option "`Basics:Y=f(x,z)`"). Multidimensional dependencies (y=f(T,p)) can also be approximated with these specialized functions.

Contact EESIFLO for further information about specialized interpolations.

```
Libraries          ⇕
Extended Library
```

In the `SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ LIBRARIES` program branch, select the entry `EXTENDED LIBRARY`.

Confirm by pressing **ENTER**.

```
Extended Library
 off          >ON<
```

Select `ON` if you wish to enter additional properties of the media/materials or temperature or pressure dependent properties.

Select `OFF` to disable the Extended Library function. You can then enter basic material and media properties only as constants. The installation of a user medium/material will require only a few keystrokes. The library will be compatible to firmware version V3.xx.

Confirm by pressing **ENTER**.

11.2.3 Input of Material/Media Properties without the Extended Library Function

If you do not wish to define temperature or pressure dependent material or medium, the extended library function should be disabled (see section 11.2.2). The procedures for the input of material and medium properties are the same.

```
Special Funct.  ⇳
Install Material
```

In the program branch `SPECIAL FUNCTION` select `INSTALL MATERIAL` or `INSTALL MEDIUM` and press **ENTER**.

```
USER Material
NOT FORMATTED  !
```

An error message appears in case you did not reserve data sets for user materials or user media when formatting the user area. In this case, partition the user area according to your needs (see section 11.2.1).

```
Install Material
>EDIT<   delete
```

Select `EDIT` and press **ENTER**.

```
USER MATERIAL   ⇳
#01:--not used--
```

Select one of the available memory locations.

Confirm by pressing **ENTER**.

```
EDIT TEXT(↑↓←→)
USER MATERIAL  1
```

Default name for a user material or medium is "`USER MATERIAL N`" or "`USER MEDIUM N`", with `N` an entire number. This designation can be modified now.

Note:	There are 95 ASCII-characters (letters, capital letters, numbers, special characters [! ? " + - ( ) > < % * ~ etc.] available for the designation of your material/medium, with a maximum of 16 characters per designation. The input of text is described in section 4.2.


```
EDIT TEXT(↑↓←→)
Polystyrene
```

Press **ENTER** when the edition of the designation is finished.

FOR A MATERIAL:

```
c-Material
    1590.0   m/s
```

EESIFLO asks for the sound velocity of the material. Table B . 1 of Appendix B gives the sound velocities of some materials. Values between 600.0 and 6553.5 m/s are accepted.

Confirm by pressing **ENTER**.

```
Roughness
       0.4    mm
```

Enter the roughness of the pipe, taking into consideration the state of the pipe. Table B . 2 of Appendix B gives typical roughness values of pipes.

Confirm by pressing **ENTER**.

FOR A MEDIA:

```
c-Medium     MIN
    1400.0   m/s
```

Enter the minimum value of the sound velocity (in m/s) for the medium you want to measure. Values between 800.0 and 3500 m/s are accepted.

Confirm by pressing **ENTER**.

```
c-Medium     MAX
    1550.0   m/s
```

Enter the maximum value of the sound velocity (in m/s) for the medium you want to measure. Values between 800 and 3500 m/s are accepted.

Confirm by pressing **ENTER**.

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

Enter the kinematic viscosity of the medium. Values between 0.01 and 30,000.00 mm^2/s are accepted.

Confirm by pressing **ENTER**.

```
Density
     1.00  g/cm3
```

Enter the density of the medium.

Confirm by pressing **ENTER**.

11.2.4 Input of Material Properties with the Extended Library Function

Make sure the Extended Library function is activated (see section 11.2.2).

```
Special Funct.  ⇳
Install Material
```

In the program branch `SPECIAL FUNCTIONS`, select `INSTALL MATERIAL` and press **ENTER**.

```
USER Material
NOT FORMATTED  !
```

An error message appears in case you did not reserve data sets for user materials when formatting the user area. In this case, partition the user area according to your needs (see section 11.2.1).

```
Edit Material   ⇳
Basics:Y=const.
```

Select the wished dependence of the properties on the temperature or pressure.

Select "`Y=const.`" to enter the properties as constants.

```
Basics:Y=m*X +n
```

Select "`Y=m*X +n`" to enter the properties as linear functions of the temperature.

```
Basics:Y=Polynom
```

Select "`Y=Polynom`" to enter the properties as polynomials $y = k_0 + k_1 \cdot x + k_2 \cdot x^2 + k_3 \cdot x^3 + k_4 \cdot x^4$.

```
Basics:Y=f(x,z)

...go back
```

Select "Y=f(x,z)" to enter the properties as one of the pre-defined functions (for experienced users or by arrangement with EESIFLO).

Select GO BACK to return to the previous menu.

```
USER MATERIAL   ⇳
#02:--not used--
```

Select the material which properties you want to define. Default name for a user material or medium is "USER MATERIAL N" or "USER MEDIUM N", with N an entire number.

```
USER MATERIAL  2
>EDIT<   delete
```

If you have selected a material which properties are already defined, EESIFLO asks for confirmation. Select EDIT to edit the properties of the material, DELETE to delete the already defined properties and return to the EDIT MATERIAL scroll list.

```
#2:Input Name:
USER MATERIAL  2
```

Enter the material designation. Press **ENTER** to confirm when finished.

You will now be requested to enter the transversal and longitudinal sound velocity of the material in m/s. Depending on the selected dependence of the material properties on the process quantities, you will have to enter one to five coefficients for each material property. Confirm each value with **ENTER**. If you are editing an already defined material, EESIFLO will ask you for each property if it should be edited. Select YES or NO and confirm by pressing **ENTER**, then edit the coefficients.

```
Default soundsp.
 long.   >TRANS.<
```

Select the kind of sound wave to be used for the flow measurement. The transversal sound wave (TRANS) is normally used.

Confirm by pressing **ENTER**.

```
Roughness
       0.4    mm
```

Enter the typical roughness of the material.

Confirm by pressing **ENTER**.

```
Save changes
 no        >YES<
```

Select YES to save the entered properties, NO to leave without saving.

Confirm by pressing **ENTER**.

11.2.5 Input of Medium Properties with the Extended Library Function

Make sure the Extended Library function is activated (see section 11.2.2).

```
Special Funct.  ⇳
Install Medium
```

In the program branch SPECIAL FUNCTIONS, select INSTALL MEDIUM and press **ENTER**.

```
USER Medium
NOT FORMATTED   !
```

An error message appears in case you did not reserve data sets for user media when formatting the user area. In this case, partition the user area according to your needs (see section 11.2.1).

```
Edit Medium      ⇕
Basics:Y=const.
```

Select the wished dependence of the properties on the temperature or pressure.

Select "Y=const." to enter the properties as constants.

```
Basics:Y=m*X +n
```

Select "Y=m*X+n" to enter the properties as linear functions.

```
Basics:Y=Polynom
```

Select "Y=Polynom" to enter the properties as polynomials $y = k_0 + k_1 \cdot x + k_2 \cdot x^2 + k_3 \cdot x^3 + k_4 \cdot x^4$.

```
Basics:Y=f(x,z)
```

Select "Y=f(x,z)" to enter the properties as one of the pre-defined functions (for experienced users or by arrangement with EESIFLO).

```
Heat-flow coeffs
```

Select HEAT FLOW COEFFS to enter the heat flow coefficients of a medium. This option won't be displayed if your instrument is not equipped with a temperature input.

```
Steam coeffs
```

Select STEAM COEFFS to enter the steam coefficients of a medium. This option won't be displayed if your instrument is not equipped with a temperature input.

```
Concentr. Coeffs
```

Select CONCENTRATION COEFFS to enter the concentration coefficients of a medium. This option won't be displayed if your instrument is not equipped with a temperature input.

```
...go back
```

Select GO BACK to return to the previous menu.

```
USER MEDIUM      ⇕
#01:--not used--
```

Select the medium which properties you want to define. Default name for a user material or medium is "USER MATERIAL N" or "USER MEDIUM N", with n an entire number.

```
USER MEDIUM     1
>EDIT<   delete
```

If you have selected a medium which properties have already been defined, EESIFLO asks for confirmation. Select EDIT to edit the properties of the medium, DELETE to delete the already defined properties and return to the EDIT MEDIUM scroll list.

```
#1:Input Name:
USER MEDIUM     1
```

Enter the medium designation. Press **ENTER** to confirm when finished.

You will now be requested to enter the longitudinal sound velocity (in m/s), the kinematic viscosity (in mm^2/s) and the density (in g/mm^3) of the medium. Depending on the selected dependence of the medium properties on the process quantities, you will have to enter one to five coefficients for each medium property. Confirm each value by pressing **ENTER**. If you are editing an already defined medium, EESIFLO will ask you for each property if it should be edited. Select YES or NO and confirm by pressing **ENTER**, then edit the coefficients.

```
Save changes
 no        >YES<
```

Select `YES` to save the entered properties, `NO` to leave without saving.

Confirm by pressing **ENTER**.

11.2.6 Input of Heat Flow Coefficients

Note:	The heat flow coefficients can also be edited with the utilities FluxKoef and FluxData.

Attention!	EESIFLO does not control the coefficients entered. Absurd coefficients can lead to absurd measured values or result in permanent numerical system errors.

```
Edit Medium     ⇕
Heat-flow coeffs
```

In the `SPECIAL FUNCTION` program branch, select the option `INSTALL MEDIUM`.

Confirm by pressing **ENTER**.

The `EDIT MEDIUM` scroll list is displayed. Select the `HEAT-FLOW COEFFS` option.

Confirm by pressing **ENTER**.

```
Heat-flow coeffs
NOT FORMATTED  !
```

An error message appears in case you did not reserve data sets for the heat flow coefficients when formatting the user area. In this case, partition the user area according to your needs (see section 11.2.1).

```
Heat-Coeffs for ⇕
BEER
```

Select the medium for which you want to enter the heat flow coefficients.

User media are displayed first, followed by the media of the internal data bank.

```
Select index    ⇕
02(--not used--)
```

Select an index for recording of the heat flow coefficients of the selected medium and press **ENTER**. If the user area was partitioned in order to enter heat coefficients for two media, the index 1 and 2 are available.

```
Heat-flow coeffs
          0.0 a0
```

Input the 10 heat flow coefficients (a0 .. a4, r0 .. r4), confirming each of them by pressing **ENTER**.

```
Heat-flow coeffs
Save?  no  >YES<
```

After the input of those coefficients, EESIFLO asks whether you wish to store the changes or not.

Confirm your selection by pressing **ENTER**.

11.2.7 Input of Steam Coefficients

Use PC-Software **FluxKoef**!

Attention!	EESIFLO does not control the coefficients entered. Absurd coefficients can lead to absurd measured values or result in permanent numerical system errors.

11.2.8 Input of Concentration Coefficients

Use PC-Software **FluxKoef**!

Attention!	EESIFLO does not control the coefficients entered. Absurd coefficients can lead to absurd measured values or result in permanent numerical system errors.

11.2.9 Deleting a User Material or User Medium

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

```
Install Material
 edit   >DELETE<
```

In the program branch `SPECIAL FUNCTION`, select `INSTALL MATERIAL` or `INSTALL MEDIUM` and press **ENTER**.

Select `DELETE` and confirm by pressing **ENTER**.

```
USER MATERIAL   ⇳
#01:Polystyrene
```

Select the user material or medium to be deleted.

Confirm by pressing **ENTER**.

```
Really Delete?
 no        >YES<
```

EESIFLO asks for confirmation. Select `YES` or `NO`.

Confirm your selection by pressing **ENTER**.

12 Settings

12.1 Setting the Internal Clock

EESIFLO features a battery buffered clock. During measurement, the data are automatically stamped with date and time.

12.1.1 Setting the Time

```
SYSTEM settings ⇕
Set Clock
```

In the program branch `SPECIAL FUNCTION`, select the `SYSTEM SETTINGS` option.

Confirm by pressing **ENTER**.

```
TIME         11:00
 ok         >NEW<
```

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

Confirm by pressing **ENTER**.

```
TIME         11:00
Set Time         !
```

Use keys **4** and **6** to select the digit to be edited.

Use keys **8** and **2** to edit the selected digit.

Confirm your setting by pressing **ENTER**.

```
TIME         11:11
>OK<          new
```

The next display shows the newly set time. Select `OK` to confirm or `NEW` to set the time again.

Confirm by pressing **ENTER**.

12.1.2 Setting the Date

```
DATE   25.01.2002
 ok         >NEW<
```

After the time has been set, the `DATE` display will appear. Select `OK` to confirm or `NEW` to set the date.

Confirm by pressing **ENTER**.

```
DATE   25.01.2002
Set Date         !
```

Use keys **4** and **6** to select the digit to be edited.

Use keys **8** and **2** to edit the selected digit.

Confirm your setting by pressing **ENTER**.

```
DATE   26.01.2002
>OK<          new
```

The next display shows the newly set date and asks for confirmation. Select `OK` to confirm or `NEW` to set the date again.

Confirm by pressing **ENTER**.

12.2 Settings for the Dialogues and Menus

```
SYSTEM settings ⇕
Dialogs/Menus
```

In the program branch SPECIAL FUNCTION, select the SYSTEM SETTINGS, then the DIALOGS/MENUS option.

Note:	EESIFLO stores the DIALOG/MENUS settings at the end of the dialogue. If you leave the program branch before the end of the dialogue, your settings won't be effective.

12.2.1 Input of the Pipe Circumference

```
Pipe circumfer.
 off       >ON<
```

ON enables you to enter the pipe circumference instead of the pipe diameter in the program branch PARAMETER.

This setting is cold-start resistant.

Confirm by pressing **ENTER**.

```
Outer Diameter
    100.0     mm
```

When the PIPE CIRCUMFERENCE option is ON, EESIFLO will still first ask for the outer diameter in the program branch PARAMETER. However, you can switch to the CIRCUMFERENCE display by entering 0 (zero) and pressing **ENTER**.

```
Pipe Circumfer.
    314.2     mm
```

The value displayed in the CIRCUMFERENCE display is calculated using the last displayed value of the outer diameter.

(For example: 100 mm x π = 314.2 mm)

```
Pipe Circumfer.
    180       mm
```

You can now enter the circumference of the pipe.

(The parameter limits for the circumference are calculated using the limits for the outer diameter.)

```
Outer Diameter
     57.3     mm
```

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

(For example: 180 mm : 3.142 = 57.3 mm)

Note:	The edition of the circumference is of a temporary nature. When the unit switches back to the display of the pipe circumference (internal re-calculation), slight rounding errors may occur. Example: Entered circumference = 100 mm, displayed outer diameter = 31.8 mm. When the unit switches back to the circumference internally, a value of 99.9 mm will be displayed.

12.2.2 Input of the Fluid Pressure

EESIFLO can take into account the dependency of fluid properties on pressure.

```
Fluid pressure
 off         >ON<
```

In the FLUID PRESSURE display, select ON if you wish to activate the fluid pressure query in the program branch PARAMETER. The fluid pressure must lie between 1 and 600 bar.

If you select OFF, EESIFLO uses a fluid pressure of 1.0 bar in all calculations.

12.2.3 Input mode for the Measuring Point Designation

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

Select "1234" if you wish to identify the measuring points using only numbers, point and dash.

Select "↑↓←→" if you wish to enter the measuring point designations using the ASCII-editor (see section 4.2).

12.2.4 Display of the Last Entered Transducer Distance

```
Transd. Distance
 auto      >USER<
```

If you select TRANSDUCER DISTANCE \ USER, EESIFLO will display the last precise transducer distance you have entered after positioning of the transducers.

```
Transd.Distance?
(50.8)  50.0  mm
```

If the suggested transducer distance and the entered distance are not identical, the suggested value is then displayed in parenthesis on the left, followed by the last precise transducer distance entered. **This setting is recommended if you always measure at the same measuring point.**

```
Transd.Distance?
        50.8  mm
```

If you select TRANDUCER DISTANCE \ AUTO, EESIFLO will only display the suggested transducer distance after the positioning of the transducers. **This setting is recommended if the measuring point changes often.**

12.2.5 Steam Option


```
Steam in inlet
>OFF<          on
```

ON enables you to measure the heat quantity in spite of the heat carrier being turned into vapor in the pre-flow.

When the STEAM IN INLET option is activated, you will be asked to enter the inlet pressure in the program branch PARAMETER.

```
Inlet pressure
      10.0   bar
```

For more information about the steam option of the heat quantity measurement, refer to section 18.5.

