User manual
deltawaveC-F

stationary ultrasonic flow and heat measuring

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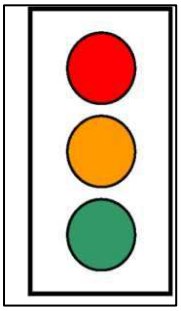
1. About this manual

You don't have much time for reading? Use the beacon!

You are a:



Newcomer ?

Advanced user ?

Professional ?

The chapter headings are appended red, orange, or green spots. These will help you in getting started with deltawaveC-F in no time at all.

Professional:
You already have professional knowledge of ultrasonic measuring systems? ->Set out with the deltawaveC-F Getting Started (separate attachment) ->You may also want to read the chapters that are marked with the green dot,

Advanced user:
You occasionally had the opportunity to handle ultrasonic measuring equipment?
-> Start with chapter 8.3 "Quick setup"
Start with the chapters that are marked with an orange spot. You may also want to continue reading the chapters with the green spot.

Newcomer:
You have never worked with an ultrasonic meter before?
Start at the first chapter. You will receive a step-by-step introduction to ultrasonic measuring technology.

⚠ The fields identified with an exclamation mark contain important information that relates to the basic data and operation of the device.

ℹ The fields identified with the letter “i” contain supplementary and helpful information.

Key aspects of deltawaveC-F:

- deltawaveC-F is a portable clamp-on ultrasonic flow meter for measuring liquids in filled piping systems.
- deltawaveC-F operates by the ultrasonic transit-time differential method
- Heat measurement is included as standard application. Optional clamp-on PT100 temperature sensors are available.
- deltawaveC-F can be operated in cordless mode as well as on a power adapter for operation with 100% duty cycle.
- The device supports measurements on piping with diameters from DN10 to DN6000 (depending on the sensor used)
- The media to measure may have a temperature range from -40°C to +150C (depending on the transducer used)
- You can save the measuring data to the internal SD card, read the data via USB port, and import this data using an office software such as MS Excel.
- The device is equipped with an electrically isolated relay output, as well as two 4mA to 20mA current outputs that can be operated in active and passive mode.

2. Approvals / CE

deltawaveC-F is compliant with the following European Directives and Standards

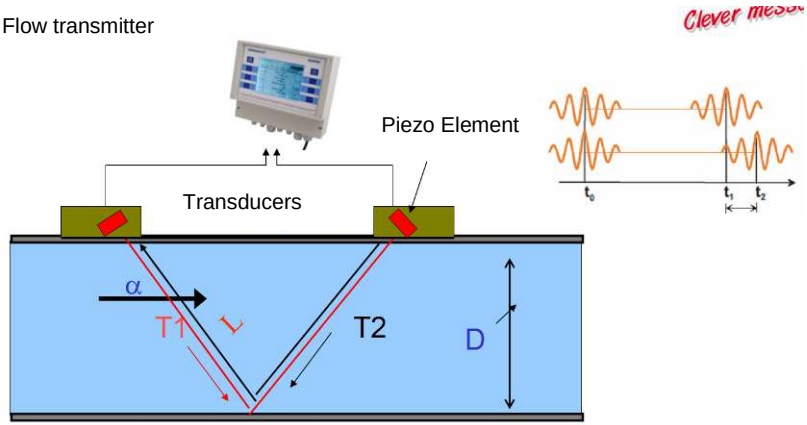
Test specifications

DIN EN 55011 B (11/2007)
DIN EN 61000-4-2 (09/2008)
DIN EN 61000-4-3 (06/2008)
DIN EN 61000-4-4 (07/2005)
DIN EN 61000-4-5 (06/2007)
DIN EN 61000-4-6 (10/2008)
DIN EN 61000-4-8 (12/2001)
DIN EN 61000-4-11 (02/2005)

Test requirements

DIN EN 61000-6-1 (10/2007)
DIN EN 61000-6-3 (09/2007)

3. Measuring Principle



Picture 1 Measuring Principle

deltawaveC-F employs the precise ultrasonic transit-time differential method. This method involves installation of two ultrasonic transducers on the surface of the piping and their interconnection with the electronic evaluation system. The ultrasonic transducers operate in alternating mode as transmitter and receiver with cyclic exchange of ultrasonic signals. Measurements cover the transit times of the upstream and downstream signals (t1, t2). The electronic circuit of deltawaveC-F measures the transit-time differential of the ultrasonic signals t1 and t2 that that travel upstream and downstream. These signals are accelerated (t1) or retarded (t2). The difference that develops between both signal transit times is proportional to flow velocity and is used on combination with the piping geometry data for precise calculation of the volumetric flow rate

$$\bar{v} = L\frac{(T2 - T1)}{T1 \cdot T2 \cdot 2\cos\alpha}$$

calculation of flow velocity [m/s]

$$Q = L\frac{(T2 - T1)}{T1 \cdot T2 \cdot 2\cos\alpha} \cdot \frac{D^2}{4} \cdot \pi$$

calculation of flow rate [m3/s]

The flow transmitter uses a sophisticated cross-correlation to detect signals. This ensures a reliable detection of signals even in case of harsh circumstances like gas and/or particle load.

4. deltawaveC-F and components

Picture 2 deltawaveC-F – With mounted ultrasonic transducers (bottom) and flow transmitters

Your deltawaveC-F essentially consists of the ultrasonic transducers and the flow transmitter that are mounted onto your piping.

4.1. deltawaveC-F flow transmitter

Picture 3 deltawaveC-F flow transmitter

The flow transmitter processes the signals and makes the measurement results available to the user.

4.2. Ultrasonic transducers

The ultrasonic transducers are mounted onto the piping and transmit and receive the ultrasonic signals that are used in the flow transmitter to calculate the volumetric flow rate.

Ultrasonic transducer XUC-FW 21 (2 MHz),
For pipe diameters DN10…DN100
Temperature: -40°C…150°C

Picture 4 Ultrasonic transducers type -F21

Ultrasonic transducer XUC-FW 20 (2 MHz),
For pipe diameters DN10…DN100
Temperature: -40°C…150°C

Picture 5 Ultrasonic transducers (types –F10 /-F20)

Ultrasonic transducer XUC-FW 10 (1 MHz),
For pipe diameters DN10…DN100
Temperature: -40°C…150°C

⚠	The ultrasonic transducer XUC-PW F20 was replaced by model type XUC-PW F21

Picture 6 Ultrasonic transducer type –F10

Ultrasonic transducer XUC-FW-F05 (0,5 MHz). For pipe diameters from DN200 to DN6000. Operating temperatures: -40 °C to 80 °C (150 °C optional on request)

Picture 7 Ultrasonic transducers type –F05

4.3. Mounting material and accessories

4.3.1. Signal cables

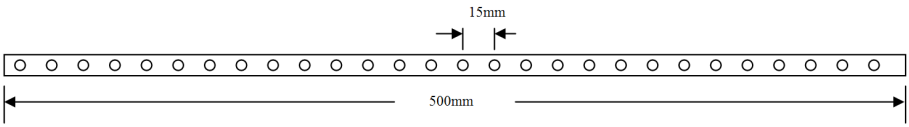
Signal cables are a part of the ultrasonic transducers and can not separated from transducers.

4.3.2. Spacer bar for transducer mounting

For transducers -F10/ -F21/- F20 spacer bars are available (Transducer XUC-FW-F05 is mounted on pipes using textile belts rather than spacer bar).

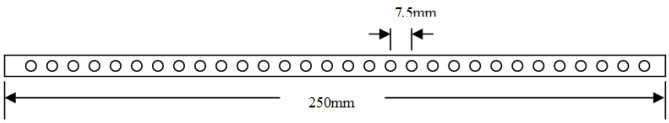
Spacer bar types	**F10**	**F20**	**F21**
Short (25 cm)			X
Long (40 cm)	X	X	

⚠	Space bar “long” is not compatible with ultrasonic transducer model XUC-PW F21



Picture 5 Spacer bar long for Transducer models –F10, -F20

⚠	Spacer bar „short“ is not compatible with ultrasonic transducer models XUC-PW-F20 and XUC-PW-F10 !



Picture 7 Spacer bar short for Transducer model –F21

4.3.3. Mounting belt (metal) for transducer mounting

Picture 6 Mounting belt (stainless steel)

Picture 7 Transducers mounted with spacer bar and mounting belts

4.3.4. Coupling grease

The ultrasonic coupling gel is applied between the ultrasonic transducer and the piping in order to optimize signal input.

4.3.5. PT100 Temperature sensors

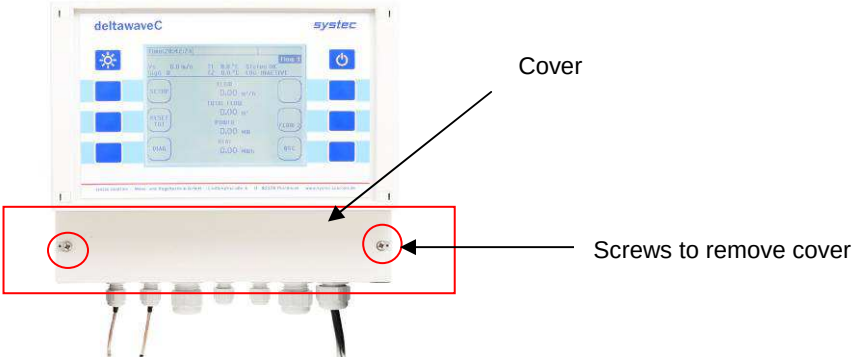
Picture 8 Clamp-on temperature sensors, Typ PT100

The clamp-on temperature sensors enable acquisition of temperature data in heating and cooling circuits. This data is then used to calculate heating and cooling quantities.

Picture 9 PT100 temperature sensor mounted with metal belt

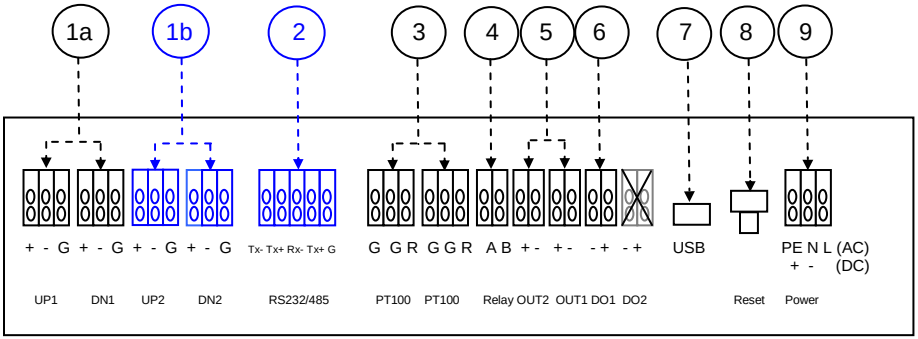
4.4. Interfaces of deltawaveC-F

Please open the cover to access the connecting terminals (see Picture 10)



Picture 10 Front view of deltawaveC-F showing cover

Connector- Board



Optional (please ask systec)

Picture 11 Connecting terminals of deltawaveC-F

1a Input for ultrasonic transducers

These terminals are for the connection of one pair of transducers (1 path, 1a). Connection of an additional path (1b) is possible as an option to measure 2 independent pipes or to make a two path measurement at one pipe (this “two channel version” will be available in 2012)

2 RS232/RS485 Interface boards

Digital Interface boards RS232 or RS485 are available as an option to provide digital communication via ASCI strings.

3 Input for temperature sensors PT100 (3- wire)

Here the two temperature sensors (feed and return pipe) can be connected in order to measure heat / thermal output. The flow transmitter always includes the capability for heat / thermal output measurement. Please note that (if required by customer) the PT100 inputs can be also used to reset deltawaveC-F’s counters. If you use this reset function you can not measure heat / thermal output at same time.

4 Relay output (potential-free)

This output is potential-free NO (normally open) relay output. With this output one might establish alarm (e.g. when exceeding a certain flow speed).

5 Analog output 4…20mA (active)

These 4…20mA outputs can be used to submit measurement data like flow, thermal output, velocity etc. to the PCS. These outputs are in active mode (supply voltage provided internally by flow transmitter)!

6 Digital output (OC, passiv)

There is one digital output (when having two channel version there will be two outputs (available in 2012) which is typically used as a counter (energy or volume). It is a transistor (open collector) output.

7 USB- Interface

To be used for firmware updates. Standard USB (microUSB)- cable required to connect to PC (not within systec's scope of supply)

8 Hardware Reset

Used to reset unit (e.g. when facing hang-ups).

9 Power Supply

Here you need to connect the supply voltage. deltawaveC-F is available as AC (90…240VAC) as well as DC (18…36VDC) version.

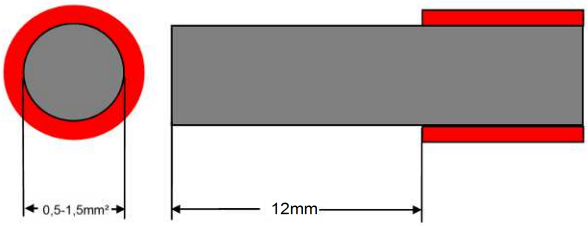
Attention!
Please always make sure to put the correct voltage to your deltawaveC-F. Improper supply voltage might seriously damage the flow transmitter. You can check the type of power supply at the name plate (printed on right side of enclosure of flow transmitter) as shown in this picture (here AC version 90…240VAC)

4.5. Wiring

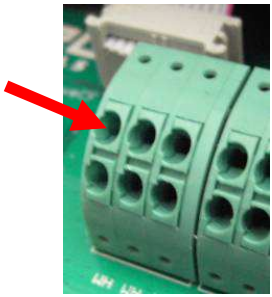
The connection terminals are located under the lower cover. Please open the two screws to remove plastic cover and to get access to connection terminals as shown Picture 12 Access the connection **terminals**.

Picture 12 Access the connection terminals

> Please use cables with a cross section of ca. 0.5…1.5mm². Cables should be dismantled about 12mm to allow proper contact to terminals.

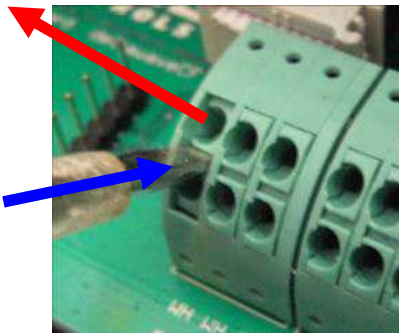


Please put the dismantled end of the related cable into the related hole. Cables will be held by spring. It might be useful to use cable end sleeves or to tin the cable ends.



Picture 13 Connection terminals – fasten cables

To unfasten cables please use screw driver (slotted) and press middle part between the two holes as shown in Picture 14 to loose the spring and to remove cables.



Picture 14 Connection terminals - Unfasten cables

4.6. Terminal Diagram

Terminals (as marked on green board)	Designation
UP1	Connection of upstream transducer Red cable to be connected to + Black cable to be connected to -
DOWN1	Connection of downstream transducer Red cable to be connected to + Black cable to be connected to -
UP2	Connection of upstream transducer (path2) Red cable to be connected to + Black cable to be connected to – [OPTIONAL WHEN USING 2 PATH VERSION (2012)]
DOWN	Connection of downstream transducer (path2) Red cable to be connected to + Black cable to be connected to – [OPTIONAL WHEN USING 2 PATH VERSION (2012)]
RS485	Optional Interface board
PT100	Please connect temperature sensors (measuring colder temperature) to left PT100 terminal WH = White cable from PT100 RD = Red cable from PT100
PT100	Please connect temperature sensors (measuring warmer temperature) to right PT100 terminal WH = White cable from PT100 RD = Red cable from PT100
Relay	Relay output, external voltage required
OUT1	Analog output1, 4…20mA, active, voltage provided internally
OUT2	Analog output2, 4…20mA, active, voltage provided internally
DO1	Digital output (Transistor), passive mode, external voltage required.
DO2	Optional, Digital output 2
Power Supply	Either DC (18…36VDC) or AC (90…240VAC). Please check order confirmation or name plate on flow transmitter to find out operating voltage.

Table 1 Terminal Diagram

⚠	**Attention!** - The 4…20mA outputs are set in active mode. That means the required voltage is provided by flow transmitter internally. DO NOT USE additional external voltage. - The digital output is set in passive mode and requires external voltage to be operated. - Relay is rated to max. 45V, 0.25mA. These values must not be exceeded.

4.7. Scope of supply basis package

- deltawaveC-F flow transmitter
- Ultrasonic transducer (as ordered by the customer)
- Spacer bar for the ultrasonic transducers (for types –F10 / -F20)
- Stainless steel mounting belts
- Getting Started ("Quick-start") manual
- CD with user manual
- Ultrasonic coupling grease

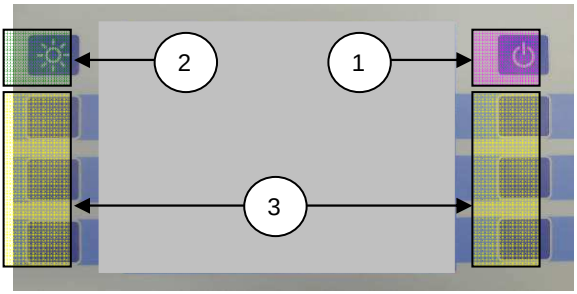
Other ultrasonic transducers for smaller or larger pipe dimensions, as well as clamp-on temperature sensors, are available on separate order. You can reach your personal contact partner on the Internet at www.systec-controls.de, or at the phone number +49 (0)89 80 90 60.

4.8. Saftey instructions

- The flow transmitter may not be operated outside the temperature range from -20°C to 60°C!
- The ultrasonic transducers are sensitive to mechanical stress such as impact and vibration. You should always safeguard the transducers against strong vibration or impact. Irreparable damage or destruction must be expected if you unintentionally drop the transducer!
- The plug-in power supply is suitable for operation in closed rooms only!
- The plug-in power adapter or the 230 V IEC power cable must be replaced completely in the case of mechanical or electrical damage!
- Information on operation in ATEX protected zones: The flow transmitter is generally not approved for operation in Ex / ATEX protection zones! The standard ultrasonic transducers are not approved for operation in Ex protection zones!
  Optional ultrasonic transducers for operation in ATEX protection zones are expected to be available towards the mid of 2012.
- The ultrasonic transducers may not be operated outside their specified media temperatures.