12.2.6 Time-programmable Measurement

```
Time-progr.Meas.
 off         >ON<
```

Select ON to enable the time-programmable measuring mode (see chapter 14), OFF to disable it.

12.2.7 Temperature Offset

```
Tx Corr. Offset
 off         >ON<
```

ON enables you to input an offset value for each temperature channel (see section 18.4).

12.2.8 Error-Value Delay

```
Error-val. delay
 damping  >EDIT<
```

EDIT enables you to enter an error-value delay. The error-value delay is the time after which a special error value will be sent to an output when no valid measured values are available. If you select DAMPING, EESIFLO uses the value of the damping as error-value delay.

See section 20.1.2 and 20.2 for more information on the behavior of EESIFLO in case no measured values can be obtained.

12.2.9 Display of the Alarms' State

```
SHOW RELAIS STAT
 off         >ON<
```

ON activates the display of the alarms' state during measurement.

See section 20.6 for more information on the alarm outputs.

Note:	EESIFLO stores all changes now at the end of the configuration dialogue.

12.3 Measurement Settings

```
SYSTEM settings ⇳
Measuring
```

In the program branch SPECIAL FUNCTION, select the SYSTEM SETTINGS, then the MEASURING option.

Note:	EESIFLO stores the MEASURING settings at the end of the dialogue. If you leave the program branch before the end of the dialogue, your settings won't be effective.

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

YES enables concentration measurement (optional). NO disables it. See chapter 17 for more information on concentration measurement.

```
SKYDROL Korrect
>OFF<        on
```

Select `OFF` and confirm by pressing **ENTER**.

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

Select `NORMAL` to always have the profile corrected flow values displayed and output, `UNCORR.` to obtain flow values without flow profile correction for output and data storage. This setting is cold-start resistant. See section 8.5 for more information about this option.

Confirm by pressing **ENTER**.

```
Cut-off Flow
>ABSOLUTE< sign
```

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

You can define here a lower limit for the flow velocity. See section 8.4.

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

You can enter here an upper limit for the flow velocity (see section 8.3). Values between 0.1 and 25.5 m/s are accepted. Entering "0" switches off the flow velocity control.

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

Select here the basic unit of measurement for the heat quantity (totalization of the heat flow rate): Joule [J] or Watt-hours [Wh].

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

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

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

Select here the overflow option of the totalizers. See section 8.2.2.

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

In the `QUANTITY RECALL` display, select `ON` if you wish that the previous numerical values of the totalizers are kept after restart of the measurement. Select `OFF` if you wish the totalizers to be reset to zero after restart of the measurement.

Note:	EESIFLO stores all changes of the `SYSTEM SETTINGS` now at the end of the dialogue.

12

12.4 Setting the Contrast

```
SYSTEM settings ⇕
Miscellaneous
```

In SPECIAL FUNCTION \ SYSTEM SETTINGS, select MISCELLANEOUS and press **ENTER**.

```
SETUP DISPLAY
<   CONTRAST   >
```

Set the contrast of the display using the following keys:

6 Q+	increases contrast
Q- **4**	decreases contrast
2 Q OFF	= minimum contrast
5	= medium contrast
Q ON **8**	= maximum contrast

Note:	The contrast will be reset to "medium" after a coldstart. With firmware version 5.32 and higher, you can also set the contrast to "medium" by entering the HotCode **555000**.

12.5 Instrument Information

```
Special Funct.  ⇕
Instrum. Inform.
```

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

- the type designation and the serial number of your instrument,
- the memory still available for data storage,
- the version of the firmware.

Confirm with **ENTER**.

```
EESXXXX-00000999
FREE:       18327
```

The type designation and the serial number of your instrument are given on the first line. Here: Type designation = EESXXXX and serial number = 00000999

The memory still available for data storage is given on the second line. Here: 18,327 measured values can still be stored.

Confirm with **ENTER**.

```
EESXXXX-00000999
v 5.xx  11.11.00
```

The type designation and the serial number of your instrument are given on the first line.

The firmware version and its date are given on the second line. Here: Version V5.xx from 11/11/ 2000

Confirm with **ENTER**.

12.6 Charging the Battery

To charge the NiCd batteries, connect the instrument to a power supply of 220 VAC using the supplied power adapter. During the charging process, the battery set must remain in the battery compartment of the instrument.

```
Special Funct.  ⇳
Charge Battery
```

In the main menu, select `SPECIAL FUNCTION \ CHARGE BATTERY`.

Confirm by pressing **ENTER**.

```
NO EXTERN. POWER
Charg.Impossible
```

This error message appears if you have activated the battery charging process although there was no external power supply connected to EESIFLO.

Confirm by pressing **ENTER**.

```
Charge Time Batt
       15.0    h
```

Enter the desired charging time for the battery (maximum: 15 h).

Confirm by pressing **ENTER**.

The time necessary for full recharging of the battery is 15h. The charging current is 400 mA.

```
Battery Charging
(15:00)  12:30 *
```

The selected charging time is displayed in parenthesis on the left of the display. The remaining charging time is displayed on the right.

A "*" is displayed every second to signal that the charging process is running.

BATTERY

During battery charging, the battery status LED is red. When you press **ENTER**, the charging process continues in background mode, and the following display appears:

```
Stop Charging
 no        >YES<
```

Select `YES` and confirm by pressing **ENTER** to stop the battery charging process. The main menu will appear.

Select `NO` and **ENTER** to continue the battery charging process in the background. The main menu will appear.

```
**Batt. Charg.**
**   Done     **
```

A message will appear when the battery charging process is completed, provided it did not run in background mode.

If the external power supply is disconnected during the charging process, the following error message will appear:

```
NO EXTERN.POWER
(15:00)  11:00 -
```

EESIFLO stops the battery charging process. The remaining charging time will be saved (for example 11:00). When the external power supply is reconnected, the charging will continue for the remaining time.

BATTERY

If there is a battery charging error, i.e. there is no external power supply, the battery status LED flashes (0.5 Hz).

Attention!	• Use only the battery set authorized by **EESIFLO**. This battery set can be ordered from **EESIFLO** or an authorized dealer. • The use of non-rechargeable batteries is prohibited. • Take care to plug correctly the connector: its shape prevents from reversing the polarity.

13 SuperUser Mode

The SuperUser mode gives you the opportunity for experimental work.

Features of the SuperUser mode:

- The flowmeter operates without observing pre-set standard parameters
- There are no plausibility checks when parameters are being entered.
- EESIFLO does not control if the entered values respect the limits given by physical laws and specifications.
- The cut-off flow velocity is not active.
- The sound path factor must always be entered numerically.

It is possible to modify the value of the minimal pipe inner diameter accepted by EESIFLO for a certain type of transducer without entering the SuperUser mode. Refer to section 8.8.

13.1 Activating/Deactivating

Enter the HotCode **071049** to activate the SuperUser mode.

```
SUPERUSER MODE
*IS ACTIVE NOW *
```

EESIFLO indicates that the SuperUser mode is activated.

Confirm by pressing **ENTER**. The main menu will appear again.

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

```
SUPERUSER MODE
IS PASSIVE NOW
```

EESIFLO then indicates that the SuperUser mode is deactivated.

Confirm by pressing **ENTER**. The main menu will appear again.

You can also deactivate the SuperUser mode by switching EESIFLO off.

13.2 Transducer Parameters

In SuperUser mode, the TRANSDUCER TYPE display will appear at the end of parameter input even though the transducers were detected and recognized by the instrument.

```
Transducer Type ⇕
Q2E-314
```

Confirm the displayed transducer type (here: Q2E-314) or select a transducer type in the scroll list. If you wish to edit the transducer parameters, select the option SPECIAL VERSION.

Confirm by pressing **ENTER**.

```
Transd. Data   1
     35.99
```

If you have selected SPECIAL VERSION, EESIFLO will ask for the . data .Enter the value of the 6 parameters as given on the transducer data card, confirming each entry with **ENTER**.

13

13.3 Malfunctions in SuperUser Mode

Since the SuperUser mode operates without any plausibility checks, nonsensical entries may result in an automatic switching-off of the instrument or in a crash of the internal software. This would occur, for example, if you enter 0 (zero) as the number of sound paths or if you specify an outer diameter of 0.1 mm.

In such a case, switch the flowmeter ON again and reactivate the SuperUser mode.

If necessary, RESET the instrument by pressing keys **BRK**, **C** and **ENTER** simultaneously.

Note:	Switching OFF and resetting both deactivate the SuperUser mode.

14 Time-programmable Measurement

The time-programmable measuring mode allows the user to program the beginning and the end of a measurement. EESIFLO waits for the defined start time and then automatically starts the measurement as well as the storage and the output of the measured values. EESIFLO can also automatically stop the measurement. The time-programmable measurement allows you to record process data at a high storage rate at the needed time, instead of having to measure the whole time at a low storage rate in order to have enough storage capacity left when needed.

14.1 Enabling and Disabling

The time-programmable measuring mode can be enabled and disabled in the program branch `SPECIAL FUNCTION \ SYSTEM SETTINGS \ DIALOGS/MENUS`. This setting is cold-start resistant.

```
Time-progr.Meas.
 off         >ON<
```

Select the `TIME-PROGR.MEAS.` option.

Select `ON` to enable the time-programmable measuring mode, `OFF` to disable it.

14.2 Input of the Start Time

```
Time-progr.Meas.
 no         >YES<
```

In the `TIME-PROGR.MEAS.` display of the program branch `MEASURING`, select `YES` to program the time for the measurement.

Confirm by pressing **ENTER**.

Note:	The `TIME-PROGR.MEAS.` display will appear only if • the storage of measured values or • the serial output or • one of the available process outputs is activated.

```
START:      04:15
Set Time
```

Select the digit you want to edit using keys Q- **4** and **6** Q+.

Set the hours or minutes using keys **2** Q_{OFF} and Q_{ON} **8**.

Confirm the entered start time by pressing **ENTER**.

```
START:      24:15
INVALID TIME    !
```

If this error message appears, you have probably made the day longer than it is. The start time must be set between 00:00 and 23:59.

Press any key (except **BRK**) to return to the `SET TIME` display.

Note:	The internal clock of EESIFLO works with a 24-hours clock. Times must therefore be specified in the 24-hour style, e.g. 02:35 PM = 14:35.

As soon as a valid start time has been entered, the display to set the start date appears.

```
START: 25.01.2002
Set Date
```

Set the day, month and year. Confirm the set start date by pressing **ENTER**.

If the entered start time exists and is in the future, EESIFLO will ask for the stop time (section 14.3).

```
START: 39.01.2002
INVALID DATE    !
```

If this error message appears, the date entered does not exist (EESIFLO also recognizes leap years!).

Press any key (except **BRK**) to return to the `SET DATE` display.

```
25.01.2002/04:15
INVALID START  !
```

If this error message appears, the set start time is in the past. Press any key (except **BRK**) to confirm this message.

Note:	The seconds for the start time are set to zero automatically. Therefore, the set start time must be at least one minute ahead of the actual time.

```
*=25 .01.02/15:17
↑=25.01.02/04.15
```

EESIFLO then displays the actual time on the upper display line ("*=") and the programmed start on the lower line ("↑=).

Here, it can be seen that the programmed start is invalid because it is in the past ("↑=).

```
*=25 .01.02/15:17
*↑:- 11h:02m:23s
```

Using key 9 or 3, it is possible to switch between the display of the start time and the display of the difference between the start time and the actual time ("*↑:-") on the lower display line.

Press any key (except **BRK**) to return to the `SET TIME` display.

14.3 Input of the Stop Time

EESIFLO can automatically stop a time-programmed measurement. Shortly after such a stop, the unit switches itself off if it is in battery mode. The `STOP MEASURING` screen is displayed after the input of the start time.

```
Stop measuring  ⇕
Don't stop
```

Select one of the options described below.

Confirm by pressing **ENTER**.

Table 14.1: Options for the automatic stop of the measurement

Option	Result
DON'T STOP	Measurement will not be stopped automatically unless if: • the batteries are empty or • the internal memory is full and no output option other than storing has been selected.
STOP: DATE/TIME	You can define the date and time of the automatic stop.
STOP: DURATION	You can define the duration of the measurement. EESIFLO will then calculate when the measurement should be stopped (START + DURATION = STOP).

Note:	Every hour EESIFLO waits for the start time reduces the battery capacity by 2%. This reduces the operating time left for the measurement accordingly.

14.3.1 Entering the Stop Time

If you have selected the option STOP: DATE AND TIME in the previous step, enter the date and time for the automatic stop of the measurement in the same way as the start time. Confirm each value by pressing **ENTER**. EESIFLO will check if date and time entered are valid and will not accept a stop time that is before the previously entered start time.

```
↑=26.01.02/04.15
↓=26.01.02/08:15
```

As soon as you have entered a valid stop, EESIFLO displays again the start ("↑=") and the stop time ("↓=").

In our example, EESIFLO starts the measurement on 30/04/2001 at 04:15, will measure for 4 hours and automatically stop the measurement at 08:15.

```
↑=26.01.02/04.15
↑↓:   04h:00m:00s
```

Using key 9 (DISP) or 3 (DISP), it is possible to switch between the display of the stop time and the display of the duration of measurement ("↑↓:") on the lower display line.

Press any key (except **BRK**) to go to the next option of the MEASURING program branch.

14.3.2 Entering the Duration

```
Duration: 04h:00m
Set duration
```

If you have selected the option STOP: DURATION in the previous step, enter the duration of the measurement in the same way as the start time. Confirm by pressing **ENTER**. The maximum measurement duration is of 999 hours and 59 minutes or about 41 days.

```
↑=26.01.02/04.15
↓=26.01.02/08:15
```

EESIFLO displays the start time ("↑=") and the stop time ("↓=") calculated using the entered duration.

```
↑=26.01.02/04.15
↑↓:  04h:00m:00s
```

Use keys 9 and 3 to switch between the display of the stop time and the display of the duration of measurement ("↑↓:") on the lower display line.

Press any key (except **BRK**) to go to the next option of the `MEASURING` program branch.

14.4 Measuring in Time-programmable Mode

When the time-programmable measuring mode is activated, the output options are defined and the start and stop time are set:

- Start measurement in the usual way. The instantaneous measuring values are displayed and stored and/or transmitted depending on the selected output options.
- Activate all settings needed for the programmed 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 at any time by pressing key **BRK**.

The memory requirements for the operational activities to come can now be calculated. If a stop time or a measurement duration has been defined and the storage of measured values is activated, EESIFLO checks if the free memory capacity is sufficient to store the measured values for the duration of measurement. If it is not, the following display will appear:

```
WARNING: MAX 85%
Store Meas.Data
```

In our example, the free memory capacity only covers 85% of the expected measuring values.

```
FULL=26.01/07:39
Store Meas.Data
```

Press key 9 or 3 to have the time at which the memory is expected to be full displayed on the upper line of the display.

If storing is the only output option activated, the measurement will be stopped when the memory is full, even if the stop time is not reached. If another output option is also activated, EESIFLO will continue the measurement until the defined stop time is reached even if the memory is full.

If the free memory capacity is insufficient, try the following:

- Delete all previously stored measured values (`SPECIAL FUNCTION \ DELETE MEAS. VAL.`).
- Extend the storage interval (`OUTPUT OPTIONS \ STORAGE RATE`). Doubling the storage interval, e.g. from ‘every second’ to ‘every two seconds’ will halve the memory requirement.
- Deactivate the totalizer if possible. The storage of one totalizer value app. triples the memory requirement.
- Check the totalizer storage mode. In `SYSTEM SETTING \ STORING \ QUANTITY STORAGE`, select `ONE` if your measurement problem allows the storage of the totalizer for only one flow direction.

The countdown

```
WAIT TO START AT
26.01. /04:15:00
```

EESIFLO indicates that the countdown is running. The upper line of the display shows the current status (waiting for the start time) or the current time.

```
25.01. /15:18:44
26.01. /04:15:00
```

Use key 3 DISP to switch between the display of the start and the display of the time remaining before measurement start ("*↑") on the lower line.

At any time during the countdown, you can check if a stop time has been programmed. Press key DISP 9 to display information on the upper line.

```
NO STOP DEFINED
```

- This message appears on the upper line when no stop time has been programmed.

```
STOP MEASURE AT
26.01. /08:15:00
```

- This message shows that EESIFLO will automatically end the measurement at the displayed time.

```
25.01/15:18:46
↑↓:  04h:00m:00s
```

Press key 3 DISP now to display the stop date and time or the programmed duration of the measurement ("↑↓:").