5. Operating

5.1. Control Buttons



1 Without function. NOT to switch on or off the flow transmitter. Flow transmitter will automatically start when connected to voltage supply.

2 switches the backlight On and Off

3 Multifunctional buttons: Use this button to select the function that is displayed next to it on the screen

.

5.2. How to navigate

Use the corresponding multifunctional buttons:

Arrow buttons for navigation

Confirms your entry

Confirms your entries and opens the next window

Returns you to the previous window

Increases the value

Reduces the value

Triggers the XYZ function (variable, depending on the application

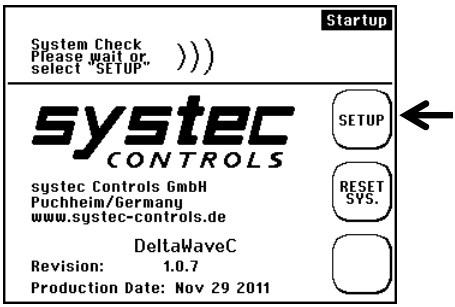
No function

6. Get started

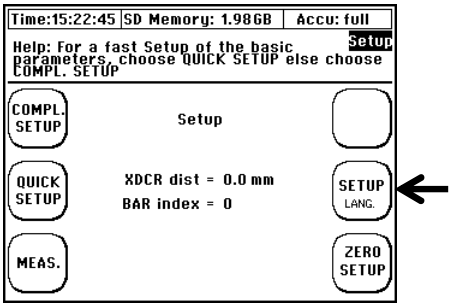
6.1. Basic settings, main menu, navigation

6.1.1. Setting language

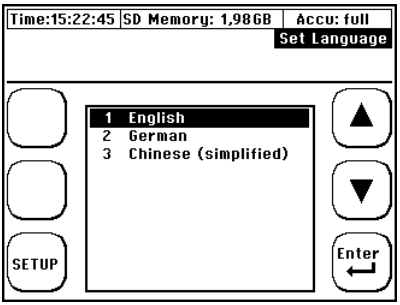
- Switch on the device. During the start sequence, press the multifunctional button that is located next to the "SETUP" field.



- Confirm the "SETUP LANG." button



- Use the arrows in the next window to select the dialog language. Confirm your entry with "Enter". Exit the menu with "SETUP

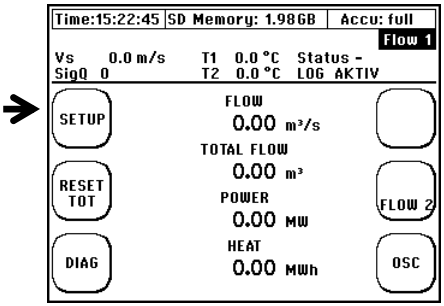


⚠ The language setting changes the language used in the menus. The language in the fields next to the multifunctional button remains more or less unchanged

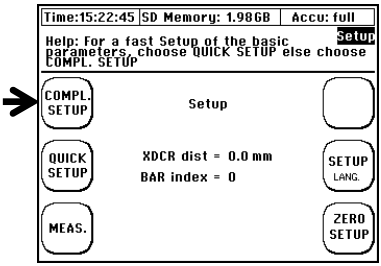
6.1.2. Navigation in main menu (flow 1)

The "Flow rate 1" measuring window is automatically opened with a delay of a few seconds after power on of the deltawaveC-F and display of the start screen. The "Flow 1" measuring window provides an overview of all data that is necessary for flow and heat measurements.

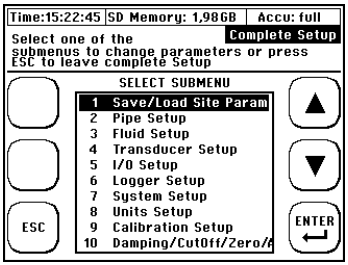
- Select "Setup“



- Select "COMPL Setup" once you can see the window“



- You are now in the main menu. You can select all necessary functions of the device in this menu.



- To return to the measuring window, proceed as follows: Select "ESC" -> "MEAS" in the next window

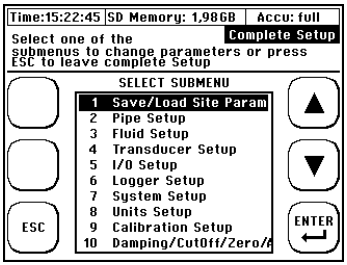
You have now learned the fundamentals for operating your deltawaveC-F .

You can accelerate access to the main menu after power on by way of a simple trick: select the start sequence "SETUP" directly after power on of the deltawaveC-F . Select "KOMPL SETUP" in the next window

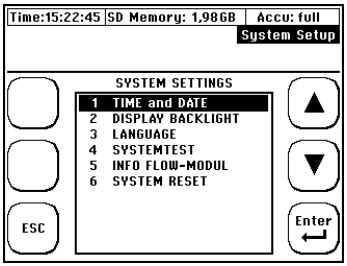
6.1.3. Setting the time and date

Once you selected the dialog language, the setup menu of the device will be opened

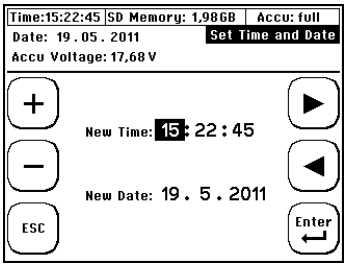
- Select the “System Setup” menu command using the arrow keys.



- Select the Time and Date menu command



Enter the time in the following notation **Hour (hh) : Minute (mm) : Second (ss)**. Enter the date in the following notation **Day (dd) : Month (mm) : Year (YYYY)**.

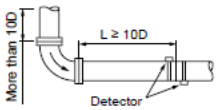
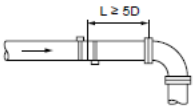
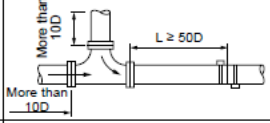
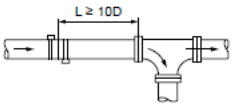
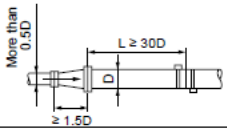
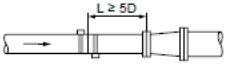
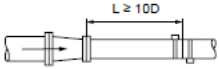
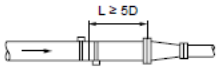
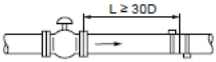
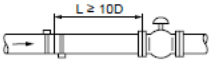
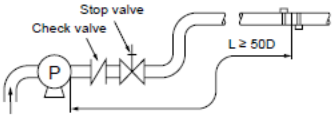


7. Preparing for measurement

The following section elaborates on essential aspects that must be taken into account for successful flow rate measurements.

7.1. Required straight runs

The selection of the mounting location has a significant impact on measurement quality. Particularly the charge and discharge area listed in the following table should be taken into account

Classification	For upstream side	For downstream side
90° bend		
Tee		
Diffuser		
Reducer		
Valves	 Flow control valve exists on upstream side.	 Flow control valve exists on downstream side.
Pump		

Picture 15 Straight run requirements

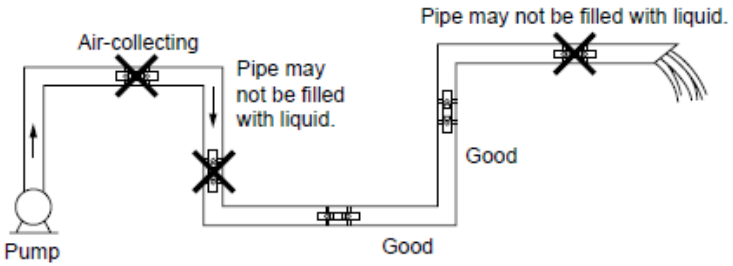
7.2. Mounting positions for transducers

7.2.1. Basics on the mounting of ultrasonic transducers

The pipe always has to be filled completely at the mounting positions of the ultrasonic transducers! It is not possible to take measurements on partially filled piping

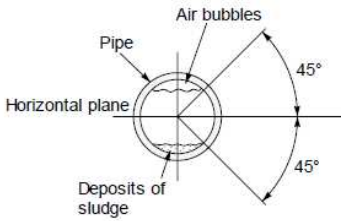
The ultrasonic transducer can be operated in any mounting position. However, conformation with the mounting positions shown below is mandatory: The drawing shows the side view of the piping

7.2.2. Mounting ultrasonic transducers on horizontal piping



Picture 16 Preferable mounting positions for ultrasonic transducers (1)

On horizontal piping, it is recommended to mount the transducer with an offset of approx. +/-45% to the horizontal plane. This is based on the fact that there is a risk of the accumulation of bubbles in the upper section and sedimentation in the lower section of the pipe.



Picture 17 Preferable mounting positions for ultrasonic transducers (2)

deltawaveC-F uses the cross section of the pipe to calculate the flow. The cross section is calculated from the parameterized inner diameter (user setting). If you have sedimentation in your pipe which decreases the real inner diameter you might get a (usually very small) uncertainty. Same happens when inner diameter is not known / estimated.

$$Q = L \frac{(T2 - T1)}{T1 \cdot T2 \cdot 2\cos\alpha} \cdot \frac{D^2}{4} \cdot \pi$$

If you usually want to measure pipes with unknown / undocumented wall thicknesses we would recommend to use a wall thickness gauge to precesily measure the wall thickness. systec is offering the wall thickness gauge deltawaveC-F-WD. Please ask you systec dealer for further information or visit us at www.systec-controls.de

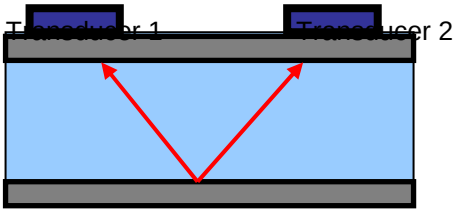
7.2.3. Ultrasonic transducers on non-planar surface

You should never mount the transducers on non-planar surfaces such as welding seams or deformations. You should always try to remove thick and uneven protective paint coating from the piping area where the ultrasonic transducers are to be mounted.

7.3. Mounting ultrasonic transducers

This chapter informs you of the options for mounting the ultrasonic transducers. The V-mode is standard for most applications.

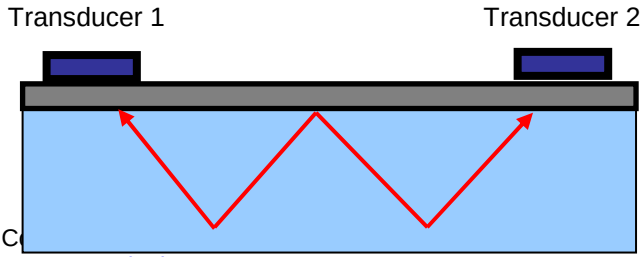
7.3.1. V-Mode



Picture 18 Mounting of transducers in V-mode

In the so-called V-mode, both ultrasonic transducers are mounted onto the same side of the pipe. This mode is the standard for small and medium pipe dimensions. The ultrasonic signals are reflected from the pipe wall.

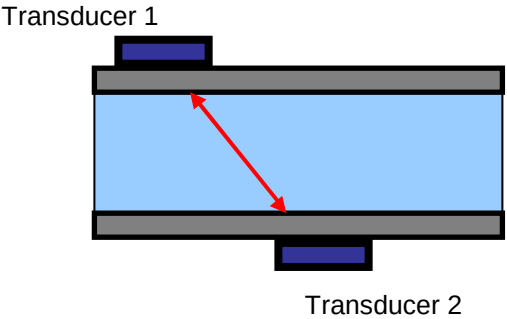
7.3.2. W- Mode



Picture 19 Mounting of transducers in W-mode

The W-mode is a special method for mounting the ultrasonic transducers. This method is usually employed on small to very small piping.

7.3.3. Z- Mode



Picture 20 Mounting of transducers in Z-mode

The Z-mode is a special method for mounting the ultrasonic transducers. In comparison to the V- and W-mode, the signal is transmitted across a shorter distance with this installation method. It is normally used for measurements in large-scale piping systems, or where the system is filled with heavily contaminated or gas-loaded media.

8. Measuring with deltawaveC-F

5 steps to flow measurement:

- Look for a suitable location for mounting the ultrasonic transducers
- Parameterize your deltawaveC-F
- Mount the ultrasonic transducers onto the piping
- Perform a zero calibration
- Start the flow measurement

8.1. Parameterization

8.1.1. Fundamentals of parameterization

The Parameterization chapter defines the input of all data that is necessary for flow measurement.

- **"QUICK SETUP":** The Quick Setup guide offers step-by-step instructions on the essential tasks you have to complete for deltawaveC-F parameterization. This Quick Setup is quite sufficient for handling most applications and gets you started with fast and efficient parameterization in no time at all.

- **"CMPL SETUP":** The complete setup function enables access to all options and expert settings.

8.2. What needs to be parameterized?

- The pipe's outer diameter or circumference.
- The wall thickness of the pipe. The material and thickness of the pipe lining, if such lining exists.
- The pipe material
- The medium
- The type of ultrasonic transducers
- The mounting mode for the ultrasonic transducers

8.3. Parameterizing with Quick Setup

Ultrasonic measurement is based on the signal transit time process. The ultrasonic signals penetrate the piping and the medium. In order to calculate the signal transit time, each medium, piping material and existing lining will be assigned a sonic speed value, as well as the pipe diameter or circumference value. The tabular database of deltawaveC-F specifies the sonic speed values for the materials and media. The sonic speed for materials not listed in the tables has to be entered manually. Tables that list additional sonic speed parameters for different materials are available in the annex to these operating instruction

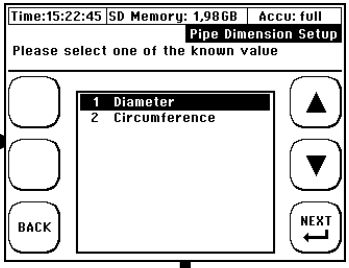
How to access the parameterization dialog:

After power on: Select "Setup" -> "Quick Setup" within the start sequence.
In the primary measuring window "Flow 1": Select "Setup" -> "Quick "Setup".

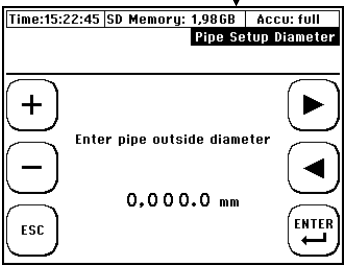
Start

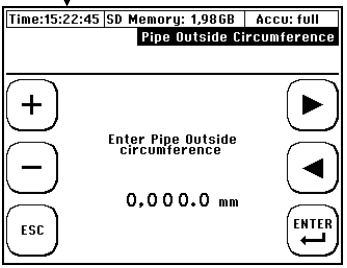
1

Specify whether to enter the pipe circumference or outer diameter



OR



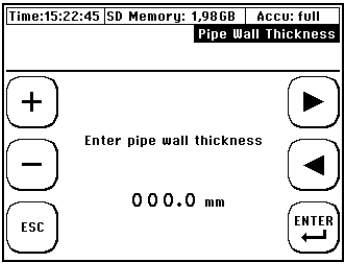


Enter the outer diameter

Enter the diameter

Enter the pipe's wall thickness

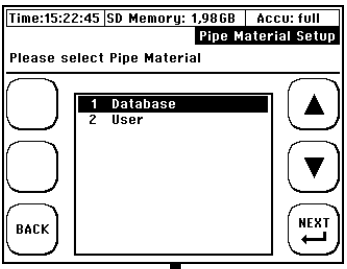
2



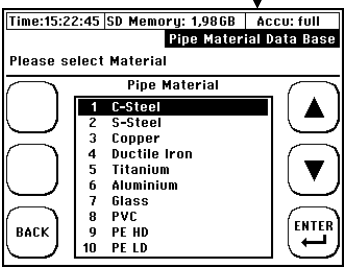
It is advisable to use a wall thickness meter if you do not know this parameter.