The measurement

When the defined start time is reached, EESIFLO continues the previously interrupted measurement. During the measurement, you can check if a stop time has been programmed:

```
Volume Flow
    54.5    m3/h
```

In the volume flow display, press key DISP 9 once or several times.

```
*↓=03h:58m:17s
   54.5     m3/h
```

Additional information will be displayed in the upper line, amongst others the time remaining until automatic stop ("*↓:").

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

Note:	The programmed measurement can be stopped at any time by pressing key **BRK**.

EESIFLO will automatically stop the programmed measurement if:

- the programmed stop time has been reached,
- the memory is full and no other output option was activated,
- the battery is empty.

14.5 Storage of Measured Values

- When the storage function is activated, the measured values will be stored in memory after measurement is started. These stored values will be kept when the measurement is interrupted (key **BRK**) to start the countdown or during countdown.
- However, when the programmed measurement is started at the programmed start time, all values stored before the countdown will be disregarded. The first measured value recorded after the automatic start is the first value of the current measuring data set. The start time will be stored as date and time reference for the current measuring data set.

14.6 Online Output

- When the online output via the serial interface is activated, the usual 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 transmitted normally.
- As soon as the countdown is started, EESIFLO will confirm that it is waiting for the start time and interrupts measurement.
- When the start time is reached, EESIFLO will transmit or print date, time and measuring point number.
- Then, after the character string `\DATA`, the measured values will be printed in the normal fashion.
- If the unit works in battery mode and the battery discharged itself during countdown or measurement, this will be acknowledged as follows:

```
\LOWBAT 29.04. /01:30:46
```

- An automatic stop of the measurement by reaching the pre-programmed stop time is indicated as follows:

```
\STOP MEASURE AT : 30.04. /08:15:00
```

15 Wall Thickness Measurement

Equipped with the Wall Thickness Measurement (WTM) option, EESIFLO can be used to measure wall thickness and the longitudinal sound velocity in a material. A dedicated wall thickness probe to be connected directly with the probe connection socket is supplied. EESIFLO will automatically recognize the wall thickness probe when connected. The wall thickness measured values can easily be transferred into the current parameter record for the flow measurement.

EESIFLO with WTM option uses a modified transit-time method to determine the thickness or sound velocity of a material (test piece). The probe emits a short ultrasonic pulse which propagates in the test piece. The pulse is reflected by the boundary layer of the test piece and comes back to the probe. The time difference between the emission and the reception of the signal is a measure for the thickness of the test piece (with known sound velocity of the material) or for its longitudinal sound velocity (with known thickness of the material).

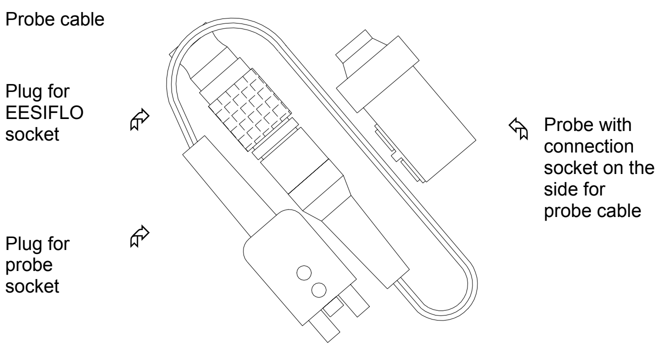


Fig. 15.1: Wall thickness probe assembly

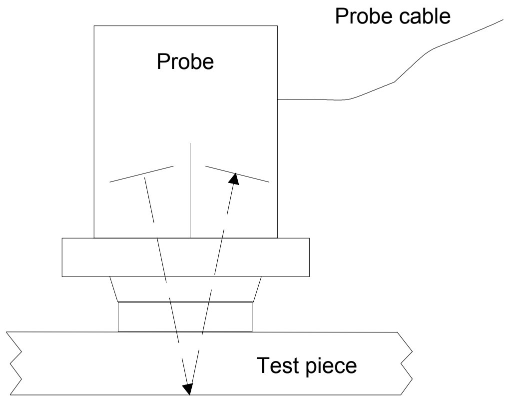


Fig. 15.2: Measuring principle

Note:	With some exceptions, the transversal sound velocity for a material is about 30% to 60% of the longitudinal sound velocity.

15.1 Activating the WTM Mode

To activate the WTM mode, connect the probe cable into the socket for channel A or B at the front of the unit. EESIFLO automatically switches to the WTM mode.

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

A message acknowledging the detection of the probe is displayed. It shows that the WTM option is available.

The main menu of the WTM option is displayed. The menus are similar to those of the flow measurement mode. The program branches are adapted to wall thickness measurement.

Note:

- As long as the probe is connected to the socket of a measuring channel EESIFLO stays in wall thickness measurement mode on that channel.
- The parameter record for the flow measurement will not be influenced by the WTM mode, with the exception of the possible change of the measured pipe wall thickness.

15

15.2 Parameter Input

15.2.1 Parameter Input for Wall Thickness Measurement

The sound velocity in the test piece material must be entered in order to determine the wall thickness.

```
Physic. Quant.  ⇳
Wall thickness
```

In the program branch OUTPUT OPTIONS, select the physical quantity WALL THICKNESS for the channel on which the probe is connected.

```
Pipe Material   ⇳
Carbon Steel
```

Select in the PIPE MATERIAL selection list of the program branch PARAMETER the material of the test piece. If the material is not part of the list, select OTHER MATERIAL. Confirm by pressing **ENTER**.

```
c-LONGITUDINAL
    5800.0   m/s
```

The longitudinal sound velocity in the selected material is displayed as a suggestion. If you have selected OTHER MATERIAL in the previous display, 0.0 m/s is displayed. Edit the velocity if necessary. The maximal sound velocity that can be entered is 20.000 m/s.

Confirm by pressing **ENTER**.

Note:

- The measurement will only start if a c-LONGITUDINAL other than zero is entered.
- Unlike in the case of flow measurement, the sound velocity has here a great influence on the result. It influences the measuring result in an approximately linear fashion. A sound velocity 10% higher than the actual one gives a wall thickness approximately 10% too high.
- The actual sound velocity of a material often differs substantially from the values published in the literature because it depends on the composition and on the manufacturing process of the material as well as on temperature. The sound velocities given Table B . 1 of Appendix B should only serve as orientation values.
- The longitudinal sound velocity in a given material can be measured precisely using a comparative block of known thickness. See section 15.3.1.

15.2.2 Parameter Input for the Sound Velocity Measurement

The thickness of the test piece must be entered in order to determine the longitudinal sound velocity in a material.

```
Physic. Quant.  ⇳
c-LONGITUDINAL
```

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

```
Wall thickness
      5.12    mm
```

In the program branch PARAMETER for the channel on which the probe is connected, enter the wall thickness of the test piece. Values between 0.8 mm and 200 mm are accepted.

Note: The wall thickness influences the measuring result in an approximately linear fashion. Thus, the input of a wall thickness 10% higher than the actual one gives a sound velocity approximately 10% too high.

15.3 Measurement

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

Select in the main menu the program branch `MEASURING`. Confirm by pressing **ENTER**.

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

If this error message appears:

- you did not enter all the required parameters or
- the sound velocity for the material was set to 0.0 m/s.

15.3.1 Measurement of Wall Thickness

```
Wall thickness
             mm?
```

This display appears if the wall thickness was selected as quantity of measurement for the channel on which the probe is connected. As long as there is no valid measured value, the unit of measurement and a question mark are shown on the lower display line.

```
Wall thickness  √
      3.51    mm
```

Apply a film of acoustic coupling compound on the test piece. Firmly press the probe against the test piece. As soon as a valid measured value is obtained, it is displayed on the second line. A tick is displayed on the right of the first line. The measured value remains on the display when the probe is taken off the material.

To minimize errors during the measurement of the wall thickness:

Measure the actual longitudinal sound velocity of the material using a comparative block of the same material with known dimensions.

- The comparative block should be even and plain.
- The thickness of the comparative block should be comparable to the maximum thickness of the test piece.

Attention!	The sound velocity of the material depends on the temperature. The measurement of the sound velocity using a comparative block should thus be performed at the location where flow measurement will be performed later, in order to obtain the sound velocity at the right temperature.

15.3.2 Measurement of Sound Velocity

```
c-LONGITUDINAL
            m/s?
```

This display appears if the sound velocity was selected as quantity of measurement for the channel on which the probe is connected. As long as there is no valid measured value, the unit of measurement and a question mark are shown on the lower display line.

```
c-LONGITUDINAL  √
      5370   m/s
```

Apply a film of acoustic coupling compound on the test piece. Firmly press the probe against the test piece. As soon as a valid measured value is obtained, the measured thickness is displayed on the second line. A tick is displayed on the right of the first line. The measured value remains on the display when the probe is taken off the material.

15.3.3 Further Information about the Measurement

```
SIGNAL IS GOOD
      3.51    mm
```

Press key DISP 9 to obtain information about the signal.

If the signal is sufficient for measurement, the message "SIGNAL IS GOOD" appears. The SIGNAL LED of the channel shows green.

```
ERROR SIGNAL    #
              mm?
```

If the signal is insufficient for measurement, the message "ERROR SIGNAL #" (with # a number) appears. The SIGNAL LED of the channel shows red.

```
Q= ■■■■■■
       3.51   mm
```

Press key DISP 9 again.

The bar graph indicating the quality of the signal ("Q=") will appear.

If the signal is insufficient for measurement, "UNDEF" is displayed. The SIGNAL LED of the channel shows red.

In this case, adjust the transducers by moving them slightly until the SIGNAL LED shows green.

```
Wall thickness
TRANS.= 186  ns
```

Press key 3 DISP to have the transit time ("TRANS") displayed.

15.3.4 Failure of Measurement

If no valid thickness can be obtained:

- Take the probe off the test piece .
- Clean the probe and the area of the test piece where the measurement takes place.
- Apply a film of acoustic coupling compound onto the test piece.

Firmly press the probe against the test piece.

Try measuring again.

Note:	• Use a small amount of coupling compound. Always apply the coupling compound in the same way to avoid fluctuations caused by different film thickness. • Apply constant pressure when pressing the probe against the test piece.

15.3.5 Possible Reasons for Incorrect Measuring

Temperature fluctuations

The sound velocity is temperature dependent.

Doubling effect

When measuring wall thickness using ultrasonic signals, a phenomena called 'doubling effect' can be observed when the thickness of the test piece is smaller as the lowest measuring range of the probe. The measured value is then twice (or sometimes three times) as big as the actual thickness of the piece because of repeated reflections of the ultrasonic signal.

Measured value is too small

A value considerably smaller than expected might be caused by a material defect. The ultrasonic signal was reflected by the defect and not by the boundary layer, leading to a shorter transit time and thus a smaller thickness.

Surface condition

Periodical unevenness (e.g. small grooves) on the surface of the test piece can lead to wrong measuring results. Normally, this problem can be overcome by turning the probe so that the acoustic partition boundary of the probe (see drawing below) is perpendicular to the orientation of the grooves.

In some cases, measuring on a rough surface with too much coupling compound will lead to wrong measured values. Measurement on very rough surfaces might be impossible (the display will show `NO COUPLING`). In such a case, the surface should be treated and smoothed out accordingly.

Curved surfaces

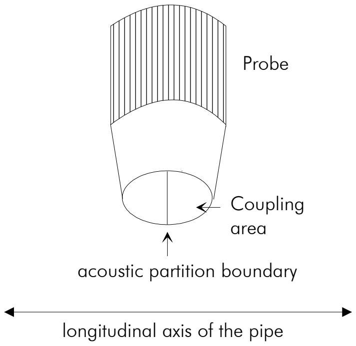


Fig. 15.3: Acoustic partition

During measurements on pipes or cylindrical containers, the probe must be pressed as centrally as possible against the piece. Applied pressure must be constant.

The acoustic partition boundary of the probe must be perpendicular to the longitudinal axis of the test piece.

15.3.6 Storage / Transfer of the Thickness Value

Press **ENTER** to end measurement run and store or output the measured value.

The following display appears when a valid wall thickness value has been obtained and one of the available output options is activated:

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

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

- The wall thickness measured values can easily be transferred into the current parameter record for the flow measurement. The pipe material of the parameter record will be replaced by the material used for the thickness measurement.
- If the serial output is activated, the measured value will be transmitted.

15.3.7 Leaving the WTM Mode

To leave the wall thickness measurement mode, you only have to disconnect the WTM probe.

16 Measuring the Sound Velocity of the Medium

```
Physic. Quant.  ⇕
Sound velocity
```

In the program branch `OUTPUT OPTIONS`, select the channel you want to use to measure the sound velocity. Confirm by pressing **ENTER**. Select the sound velocity as quantity of measurement.

Confirm by pressing **ENTER**.

This selection immediately ends the program branch `OUTPUT OPTIONS` since the sound velocity measurement is whether stored nor transmitted to the outputs.

```
A:c-Medium ca. ?
      1475   m/s
```

Select the program branch `MEASURING` and activate all channels on which you want to measure. For the channel on which the `SOUND VELOCITY` is to be measured, EESIFLO will ask for an estimated value of the sound velocity of the medium. Enter a value between 800 and 3500 m/s are accepted.

Confirm by pressing **ENTER**.

```
A:Reflection Mod
 no        >YES<
```

Select `YES` to measure in reflection mode, `NO` to measure in diagonal mode. Generally, the correct positioning of the transducers in reflection mode is easier than in diagonal mode.

```
A:Transd. Distan
24.7 mm Reflecti
```

Mount the transducers on the pipe, taking into account the suggested transducer distance. Confirm by pressing **ENTER**.

(EESIFLO calculates the suggested transducer distance on the base of the estimated value of the sound velocity and the actual parameters.)

```
MOVE TRANSDUCER!
■■■■■■■
```

The amplitude of the received signal is displayed as a bar graph. Move the transducers in direction of another until the bar graph starts to get smaller. One should try to obtain the maximal signal amplitude at the shortest transducer distance possible.

Press **ENTER** to conclude the positioning of the transducers.

Attention!	Do not move the transducers any more!

```
Transd.Distance?
     25.5     mm
```

Measure and enter the current (precise) transducer distance.

(In this example, 25.5 mm is the current precise transducer distance.)

Confirm by pressing **ENTER**.

Following error messages might appear at this point:

```
ESTIMATED VALUE
TOO LARGE      !
```

```
ESTIMATED VALUE
TOO SMALL      !
```

In both cases, the entered estimated value for the sound velocity differs too much from the real sound velocity of the medium. The transducers were positioned to a parasitic signal or an echo.

Take note of error messages by pressing **ENTER**. Enter a new estimate for the sound velocity.

```
Sound velocity
c=    1488.1 m/s
```

As soon as you have entered an estimated value compatible with the real sound velocity of the medium, the measurement starts.

16.1 Displayed Information

Press keys 9 and 3 to obtain further information in the upper or lower line of the display.

```
Curr.Trans.Dist.
L=       25.5  mm
```

3 ↓

Current transducer distance (L):

Distance entered during the last positioning of the transducers. The sound velocity is calculated using this value.

```
Better distance
(L*=   25.2)  mm
```

3 ↓

Better distance (L*):

Transducer distance derived from the measured sound velocity.

This allows you to detect wrong positioning. Still, do not change the transducer distance at this point!

```
t=      94.51   µs
c=    1488.1 m/s
```

9 →

Signal transit time (t):

The signal transit time in the medium can be displayed on the upper line.

Conclude the ongoing measurement by pressing **ENTER**.

The positioning of the transducers can be repeated now.

```
Search again   ?
 no         >YES<
```

EESIFLO asks you if you want to search again for the correct transducer distance.

Select NO if the sound velocity of the medium has been measured precisely (| L*-L | < 1 mm).

Select YES if the difference between the actual transducer distance and the better distance is of 1 mm or more, or if no signal could be found. A new measurement cycle will be started.

The cycle can be repeated as often as necessary. In most cases, one or two cycles are quite enough for measuring the sound velocity.

```
Store data     ?
 no        >YES<
```

Select YES to store the measured sound velocity in the actual parameter record for flow measurement.

```
c-Medium is:
      1488.1 m/s
```

The measured sound velocity can be edited before it is stored.

Confirm by pressing **ENTER**.

The name of the medium of the actual parameter record is changed to OTHER MEDIUM.

17 Concentration Measurement

If EESIFLO is equipped with the concentration measurement option, concentration measurement is possible when following conditions are fulfilled:

- Valid parameters and concentration coefficients for the measured media are available in the EESIFLO internal data bank.
- The measurement of the temperature of the medium (via Pt100 or current input) is activated.

The measured concentration can be stored and output with the other measured values.

17.1 Principle of Measurement

Concentration measurement is possible when the variation of the velocity of sound in the flowing medium can be attributed to a variation of the concentration of a constituent of the medium.

Measurement is possible on media consisting of two constituents: the main constituent, mostly the solvent, and the measured constituent. The constituents themselves must not be pure. For a dyestuff dissolved in a solvent mixture for example, the solvent mixture is the main constituent and the dyestuff the measured constituent.

Examples of media adequate for concentration measurement:

- A liquid in which a solid is completely dissolved (a salt in water for example).
- A liquid in which a solid is partly dissolved, for example a saturated salt solution (a solution containing more salt than can be solved under the given conditions, so that a deposit is built).
- A liquid constituent in which a solid substance is in suspension (water and powdered coal for example).
- A mixture of two liquids, oil and water for example.
- A liquid in which a gas is partly dissolved (only the concentration of dissolved gas can be measured).
- A liquid containing a substance which concentration is varying with the time as a result of some chemical reaction or physical effect, for example aggregation and change of the emulsion or suspension state. In this case, the change of the sound velocity could be interpreted as turnover or degree of aggregation.

Even deposits on the inner pipe wall can be interpreted as a constituent of the medium.

For the determination of the concentration, a linear dependency of the concentration of the measured constituent on the sound velocity measured in the medium is assumed, taking into account the dependency of the sound velocity on temperature:

$$K = \frac{c_{measured} - (K0_{F1} + K1_{F1} \cdot T)}{K0_{F2} + K1_{F2} \cdot T}$$

with *K* the concentration in mass percent, *c* the sound velocity in m/s and *T* the temperature in °C. The concentration coefficients *K0* and *K1* define the family of characteristics of the measured constituent. They have already been determined in our laboratories or will be determined on you installation basing on parallel measurements of the concentration. The coefficients are saved in the internal data base as properties of an user-defined medium.

17.2 Enabling the Concentration Measurement

```
SYSTEM settings ⇳
Measuring
```

In the program branch SPECIAL FUNCTION \ SYSTEM SETTINGS, select the option MEASURING

Confirm by pressing **ENTER**.

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

In the ENABLE CONCENTRATION display, select YES to enable the concentration measurement for all channels.

Confirm by pressing **ENTER**.

17.3 Setting the Parameters

Define the material and medium parameters in the program branch PARAMETER as in the case of flow measurement. After that, the parameters of the concentration measurement have to be entered.

17.3.1 Calibration Polynomial

The measuring point specific inaccuracies vary with the temperature. In order to compensate this effect when determining the concentration, a calibration must be carried out by **EESIFLO** before delivery or by yourself directly on the installation. The calibration process allows to determine the coefficients of the following calibration polynomial for the measured sound velocity:

$$c = c_{meas} + K_0 + K_1 \cdot T + K_2 \cdot T^2 + K_3 \cdot T^3 + K_4 \cdot T^4$$

with *c* the sound velocity in m/s, K_0, K_1, K_2, K_3, K_4 the calibration coefficients and *T* the temperature in °C.

```
Fluid c-Calibr.
Edit?  no  >YES<
```

In the Fluid c-Calibr. display, select YES to edit the calibration polynomial.

Confirm by pressing **ENTER**.

You can now edit the calibration polynomial for the measured sound velocity.

```
c-Calibr.
       1      TYPE
```

Enter 1 as calibration function type.

Confirm by pressing **ENTER**.

```
c-Calibr.  [m/s]
          0.0  K0
```

Enter the values for K_0, K_1, K_2, K_3, K_4.

Confirm each value with **ENTER**.

```
c-Calibr.  [m/s]
Save?  no  >YES<
```

Select YES to save the edited calibration polynomial. If you select NO, the polynomial won't be saved and the last polynomial entered remains valid.

17.3.2 Offset Correction

Deviations of the operational parameters or divergences between installation and laboratory can easily be corrected by adding a constant value (offset) to the measured concentration.

```
Concentr.Correc.
        1.0    M%
```

At the end of the PARAMETER program branch, EESIFLO asks you to enter the value of the offset.

Enter the correction value.

Confirm by pressing **ENTER**.

17.4 Measurement

Once the concentration measurement has been enabled, the concentration (in mass percent) will automatically be displayed in the program branch MEASUREMENT:

```
K=Concentration
A:K=  82.4    M%
```

```
K=Concentration
A:K=FAIL_20   M%
```

If EESIFLO cannot determine the concentration, the message "FAIL_XX" appears, with XX a bit-coded hexadecimal error code (see below).

Table 17.1: Error codes of the concentration measurement

2^5	2^4	2^3	2^2	2^1	2^0	**Cause of the problem**
					1	Invalid coefficients
				1	0	Numerical error during calculation
			1	0	0	Temperature out of the range of the coefficients
		1	0	0	0	Concentration out of the range of the coefficients
	1	0	0	0	0	Temperature of medium not available
1	0	0	0	0	0	Sound velocity not available

Example: *FAIL_10= Temperature of medium not available (since HEX 10 = DEC 16 = BIN 10000)*

FAIL_20 = Sound velocity not available

FAIL_04 = Temperature out of the range of the coefficients

FAIL_0C = Temperature and concentration out of the range of the coefficients

17.5 Saving the Measured Concentration

```
SYSTEM settings ⇳
Storing
```

In the program branch SPECIAL FUNCTION \ SYSTEM SETTINGS, select the option STORING.

Confirm by pressing **ENTER**.

```
Store Concentr.
 off        >ON<
```

In the scroll list, select the STORE CONCENTR. option.

If you select ON, the measured values for the concentration will be stored automatically when the storage of measuring data is activated. If you select OFF, the concentration will not be stored.

Confirm your selection by pressing **ENTER**.

18 Heat Flow Rate and Heat Quantity

When equipped with the Heat Quantity Measurement option and two temperature inputs (Pt100 or current loop), EESIFLO can measure the heat flow rate and the heat quantity (the totalizer of the heat flow rate). The use of surface temperature sensors allows for a non-invasive measurement of the thermal energy transported by the medium.

For the calculation of the heat flow rate, EESIFLO needs the temperatures of the inlet and outlet, the flow rate at the outlet and some medium dependent properties. The temperature dependency of the medium parameters is taken into account.

Features

- If the inlet or outlet temperature is known and constant during the whole measuring period, this temperature can be entered manually and the corresponding temperature sensor must not be connected.
- EESIFLO needs 10 medium dependent coefficients for heat flow measurement. The heat flow coefficients of some media (water and Shell Thermina B for example) are already stored in the EESIFLO internal data base. The coefficients of the other media must be entered.
- A temperature correction value (offset) can be defined for each temperature input (see section 18.4).
- If the pressure in the inlet is constant or if the pressure of the inlet can be measured with an additional process input, EESIFLO can measure the heat flow rate/heat quantity correctly independently of the state of the medium in the inlet (liquid or vapor). See section 18.5.

To measure heat flow and/or heat quantity, proceed as follows:

- Configure the temperature inputs as described in section 19.1.
- Enter the heat flow coefficients of the medium if necessary (see section 11.2.6).
- Proceed to setup as described in section 18.1.
- Mount the temperature sensors and the flow transducers on the pipe as described in section 18.2.
- Start measurement as described in section 18.3.

18.1 Settings

```
par mea >OPT< sf
Output Options
```

In the main menu, select the program branch `OUTPUT OPTIONS`.

```
Output Options  ⇕
For Channel   A:
```

Select the measuring channel on which you want to measure the heat flow rate (the channel to which the temperature inputs were linked).

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
Physic. Quant.  ⇕
Heat Flow
```

Select `HEAT FLOW` as quantity of measurement.

Confirm by pressing **ENTER**.

```
SYSTEM settings ⇕
Measuring
```

The unit of measurement for the heat quantity can be selected in the program branch `SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ MEASURING`.

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

Confirm all `MEASURING` options with **ENTER** until you reach the `HEAT QUANTITY` display.

Select the unit of measurement (Joule [J] or Watt-hours [Wh]). This setting is cold-start resistant.

Confirm by pressing **ENTER**.

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

In the following display, select `ON` if you wish to output and store both the volume flow totalizer and the heat totalizer.

Confirm by pressing **ENTER**.

18.2 Mounting and Connecting the Sensors

- Mount the flow transducers at the outlet as described in section 6.6.
- Mount one temperature sensor at the inlet and one at the outlet as described below.

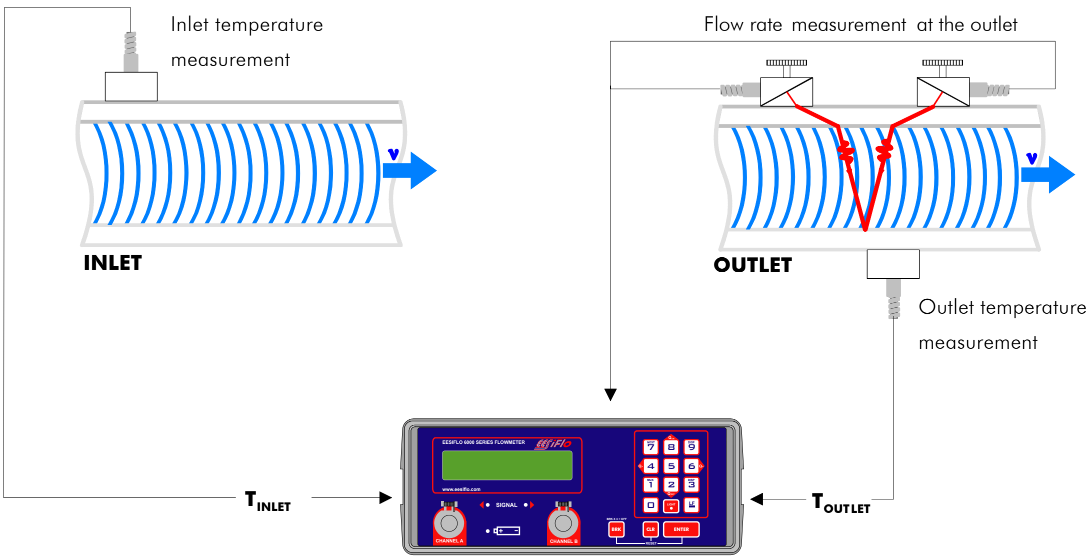
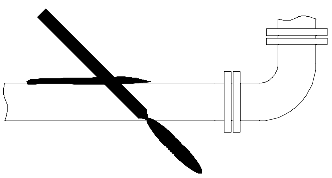


Fig. 18.1: Connection of the flow transducers and temperature sensors

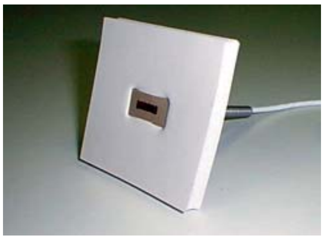
Attention!	The heat flow coefficients are defined in such a way that the flow must **always** be measured at the **outlet** of the system.

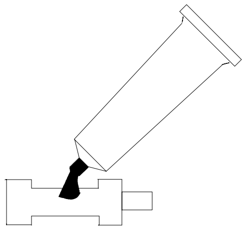


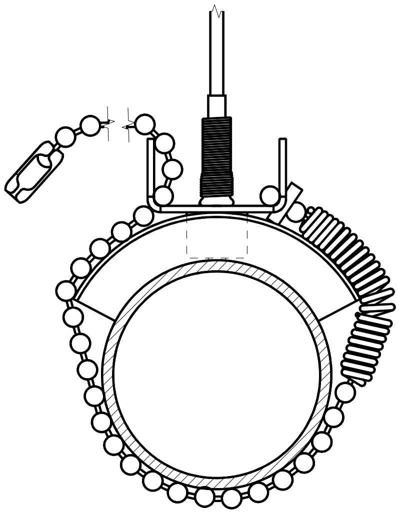
The temperature sensors must be mounted onto a clean pipe area.

Remove any rust, loose paint and insulation in order to get a good thermal contact between sensor and pipe wall.

- Pull the plastic protection plate, then the isolation foam on the temperature sensor. The temperature measuring point has to be isolated in order to minimize heat loss.
- Apply a film of thermal conductivity paste onto the contact surface of the sensor.







- Take the spring end of the ball chain and insert the last ball in one of the slots on the top of the sensor.
- Lay the chain around the pipe, pull the chain firmly and insert it in the second slot of the sensor.

- Connect the temperature sensor to the corresponding temperature input socket at the back of the flowmeter.

18.3 Measuring

Start the measurement as usual.

```
Heat Flow
*INVALID MEDIUM*
```

An error message will appear if there are no heat flow coefficients available for the selected medium.

```
T1=  90.2 C
T2=  70.4 C
```

EESIFLO first controls the two temperature inputs and displays the measured temperatures.

Press any key to continue.

```
T1=?UNDEF C
T2=  70.4 C
```

If a temperature cannot be measured (e.g. the Pt100 probe is not connected or is defective), "`?UNDEF`" will be displayed. In our example, T1 cannot be measured.

```
T1 manual FIX
      0.0 C
```

If you have selected `FIXED VALUE` for a temperature input during the configuration of the temperature inputs, EESIFLO will ask you now to enter it.

Enter a temperature value.

Confirm by pressing **ENTER**.

Note:	The input of a fixed temperature value is sometimes advisable, for example if the measurement at the inlet cannot be easily undertaken, but the temperature is known and constant.

```
A:T1 manual FIX
     10.0 C
```

For simulations, it is possible to enter both inlet and outlet temperatures as constants. In this case, do not plug the Pt100 probes to the flowmeter. EESIFLO will automatically ask you to enter the temperature values ("MANUAL").

```
A:Heatflow
      0.0     kW
```

Once all necessary values have been entered, the measured heat flow will be displayed.

If you are interested in knowing the heat quantity, activate the heat flow totalizer now (see section 8.2).

18.4 Temperature Correction

It is possible to define a correction value (offset value) for each temperature input. If a correction value has been defined, this value will be automatically added to the measured temperature.

This function is useful if, for example,

- the characteristic curves of the two temperature sensors differ considerably from another
- or if a known and constant temperature gradient exists between the measured value and the actual temperature of the medium.

18.4.1 Activating/Deactivating the Temperature Correction

The temperature correction can be activated and deactivated in the program branch SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ DIALOGS/MENUS.

```
Tx Corr. Offset
 off        >ON<
```

In the TX CORR.OFFSET display, select ON to activate the temperature correction, OFF to deactivate it.

Note:	If you select OFF, the temperature correction will be deactivated for all inputs. However EESIFLO remembers the defined correction values for each temperature input. These values will be displayed when the function is re-activated.

18.4.2 Input of the Offsets

The input of the offset will be requested for each temperature input during the transducer positioning procedure if:

- the temperature input is activated,
- the temperature can be measured,
- the temperature correction is activated.

```
T1 Corr. Offset
      0.3  C
```

Edit the displayed correction values for the different temperature inputs if necessary.

Confirm by pressing **ENTER**.

Note:

- Only measured temperatures can be corrected.
- For a zero adjustment, measure a same reference temperature with the two Pt100 sensors, then give the offset of one of the temperature inputs the value of the difference of the measured temperatures. 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.

```
T1= 90.5 C(COR)
      0.00    kW
```

During measurement, an offset corrected temperature value is indicated by the suffix ´COR´.

18.5 Steam Option

If the pressure in the inlet is constant or if the pressure of the inlet can be measured with an additional process input, EESIFLO can measure the heat flow rate/heat quantity correctly independently of the state of the medium in the inlet (liquid or vapor).

EESIFLO considers the pressure and the temperature inside the inlet to determine the state of the medium.

Attention!	The measurement of the volume flow rate, and thus of the heat flow, is only possible when the heat carrier is liquid in the outlet.

The steam coefficients of water are stored in the EESIFLO internal data bank. The coefficients of other media must be entered using the Windows utility .

18.5.1 Activating / Deactivating the Steam Option

```
SYSTEM settings ⇕
Dialogs/Menus
```

In the program branch SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ DIALOGS/MENUS, select the STEAM IN INLET option.

```
Steam in inlet
 off        >ON<
```

Select ON to activate the steam option. EESIFLO considers the pressure and the temperature inside the inlet to determine the state of the medium. This setting is coldstart-resistant.

OFF deactivates the steam option. The medium is then always considered to be liquid in the inlet.