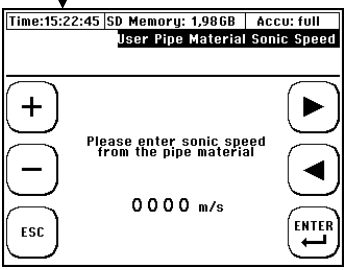
3

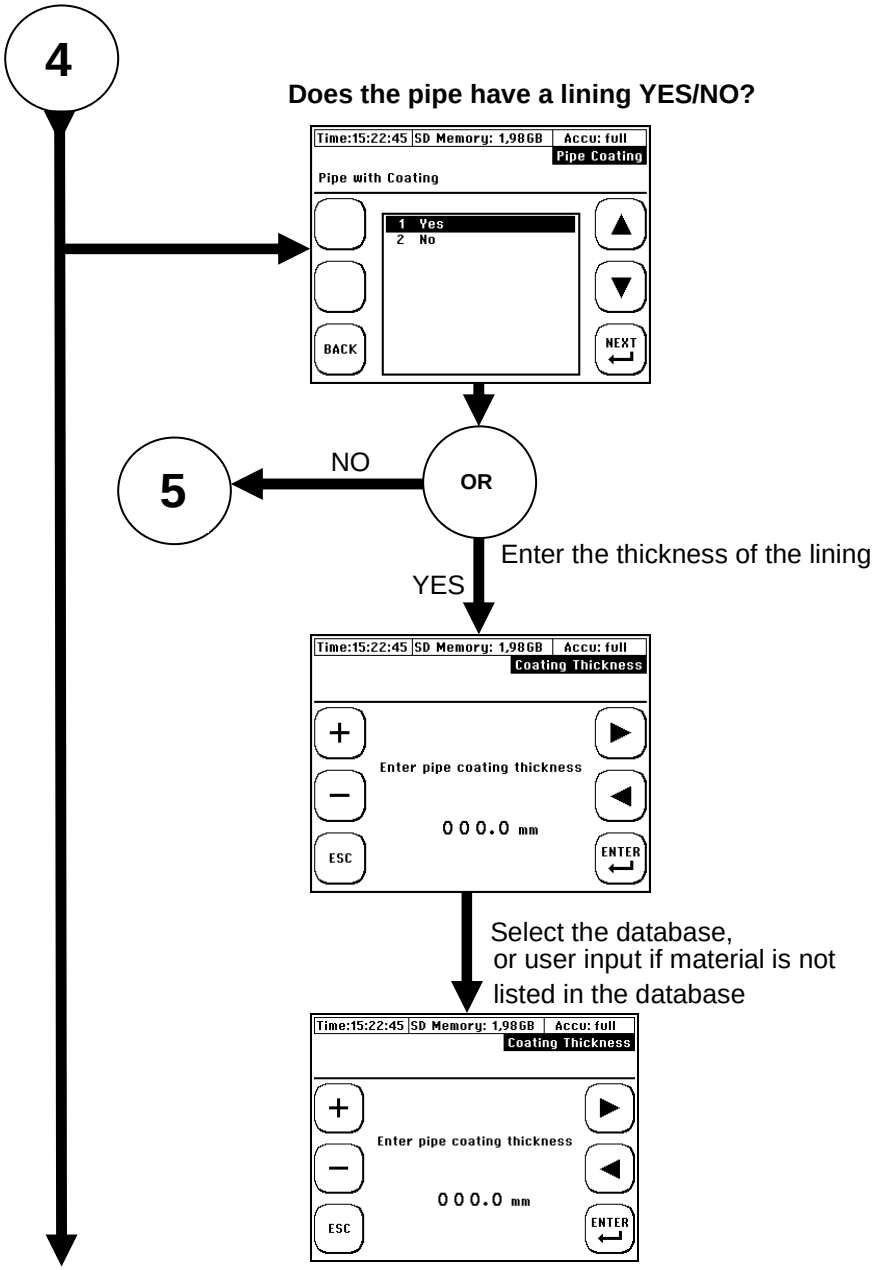
Choose pipe material

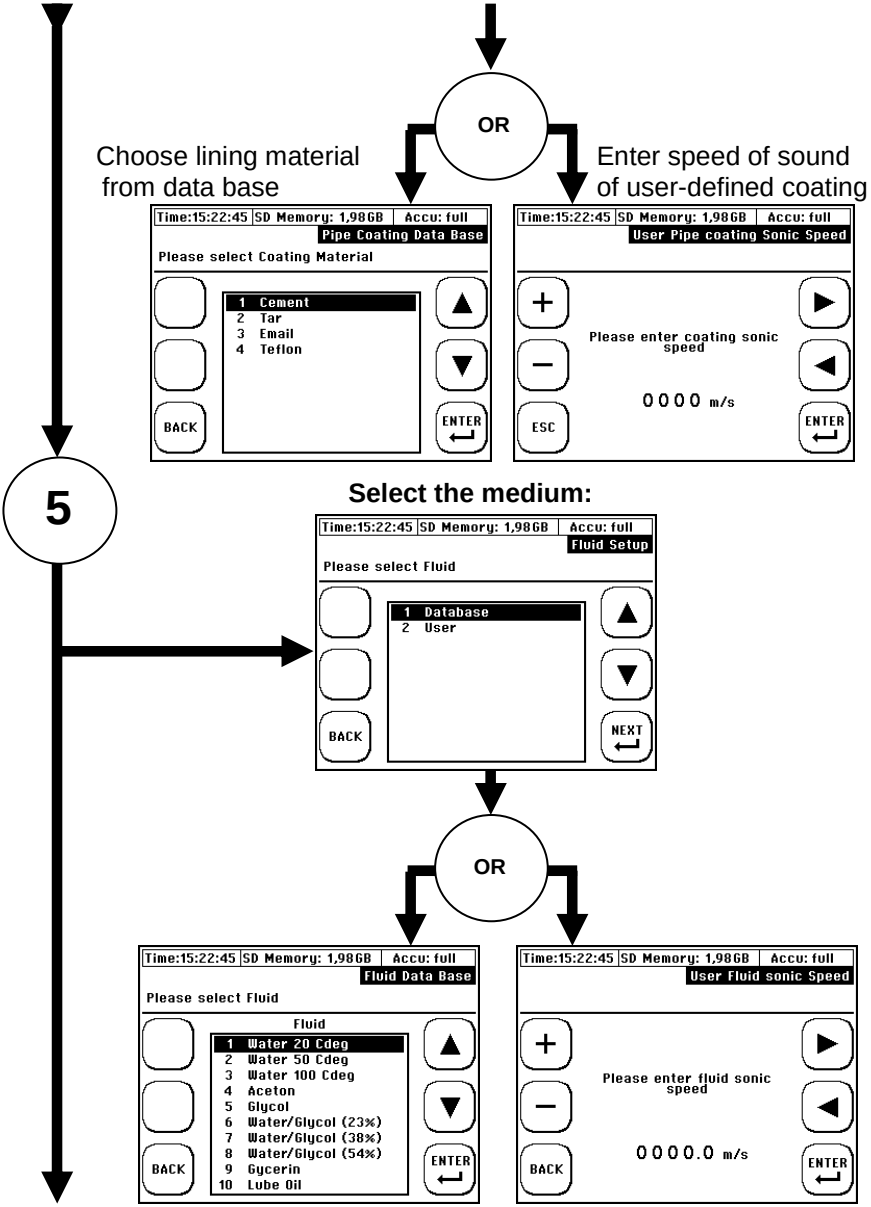


OR

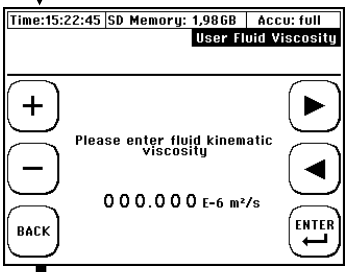




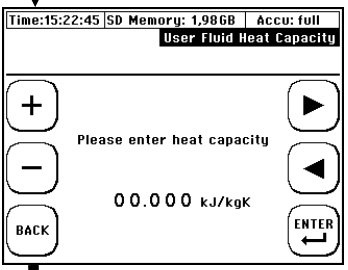

4
Does the pipe have a lining YES/NO?
Time:15:22:45
SD Memory: 1,98GB
Accu: full
Pipe Coating
Pipe with Coating
1 Yes
2 No
BACK
NEXT
OR
NO
5
YES
Enter the thickness of the lining
Time:15:22:45
SD Memory: 1,98GB
Accu: full
Coating Thickness
Enter pipe coating thickness
000.0 mm
ESC
ENTER
Select the database,
or user input if material is not
listed in the database
Time:15:22:45
SD Memory: 1,98GB
Accu: full
Coating Thickness
Enter pipe coating thickness
000.0 mm
ESC
ENTER


OR
Choose lining material from data base
Enter speed of sound of user-defined coating
Time:15:22:45 SD Memory: 1,98GB Accu: full
Pipe Coating Data Base
Please select Coating Material
1 Cement
2 Tar
3 Email
4 Teflon
BACK
ENTER
Time:15:22:45 SD Memory: 1,98GB Accu: full
User Pipe coating Sonic Speed
Please enter coating sonic speed
0000 m/s
ESC
ENTER
5
Select the medium:
Time:15:22:45 SD Memory: 1,98GB Accu: full
Fluid Setup
Please select Fluid
1 Database
2 User
BACK
NEXT
OR
Time:15:22:45 SD Memory: 1,98GB Accu: full
Fluid Data Base
Please select Fluid
Fluid
1 Water 20 Cdeg
2 Water 50 Cdeg
3 Water 100 Cdeg
4 Aceton
5 Glycol
6 Water/Glycol (23%)
7 Water/Glycol (38%)
8 Water/Glycol (54%)
9 Gycerin
10 Lube Oil
BACK
ENTER
Time:15:22:45 SD Memory: 1,98GB Accu: full
User Fluid sonic Speed
Please enter fluid sonic speed
0000.0 m/s
BACK
ENTER

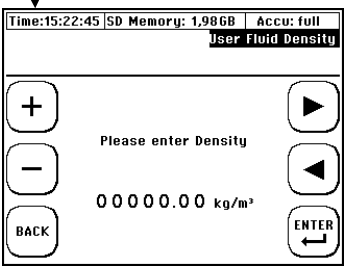
Enter the kinematic viscosity of the medium:



Enter the thermal capacity of the medium

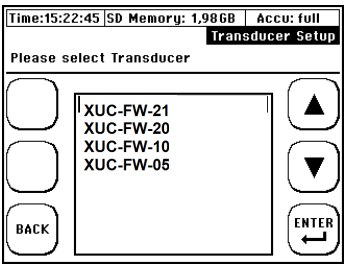


Enter the density of the medium:



6

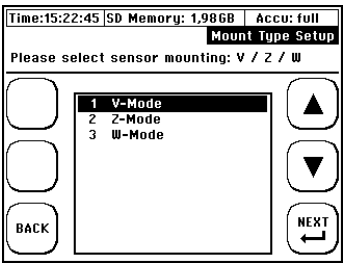
Select a suitable ultrasonic transducer



For information on suitable transducers for specific pipe dimensions, refer to chapter **"deltawaveC-F and components** ".

7

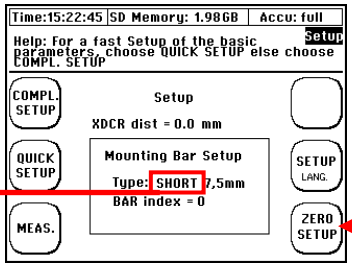
Select a suitable mounting mode



For information on suitable transducers for specific pipe dimensions, refer to chapter **"deltawaveC-F and components** .

8

Output of the distance between the ultrasonic transducers:



Before you start measuring we highly recommend a zero setup (if possible)

Important !

Please pay attention which spacer bar type is displayed.
Short=25cm long, distance between two boreholes is 15mm.
Long=50cm long, distance between two boreholes is 7,5mm.

The spacer bar type “short” could only be used in combination with ultrasonic transducer type XUC-PW-F21.
The spacer bar type “long” could only be used in combination with ultrasonic transducers type XUC-PW-F20 and XUC-PW-F10.

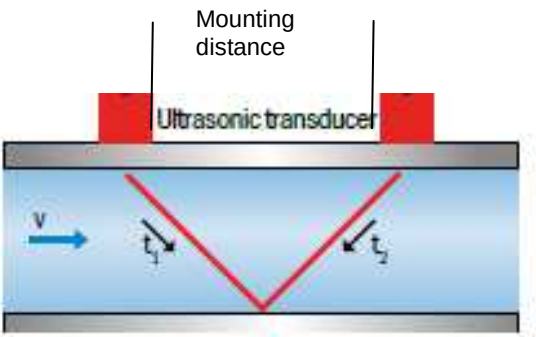
END

The distance between transducers is specified in millimeters and always measured between the faces of transducers 1 and 2. These dimensions are independent of the selected mounting mode.

8.4. Mounting distance

The distance between the ultrasonic transducers is always measured between their opposing surfaces in all mounting modes. Once you have completed the parameterization of the measuring point, the flow transmitter displays the distances that have to be set up using a measuring tape. When using a spacer bar in the so-called V-mode, you can position the transducers conveniently by means of the spacer bar.

8.4.1. V-mode and W-mode

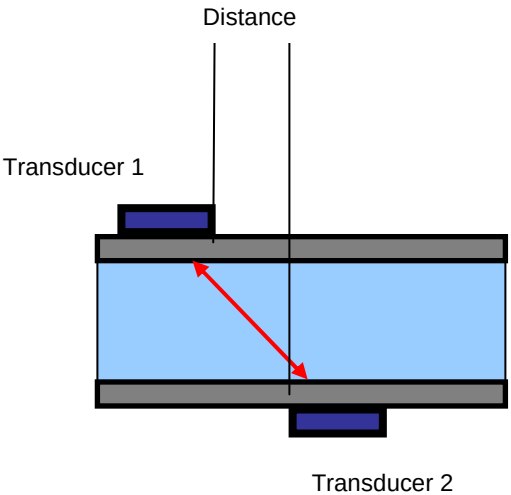


Picture 21 Mounting of ultrasonic transducers V-mode

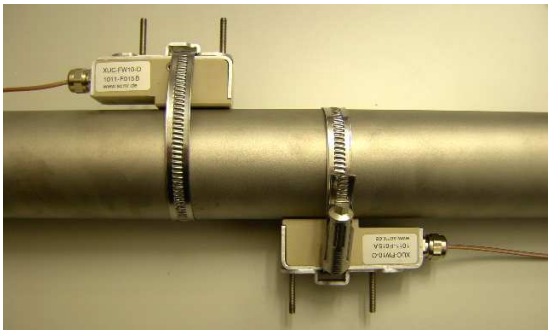
Picture 22 Example of the V- or W-mode with spacer bar

Picture 23 Example of the V-mode mount with fabric-reinforced tensioning tapes for large pipe diameters

8.4.2. Installation at Z- Mode



Picture 24 Mounting of ultrasonic transducers Z-mode



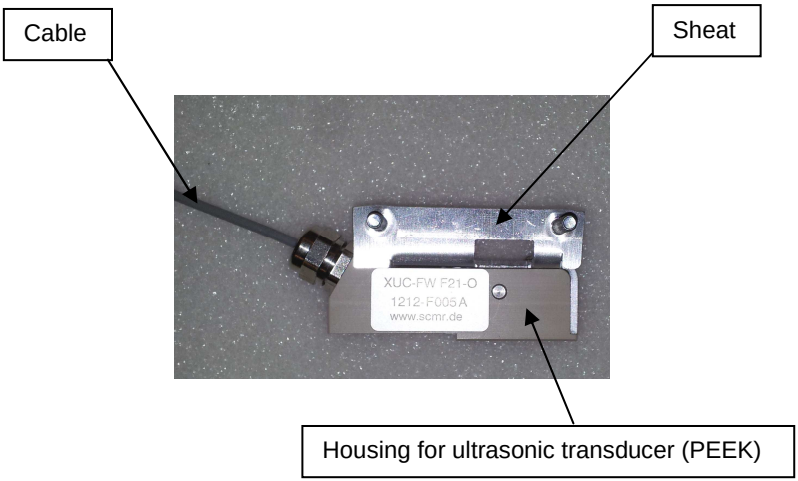
Picture 25 Mounting of ultrasonic transducers in Z-mode using mounting chains

Picture 26 Example of Z-mode installation with fabric-reinforced tensioning tapes for large pipe diameters

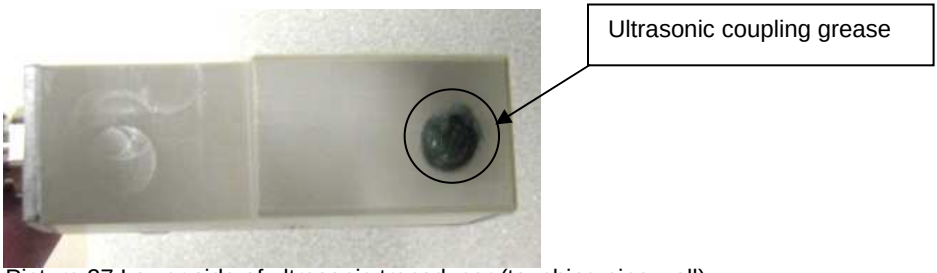
8.4.3. Introduction in ultrasonic transducer mounting

Basic structure of the ultrasonic transducer:

The ultrasonic transducer (-F10 and- F20/-F21) consists of a transducer carrying element and the actual ultrasonic transducer. The ultrasonic transducer is made of plastic (PEEK) that has a beige colour and is protected by means of a metal sheath. The sheat has two threaded bars ontop which prepares the transducer for use of spacer bar. The ultrasonic transducer type F05 consists only of the sensor sheath and the actual ultrasonic transducer.



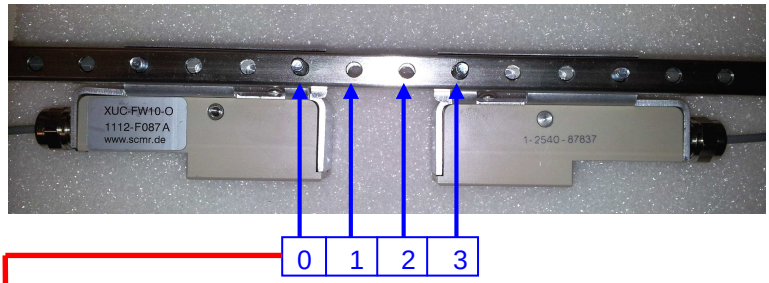
Picture 27 shows the back side of the transducer. Some coupling grease (app. size of a peanut) has to be put at the part which touches the pipe wall after installation.



Picture 27 Lower side of ultrasonic transducer (touching pipe wall)

8.4.4. Mounting in V-mode or W-mode

Once you have completed parameterization of the measuring point the flow transmitter displays the distance between the transducers units in mm (face to face) as number of grid holes for use of the spacer bar (ultrasonic transducers type F10 and F20). Grid number 3, for example, means two free **grid holes between the ultrasonic transducers.** Install the transducers on the spacer bar as shown in the figure. Secure the transducers on the spacer bar using the knurled screws (B).

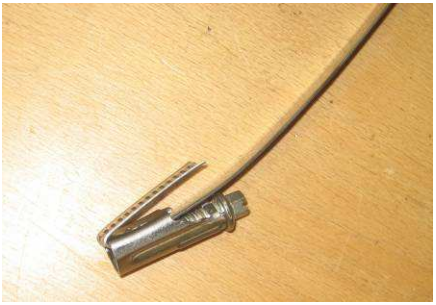


Picture 28 Using spacer bar – grid holes numbering, Example bar index = 3

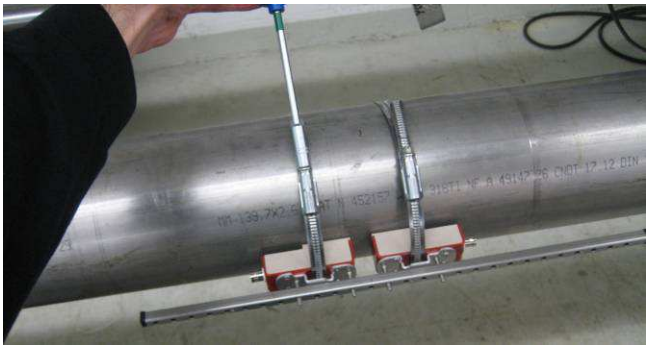
Will be used the wrong spacer bar (short or long version) the measurement will fail or you will got wrong measurement values !