```
Inlet pressure
      10.0   bar
```

When the STEAM IN INLET option is activated, you will be asked to enter the inlet pressure in the program branch PARAMETER. Enter the pressure.

Confirm by pressing **ENTER**.

Note:	The STEAM IN INLET display will appear independently of the selected quantity of measurement. However, the inlet pressure will be considered only for heat flow measurement.

18.5.2 Displays of the Steam Option

During measurement of the heat flow rate, press key DISP 9 one or many time to have the state of the medium displayed on the upper line.

```
Inlet=FLUID
      426.23  kW
```

This message appears if the medium in the inlet is completely in its liquid state.

```
Inlet=STEAM
     9565.23  kW
```

This message appears if the medium in the inlet turned completely into vapor.

```
Inlet=BOILING  !
     7895.78  kW
```

This message appears if the medium in the inlet is in its phase transition (critical range). In this case, an exact measurement of the heat flow rate is not possible because the proportion of medium in liquid phase in the inlet has to be known for calculating the enthalpy of the inlet. For water, EESIFLO considers a critical range of ±3°C around the boiling temperature. For this range, the heat flow rate will be calculated with the steam saturation enthalpy.

```
HEAT FLOW
     7895.78  kW
```

EESIFLO also signalizes the critical range by displaying the quantity of measurement in CAPITAL LETTERS.

19

19 Process Inputs

External sensors measuring the following process properties can be connected to the process inputs (if available):

- temperature,
- density,
- pressure,
- kinematic viscosity,
- dynamic viscosity.

EESIFLO can be equipped with a maximum of 4 inputs. The values given by the current, voltage or temperature inputs can be used by the different measuring channels.

A process input must be linked to a measuring channel (sections 19.1 and 19.2) and activated (section 19.3) before it can be used for measurement, display and data storage.

Note:	When a new input module has been built in, EESIFLO has to be rebooted (RESET or Power OFF→ON) in order to enable it to detect the newly available inputs.

To open the process inputs configuration dialogue, proceed as follows:

```
SYSTEM settings ⇕
Proc. inputs
```

In the program branch `SPECIAL FUNCTIONS`, select `SYSTEM SETTINGS`, then `PROCESS INPUTS`. Depending on the functionalities of your EESIFLO, some of the following options will appear in the scroll list:

Table 19.1: Options of the "Process Inputs" menu

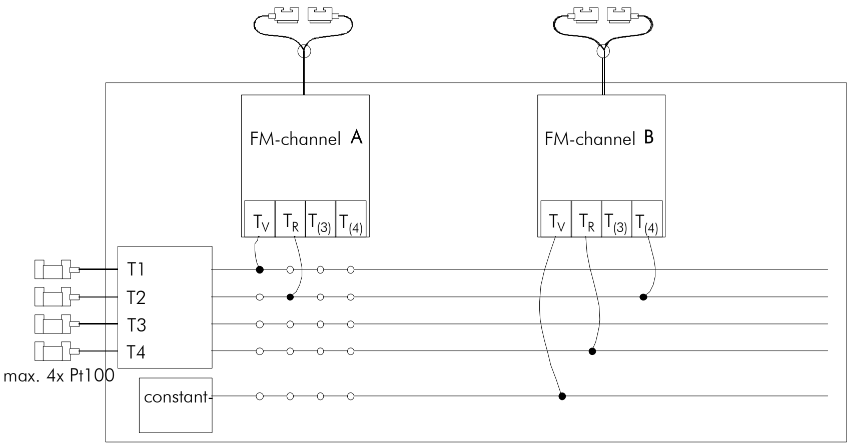
Menu option	Function
`Link temperature`	Link the temperature inputs to the measuring channels.
`Link others`	Link inputs other then temperature to the measuring channels.
`...go back`	Return to the previous menu level.

19.1 Linking the Temperature Inputs to the Channels

19.1.1 Temperature Inputs and Heat Flow Measurement

The inlet and outlet temperature necessary for heat flow and heat quantity measurement must be linked to the corresponding measuring channel as "T-Inlet" and "T-Outlet" (see section 19.1.2). The inlet and outlet temperatures are usually measured, but can also be entered as constants.

Note:	The measuring quantity `HEAT FLOW` appears in the program branch `OUTPUT OPTIONS` of a given measuring channel only if you have linked an inlet and an outlet temperature to that channel.



Channel A	Temperature input:	Channel B	Temperature input:
Inlet temperature T_V	T1	Inlet temperature T_V	Constant value
Outlet temperature T_R	T2	Outlet temperature T_R	T4
Heat quantity measurement	possible	Heat quantity measurement	possible

Fig. 19.1: Example of configuration of the temperature inputs for heat flow measurement

With this configuration, two independent heat flow measurements can be performed simultaneously. The temperature measured by T2 can not be used for heat flow measurement on channel B, but can be displayed and output.

19.1.2 Linking the Temperature Inputs

```
SYSTEM settings ⇕
Proc. inputs
```

In the program branch `SPECIAL FUNCTIONS`, select `SYSTEM SETTINGS`, then `PROCESS INPUTS`.

```
Proc. inputs    ⇕
Link temperature
```

In the `PROCESS INPUTS` scroll list, select the option `LINK TEMPERATURE`.

```
A:T-Inlet       ⇕
Input T1
```

Select in the scroll list the temperature input you want to link to channel A as inlet temperature.
Select the option `FIXED INPUT VALUE` if the inlet temperature should be entered manually before measurement.
Select the option `NO MEASURING` if you don't want to link an inlet temperature to channel A.

Confirm by pressing **ENTER**.

EESIFLO will now ask in the same way which temperatures should be linked to channel A as T-Outlet, T(3) and T(4), and then which temperatures should be linked to the other channels.

Note:	EESIFLO stores the configuration of a measuring channel when switching to the configuration of the next channel. You must go through the whole configuration dialogue for this channel to save changes.

19.2 Linking Other Inputs to the Channels

```
SYSTEM settings ⇕
Proc. inputs
```

In the program branch `SPECIAL FUNCTIONS`, select `SYSTEM SETTINGS`, then `PROCESS INPUTS`.

Confirm by pressing **ENTER**.


```
Proc. inputs    ⇕
Link others
```

In the `PROCESS INPUTS` menu, select the option `LINK OTHERS`.

```
A:ext.Input(1)  ⇕
Input I1
```

Select the first input you want to link to channel A.

Only the existing inputs are displayed in the scroll list. Select the option `NO MEASURING` if you don't want to link an input to channel A.
Confirm by pressing **ENTER**.

EESIFLO will now ask in the same way which three other inputs should be linked to channel A, and then which inputs should be linked to the other channels.

Note:	EESIFLO stores the configuration of a measuring channel when switching to the configuration of the next channel. You must go through the whole configuration dialogue for this channel to save changes.

19.3 Activation of Process Inputs

Note:	The displays for the activation of a given process input in the program branch `OUTPUT OPTIONS` appears only if EESIFLO is equipped with that type of input and if the latter has been linked to a channel.

19.3.1 Activation of Temperature Inputs

Note:	If the selected quantity of measurement is `HEAT FLOW`, EESIFLO automatically activates the temperature inputs associated with this option. The steps described below are not necessary unless you want to display or output the measured temperatures.

Temperature inputs must be activated if you want the measured temperatures to be displayed, stored and/or output with the other measured values, or if you wish the temperature to be used for the interpolation of the viscosity and density of the medium.

```
Temperature  T1
 no        >YES<
```

In the program branch `OUTPUT OPTIONS`, select the channel for which you want to activate a temperature input.

The temperature inputs linked to the selected channel will be displayed one after the other for activation. Select `YES` for the temperatures you want to activate.

Note:	The activation of a temperature input reduces the total number of measured values that can be stored.

19.3.2 Activation of Other Inputs

Process inputs must be activated if you want the measured values to be displayed, stored and/or output with the other measured values.

```
INPUT         I1
 no         >YES<
```

In the program branch `OUTPUT OPTIONS`, select the channel for which you want to activate an input.

The process inputs linked to the selected channel will be displayed one after the other for activation. Select `YES` for the inputs you want to activate.

Note:	The activation of a process input reduces the total number of measured values that can be stored.

19.4 Connection of a Current Source

An active current source must be connected to a passive current input. A passive current source can be connected directly to an active current input, or indirectly to a passive current input via an external power supply.

19.4.1 Connection to an Active Current Input

Important:	Never connect an active current source to an active current input!

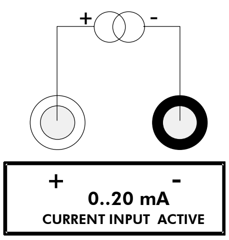


Fig. 19.2: Passive current source with active current input

At full load (20 mA), a DC voltage of 13 Volt minimum is available for your passive current source.

Respect the polarity to avoid damaging the current source. A permanent shorting of both terminals could destroy the current input.

Table 19.2: Technical data of the active current input

Measuring range:	0 mA ... +20 mA
Accuracy:	0.1% of reading ±10 µA
Input impedance:	50 Ω / 0.6 W
Short circuit current:	100 mA

19.4.2 Connection to a Passive Current Input

Table 19.3: Technical data of the passive current input

Measuring range:	-20 mA to +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 directly to a passive current input as follows:

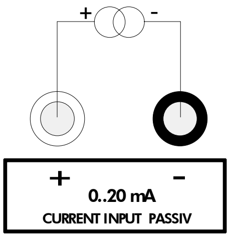


Fig. 19.3: Active current source with passive current input

If you inverse the polarity of the signal, only the sign of the measured current will change.

Connection of a Passive Current Source

Connecting a passive current source requires an additional external power supply:

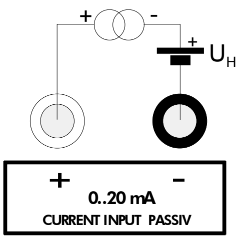


Fig. 19.4: Passive current source with passive current input

The power supply U_H must be able to supply

- sufficient power to provide for the energy requirements of the passive current source,
- the voltage drop over the measurement resistance (max. 1 V),
- and all other voltage drops (e.g. cable resistance) in the circuit.

The external auxiliary power supply must be able to provide a current of 20 mA.

Example:

A passive current source such as a pressure sensor 4 to 20 mA is connected to a passive current input.

Manufacturer's data of the pressure sensor: Aux. power supply: U_S = 11 to 30 VDC
Output signal: 4 to 20 mA

The required auxiliary power supply for the pressure sensor can be calculated as follows:

U_H minimal $= U_{S\text{-}MIN} + I_{MAX} \bullet R_{MEAS} + I_{MAX} \bullet R_{CAB}$ *(R_{MEAS}= input impedance, R_{CAB}= cable resistance*
$= 11V + 20mA \bullet 50\Omega + 20mA \bullet 2\Omega$
$= 12.04\ V$
U_H maximum = 30 V (acc. to manufacturer's data)

20 Process Outputs

If your instrument is equipped with process outputs, these outputs must be installed and activated before they can be used.

The installation of an output consists of three steps:

- Assigning a measuring channel (source channel) to the output.
- Defining the measured value the assigned channel should transmit to the output (source item) and the properties of the signal.
- Defining the behavior of the output in case no valid measured values are available.

Afterward, the installed output must be activated (program branch `OUTPUT OPTIONS)`. Only after this procedure has been gone through will measured values be available at the outputs.

20.1 Installation of a Process Output

The installation of the process outputs takes place in the `SPECIAL FUNCTION \ SYSTEM SETTINGS \ PROCESS OUTPUTS` program branch.

Note:	EESIFLO stores the configuration of an output at the end of the installation dialogue. If you leave the installation dialogue by pressing **BRK**, changes won't be saved.

```
SYSTEM settings ⇳
Proc. outputs
```

In the `SPECIAL FUNCTION \ SYSTEM SETTINGS` program branch, select the `PROCESS OUTPUTS` option. Confirm by pressing **ENTER**.

```
Install Output ⇳
Current I1
```

Select the output you want to install. The scroll list contains all the actually available process outputs. A tick (✓) after an item of the list means that this output has already been installed.

Confirm by pressing **ENTER**.

```
I1 enable
 no        >YES<
```

This display will appear if the selected output was not already enabled.

Select `YES` and confirm by pressing **ENTER**.

```
I1 disable
>NO<        yes
```

If the selected output was already enabled, select `NO` to reconfigure it, or `YES` to go back to the previous menu and select another output.

Confirm by pressing **ENTER**.

```
I1 Source chan. ⇳
Channel A:
```

Select in the scroll list the channel which you want to assign as source channel to the previously selected output.

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
I1 Source item  ⇳
Flow
```

Select the measuring quantity the source channel should transmit to the output (source item). The available source items and their configuration options are described in the table below. If you are configuring a binary output, only the options `LIMIT` and `IMPULSE` are offered.

Table 20.1: Configuration options for the process outputs*

Source item	Available configuration options	Output
`Flow`	`Actual measure`	Output of the measuring quantity selected in program branch `OUTPUT OPTIONS`
	`Flow`	Output of the flow rate independently of the measuring quantity selected in program branch `OUTPUT OPTIONS`
	`Heat flow`	Output of the heat flow independently of the measuring quantity selected in program branch `OUTPUT OPTIONS`
`Quantity`	`Q+`	Output of the totalizer for the **positive** flow direction
	`* Actual measure`	• Output of the totalizer for the measuring quantity selected in program branch `OUTPUT OPTIONS`
	`* Flow`	• Output of the flow rate totalizer
	`* Heat flow`	• Output of the heat flow totalizer
	`Q-`	Output of the totalizer for the **negative** flow direction
	`* Actual measure`	• Output of the totalizer for the measuring quantity selected in program branch `OUTPUT OPTIONS`
	`* Flow`	• Output of the flow rate totalizer
	`* Heat flow`	• Output of the heat flow totalizer
	`ΣQ`	Output of the **sum** of the totalizers
	`* Actual measure`	• Output of the totalizers for the measuring quantity selected in program branch `OUTPUT OPTIONS`
	`* Flow`	• Output of the flow rate totalizers
	`* Heat flow`	• Output of the heat flow totalizers
`Temperature`		Output of a temperature value. This item appears only if a temperature input was linked to the channel.
	`T-Inlet (T1)`	• T_I for heat flow
	`T-Outlet (T2)`	• T_O for heat flow
	`T(3)=Input T3`	• Further temperature input value
	`T(4)=Input T4`	• Further temperature input value
	`Ti(=T1)-To(=T2)`	• Difference between inlet and outlet temperature
	`Ti(=T1)-T3`	• Difference between inlet temperature and T(3)
	`To(=T2)-T3`	• Difference between outlet temperature and T(3)
	`Ti(=T1)-T4`	• Difference between inlet temperature and T(4)
	`To(=T2)-T4`	• Difference between outlet temperature and T(4)
	`T3-T4`	• Difference between T(3) and T(4)
`Limit`	`R1`	Output of a limit message (alarm output R1)
	`R2`	Output of a limit message (alarm output R2)
	`R3`	Output of a limit message (alarm output R3)

Impulse	From abs (x) from x > 0 from x < 0	Impulse output without sign consideration Impulse output for positive measured values Impulse output for negative measured values
Miscellaneous	Soundspeed fluid Concentration K Signal	Output of the sound velocity (see chapter 16). Output of the concentration (see chapter 17). Output of the amplitude of the signal of a measuring channel

*** (* indicates that an option will be available only if HEAT + FLOW QUANTITY was selected in the program branch SPECIAL FUNCTIONS \ SYSTEM SETTINGS \ MEASURING)**

20.1.1 Output Range

```
I1:Output range ⇕
     4/20  mA
```

If you are configuring an analogue output, EESIFLO now asks you for the output range. Select one of the ranges offered in the scroll list or OTHER RANGE to enter manually the output range.

```
I1:Output MIN   ⇕
     10.0  mA
```

```
I1:Output MAX   ⇕
     11.0  mA
```

If you have selected OTHER RANGE, enter the minimal output value (OUTPUT MIN) and the maximal output value (OUTPUT MAX).

Confirm each value with **ENTER**.

```
I1:Output MAX   ⇕
   12.0  MINIMAL
```

The entered output range should cover at least 10% of the full physical output range (I_{MAX} - I_{MIN} ≥ 2mA for a 20 mA current loop for example). If this is not the case, EESIFLO will display the smallest maximal output value (OUTPUT MAX) possible for the entered minimal output value (OUTPUT MIN).

20.1.2 Output Value in Case of Error

In the further dialogue, you can select that value which EESIFLO shall output in case the assigned source item cannot be measured or located. For example, EESIFLO might not be capable to measure the flow during a certain period of time because of the presence of gas bubbles in the medium. It will then output the defined "error value".

Table 20.2: Error value options

Error value option	Result
Minimum	Output of the lowest possible value (lower limit of the output range)
Hold last value	Output of the last measured value
Maximum	Output of the highest possible value (upper limit of the output range)
Other value	Output of a value to be defined within the physical limits of the output.

Example:

The flow volume was selected as source item for the current loop, the current loop range was set to 4/20 mA, the error value delay t_d to a value greater as zero.

The measurement of the volume flow rate is impossible during the time interval $t_0 ... t_1$.

What signal should be output during this time interval?

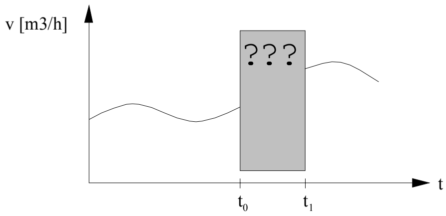
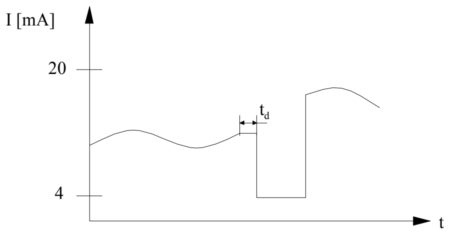
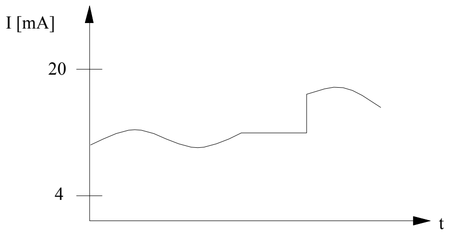
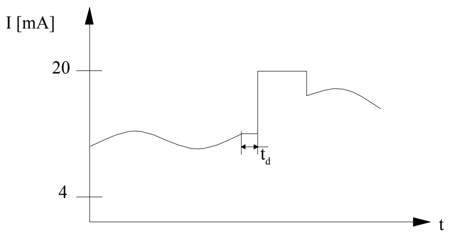
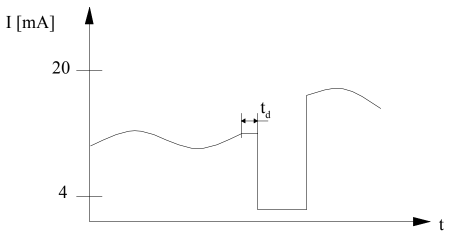


Fig. 20.1: Error value delay

Table 20.3: Error value options

Selected error value option	Output signal
Error-value ⇳ Minimum (4.0mA)	
Error-value ⇳ Hold last value	
Error-value ⇳ Maximum (20.0mA)	
Error-value ⇳ Other value ... Error-value: 2.00 mA	

```
Error-value      ⇳
Minimum   (4.0mA)
```

Select an error value in the scroll list.

Confirm by pressing **ENTER**.

```
Error-value:
      ...
```

If you have selected OTHER VALUE, enter an error value now. The value must be within the physical limits of the process output.

Confirm by pressing **ENTER**.

Note:	EESIFLO stores your settings now at the end of the dialogue.

```
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).

Confirm by pressing **ENTER**.

20.1.3 Function Check

Finally, you can test the function of the installed output. Connect the terminals assigned to the output you have installed to a multimeter.

Test of analogue outputs

```
I1:Output Test
      4       mA
```

Enter a test value (in our example, the current output is tested). The test value should be in the selected output range.

Confirm by pressing **ENTER**.

```
I1=  4.0 mA
Again?  no >YES<
```

The input functions correctly if the measuring instrument displays the entered value.

Select YES to repeat the test, NO to return to the SYSTEM SETTINGS.

Confirm by pressing **ENTER**.

Test of binary outputs

```
B1:Output Test
 Reed-Relais OFF
```

In the OUTPUT TEST scroll list, select OFF to test the de-energized state of the output.

Confirm by pressing **ENTER**.

No current should be flowing at the output now.

```
B1= OFF
Again?  no >YES<
```

Select YES.

Confirm by pressing **ENTER**.

```
B1:Output Test
  Reed-Relais ON
```

In the OUTPUT TEST scroll list, select ON to test the energized state of the output.

Confirm by pressing **ENTER**.

A current should be flowing now.

```
B1= ON
Again?  no >YES<
```

Select YES to repeat the test, NO to return to the SYSTEM SETTINGS.

Confirm by pressing **ENTER**.

20.2 Defining the Error Value Delay

The error value delay is the time interval after which EESIFLO will transmit the error value to the output in case no valid measured values are available.

The error value delay can be entered in the `OUTPUT OPTIONS` program branch if this inquiry has been previously activated in the program branch `SPECIAL FUNCTION`. If you don't enter a specific value for the delay, EESIFLO will use the damping value.

```
Error-val.delay
>DAMPING<  edit
```

In the `SPECIAL FUNCTION \ SYSTEM SETTINGS \ DIALOGS/MENUS` program branch, select the `ERROR-VAL. DELAY` option.

```
Error-val.delay
        10     s
```

Select `DAMPING` if you wish the damping factor to be used as error-value delay (default setting). Select `EDIT` to activate the error value delay inquiry. From now on, EESIFLO will ask for the error value delay in the program branch `OUTPUT OPTIONS`.

This setting is coldstart resistant.

20.3 Circuits of the Process Outputs

Table 20.4: Circuits of the process outputs

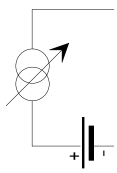
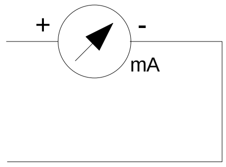
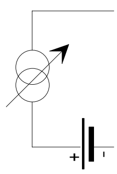
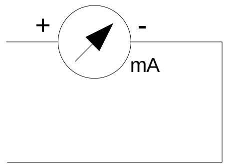
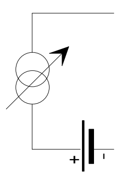
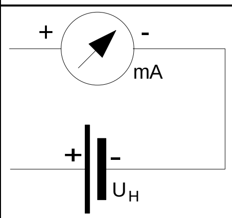
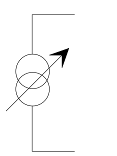
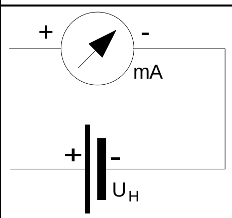
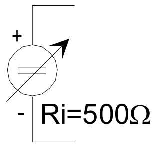
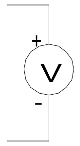
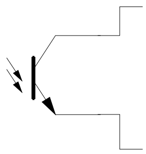
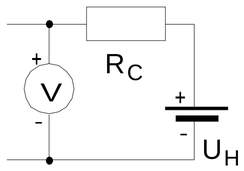
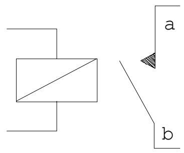
OUTPUT	EESIFLO	TERMINAL (socket)	CIRCUIT	
Current loop active		Px**+** (red) (black) Px**-**		R_{LOAD} < 500 Ω
Current loop semi-active used as active current loop		Px+ (red) (black) Px-		R_{LOAD} < 50 Ω
Current loop semi-active used as passive current loop		Px+ (red) (black) Px-		U_H = 0 to 24 V U_H > 0.021A * R_{LOAD}[Ω]
Current loop passive		Px**+** (red) (black) Px**-**		U_H = 5 to 25 V U_H > 0.021 A*R_{LOAD}[Ω] + 4 V ***Example:*** *If U_H =12V, then R_{LOAD} must be between 0 Ω and 380 Ω!*

Table 20.4 (cont'd)

Voltage output		Px**+** (red) (black) Px**-**		R_{LOAD} > 2 MΩ A smaller R_{LOAD} diminishes the precision.
Binary output Open-Collector		Px**+** (red) (black) Px**-**		U_H = 5 to 24 V R_C[kΩ] = U_H / Ic[mA] Ic = 1 to 4 mA
Binary output Relays (Reed-Contact)		Px**+** Pxa Pxb Px**-**		U_{MAX} = 24 V I_{MAX} = 150 mA

20.4 Activation of an Analogue 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 the OUTPUT OPTIONS program branch of the channel on which you want to activate an output.

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
Current Loop
I1:  no    >YES<
```

Select YES in the display of the output to be activated.

Confirm by pressing **ENTER**.

20.4.1 Scale Values for the Analogue Outputs

After you have activated an analogue output in the program branch OUTPUT OPTIONS, EESIFLO will ask for the scale values for the source item.

```
Zero-Scale Val.
     0.00   m3/h
```

Enter as ZERO-SCALE VALUE the lowest measured value expected. The displayed measuring unit is the unit of the source item of the output. The ZERO-SCALE VALUE is the measured value corresponding to the lower limit of the output range as defined in section 20.1.1.

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

Enter as FULL-SCALE VALUE the highest measured value expected. The FULL-SCALE VALUE is the measured value corresponding to the upper limit of the output range as defined in section 20.1.1.

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.

A signal of 20 mA will be transmitted to the current output when a flow rate of 300 m^3/h is measured. For a measured current of 0 m^3/h, a signal of 4 mA will be transmitted.

20.5 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 attains a given value (=PULSE VALUE). The integrated quantity is the selected quantity of measurement. Integration is restarted when a pulse is emitted.

Note:	The display PULSE OUTPUT only appears in the program branch OUTPUT OPTIONS if a pulse output has been installed.

```
Output Options  ⇕
For Channel   A:
```

Select the OUTPUT OPTIONS program branch of the channel on which you want to activate an output.

Confirm by pressing **ENTER**.

Note: This display does not appear if your instrument has only one measuring channel.

```
Pulse Output
B1:  no    >YES<
```

Select YES in the display of the output to be activated.

Confirm by pressing **ENTER**.

```
Pulse Output
NO COUNTING!
```

If the flow velocity is selected as the quantity of measurement, an error message is displayed. The use of the pulse output is not possible because it is technical nonsense to totalize the flow velocity!

```
Pulse Value
       0.01   m3
```

Enter the PULSE VALUE. EESIFLO automatically displays the unit of the actual measuring quantity. When the totalized measuring quantity reaches the pulse value, a pulse will be emitted.

```
Pulse Width
       100    ms
```

Enter the PULSE WIDTH. Values between 80 and 1000 milliseconds are accepted. The range of possible pulse widths depends on the specifications of the instrument (e.g. counter, totalizer, PLC) which will be connected with the pulse output.

EESIFLO then displays the maximum possible flow in the pipe that the pulse output can work with. This value is calculated from the data given for pulse value and pulse width. If the actual flow exceeds this 'Max-Value', the pulse output will not function properly. In such a case, the pulse value and pulse width should be changed to accommodate the flow conditions. Confirm the maximal value by pressing **ENTER**.

Attention!	If the actual flow rate exceeds this 'Max-Value', the pulse output will not function correctly.

20.6 Activation of an Alarm Output

Note:	The display ALARM OUTPUT only appears in the program branch OUTPUT OPTIONS if an alarm output has been installed.

A maximum of three alarm outputs operating independently of each other can be linked to each channel. The alarm outputs can be used for the output of status information about the ongoing measurement or to start and stop control pumps, electrical motors or other equipment.

20.6.1 Setting the Alarm Properties

You can define the switching condition, the type (the holding behavior) and the mode (the state in de-energized condition) of the alarm output. The settings are described in the following table:

Table 20.5: Alarm properties

Alarm property	Available settings	Description
FUNC (switching condition)	**MAX**	Alarm switches when the measured value exceeds the upper limit.
	MIN	Alarm switches when the measured value falls below the lower limit.
	+⇨ - -⇨ +	Alarm switches when the flow changes its direction (sign change of measured value).
	QUANTITY	Alarm switches when the totalizing function is activated and the totalizer reaches or exceeds the programmed limit.
	ERROR	Alarm switches when no measurement is possible.
	OFF	No function, the alarm is not working..
TYP (holding behavior)	**NON-HOLD**	Alarm returns to idle state after approx. 1 second if the switching condition is not true any more.
	HOLD	Alarm stays activated even if the switching condition is not true any more.
MODE (alarm state in de-energized condition)	**NO Cont.**	Alarm is energized when the switching condition is true, i.e. de-energized when idle (NO=normally open).
	NC Cont.	Alarm is de-energized when the switching condition is true, i.e. energized when idle (NC=normally closed).

Attention:	When EESIFLO is not measuring, all alarms are in de-energized state, independently of the programmed function.

```
Output Options  ⇳
For Channel   A:
```

Select the `OUTPUT OPTIONS` program branch of the channel on which you want to activate an output.

Confirm by pressing **ENTER**.

```
Alarm Output
 no        >YES<
```

Select `YES` in the display of the output to be activated.

Confirm by pressing **ENTER**.

```
R1=FUNC<typ mode
Function:    MAX
```

The display that then appears contains three scroll lists:

- `FUNC` for setting the switching condition,
- `TYP` for setting the holding behavior,
- `MODE` for setting the state in de-energized condition.

Use keys Q- **4** and **6** Q+ to select an scroll list on the first line.

Use keys QON **8** and **2** QOFF to select the corresponding setting on the second line.

Press **ENTER** to confirm the selected settings at the end of selection.

20.6.2 Setting the Limit Values

For the functions `MAX` and `MIN`

If you have selected the switching condition `MAX` or `MIN` under `FUNC`, you can enter the desired limit values for the alarm outputs as follows:

```
R1 Input:          ⇳
Volume Flow
```

Select in the `INPUT` scroll list which physical quantity should be used for comparison. Available options are:

- the volume flow,
- the signal amplitude,
- the sound velocity for the medium.

Confirm by pressing **ENTER**.

EESIFLO will then ask for the value of the limit.

Table 20.6: Limit values

Function	**Display and comparison**	**Remarks**
`MAX`	`High Limit:` `   -10.00   m3/h` Comparison: measured value > limit The alarm output switches when the measured value exceeds the programmed limit.	The sign is taken into consideration! *Example:* *High limit = -10.0 m^3/h* *The limit will be exceeded by a measured value of -9.9 m^3/h or +2.5 m^3/h. The alarm won't switch if, for instance, the measured value amounts to -11.0 m^3/h.*
`MIN`	`Low Limit:` `   -10.00   m3/h` Comparison: measured value < limit The alarm output switches when the measured value falls below the programmed limit.	The sign is taken into consideration! *Example:* *Low limit = -10.0 m^3/h* *The limit will be exceeded by a measured value of -11.0 m^3/h or -22.5 m^3/h. The alarm won't switch if, for instance, the measured value amounts to -9.9 m^3/h.*
`QUANTITY`	`Quantity Limit:` `      1.00    m3` Comparison: totalizer value ≥ limit The alarm output switches when the totalizer reaches the programmed limit.	EESIFLO has a totalizer for each flow direction (positive and negative). If you enter a **positive limit**, the comparison will be made with the totalizer value for positive flow direction. If you enter a **negative limit**, the comparison will be made with the totalizer value for negative flow direction. The comparison will also be made if the totalizer of the other flow direction has been selected for displaying.

Note:	During measurement, the limit values will always be interpreted in terms of the unit of measurement that was selected at the time the quantity limit was set. The limit value stays the same even if the quantity and/or unit of measurement is changed. If you change the unit of measurement, also change the quantity limit. *(Example: You have entered a limit value of 60.0 m^3/h, then changed the unit of measurement to m^3/min. You should also change the quantity limit from 60.0 m^3/h to 1.0 m^3/min).*

20.6.3 Defining the Hysteresis

It is now possible to define an hysteresis for the alarm.

This function is useful to avoid a constant triggering of the alarm by measuring values fluctuating around the limit. The hysteresis is a symmetrical range around the limit in which fluctuation is permitted. The alarm will be activated when the measuring values reach the upper limit of this range and deactivated when the measuring values fall below the lower limit.

Example: For an hysteresis of 1 m/s and a limit of 30 m/s, the alarm will be activated at 30.5 m/s and deactivated at 29.5 m/s. Small fluctuations around 30 m/s won't have any effect on the alarm.

```
R1 Hysteresis
      1      m/s
```

Enter the desired value or enter "0" (zero) if you don't wish to work with an hysteresis.

Confirm by pressing **ENTER**.

20.7 Operation of the Alarm Outputs

20.7.1 Apparent Delays when Alarm Outputs switch

EESIFLO rounds the measured value and totalizer value with a precision of two decimal places behind the decimal separator before they are displayed. However, EESIFLO compares the limits with the non-rounded values. This might cause an apparent output switching delay, especially when extremely small changes of the measured value take place (smaller than the equivalent of two decimal places behind the comma). In these cases, remember that the accuracy of the output switching is higher than the accuracy of the display.