8.4.5. Fix transducers at pipe using mounting chains

The transducers are mounted by using the metal tension belts. The length of the belts are related to the max. pipe size of the corresponding transducer (e.g. when using –F10 (DN32…DN400) size of belt is suited for max. DN400). If you use the same transducer for smaller pipes you can shorten the belts. The belts are fastend by a tightener (**Picture 29**) which can be tighten by using a screw driver (**Picture 30**). Please



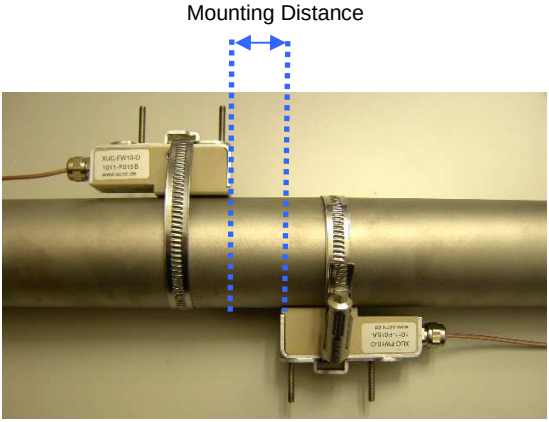
Picture 29 Tightener for metal tension belts



Picture 30 Tighten metal belts with screw driver

8.4.6. Mounting the ultrasonic transducers based on the Z method

As shown in chapter 7.3.3 the mounting of transducers in Z-Mode might be useful for bigger pipes and/or applications with low signals strengths (high particle / gas load). When using Z-mode the spacer bar can not be used since the two transducers are located on the opposite sides of the pipe. The distance between the transducers ("mounting distance") depends on application (mainly pipe size). In Picture 1 the principle is illustrated. The following chapters shows you how to place the transducers correct

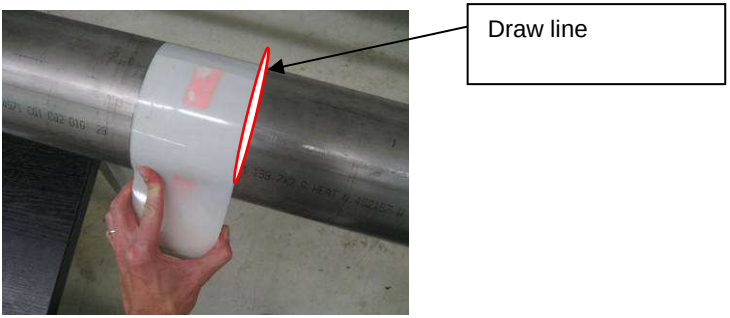


Picture 31 Transducers mounted in Z-Mode

Use a plastic or paper template to mark the mounting positions. The example shows how to mark the positions using a plastic template.

- Wrap the plastic template once around the pipe at the mounting position of the first ultrasonic transducer (transducers face has to be in line with the line to be drawn).
- Using a felt tip pen, draw a line on the pipe along the template (corresponds with the pipe circumference)

Picture 32 Attaching plastic template



Picture 33 Attaching plastic template 2

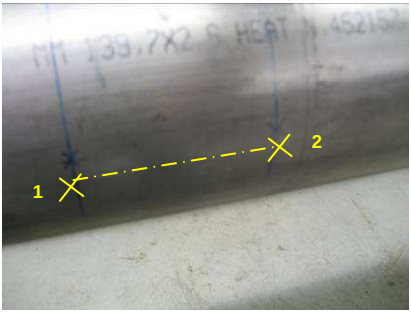
Picture 34 Pipe with first mounting line for first transducer

- On successful completion of parameterization, your deltawaveC-F displays the axial distance between the ultrasonic transducers (transducer distance). Measure the transducer distance based on the value displayed on your deltawaveC-F , starting from the first line drawn to the position at which the second line is to be drawn (mounting position for face of the second transducer).

Picture 35 Measure required distance (given by flow transmitter)

Picture 36 Set up the template to mark the mounting position of the second transducer

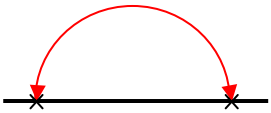
- Draw two crosshairs on the same axis, centered on the lines drawn with the help of the template..



Picture 37 Auxiliary marks

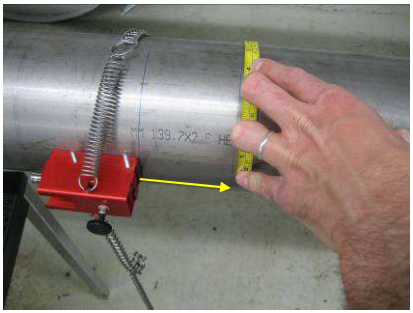
- Mount the first transducer. Its face is positioned on the axis of the first line drawn. The **transducer face** (not the transducer) is centered onto the first crosshair. Now, calculate half of the pipe's outer circumference..

$$U_{1/2} = \frac{2 \cdot \pi \cdot r}{2}$$



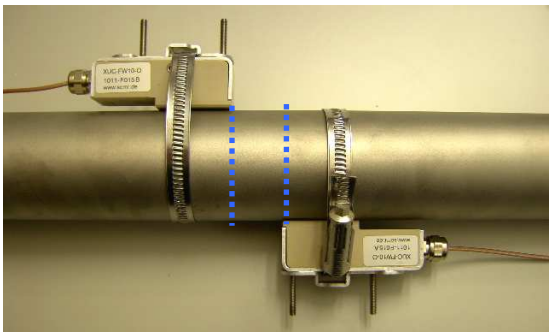
r = Radius of pipe including wall thickness („outer radius“)
Example: Radius (outer) = 250mm -> U = 2*3.1415*250mm / 2 = 785.4mm

- Position the zero line of the measuring tape onto the center of the second crosshair drawn on the pipe (at same level as first transducer). Measure the previously calculated distance (half circumference). You should now have located the precise position opposite to the first transducer. Draw a (third) onto the pip at this position.



Picture 38 Determining the mounting position for transducer

- Mount the second transducer. Its face is positioned on the axis of the second line drawn. The **transducer face** is centered onto the third crosshair. The transducers are now mounted precisely opposite to each other and are prepared for measuring in Z-mode.



Picture 39 Right mounting of transducers in Z-mode

8.5. Edit parameters

You can also parameterize the system using the complete setup menu. However, this method is less convenient, as it does not offer a step-by-step guide to parameterization. It is therefore recommended to use the main menu only in situations that require editing of an individual parameter.

You have direct access to the parameters of the piping and medium, as well as to the dialogs for selecting the ultrasonic transducers and mounting mode.

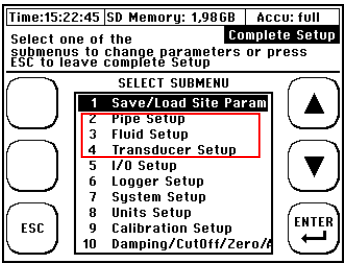
If you only want to change the mounting mode from V to Z, simply select "Transducer parameters" and change it without having to run a complete "Quick Setup" session.

This document provides only a brief overview of parameterization and main menu in the form of structure diagrams that help you to identify the functions grouped in the respective menu. The basic parameterization sequence is similar to a complete parameterization using the Quick Setup tool. We therefore do not elaborate in closer detail on this topic.

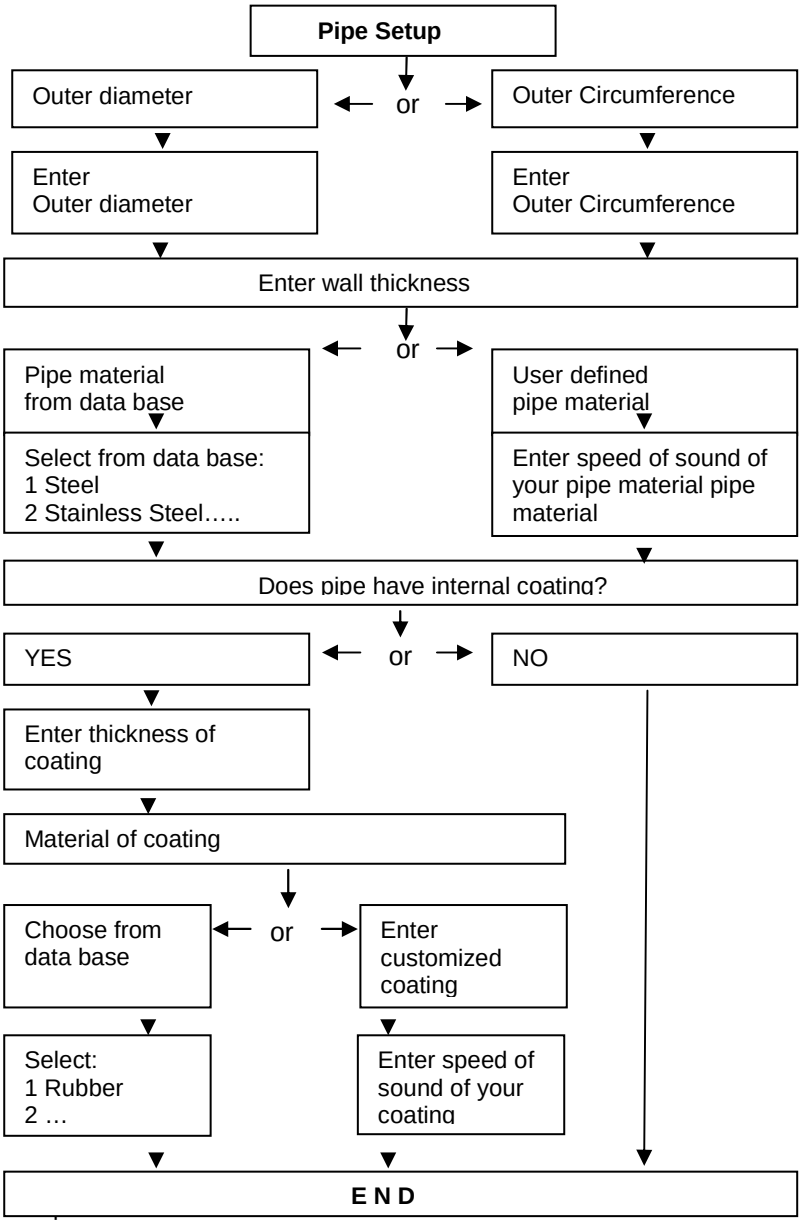
Navigate to the main menu:
In the primary measuring window "Flow 1": Select "Setup" -> "CMPL. SETUP"

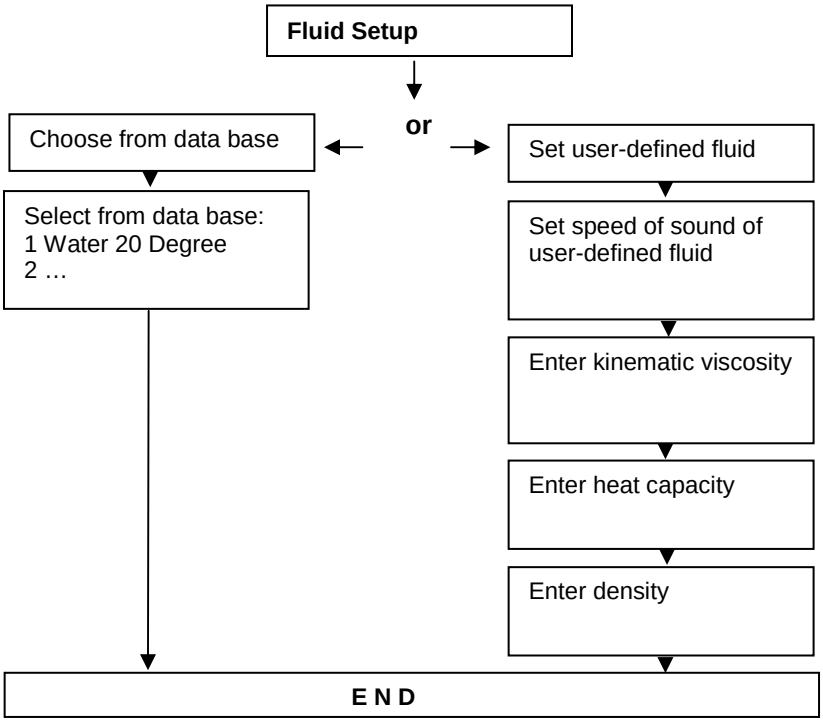
Select the parameters to edit, e.g. "Pipe parameters", "Medium

parameters", or "Transducer parameters":

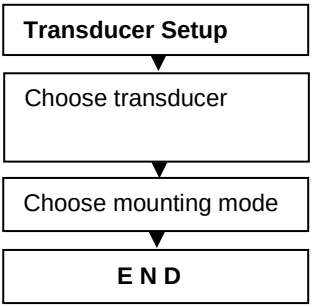


Direct access to the pipe parameters:




Fluid Setup
or
Choose from data base
Select from data base:
1 Water 20 Degree
2 …
Set user-defined fluid
Set speed of sound of user-defined fluid
Enter kinematic viscosity
Enter heat capacity
Enter density
E N D

Direct access to selection of ultrasonic transducer and mounting mode:



8.6. Zero Setting

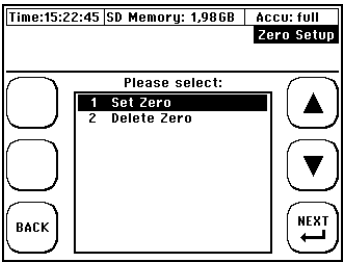
It is advisable to run a zero calibration before you start measurements if possible.

Prerequisite for error-free zero calibration is the complete parameterization of the device, proper installation of both ultrasonic transducers on the pipe, as well as their electrical interconnection with the flow transmitter. Also there should be really “zero-flow”. It is recommendable to wait some minutes after stopping process / shut-off pipe to allow the flow to calm down.

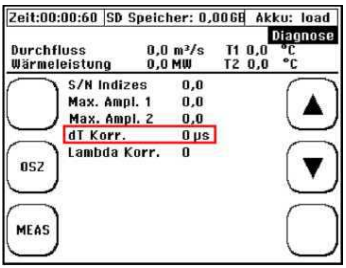
8.6.1. Zero calibration starting in "Flow1" menu

- Close the valves of the piping.
- Navigate to the "Setup" window as follows, using either of three options:

- **After power on:** Select "Setup" within the start sequence
- **In the primary measuring window "Flow 1":** Select "Setup" and "Zero Setup"
- Select "Set Zero"



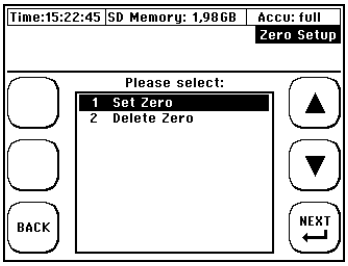
The following window opens on completion of zero calibration:



Your deltawaveC-F displays the calculated correction value for the signal transit time on completion of zero calibration**:**

8.6.2. Zero calibration using the main menu:

In the main menu, select "damping/cutOff/Zero" -> "Zero calibration“



- Stopp flow of media (closing a valve)
- Choose Set Zero

8.6.3. Deleting the zero value

In the main menu, select "Zero Setup" - "Zero" - "Delete zero". This action deletes your zero calibration and resets the device to factory settings
.

Once the zero offset has been set it will remain in the system until it will be deleted or a new zero offset will have been set. Please consider this for your next item. We recommend to make new zero setting at each new measurement when possible.

In the course of zero calibration with closed pipe valves, your deltawaveC-F calculates the transit-time differential that may develop between the transducers and any residual flow. This calculated time (including zero) is automatically included for subsequent calculations during flow measurement. This method enhances the precision of your flow measurements. If it is not possible close the pipe valves, delete the zero value that may have been set previously. If anything prevents you from performing a zero calibration, you will have to take the corresponding imprecision into account in your measurements. The zero setpoint is retained in device memory until it is

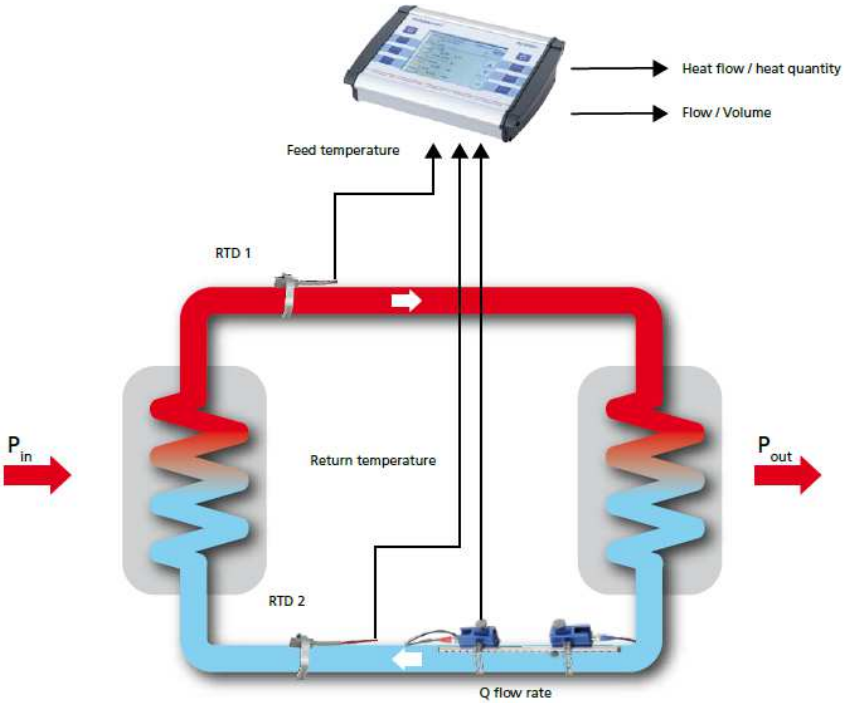
overwritten with a new zero setpoint. If it was possible to close the pipe valves, check the "Flow" column in one of the three measuring window to determine whether or not the flow rate is going down. You should not perform a zero calibration until a settled value is output to the flow display. A stop valve is not available at all positions of the piping. The tolerances that develop during installation, including tolerances of the ultrasonic transducers and pipe data, will lead to a certain zero offset error in the measuring equipment. Provided meticulous care was taken during installation, the flow velocity error should stay within the range from 0.00 m/s to 0.03 m/s. The zero offset error is reduced in proportion with increasing pipe size.

8.7. Heat measurement

The integrated heat measurement function enables you to determine the heat and cooling flow in your application using PT100 temperature sensors.