20.7.2 Reset and Initialization of the Alarms

- After a coldstart, all alarm outputs will be initialized. They will then be in the following state:

Table 20.7: State of the output after initialization

FUNC:	OFF
TYPE:	NON HOLD
MODE:	NO CONT.
LIMIT:	0.00

- **(only in firmware version 5.42 and higher)** During measurement, pressing key **C** three times will switch all alarms to their idle state. However, all alarms which switching condition is still met will switch back into their active state after 1 second. Use this function to reset an alarm of type `HOLD` when the switching condition is not met anymore.
- Pressing **BRK** stops measurement and brings you back to the main menu. All alarms are switched to their de-energized state, independently of their programmed idle state.

20.7.3 Alarm Outputs in the Parameter Record

The configuration of the alarm outputs will be stored with the current parameter record (program branch SPECIAL FUNCTION). Thus, the configuration of the alarm outputs will also be loaded when a stored parameter record is loaded.

20.7.4 Alarm Outputs during Transducer Positioning

When the positioning of the transducers begins (bar graph display), all alarms outputs switch to their programmed idle state.

If you return to the bar graph display during measurement, the alarms will switch back to their programmed idle state. An alarm output of the type HOLDING which has switched during the previous measurement will remain in its programmed idle state after completion of the transducer positioning if the switching condition is not met any more.

You can obtain the same result by pressing key **C** three time during measurement. The switching of the alarms into their programmed idle state is not indicated on the display.

20.7.5 Alarm Output during Measurement

Alarms with switching condition MAX or MIN will be updated once per second at most in order to avoid 'humming' (a permanently fluctuating measured value around the limit constantly triggering the alarm).

Alarms of type NON-HOLD will switch in their activated state for about 1 second when the switching condition is met.

Alarms with switching condition QUANTITY will immediately switch in their activated state when the totalizer value reaches or exceeds the limit.

Alarms with switching condition +⇨- -⇨+ (sign change) and type NON-HOLD will switch in their activated state for about 1 second with any change of flow direction.

Alarms with switching condition +⇨- -⇨+ (sign change) and type HOLD will switch in their activated state with the first change of flow direction and stay in this state. They can be switched back by pressing the key **C** three times.

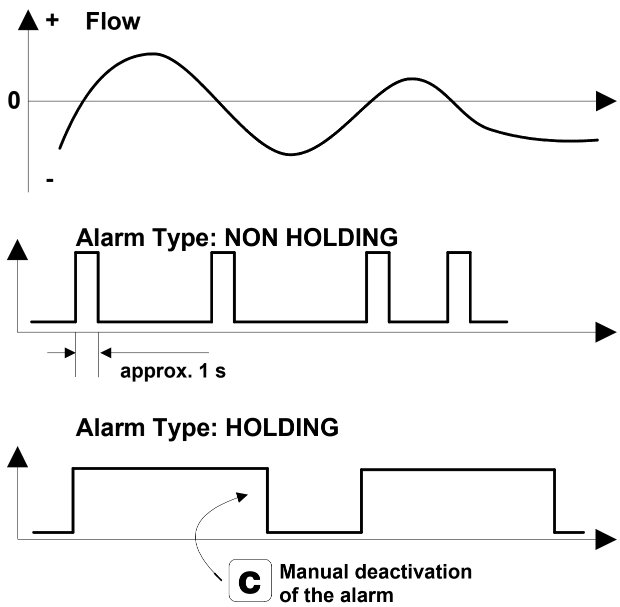


Fig. 20.2: Behavior of a relay when the flow direction changes

Alarms with switching condition ERROR will only switch in their activated state after several unsuccessful measuring attempts (the LED of the channel lights red). Therefore, typical short-term disturbances of the measurement as, for example, air bubble caused by pumps being switched on, will not activate the alarm. If the alarms are of type NON-HOLD, they will switch back as soon as a valid measured value is obtained (the LED of the channel lights green).

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.

Alarms with the switching condition `OFF` will automatically be set to the mode `NO CONT.` The alarm is de-energized.

20.7.6 Alarms' State

Note:	There are no visual or acoustic indication of alarm switching or resetting.

It is possible to have the state of the alarms displayed during measurement. This function can be activated in program branch `SPECIAL FUNCTION \ SYSTEM SETTINGS \ DIALOGS/MENUS`. This setting is coldstart resistant.

```
SHOW RELAIS STAT
 off         >ON<
```


Select the `SHOW RELAIS STAT` option. Select `ON` to activate the display of the alarms' state.

During measurement, press key DISP 9 to scroll on the first line of the display until you reach the alarm's state display.

The alarm's state is displayed in the following form:

RX = , where represents a pictogram (R1 = for example).

Table 20.8: Pictograms of the alarm's state display

	Nr.		Function	Type	Switching condition	Actual state
R		=				
	1		no function	NON-HOLD	NO (normally open)	CLOSED
	2		MAX	HOLD	NC (normally closed)	OPEN
	3		MIN			
			+ → - - → +			
			QUANTITY			
			ERROR			

20.8 Deactivating the Outputs

If you no longer require a programmed output, it can be deactivated. The configuration of the deactivated output is stored and will be available when the output is re-activated.

```
Alarm Output
>NO<         yes
```

Deactivate the outputs by selecting `NO` in the respective display of the program branch `OUTPUT OPTIONS`.

Confirm by pressing **ENTER**.

21 Troubleshooting

First Step: Which of the followings describes the best your problem?

a) **The display does not work at all or always goes out.**

Make sure that the correct voltage is available at the terminals of the instrument. The necessary voltage is indicated on the metal plate under the terminal strip where the power supply is connected.

If the power supply is ok, the transducers or an internal component of the transmitter are defective. Consult **EESIFLO**.

b) **The message "System Error" is displayed.**

Press **BRK** to return to the main menu.

If this happens several times, note the code displayed on the lower line of the display, write down in which situation the error occurred and contact **EESIFLO**.

c) **The flowmeter doesn't react when BRK is pressed during measurement.**

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

d) **The backlight of the display does not light on, but everything else works.**

The backlight is defective. Send the instrument to **EESIFLO** for repair. This problem has no influence on the other functions of the display.

e) **The date and time displayed are wrong and measured values are deleted when the flowmeter is switched off.**

The data backup battery must be replaced. Send the instrument to **EESIFLO**.

f) **A process output doesn't work.**

Make sure that the output is configured correctly. Control the function of the output as described in section 20.1.3. If the output is defective, contact **EESIFLO**.

g) **Measurement is impossible or the measured values substantially differ from the expected values.**

See section 21.1.

h) **The totalizer values are wrong.**

See section 21.6.

If any problem appears which cannot be solved with the help of this chapter, please contact **EESIFLO**, giving a precise description of the problem. Don't forget to specify the model, serial number and firmware version of your instrument.

Calibration

EESIFLO 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 instrument has been calibrated at the factory and usually, a re-calibration of the flowmeter won't be necessary.

However, a new calibration might be advisable if

- the contact surface of the transducers show visible wear
- or if the transducer were used for a prolonged period at a high temperature (many months at a temperature of more than 130°C for normal transducers or of more than 200°C for high temperature transducers).

In this case, the instrument will have to be sent to **EESIFLO** for calibration under reference conditions.

21.1 Problems with the Measurement

Which of the followings describes the best your problem?

a) **Measurement is impossible because no signal can be detected.** A question mark appears at the right side of the lower display line. If the instrument is equipped with LEDs, the LED of the channel shows red.

- First of all, make sure that the entered parameter are correct, especially the outer diameter of the pipe, the wall thickness and the sound velocity of the medium.

  (Typical errors: the circumference or the radius was entered instead of the diameter, the inner diameter was entered instead of the outer diameter.)
- Make sure that the transducer distance recommended by EESIFLO was respected when mounting the transducers.
- Make sure that the selected measuring point is adequate. See section 21.2.
- Try to obtain better acoustic contact between the pipe and the transducers. See section 21.3.
- Try to measure with a smaller number of transit paths. The signal attenuation might be too high because of a high fluid viscosity or of the presence of deposits on the inner pipe wall.
- See section 21.4 "Frequent Problems".

b) The measuring signal was found but no measuring value can be obtained.

- If an exclamation mark "!" is displayed at the right of the measuring units, the measured values are greater than the velocity limit and are thus invalid. The velocity limit should be adapted to the measuring situation or the velocity check should be deactivated (velocity limit = 0).
- If no exclamation mark "!" is displayed: Measurement is fundamentally impossible at the selected measuring point.

c) Loss of Signal during Measurement

- If the pipe ran empty, then filled up again, but no valid measuring signal could be obtained afterward, consult **EESIFLO**.
- Wait a little while until the acoustic contact is established again. There might be a temporary higher proportion of gaseous or solid particles in the flowing medium. If measurement does not resume, proceed as described in a).

d) Measuring values substantially differ from the expected values.

- Wrong measuring values are often caused by false parameters. Make sure the parameters entered are correct for the point at which you are measuring.
- If the parameters are OK, refer to section 21.5. It describes some typical situations in which wrong measuring values are obtained.

21.2 Correct Selection of the Measuring Point

- Make sure that the recommended straight pipe run to any disturbance source is respected. See Table 5.1.
- When measuring on horizontal pipes, the transducers should be mounted on the side of the pipes. Avoid locations where deposits are building in the pipe.
- The pipe should always be filled at the measuring point, and the liquid must flow upward.
- No bubbles should accumulate (even bubble-free liquids can form gas pockets at places where the liquid expands, e.g. especially behind pumps and where the cross-sectional area of the pipe extends considerably).
- Avoid measuring points in the vicinity of deformations and defects of the pipe or in the vicinity of weldings.

- Measure the temperature of the pipe at the measuring point and make sure that the transducer used are adequate for this temperature.

  Note: If the temperature at the measuring point is fluctuating, it is very important that the two inner hooks of the clasp are engaged in the tension strap. Otherwise, the pressure on the transducer will be insufficient when the temperature goes down. In case of strong temperature fluctuations, it is recommended to work with the special EESIFLO tensions straps with integrated spring which will compensate the diameter fluctuation caused by thermal expansion.

- Make sure that the pipe diameter is in the measuring range of the transducers.

21.3 Maximum Acoustic Contact

In order to obtain maximum acoustic contact between the pipe and the transducers, pay attention to the following points:

- At the measuring point, the pipe must be clean and free of loose paint or corrosion.

  Rust or other deposits absorb the acoustic signals. Clean the pipe at the measuring point. Remove rust or loose paint.

- Grind off any thick layer of paint.
- Always apply a bead of acoustic coupling compound lengthwise down the center of the contact surface of the transducers.
- Make sure that the mounting fixtures apply the necessary pressure on the transducers. There should be no air pockets between transducer surface and pipe wall.

21.4 Frequent Problems

Possible problem: The entered sound velocity might be wrong. The sound velocity is used by the flowmeter to determine the transducer distance and is therefore very important for transducer positioning. The sound velocities programmed in the flowmeter should only serve as orientation values. It might be necessary to have the sound velocity of the medium measured.

Possible problem: The value entered for the pipe roughness might be inappropriate. Reconsider the entered value, taking into account the state of the pipe.

Possible problem: Measurements on porous pipe materials (e.g. concrete or cast iron) are only possible under certain conditions. Consult **EESIFLO**.

Possible problem: Lined pipes might cause problem if the lining is not bonded correctly to the pipe wall or consists of a material which has bad acoustic characteristics. Try measuring on a linerfree section of the pipework.

Possible problem: Media with high viscosity strongly attenuate the ultrasonic signals. Measurements on media with viscosity higher than 1000 mm^2/s are only possible under certain conditions.

Possible problem: Particles scatter and absorb ultrasounds and therefore attenuate the signal. Measurement is hardly possible if the proportion of solid particles or gas bubbles is of 10% or more. If the latter is high, but less than 10%, measurements might be possible under certain conditions.

Possible problem: The flow might be in the transition range between laminar and turbulent flow where flow measurement is problematic. Calculate the Reynolds number of the flow at the measuring point (with the FluxFlow software for example), then consult **EESIFLO**.

21.5 Measurement Data Substantially Differ from the Expected Value

Possible causes for wrong measured values:

- The sound velocity for the medium is wrong.

  A wrong value of the sound velocity could lead the user to identify the ultrasonic signal that was reflected on the pipe wall and did not cross the medium as the measuring signal. The measured flow rate will then be very small or fluctuate around zero.

- There is gas in the pipe.

  If there is gas in the pipe, the measured volume flow rate will always be too high, since both the gas volume and the medium volume are being measured.

- The upper limit for the flow velocity is too low.

  The measured flow velocities that are greater than the defined upper limit are ignored and marked as outlier. All quantities derived from the flow velocity are equally ignored. If a certain number of correct measuring values are higher than the limit, the totalized values will be too small.

- The defined cut-off flow is too high.

  All flow velocities below the cut-off are set to zero, as well as all quantities derived from these flow velocities. To measure at small flow velocities, the cut-off flow (default value 5 cm/s) must be set to an appropriate value.

- The pipe roughness is inappropriate.
- The flow velocity to be measured is outside the measuring range of the transmitter.
- The measuring point is inadequate.

  Try measuring somewhere else on the pipework and see if the results are better. The cross-section of the pipe is never perfectly circular and this influences the flow profile. Change the position of the transducers relative to the deformation of the pipe.

21.6 Problem with the Totalizers

- If the totalizer values are too big:

  Check `SPECIAL FUNCTIONS\SYSTEM SETTINGS\MEASURING\QUANTITY RECALL`.

  If this option is activated, the totalizer value of a measurement is saved. The totalizer will take this value at the start of the next measurement.

- If the totalizer values are too small:

  One of the totalizers might have reached the internal limit. It must be reset to zero manually.

- If the output of the sum of the totalizers is not correct:

  Check `SPECIAL FUNCTIONS\SYSTEM SETTINGS\MEASURING\QUANT. WRAPPING`.

The output of the sum of both totalizers via a process output is not valid after the overflow (wrapping) of one of the respective totalizers.

A Specifications

Specifications are subject to modifications without prior notice.

EESIFLO 6000

Measuring

Measuring principle:	Ultrasonic time difference correlation principle
Flow velocity:	(0.01 to 25) m/s
Resolution:	0.025 cm/s
Repeatability:	0.25% of reading ± 0.01 m/s
Accuracy	(for fully developed, rotationally symmetrical flow profile)
- Volume flow:	± 1% to 3% of read. ± 0.01 m/s depending on application ± 0.5% of reading ± 0.01 m/s with process calibration
Measurable fluids:	all acoustically conductive fluids with < 10% gaseous or solid content in volume

Transmitter

Enclosure	
- Weight:	approx. 3.9 kg
- Degree of protection:	IP54 acc. to EN60529
- Material:	Aluminum, powder coated
- Dimensions: (WxHxD)	(270 x 100 x 180) mm (without handle)
Measuring channels:	2
Power supply:	rechargeable battery (6 V/4 Ah) or external power supply (100-240) VAC
Operating time with battery:	>10 h
Display:	2 x 16 characters, dot matrix, backlit
Operating temperature:	-10°C to 60°C
Power consumption:	< 15 W
Signal damping:	(0 to 100) s, adjustable
Measuring cycle:	(100 to 1000) Hz (1 channel)
Response time:	1 s (1 channel), 70 ms opt.