8.7.1. Introduction

The PT100 no.1 is installed in the warmer, while PT100 no. 2 is installed on the cooler section of the circuit (The PT100 are numbered on the cable). You can position the ultrasonic transducers at the warmer or colder section. However, you are well advised to install the transducers in the cooler section, as it is unlikely that they will be operated beyond their permissible temperature limit in these sections.
deltawaveC-F displays the thermal output and the accumulated heat quantity



Picture 40 Block diagram of heat measurement

deltawaveC-F shows heat (kWh) and thermal output (kW)

Calculating thermal output

The cross-sectional area of the pipe's inner diameter [A] is multiplied by the flow velocity [v] and specific thermal capacity of the medium [c], as well as the differential temperature of both PT100, [T_hot- T_cold]. The product defines thermal output [Q] in W units.

$$\boxed{Q = A \cdot v \cdot c_w \cdot (T_{heiß} - T_{kalt})} \qquad Q = [W, kW]$$

Calculating heat (quantity)

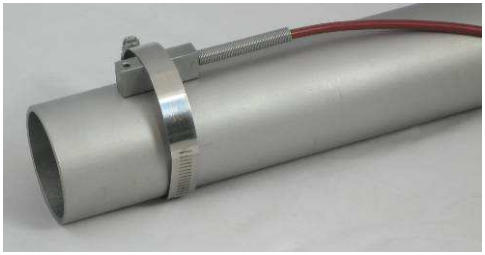
The heat quantity is derived as a function of thermal output over time.

$$\boxed{Q = \int \dot{Q} dt}$$

$$Q = [J, kW / h]$$

8.7.2. Installing the PT100

The PT100 temperature sensors can be mounted on your piping using a metal strap (photo), mounting chains, or a fabric-reinforced tape strap (which is standard when buying deltawaveC-F package). Install the PT100 on the pipe as follows, for example:

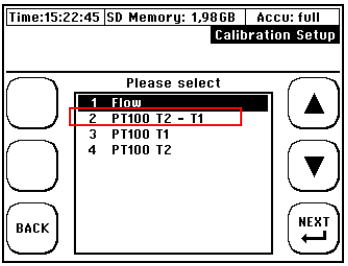


Picture 41 Mounted temperature sensor (PT100)

The measuring method deployed for the PT100 is a relative measurement. This means that the measured temperature values with absolute reference may deviate from this measuring equipment (e.g. compared to submersion thermometers). It is of importance to set up a relation between both PT100s. The ideal differential temperature between the PT100 temperature sensors should amount to zero degrees prior to installation on the piping

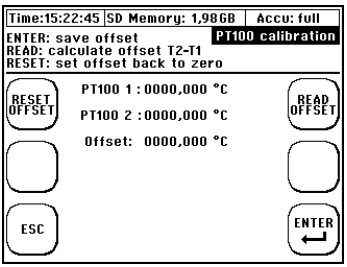
8.7.3. Zero setup of temperature sensors

From main menu flow1: Press button SETUP -> COMPL SETUP -> → CALIBRATION SETUP -> Select „PT100 T2-T1“



The differential temperature between both PT100 should amount to approximately zero degrees prior to installation of the transducers on the piping. You should avoid touching the transducers in the preliminary phases. To equal both PT100s you can e.g. put them in a glass of water for a couple of minutes. o check the temperature of both transducers, use the values displayed in the "Heat quantity" measuring window that is described in the following chapte.

Select “READ OFFSET". Now, deltawaveC-F automatically calculates the T2 to T1 offset. On completion of this calculation, the differential temperature T1 to T2 should amount to approximately zero degrees. Use the "Reset Offset" command to reset the calculated differential temperature to zero



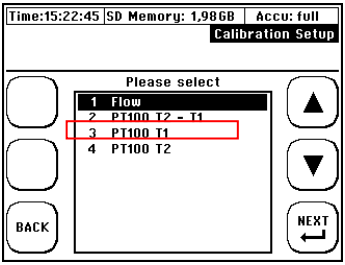
8.7.4. Absolute thermal output measurements (absolute measurement) with PT100

The device supports the alignment of the displayed temperature with a reference thermometer for each PT100 used. This functionality can be useful, for example, for heat measurements.

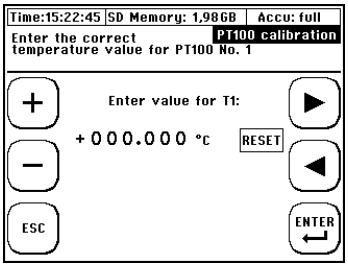
> Example: The resistance thermometer installed in the pipe displays 80 °C. However, the resistive contact thermocouple PT100 T1 of your deltawaveC-F displays only 78.5 °C. deltawaveC-F also supports manual adjustment of the offset. In this case, specify a setpoint of 80 °C. The setpoint is an absolute value and not an offset.

Proceed as follows:

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" -> CALIBRATION SETUP -> "PT100 T1"



Enter the absolute setpoint for T1. Caution: The setpoint is an absolute value and not an offset in terms of the temperature displayed! You can select "RESET" to delete the setpoint for PT100 T1. In this case, PT100 will indicate the actual temperature



Same procedure is applicable for second temperature sensor. In this case please choose PT100 T2 in calibration menu.

9. Measuring windows of deltawaveC-F

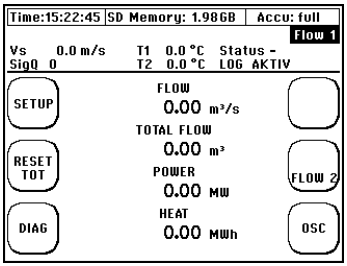
9.1. The main display „flow1“

The flow1 menu is the main menu which shows the current measured values like flow, thermal output etc.
How to open the central measuring window "Flow 1“

After power on: Wait approx. five seconds for the display of the start screen. The deltawaveC-F automatically opens the central measuring window "Flow 1“.

Starting in the main menu: Select "ESC" > "MEAS.“

The Flow 1 measuring window provides concise information that is important for your flow and heat



Parameter	Designation
FLOW 0.00 m³/s	Displays the current flow rate
TOTAL FLOW 0.00 m³	Totalizer = flow rate counter. Displays the actual flow rate value. Displays the actual heat quantity

POWER IG 0.00 MW	Displays the actual heat quantity
HEAT 0.00 MWh	Displays the actual heat quantity
Vs 0,0	Returns the sonic speed of the mediums
SigQ 0	Specifies the signal quality in [%]
T1 0,0 °C T2 0,0 °C	Outputs the actual temperature of the connected PT100 temperature sensors. Signals the measurement status
Status 0	Signalisiert den Status der Messung
LOG INACTIVE	Indicates deactivated data logging
LOG ACTIVE	Indicates ongoing data logging
USB ON	Indicates USB-connection to PC

Table 2 Data in main menu (Flow1)

RESET TOT Resets the Totalizer (flow rate counter) to zero

DIAG Change to the diagnostics windows. Only necessary for information or if you do not receive any measurement results

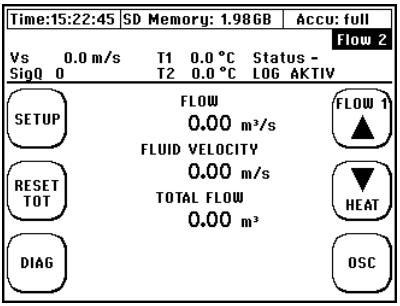
▼ FLOW 2 Change to measuring window "Flow 2“ providing further information

OSC Change to oscilloscope menu where you can watch signals

9.2. Measuring window "Flow 2“

How to open the central measuring window "Flow 2"

Starting in the primary measuring window "Flow 1": Select "Flow 2"
Flow measuring window 2 provides concise information that is important for your flow measurements (without heat measurement). The window also provides additional flow velocity data.



Funktion:	Designation
FLUID VELOCITY 0.00 m/s	Displays the actual flow velocity

Table 3 Additional content of menu flow2

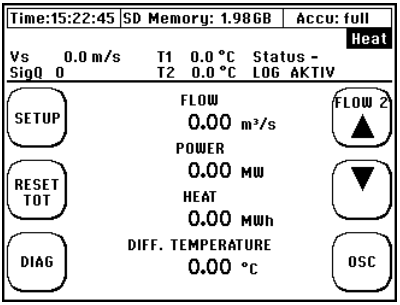
Change to the primary measuring window“

"Flow 1". Change to measuring window "Heat“

9.3. Measuring window "Heat“

How to open the primary measuring window "Heat”

Starting in the primary measuring window "Flow 1:Select "Flow 2" -> Heat"
The "Heat" measuring window outputs concise information that is important for your heat measurements



Parameter:	Designation
POWER 0.00 MW	Displays the actual thermal output.
HEAT 0.00 MWh	Displays the actual heat quantity.
DIFF. TEMPERATURE 0.00 °C	Displays the differential temperature between the connected PT100 T1 and PT100 T2 temperature sensors

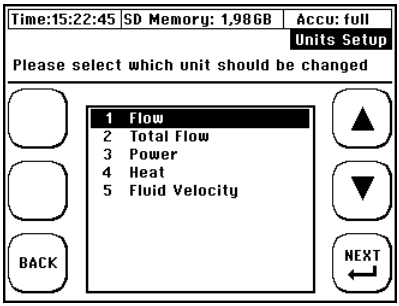
Table 4 Data in menu „heat“

Change to measuring window "Flow 2“

9.4. Selecting the physical units

How to access the "Units Setup" menu:

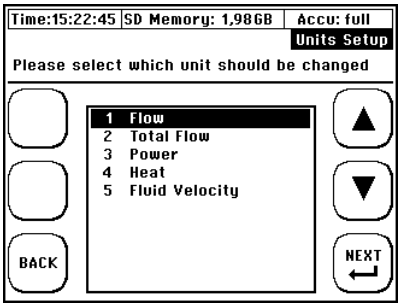
In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" -> Navigate to "Units Setup" in the main menu.
Select the variable at which you want to change the physical unit:

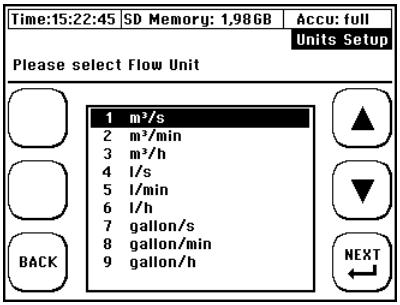


9.4.1. Selecting the flow unit

How to access the physical unit from submenu "Flow1"

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" -> Navigate to "Units Setup" in the main menu and then select "Flow"
Select the parameter you want to change the unit:





Now select the desired unit

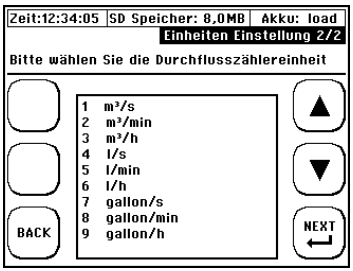
The physical unit gallon is a metric unit

9.5. Selecting the physical unit for the totalizer

How to access the physical unit submenu "Totalizer"

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" -> Navigate to "Units Setup" in the main menu and then select "Total Flow"

Select the physical unit:

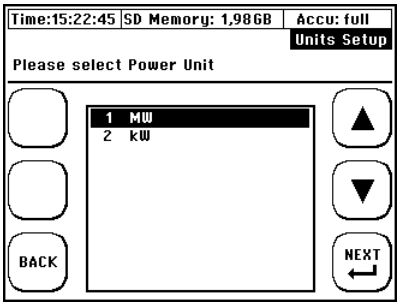


The physical unit gallon is a metric unit

9.5.1. Selecting the physical unit for thermal output

How to access the physical unit submenu "Thermal output"

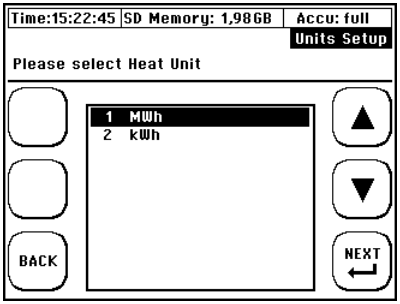
In the primary measuring window "Flow 1": Select "SETUP" ->"CMPL SETUP". In the main menu, select "Units Setup"-> "Power"
Select the physical unit:



9.5.2. Selecting the physical unit for heat quantity

How to access the physical unit submenu "Heat quantity"

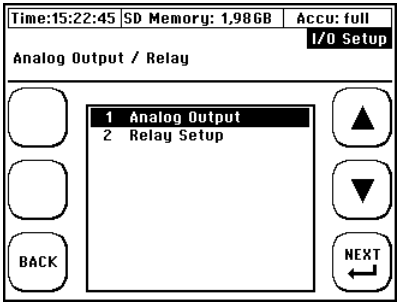
In the primary measuring window "Flow 1**":** Select "SETUP" -> "CMPL SETUP" — In the main menu, select "Units Setup" -> "Heat"
Select the physical unit:



10. Parameterizing the I/O

How to access the I/O setup menu

In the primary measuring window "Flow 1**":** Select "SETUP" -> "CMPL SETUP". In the „complete setup“ menu, select "I/O Setup“



10.1. Parameterizing the 4 mA to 20 mA current outputs

Your deltawaveC-F provides two 4 mA to 20 mA current outputs. These outputs can be assigned different measured values. The outputs are set actively by default. This means that your deltawaveC-F always provides a voltage at these outputs.

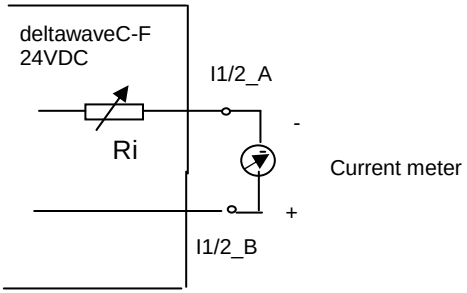
Any connection of an active 4 mA to 20 mA analog output of deltawaveC-F with an external device that also provides a voltage at its inputs will cause fatal damage to your deltawaveC-F and external device. Before you interconnect both devices, **always verify that your external recording (PCS) system is set to passive state!**

The outputs of your deltawaveC-F are work in active mode in factory state. That means that the flow transmitter provides the required voltage to run the outputs

The inputs of the external device are connected directly to your deltawaveC-F .

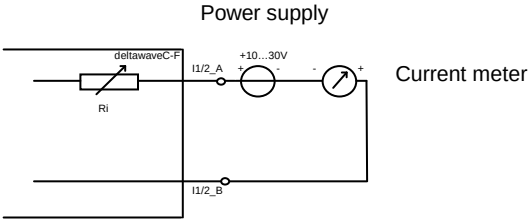
Outputs are activated (factory setting)

Activ 1:

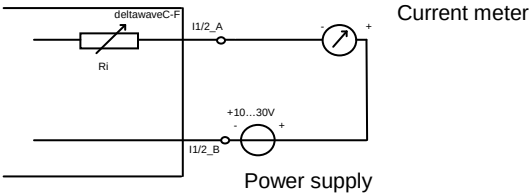


Output passiv

Passiv 1:



Passiv 2:

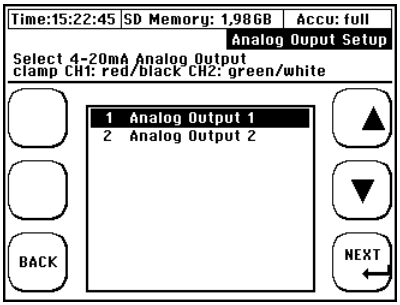


Basically the mode (passive or active) of the outputs can be changed inside of the deltawaveC-F. We always recommend using the factory setting (active mode). If you need to change the mode please contact your systec dealer.

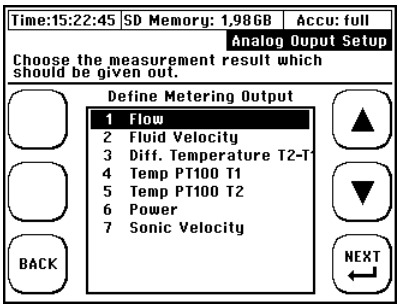
How to access the "Analog output" menu“:

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP". In the main menu, select -> "I/O Setup" -> Analog outputs".

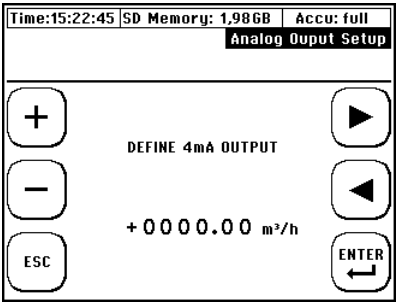
Select the analog output to be used:



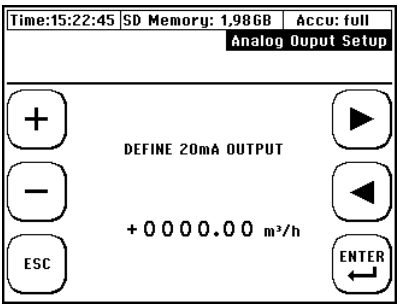
Specify the variable to be output at the analog output:



Select the value to be assigned to the 4 mA output (Example Flow)

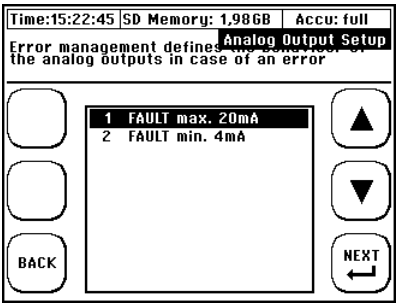


Select the value to be assigned to the 20mA output. The analog outputs at your deltawaveC-F only support unidirectional flow.

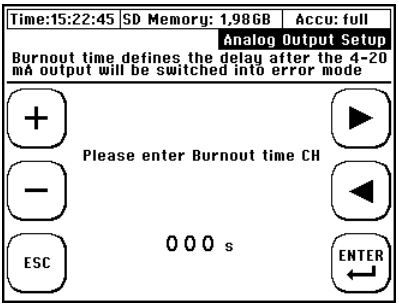


deltawaveC-F can only provide positive flows to the outputs. The flow display must return positive values. **What happens if the value exceeds the parameterized high or low limits?** ***Example:*** You expect a flow rate of 100m^3/h and assigned this rate a value of 20 mA. However, the flow rate may reach 130 m³/h. This means that a value of 20 mA will also be output for flow rates higher than 100 m3/h

Select the error response of the analog output:



Select the time that expires before deltawaveC-F switches to the fault mode:



When do you have an error situation?

- If limits of the values previously assigned to the 4 mA and 20 mA outputs were exceeded on expiration of a specific time (burnout)
- Signal loss

Example:

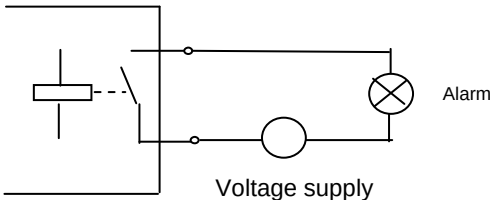
You expect a maximum flow rate of 100 m3 in your application and assigned this rate the 20 mA value. You also set the following defaults for the error mode

If an error is pending, the 4 mA to 20 mA output enters the error mode and outputs 4 mA on expiration of a delay time of *20seconds.* In practical operation you may have a flow rate of 130 m³ in the piping for a duration up to *two minutes.* In this case, your deltawaveC-F would output 20 mA for the duration of *20seconds* and then enter the error mode and output 4 mA on expiration of a timeout of *20seconds.* After the flow rate has dropped again

10.2. Parameterize the Relay

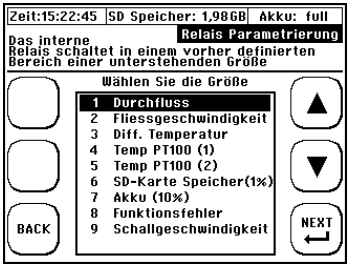
Your deltawaveC-F is equipped with a relay output.
This output can be assigned a function or a range.

Example of an external circuitry:

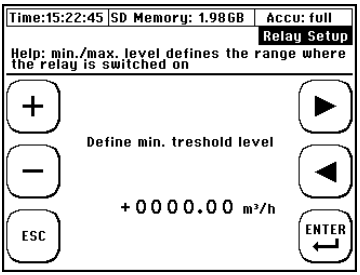


The relay has a NO (normally open) contact. The contact is only closed when triggered by a parameterized function. The contact will retain its open state on power failure and with low rechargeable battery. You do not have to observe the polarity of the wiring since it is potential free.

How to access the "Analog output" menu:
In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP". In the main menu, select -> "I/O Setup" -> "Relay:

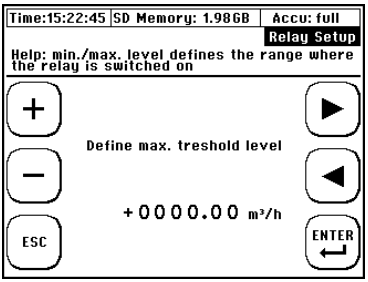


Choose value (lower limit) for activation of relay. Relay will be activated when measured value fall below the limit.



In addition to parameterized variables such as flow, your deltawaveC-F applies the corresponding unit that is selected in the "Units Setup" setting and appended to the respective variable that is displayed in a measuring window. Example: If you selected the physical unit m³ for flow variables, the values of the switching points are also parameterized in cubic meter.

Select the upper limit value for the relay. Relay will be activated when measured value exceeds the maximum limit.



Example:
A pump is operated in an application and the discharge volume of this pump is measured. The pump has a maximum discharge volume of 6000 m^3 /h and there is a risk of damage to the pump when the discharge volume drops to less than 150 m^3/h. The objective is for deltawaveC-F to shut down the pump as soon as the value drops below a point at which damage to the pump can be expected. So in that case lower limit has to be set to 150m3/h, upper limit to 6000m3/h. Relay will be activated if flow falls below 150m3/h or exceeds 6000m3/h.
The physical unit cubic meter must have been assigned to the flow variables in the physical unit settings. The minimum activation point must have been parameterized.

10.3. Parameterize the digital output (transistor)

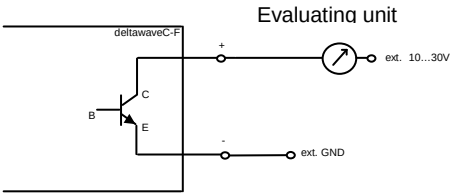
Your deltawaveC-F provides one digital output (DO). The DO is a transistor output (open collector) and is typically used as a counter for volume (m3) or heat (kWh). The DO is operated in passive mode. That means a supply voltage (10…30VDC) has to be provided externally.

Please make sure not to mix up positive (+) and negative (-) voltage in order to avoid any damage of the flow transmitter.

How to connect your DO (Examples)

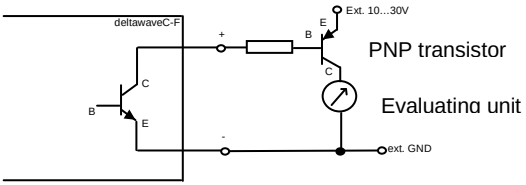
Example 1:

Connect the plus terminal of your evaluation unit (e.g. PCS) to the plus terminal of your voltage supply. Connect the negative terminal of your evaluation unit to the plus terminal of the DO. The negative terminal of the DO has to be contacted to negative terminal of external voltage supply.



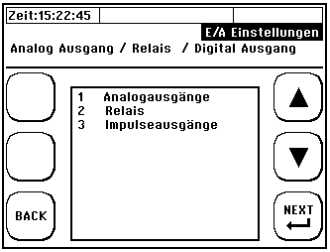
Example 2:

Connect a PNP transistor's emitter to the positive terminal of the external voltage supply. The basis of the transistor should be connected (via a resistance) to the positive terminal of the DO. The collector of the transistor should be connected to the positive terminal of your evaluating unit (PCS). The negative terminal of the evaluating unit has to be connected to the negative terminals of the DO and the voltage supply

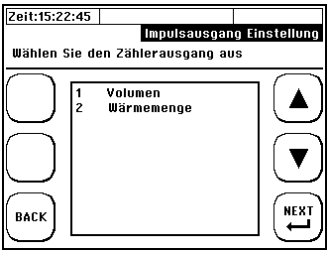


How to enter the menu for Digital outputs:

Starting from main menu flow1: Choose SETUP -> COMPL SETUP -> I/O SETUP -> Digital Output



Choose related data (heat or volume) which you want to use with your DO.



Please choose now the value (volume or heat) which should represent one pulse.
Example: If you want to get a pluse at the DO each 10m3 you have to enter 10 here. Units can be changed in units setup.

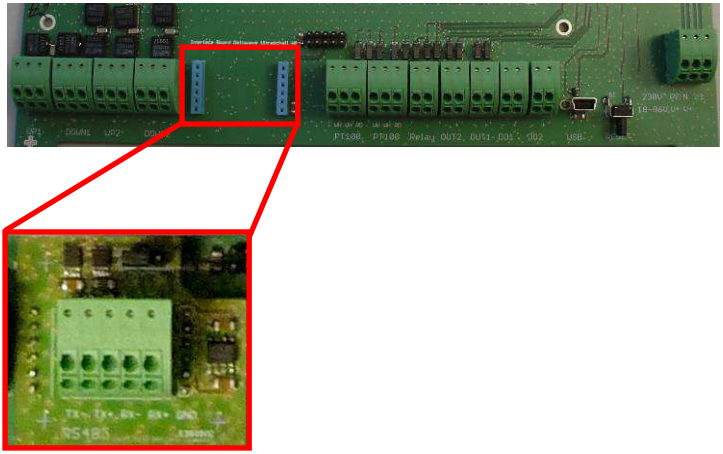
The unit in the digital output menu (e.g. m3) is related to the choosen unit of the counter (totalizer). Example: If you choose unit l (liters) for the totalizer in the units setup menu you have also liters at the DO.
If you choose kWh as unit of the totalizer when using it for heat measurement you will get also kWh at the DO.

10.4. Parameterization of the seriell Interface RS232

As an option one might use the separate RS232 interface board. deltawaveC-F can be easily upgraded by simply plug in the separate RS232 board. The RS232 sends ASCI strings including measurement data.

10.5. Upgrade your deltawaveC-F

Disconnect deltawaveC-F from power supply. Plug the RS232 board into the two plugs in the region of the connection terminals (see chapter 4.4 to see how to access the connection terminals)

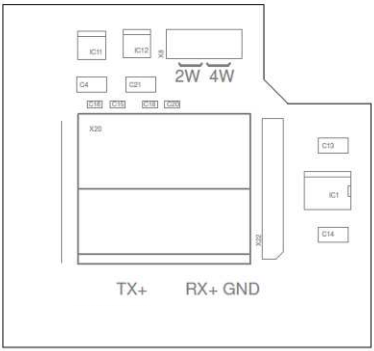


RS232 Board

Now you can connect power supply again to your deltawaveC-F.

10.6. Connect RS232 board to a receiver (e.g. PC or PCS)

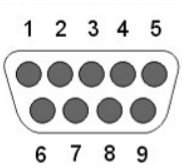
You need a cable to be connected at the RS232 board and –typically- to a SubD (others possible due to customers demands).



RS232 Interface board

TAG	Designation	Pin 9 Pol. Sub D
TX	Transmit Data	3
RX	Receive Data	2
GND	Ground	5

Pin assignment of standard Sub-D 9 pols

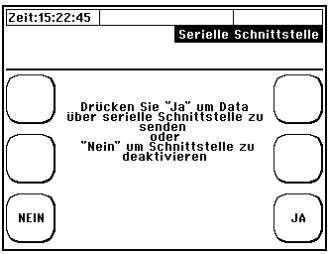


10.7. Activate the RS232 interface

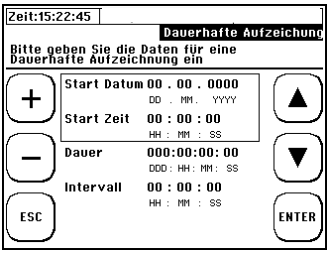
To activate the RS232 please go to menu flow1

From main menu flow1: Choose SETUP -> COMPL SETUP -> SERIAL INTERFACE (6)

To activate RS232 interface press YES



You then need to choose some parameters:



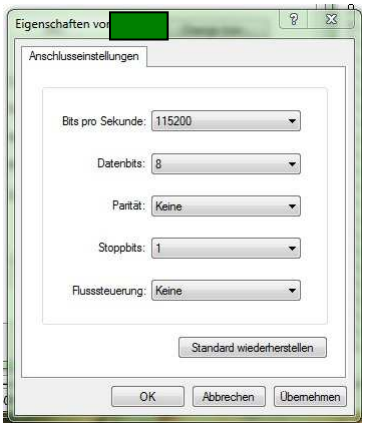
Start Datum: Set date where RS232 communication should start
Start Zeit: Set time where RS232 communication should start
Dauer: Set duration of RS232 communication
Intervall: Set interval (e.g. 5 means that a data package is sent each 5 seconds)

i	If you do not set a start time&date the communication starts immediately after setting duration and interval.

10.8. Configure your receiver (e.g. PC) to receive RS232 data

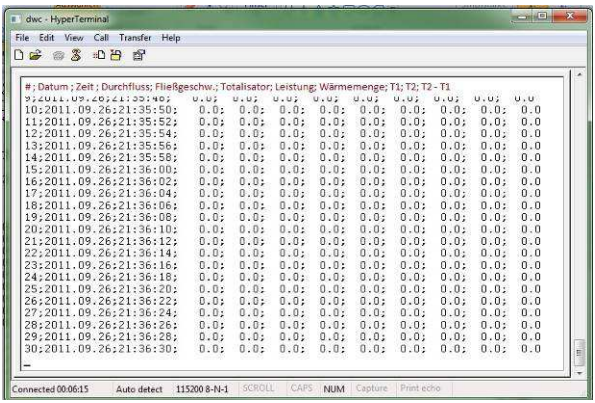
Choose your interface where you have connected the RS232 (e.g. COM1)

You need to configure your input according to Picture 42. Please note that bit rate can not be changed (115200 bits / sec).



Picture 42 Configure your input for RS232 communication

After succesful configuration you should receive data as shown in Picture 43.



Picture 43 Receiving Data via RS232 interface

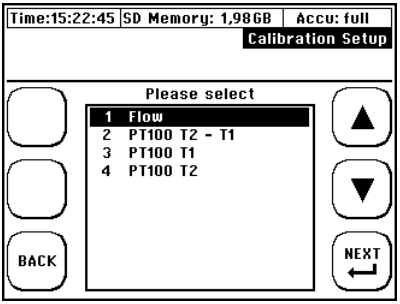
To receive Data you can use the Hyper Terminal provided by Windows. If you do not have serial interface on your PC you can use standard RS232 (Sub D-9) to USB converter.

11. Calibration

Your deltawaveC-F provides a calibrating function that can be used to calibrate the flow. It may also be used to calibrate the analog outputs and PT100 temperature sensors.

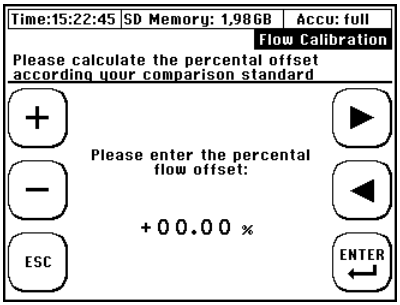
How to access the "Calibration" menu:

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" -> Navigate to "Calibration Setup" in the main menu
“



11.1. Calibrating flow

Select "Flow" from the calibration menu“.



Enter an offset percentage that is relative to your calibration reference.

To calibrate your deltawaveC-F, it is recommended to take measurements at different flow velocities and then calculate the mean value of the results. systec Controls calculates the mean value based on five different flow velocities. The flow offset is retained in device memory until it is overwritten with a new valuwird.

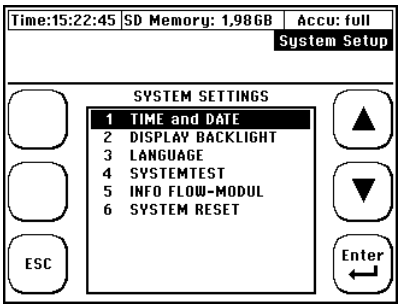
11.2. Calibrating the PT100

For more information on PT100 calibration, refer to the chapter 8.7.3 Heat measurement.

12. Systems Settings

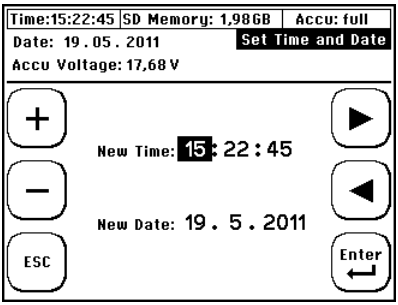
How to access the "System settings" menu:

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" -> Navigate to "System Setup" in the main menu



12.1. Editing the time and date

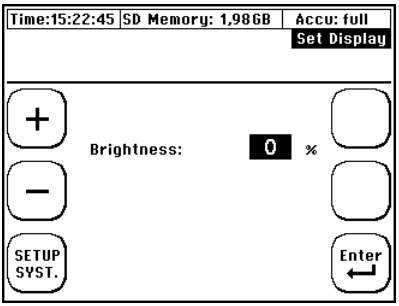
How to access the "Time and date" menu:
In the primary measuring window "Flow 1**":** Select "SETUP" -> "CMPL SETUP". In the main menu, select "System Setup " -> "Time and date



Enter the time with the notation hh(hour):mm(minutes):ss(seconds). Enter the time with the notation: dd(day).mm(month).yy(year).

12.2. Modifying the display backlight

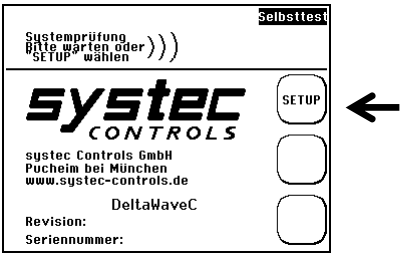
How to access the "Backlight" menu:
In the primary measuring window "Flow 1**":** Select "SETUP" -> "CMPL SETUP" — In the main menu, select "System Setup" -> "Backlight“



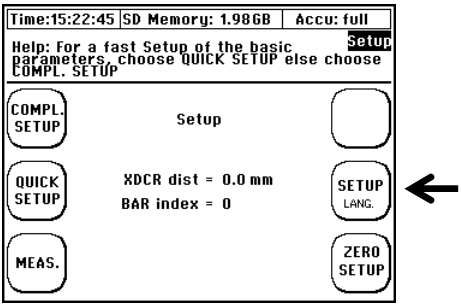
Adjust the display brightness by setting value (0% = no backlight, 100% maximum brightness).

12.3. Change language

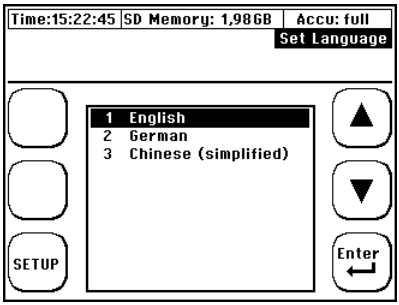
- Switch on the device — Within the start sequence, press the multifunctional key next to the "SETUP" field.



- Confirm the "SETUP LANG." button



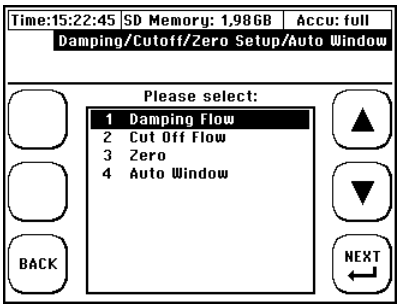
- Use the arrows in the next window to select the dialog language. Confirm your entry with "Enter" and exit the menu with "SETUP".



⚠ The language setting changes the language used in the menus. The language in the fields next to the multifunctional button remains more or less unchanged

12.4. Miscellaneous

How to access the "Miscellaneous" menu:
In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" — In the main menu, navigate to "Damping/CutOff/Zero" menu



12.5. Flow Damping

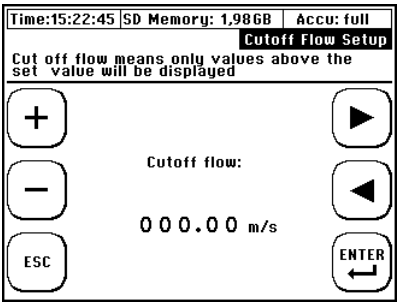
In the primary measuring window "Flow 1**":** Select "SETUP" -> "CMPL SETUP". In the main menu, navigate to "Damping/CutOff/Zero" -> "Damping Flow"

You can specify an attenuation of signal output in this dialog. Enter a damping time. It is a T63 damping. That means after damping time the displayed value has reached 63% of real change.
Example: Damping time 5 seconds, Flow change from 1 m3/h to 2 m3/h
Display: Shows 1.63m3/h after 5 seconds, 1.93 m3/h after another 5 seconds (10 seconds in total).