Measuring functions

Quantities of measurement:	Volume and mass flow rate, flow velocity, heat flow rate
Totalizers:	Volume, mass, heat
Calculation functions:	Average/Difference/Sum
Operating languages	Czech, Danish, Dutch, English, French, German, Norwegian, Polish, Spanish

Data logger

Loggable values:	all measuring quantities and totalized values
Capacity:	>100,000

Communication

Interface:	RS232
Data:	actual meas. value, logged data, parameter records

Software EesiData

Function:	Downloading meas. data/parameter records, graphical presentation, conversion to other formats
Operating systems:	Windows™ 95,98,ME,NT,XP

Process inputs

All inputs are galvanically isolated from main device.	
Temperature	PT100 four-wire circuit
- Meas. range:	-50°C to 400°C
- Resolution:	0.1 K
- Accuracy:	± (0.2 K + 0.1% of reading)
Current	R_i= 50 Ω
- Meas. range:	active: (0 to 20) mA passive: (-20 to 20) mA
- Accuracy:	0.1% of reading ± 10 µA
Voltage	R_i= 1 MΩ
- Meas. range:	(0 to 1) V or (0 to 10) V
- Accuracy:	0 to 1 V: 0.1% of reading ± 1 mV 0 to 10 V: 0.1% of read. ± 10 mV

Process outputs

All outputs are galvanically isolated from main device.	
Current	active: Rext < 500 Ω
	passive: Uext < 24 V, Rext < 1kΩ
- Meas. range:	(0/4 to 20) mA
- Accuracy:	0.1% of reading ± 15 µA
Voltage	Ri = 500 Ω
- Meas. range:	(0 to 1) V or (0 to 10) V
- Accuracy:	0 to 1 V: 0.1% of reading ± 1 mV 0 to 10 V: 0.1% of read. ± 10 mV
Frequency	open collector: 24 V/4 mA totem pool: 5 V/4 mA
- Meas. range:	(0...1) kHz or (0...10) kHz
Binary	open collector: 24 V/4 mA reed contact: 48 V/0.1 A totem pool: 5 V/4 mA
as state output:	limit, sign change or error
as pulse output:	Pulse value: (0.01 to 1000) units Width: (80 to 1000) ms

Flow transducers (clamp-on)

Type M2N, M2E, M3N, M3E	
rated (possible) diameter range:	M2N,M2E: (50)100 to 2500 mm M3N,M3E: (50)100 to 6500 mm
Dimensions:	(60 x 30 x 33.5) mm
Material:	Enclosure: stainless steel Contact surface: PEEK (M2N) or Polyimid (M2E)
Operating temperature:	M2N,M3N: -30°C to 130°C M2E,M3E: -30°C to 200°C, for short periods up to 300°C
Deg. of protection:	IP65 acc. to EN60529, (M2N, M3N: contact EESIFLO for special IP68 versions)
Type Q3N, Q3E	
rated (possible) diameter range:	(10)25 to 400 mm
Dimensions:	(42.5 x 18 x 21.5) mm
Material:	Enclosure: stainless steel Contact surface: PEEK (Q3N) or Polyimid (Q3E)
Operating temperature:	Q3N: -30°C to 130°C Q3E: -30°C to 200°C, for short periods up to 300°C
Degree of protection:	IP65 acc. to EN60529, (for special IP68 version, contact EESIFLO)

Wall thickness probes

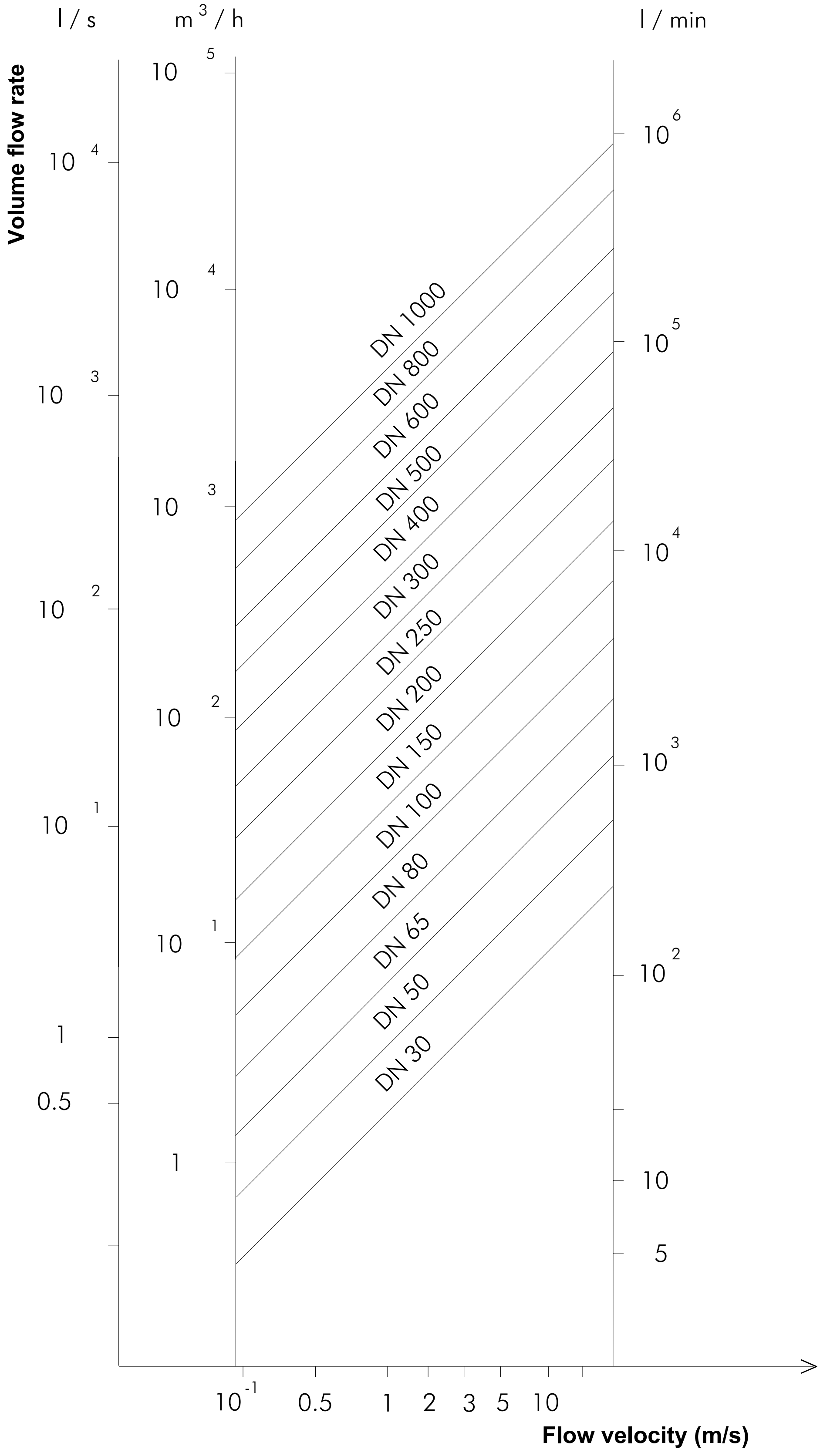
Measuring range:	(1.0 to 200) mm
Resolution:	0.01 mm
Linearity:	0.1 mm
Temperature range	
- Standard:	-20°C to +60°C
- High temperature :	0°C to +200°C, for short periods up to +540°C

Units of Measurement

Volume flow	Flow velocity	Mass flow	Totalizers		Sound velocity
			Volume	Mass	
m3/h	m/s	g/s	m3	g	m/s
m3/min	inch/s	t/h	l	kg	
m3/s		kg/h	gal**	t	
l/h		kg/min			
l/min		kg/s*			
l/s					
USgph					
USgpm					
USgps					
bbl/d					
bbl/h					
bbl/m					

*: only with firmware version 5.42 and higher
**: 1 gallon [US] = 3.78 l; 1 barrel = 42 gallons = 158.76 l

Flow Nomogram



B Overview of the Firmware

Overview of the Firmware (V5.XX)

Attention: The menu options described in gray cells are not necessarily activated!

Parameter	Measuring	Output Options	Special Function	Special Function (cont'd)
Channel	Time-prog. Meas.	Channel	**System Settings**	
Parameter from:	Meas. Point No.	Physical Quantity	**Proc. Outputs**	
Outer diameter	Profile corr.?	Unit	Install Output	
Wall Thickness	Sound Path	Temperature T1	Source channel	
Pipe material	Transd. Distance	Temperature T2	Source item	
c-Material		Damping	Output range	
Liner		Store Meas. Data No/Yes	Output MIN	
Liner material		Serial Output No/Yes	Output MAX	**Dialogs/Menus**
c-Material		Storage Rate	Error-value	Pipe Circumfer. On/Off
Liner thickness		Current Loop I#	**Storing**	Fluid Pressure On/Off
Roughness		Zero-Scale Val.	Storage Mode sample/average	Meas. Point No. 1234/<-->
Medium		Full-Scale Val.	Quantity Storage one/both	Sound Path Auto/User
c-Medium MIN		Error-value delay	Store Amplitude on/off	Transd. Distance Auto/User
c-Medium MAX		Voltage Output U#	Store c-Medium on/off	Steam in inlet On/Off
Kin. viscosity		Zero-Scale Val.	**Serial Transmiss.**	Time-progr. Meas. On/Off
Density		Full-Scale Val.	kill spaces	Error-val. delay Edit/Damp.
Temperature		Error-value delay	decimalpoint	Show relais stat On/Off
Pressure		Frequency Output F1	col-separat.	
TransducerType		Zero-Scale Val.	**Libraries**	
Transd. data		Full-Scale Val.	Material list factory/user	
Additional cable		Error-value delay	Medium list factory/user	**Measuring**
		Alarm Output R#	Format USER-AREA	Flow Velocity Normal/Uncor
		FUNC:	Materials:	Cut-Off Flow Sign/Absolute
		TYPE:	Media:	Cut-Off Flow User/Factory
		MODE:	Heat-Coeffs:	Cut-Off Flow
		R1 Input	Steam-Coeffs:	Velocity limit
		High Limit	Concentrat:	Heat Quantity
		Low Limit	Extended Library On/Off	Heat+flow quant. On/Off
		Quantity limit		Quant. wrapping On/Off
		Hysterese		Quantity recall On/Off
		Pulse Output		
		Pulse Value		
		Pulse Width		

C Reference

The content of the tables has been compiled to help the user. The accuracy of the given data depends on the composition, the temperature and the manufacturing process of the respective material. **EESIFLO** does not accept liability for possible inaccuracies.

Table B . 1: Sound velocity of some current pipe and lining materials at 20°C

You will find here the longitudinal and transversal sound velocities of some pipe and liner materials at 20°C. The gray underlayed values are not stored in the EESIFLO data bank. In the **flow** column, the sound velocity (longitudinal or transversal) used by EESIFLO for flow measurement is indicated. In the case of your particular measurement problem, remember that the sound velocity depends on the composition and on the manufacturing process of the material. The sound velocity of alloys and cast material will fluctuate over a certain range, the velocity given here should in such a case be understood as an orientation value.

Material	c_{trans} **[m/s]**	c_{long} **[m/s]**	c_{flow}	**Material**	c_{trans} **[m/s]**	c_{long} **[m/s]**	c_{flow} **[m/s]**
Aluminum	3100	6300	trans	Platinum	1670		trans
Asbestos cement	2200		trans	Polyethylene	925		trans
Bitumen	2500		trans	Polystyrene	1150		trans
Brass	2100	4300	trans	PP	2600		trans
Carbon steel	3230	5800	trans	PVC		2395	long
Copper	2260	4700	trans	PVC hard	948		trans
Cu-Ni-Fe	2510		trans	PVDF	760	2050	long.
Ductile iron	2650		trans	Quartz glass	3515		trans
Glass	3400	4700	trans	Rubber	1900	2400	trans
Grey cast iron	2650	4600	trans	Silver	1590		trans
Lead	700	2200	long	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
Plastic	1120	2000	long	Titanium	3067	5955	trans

Table B . 2: Typical roughness coefficients for pipes

For your convenience, we have already pre-programmed common roughness coefficients for pipe materials. The data are based upon experience with measurements performed with these pipe materials.

Pipe wall material	Absolute roughness [μm]			Pipe wall material	Absolute roughness [μm]		
Drawn pipes of non-ferrous metal, glass, plastics and light metal	0	...	1.5	Cast iron pipes			
Drawn steel pipes	10	...	50	• bitumen lining	120	...	
fine-planed, polished surface	up to	...	10	• new, without lining	250	...	1000
planed surface	10	...	40	• rusted	1000	...	1500
rough-planed surface	50	...	100	• encrusted	1500	...	3000
Welded steel pipes, new	50	...	100				
long usage, cleaned	150	...	200				
lightly and evenly rusted	up to	...	400				
heavily encrusted	up to	...	3,000				

Table B . 3: Typical properties of media at T=20°C and p=1 bar

Medium	Sound velocity [m/s]	Kinematic viscosity [mm^2/s]	Density [g/cm^3]
30% Glycol / H_2O	1671	4.0	1.045
50% Glycol / H_2O	1704	6.0	1.074
80% Sulphuric acid	1500	3.0	1.700
96% Sulphuric acid	1500	4.0	1.840
Acetone	1190	0.4	0.790
Ammonia	1660	1.0	0.800
Petrol	1295	0.7	0.880
BP Transcal LT	1415	13.9	0.740
BP Transcal N	1420	73.7	0.750
$CaCl_2$ -15 C	1900	3.2	1.170
$CaCl_2$ -45 C	2000	19.8	1.200
Cerium solution	1570	1.0	1.000
Ethyl ether	1600	0.3	0.716
Glycol	1540	17.7	1.260
H_2O-Ethan.-Glyc.	1703	6.0	1.000
HLP32	1487	77.6	0.869
HLP46	1487	113.8	0.873
HLP68	1487	168.2	0.875
ISO VG 22	1487	50.2	0.869
ISO VG 32	1487	78.0	0.869
ISO VG 46	1487	126.7	0.873
ISO VG 68	1487	201.8	0.875
ISO VG 100	1487	314.2	0.869
ISO VG 150	1487	539.0	0.869
ISO VG 220	1487	811.1	0.869
Copper sulphate	1550	1.0	1.000
Methanol	1121	0.8	0.791

Medium	Sound velocity [m/s]	Kinematic viscosity [mm^2/s]	Density [g/cm^3]
Milk 0.3% fat	1511	1.5	1.030
Milk 1.5% fat	1511	1.6	1.030
Milk 3.5% fat	1511	1.7	1.030
Oil	1740	344.8	0.870
Quintolubric 200	1487	69.9	0.900
Quintolubric 300	1487	124.7	0.920
R134 Freon	526	1.0	1.000
R22 Freon	563	1.0	1.000
Hydrochloride acid 37%	1520	1.7	1.200
Sour cream	1550	50.0	1.000
Shell Thermina B	1458	74.5	0.863
SKYDROL 500-B4	1387	21.9	1.057
Toluene	1305	0.6	0.861
Vinyl chloride	900	---	0.970
Water	1482	1.0	0.999
Zinc powder suspension	1580	1.0	1.000
Tin chloride suspension	1580	1.0	1.000

Table B . 4: Chemical resistance of Autotex (keypad)

Autotex is resistant (acc. to DIN 42 115, part 2) to following chemicals for a contact time of more than 24 hours without visible modification:

<table>
<tr><td>Ethanol
Cyclohexanol
Diacetone alcohol
Glycol
Isopropanol
Glycerine
Methanol
Triacetin
Dowandol DRM/PM</td><td>Formaldehyde 37%-42%
Acetaldehyde
Aliphatic hydrocarbons
Toluol
Xylol
Diluent (white spirit)</td><td>1,1,1-Trichlorethane
Ethyl acetate
Diethyl ether
N-butyl acetate
Amyl acetate
Butylcellosolve
Ether</td></tr>
<tr><td>Acetone
Methyl-ethyl-ketone
Dioxan
Cyclohexanone
MIBK
Isophorone</td><td>Formic acid <50%
Acetic acid <50%
Phosphoric acid <30%
Hydrochloric acid <36%
Nitric acid <10%
Trichloroacetic acid <50%
Sulphuric acid <10%</td><td rowspan="2">Chlornatron <20%
Hydrogen peroxide<25%
Potash soft soap
Detergent
Tensides
Softener
Iron chlorides ($FeCl_2$)
Iron chlorides ($FeCl_3$)
Dibutyl Phthalat
Dioctyl Phthalat
Sodium carbonate</td></tr>
<tr><td>Ammonia <40%
Soda lye <40%
Potassium hydroxide <30%
Alcalicarbonate
Bichromate
Potassium hexacyanoferrates
Acetonitrile

Sodium bisulfate</td><td>Drilling emulsion
Diesel oil
Varnish
Paraffin oil
Castor oil
Silicone oil
Turpentine oil substitute
Dccon
Plane fuel
Gasoline
Water
Salted water</td></tr>
</table>

Autotex is resistant (acc. to DIN 42 115, part 2) to acetic acid for a contact time of less than 1 hour without visible damage.

Autotex is not resistant to following chemicals:

Concentrated mineral acids Concentrated alkaline solutions High pressure steam over 100°C	Benzyl alcohol Methylene chloride

Table B . 5: Properties of water with pressure p = 1 bar and saturation

T (°C)	p (bar)	ρ (kg m^{-3})	c_P (kJ kg^{-1} 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	∞

T Temperature

p Pressure

ρ Density

c_p Specific heat at constant pressure

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