Typical values are 5-30 seconds. The higher the damping the slower the measurement but the “smoother” the measurement curve.

12.6. Flow Cut off

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP". In the main menu, navigate to "System Setup" -> "Damping/Cut off/ Zero" -> "Cut off Flow".
Only the flow velocities that are greater than the parameterized "Cut off" will be displayed. Lower velocities will be considered (and displayed) as 0.



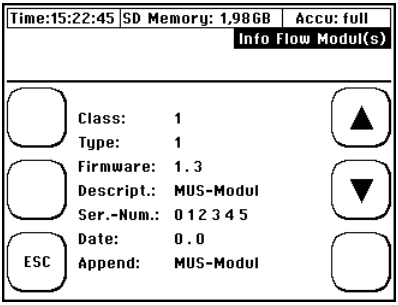
12.7. Zero Setting

In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP". In the main menu, navigate to "System Setup" -> " Damping/CutOff/Zero " -> "Zero".

For more information, refer to chapter 8.6

12.8. System Setup-> "System information“

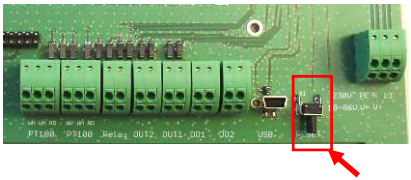
In the primary measuring window "Flow 1": Select "SETUP" -> "CMPL SETUP" — In the main menu, navigate to "System Setup" -> "Info Flow Module“. Here you can check e.g. version of your software to check whether update might be available or not.



12.9. Software Reset

You have two different types of resets:

- Hardware Reset
- Software Reset



Picture 44 Connection terminals with Reset button

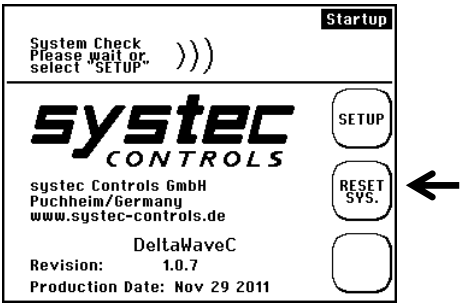
The hardware reset can be activated by pressing the button (behind cover).

Software reset

Please use software reset in all other cases like getting inplausible measurements or reading on the display. Data stored on SD card will not be deleted. Data stored in internally (parameter files) will be deleted.

There are different possibilites to make a software reset

- Immediately after switching on press „RESET SYS” at the starting screen.



- From the main menu (flow1) please choose SETUP -> COMPL SETUP -> SYSTEM -> RESET SYS.

After software reset you need to set date&time again!

13. Troubleshooting

Use the following check lists for troubleshooting and check all items listed. If the error that prevents you from taking proper measurements persists after you completed the check, contact your systec delater or the systec Controls Hotline at: +49 (0)89 809 06 0

Please make sure to have the following information at hand for your support request:

- Pipe material
- Pipe outer diameter
- Wall thickness
- Medium, medium temperature
- Type / length of the intake/discharge circuits
- Type of transducer used
-

Simply print the "deltawaveC-F troubleshooting" information (chapter 15A) for troubleshooting by means of step-by-step elimination of all items. This procedure helps you in remaining cool, calm and collected when troubleshooting an application that is possibly rather complex and in locating the fault systematically.

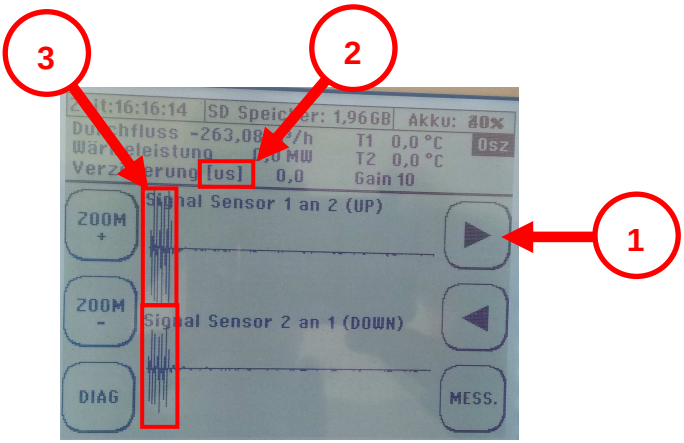
13.1. Integrated sensor test function

Your deltawaveC offers the possibility checking the ultrasonic transducers in combination with sensor cables which are connect to them.
For example: if you got no measurement results from your actual application measurement you have after the sensor test the certainty that your ultrasonic transducers work proper and the loss of measurement is caused from the application itself.

Please proceed as described in the following steps:

1. Open the OSCI window. You could navigate to the OSCI window while you activate the function “DIAG” in one of the three measurement windows.
As further step in DIAG window please press on the “OSCI” button. After you have pressed the osci button a window appears with the question if you want to use autowindow function or not. Pls. press no (if you choose yes otherwise transducer test function !).

2. Press repeatedly the arrow button on the right side of the window (1) and watch the displayed delay time (2) so long until “0.0” will occur.
At the beginning of the y- line you will see two signal packages (3). This packages are the both send signals.



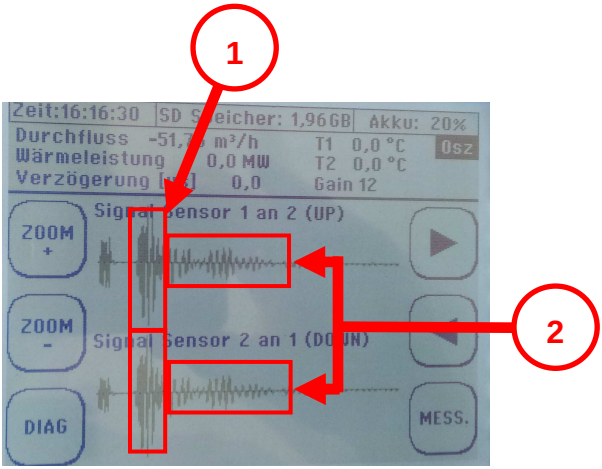
Picture 45 Osci window send signal

4. Put on one of the two transducers a little bit acoustic coupling grease.

5. Put both ultrasonic transducers as shown in the picture below together so that app. two-thirds of the (beige) surfaces overlap.

Picture 46 sensorpositions for sensortest

6. I fhe ultrasonic transducers will function well then you will see a second signal package app. 1cm beside the send signals. This signal packages are the receiving signals (1). The post pulse oscillation (2) depends on the type of ultrasonic transducer and could differ from the example photography below. But post pulse oscillation is not from interest to rate if the ultrasonic transducers is o.k..



Picture 47 Osci window send and receive signal

7. Wenn Sie beide Empfangssignale (1) sehen, dann sind Ihre Ultraschallwandler nebst Signalkabel in Ordnung. Wenn nicht, sind entweder die Ultraschallwandler oder die Signalkabel defekt.

14. Troubleshooting

A. No measurement at all

1 A. Are you absolutely certain that the piping is completely filled?	☐
2 A. Can you exclude gas load on the medium? Is a pump close by? If there is gas load: • Are the transducers installed at the 10 AM or 2 PM position on the horizontal pipe? • If there is gas load on the medium, is there an option of mounting the transducers to a vertical pipe? If yes, mount the transducers to a vertical pipe.	☐
3 A. What is the solid particle content of the medium?	☐
4 A. Are you absolutely certain of the wall thickness? Check the piping for the presence of engraved information that may be of relevance. Hot water piping is subject to the formation of lime deposits that may propagate the deposit of solid particles of media with high content thereof. Use a wall thickness meter. You can lease or purchase a wall thickness meter from systec Controls. check the wall thickness entry on the device.	☐
5 A. Did you enter the **outer diameter** of the pipe, or its **circumference**? Check the corresponding values once again. Please make sure that you did not mix it up.	☐
6 A. Have you selected the correct piping material? You are certain that the **piping is not lined**? When taking measurements on a pipe made of concrete you must presume that this piping does not have sound conducting properties. Check the parameterized values once again.	☐
7 A. Does the ultrasonic transducer match the application with regard to pipe dimensions and medium temperature? Is the	☐

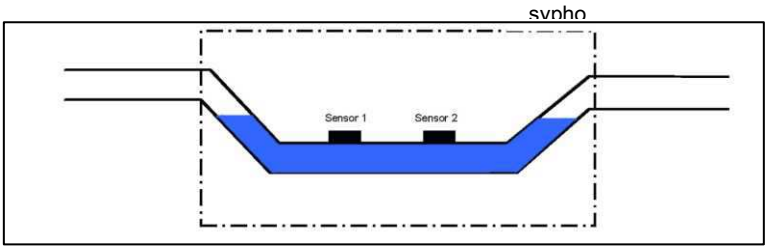
temperature of the medium within permitted limits? Did you select a suitable ultrasonic transducers for the application with regard to the pipe dimensions? Once again, verify that you selected the correct ultrasonic transducer and that it is parameterized.	
8 A. Which transducer mounting mode did you select? Standard is the V-mode. If you selected the W-mode, you should first try the V-mode.	◻
9 A. You selected the proper transducer distance. Take the measurements at the transducer faces. When using a spacer bar, **check the number of holes between the transducer mounting positions** acc. to chapter 7.3	◻
10 A. Does the piping have a thick paint coating? If yes, try to remove the paint at the position where you are planning to install the ultrasonic transducers, e.g. using sand paper. You can never take any measurements on piping insulation, no matter what type of material is involved!	◻
11 A. Did you apply an appropriate film of acoustic coupling gel (Magnalube) to the transducer faces? Small transducers (types XUC-PW-10 and -20) need approx. 3 cm, whereas the large transducer (XUC-PW-05) requires approx. 6 cm of coupling gel.	◻
12 A. Do the transducers apply adequate pressure on the piping?	◻
13 A. Are the transducers that are mounted **without spacer bar precisely aligned along a common axis (!)** on the piping?	◻
14 A. Are there any sources of strong disturbance such as transformers or electrical drives, or sources of vibration in the immediate area of measurement?	◻
14 A. Use the Z-mode for installation if all of your efforts did not yield a satisfactory result. Parameterize your device accordingly. You might also try to test your equipment on a different piping section that is close by in order to find out whether or not you can perform a measurement. Check all measuring leads for damage.	◻

B. Imprecise measurement results

1B. Did you observe the corresponding upstream and downstream distances? The quality of measurements will deteriorate in proportion to shorter upstream and downstream distances.	☐
2 B. Did you perform a zero calibration while after having closed a stop valve on piping?	☐
3 B. Once again, check the parameterized values with regard to the: • Pipe outer diameter • Wall thickness • Piping material • Transducer distance	☐

<u>What measures can you take if the piping is not filled completely?</u>

If you cannot simply separate the piping, because it is plastic piping, for example, or if the application is in the planning or installation phase, it is recommended to use a siphon to compensate for partially filled piping. The gradient of the siphon is calculated based on the expected flow (flow velocity) and contamination load. Contact us for support if it is necessary to install a siphon for your application.



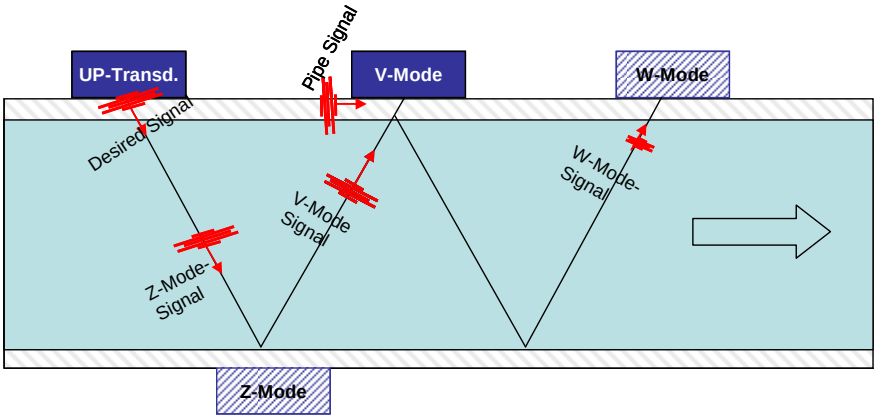
14.1. Diagnostic menu of deltawaveC-F

14.1.1. Oscilloscope / Auto-Window

14.1.1.1. Signal propagation

deltawaveC-F offers sophisticated diagnostic menus allowoing experienced users to optimize challenging measurements at harsh conditions. To use the diagnostic menu as a powerful tool for troubleshooting a background in signal propagation is provided by this chapter.

Picture 48 illustrates which signals do occur and how they progagate at your pipe.



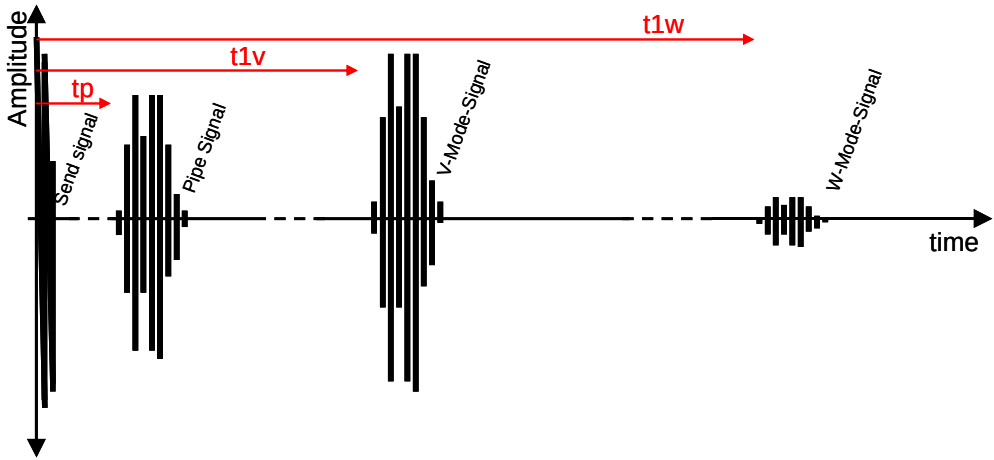
Picture 48 Signal propagation

The UP-transducer mounted at upstream position emits the send (or desired) signal. This signal propagates within the pipe wall ("pipe signal") as well as in the fluid. The signal propagating in the fluid is reflected a couple of times at the pipe walls (Z-Mode signal, V-mode signal, W-mode

signal). The signal which represents the desired signal depends on mounting mode. E.g. when mounted in V-mode the V-mode signal is the desired signal. The other signals (Z-mode, W-mode, pipe wall) are also there and might disturb (seldomly) this signal (see below). The corresponding transducer is mounted in V-mode as standard but also Z-mode and W-modes are possible. This transducers receives the signals and return another signal to UP transducer.

The time the signals needs from one transducer to the corresponding transducer (run time) depends on path length (distance), speed of sound of materials and fluid and of course on flow velocity.

Depending on mounting mode the signals might look as shown in Picture 49



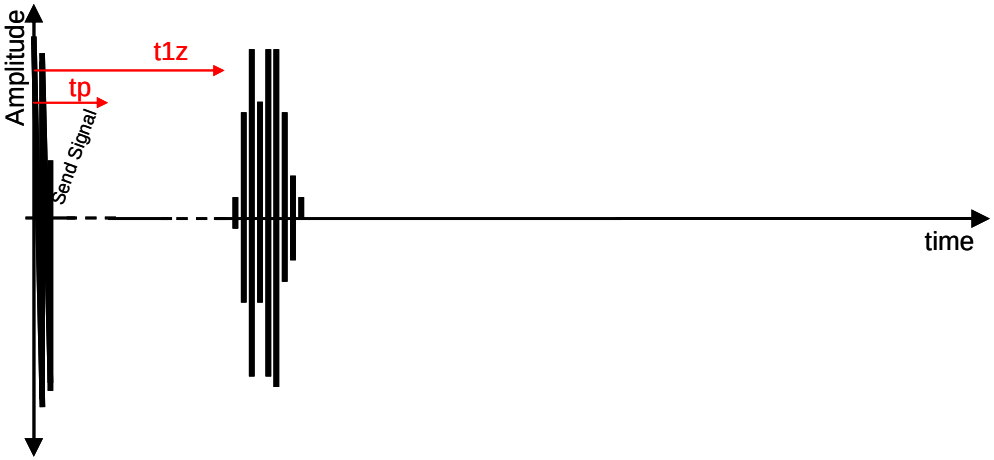
Picture 49 Signal images

At t=0 the UP-transducer starts signal transmission. After time T=tp you can see the pipe wall signal which reaches the corresponding transducer first because of shorter distance and (usually) faster propagation cause by higher speed of sound of pipe material.
After that, at time T=t1v, the V-mode signal reaches the transducer (single reflection at opposite pipe wall). After t1w (ca. 2x t1p) the W-mode signal is being detected. Usually, when having pipe materials highly conductible for ultrasonic signals (metals) and small pipes, the pipe wall signal has high amplitude which is similar to amplitude of V-mode signal. When having

sound-absorbing materials (plastic, concret) and/or coating the pipe wall signal is usually weak indicated by low amplitude. The V-mode signal is usually stronger than the W-mode signal.

The time between the different signals might be significantly higher or lower depending on pipe sizes and speed of sound of involved materials.

A different situation occurs when measuring in Z-mode



Picture 50 Signals in Z-mode

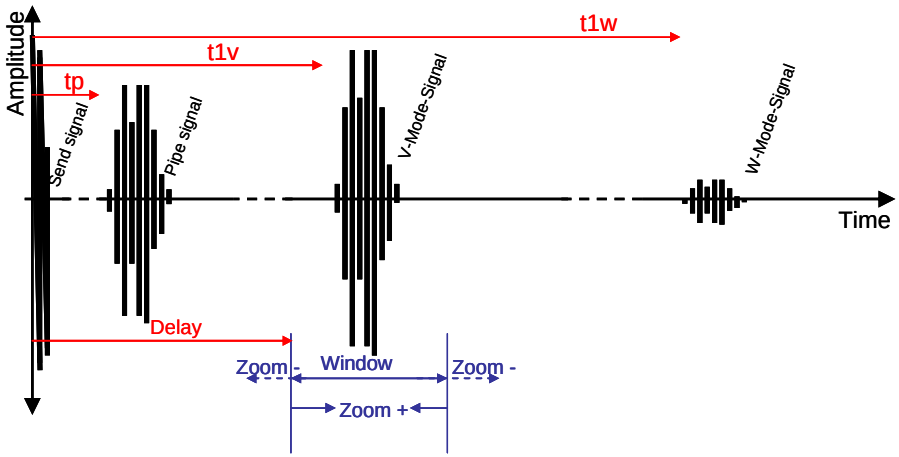
Beside the send signal only the desired signal (Z-signal) is visible. The Z-signal reaches the receiving transducer after T=t1z

14.1.1.2. Oscilloscope menu of deltawaveC-F

With the oscilloscope menu you can analyse signals and even manipulate them in order to handle very challenging applications.

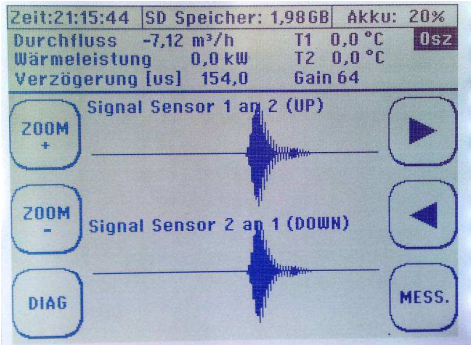
> deltawaveC-F sets all necessary parameters for the signal processing. When manipulating signals these settings will change. This might result in a loss of signals and/or failure in measurement. The changes done in the oscilloscope menu might remain valid even when leaving the menu. To get settings from deltawave the site should be parameterized again..

deltawaveC-F only works with the signals within the measuring window. The measuring window represents a certain period of time which is analysed by deltawave about signals. The measuring window can be moved back and forth by using the arrow buttons.



Picture 51 Measuring window

Normally deltawaveC-F tries to set the measuring window that way that only the desired signal (e.g. V-mode signal when using V-mode as installation). Other signals (Interfering signals) are out of window.



Picture 52 Oscilloscope menu showing desired signals

Using ZOOM- / ZOOM+ buttons you can scale-up / scale-down the measuring window (decrease / increase the time the window is open). Using arrow buttons you can move window to left or to right (opens earlier / later).

Please note that deltawaveC-F only uses signals within the window. If you move window that way that signal will disappear you might get wrong / no measurement.

You get information about starting point ("delay") of measuring window, see Picture 52. In this picture window starts at 154 µSec. Using arrow buttons will change this starting time.

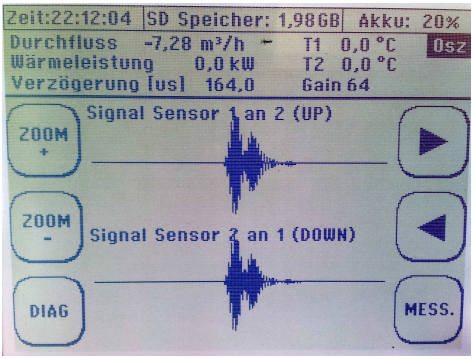
14.1.1.3. Signal analysis using oscilloscope

The oscilloscope allows quick check of signal quality. This helps when you do not get measurement or instable measurement. Good signal to noise ratio and “sharpness” of signals are important to get good results

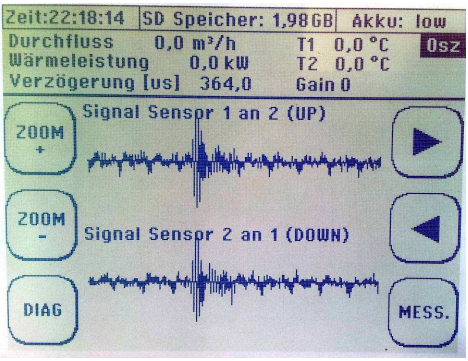
Signal-to-noise ratio (SN)

SN indicates the difference of amplitudes between the desired signal and the noise. The higher the SN the better the signal processing.

Picture 53 shows a very good signal with less SN.



Picture 53 Oscilloscope menu showing good signals



Picture 54 Oscilloscope menu showing noisy signals

Picture 54 shows a noisy signal with lower SN. You can see noise around the signal which reaches about 20-40% of signal

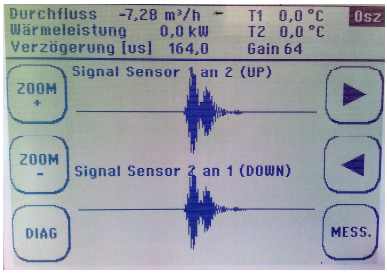
deltawaveC-F is capable to handle noisy signals thanks to its sophisticated signal processing. But of course a high SN should be approached by user to have some leeway in case of additional interferences.

If there are problems with your measurement SN can be improved by:

- Surface of pipe: Remove painting or rust
- Coupling grease: Use sufficient coupling grease (Magnalube)
- Alignment of transducers: Make sure that transducers are mounted as suggested by deltawaveC-F. Please also make sure that center of transducers touches the pipe sufficiently (might be problem at very small pipes). You can check the oscilloscope while mounting the transducers.
- Make sure that transducers are not mounted e.g. on welding seams
- Make sure to remove air from your liquid (deareate)
- Choose another mounting position (e.g. vertical pipe)
- Make sure to provide sufficient straight run
- Make sure that signal cables are not disturbed by power cables
- Especially pumps and motors (with frequency inverters) generate electric noise and should be avoided to be nearby
- Use Z-mode rather than V-mode to reduce path length and therefore to increase signal strength
- Use V-mode rather than W-mode
- Use stronger transducers, e.g. –F05 instead of –F10 or –F10 instead of –F20, -F21

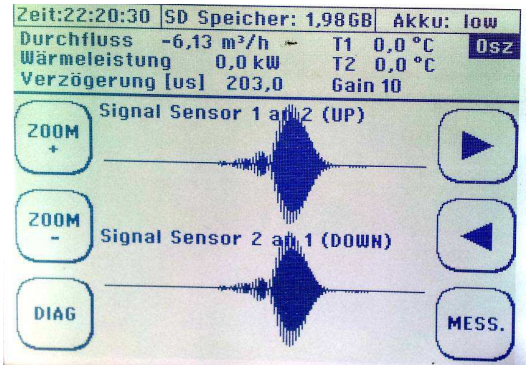
14.1.1.4. Sharpness of Signals

deltawaveC-F uses coded signals to ensure to detect signals also in case of noise. Coded means that deltawaveC-F makes phase shifts within a signal package.



Picture 55 Oscilloscope menu showing coded signals

Picture 55 shows a sharp signal. You can see ca. 5 waves followed by a phase shift and another waves.



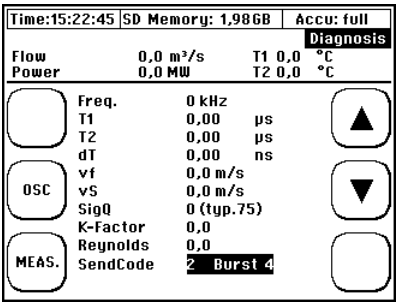
Picture 56 Oscilloscope menu showing diffuse signals

Picture 56 shows diffuse signals. There is basically no phase shift. This might result in misdetection of signals.

Thanks to it's sophisticated signal processing deltawaveC-F is able to handle diffuse signals until a certain limit. Nevertheless sharp signals should be aspired.

If there are problems the sharpness can be increased by:

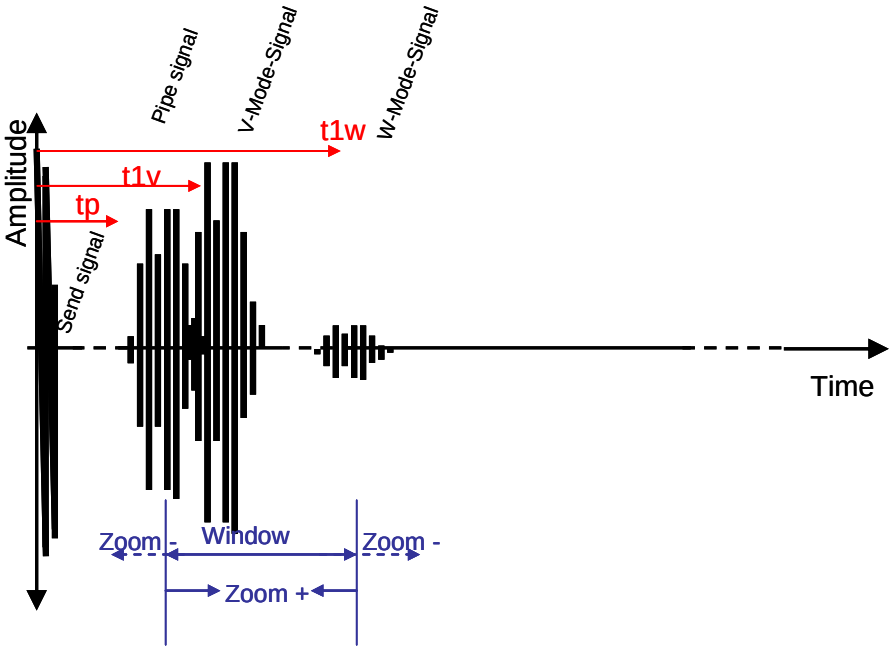
- Choose different signal sequence (described later)
- Use other mounting mode
- Use different transducer
- Pipe surface: Remove painting and/or rustKoppelpaste:
- Make sure to use sufficient amount of coupling grease (Magnalube)
- Alignment of transducers: Make sure that transducers are mounted as suggested by deltawaveC-F. Please also make sure that center of transducers touches the pipe sufficiently (might be problem at very small pipes). You can check the oscilloscope while mounting the transducers.
- Make sure that transducers are not blocked e.g. by welding seams
- Choose a different location for your measurement



To select a different signal sequence please enter the diagnostic menu (Diag) and press button on the right of parameter SendCode. Usually the signal sequences 3-Barker 5 or 4-Barker 7 are expected to bring best performance. You can try different sequences and check influence in diagnostic data (SigQ, see chapter 14.1.2) as well as visually in oscilloscope.

14.1.1.5. Separating signals (small pipes)

When measuring at small pipes (<50mm) the distances between the received signals become smaller. In worst case signals might interfere as shown in Picture 57 Interfering **signals**



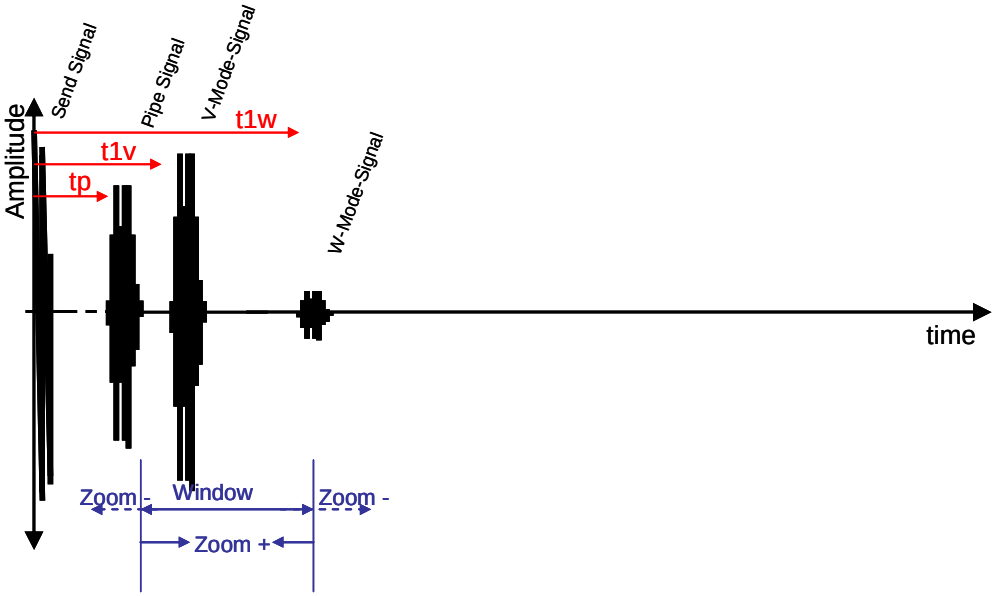
Picture 57 Interfering signals

Here, there are not only the desired signal within the measuring window but also the interfering pipe wall signal and also a part of the W-mode signal.

deltawaveC-F uses sophisticated algorithms to separate desired signals from interfering signals. These algorithms are mainly applied when having the auto window function activated. But especially when measuring at very small pipes interference might occur anyway. In that case the user can separate signals (in order to filter out the desired signal) manually in the oscilloscope mode.

If interference does occur you can try to:

- Use W-Mode rather than V-mode (first counter-measure)
- Use Z-Mode rather than V-mode (when W-mode does not work)
- Deactivate Auto-Window (see chapter 14.1.1.6) and use ZOOM function / shift function (arrow buttons) to kick out disturbing signals of the measuring window.
- Use different signal sequence (see previous chapter), e.g. 3-Barker5 or 1Puls rather than 4-Barker 7
- Use transducer working at higher frequency (-F20 rather than –F10) to get sharper signals.
  When using –F20 (2MHZ) instead of –F10 (1MHZ) the signals become half as wide (half of time) which makes it easier to separate signals.



Picture 58 Separated Signals

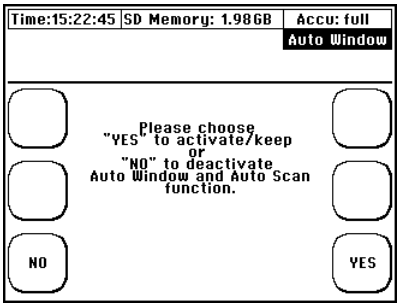
If you de-activate the auto-window –e.g. in order to separate signals manually- please always check the measured speed of sound of the separated signal. When having the (separated) desired signal within the measuring window the speed of sound (parameter vs in diagnostic menu) should be within +/- 20% of the expected speed of sound (e.g. when measuring water at 20°C speed of sound should be within 1400….1500 m/s). If vs exceeds the expected values you most likely have separated the wrong signal (e.g. pipe wall signal, then vs is showing speed of sound of pipe material)

14.1.1.6. Activate / Deactivate Auto-Window

When being in main menu (flow1) please choose OSZ to enter the oscilloscope menu.

You now have to choose if you want to use auto window or not. In case of problems with your measurement we recommend to try without auto window first.

Choose „NO“



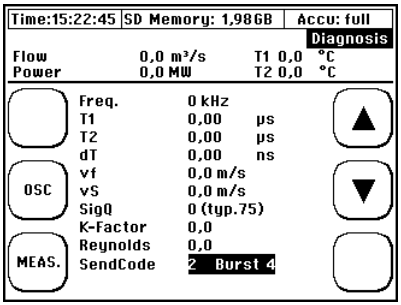
You should see distinguished signals (UP and DOWN) in the oscilloscope as described in previous chapter.

If you want to activate auto-window please press DIAG and OSZ again. Answer with YES. Please check if position of ultrasonic signals have been changed. Please also check if value for delay has been changed. If yes, please use auto window for your measurement (once you choose YES auto window is activated also when you leave oscilloscope mode. To de-activate auto window you have to enter oscilloscope mode again and answer with NO)

14.1.2. Diagnostic menu

⚠ The diagnostic menu shows a lot of parameters which are mainly readable for experienced users. The diagnostic data are also suited for troubleshooting

Diagnostic window 1 / 3:

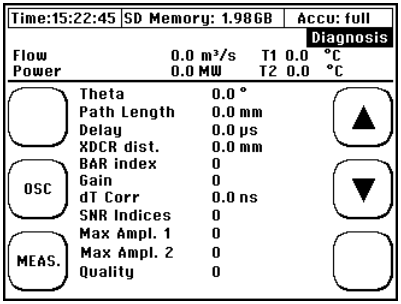


Frequency: Shows the signal frequency which depends on the selected transducer Basically there are three different transducer using different frequencies (500kHz, 1000kHz, 2000kHz)
Signal: Shows the type of signal code. deltawaveC-F uses coded signals to allow reliable detection of signals.
T1: Signal run time signal 1 (Upstream signal or downstream signal depending on connection of cables).
T2: Signal run time of back signal 2 (Upstream signal or downstream signal depending on connection of cables).
dT: Measured difference between T1 and T2 (minus zero offset if applicable). dT is proportional to flow.
vF: Measured velocity
Vs:

Measured speed of sound of media. Depends e.g. on temperature.
SigQ: Number of valid signals (in percentage). deltawaveC-F makes a lot of measurements per second and automatically filters out unreliable signals. The number of measurements in relation to valid measurements is SigQ. The achievable number is related to the choosen quality (see parameter quality below) The higher the quality the lower usually the SigQ. When setting quality to 0 there is basically no filtering of signals and all signals are used for measurement (with the risk of using bad signals
K- Factor: Factor which compensates the influence when measuring laminar flow (Re <8000). When measuring in that area a (small) additional uncertainty might occur.
Reynolds The number of Reynolds automatically affects the choosen compensation factor.
Send Code (=signal sequence): The used signal sequence

Table 5 Data in diagnostic menu 1

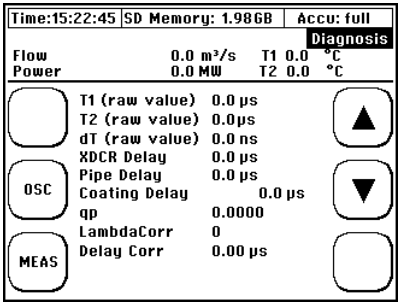
Diagnostic menu 2 / 3:



Theta: Angle between ultrasonic path and flow vector
Path length Length of acoustic path. Depends on pipe size and on choosen installation mode of transducers.
(Delay): Represents the time when the measuring window starts
Sensor distance Distance between the two transducers
Bar index Mounting positions when using spacer bar
Gain The required amplification (gain) of the signals is automatically set continously. 0 represents no amplification (not applicable) while 255 represents the maximum amplification. The lower the gain the better the signal transmission. Very high gain might indicate a disturbed signal (gas, particles, wrong mounting,…)
dT Corr: Time shift of signals created by zero setting
Quality The quality parameter represents the “thoughness” of the internal filter. Filter means that deltawaveC-F checks each signal if plausible or not using the quality parameter. When choosing quality 0 there will be no filtering. That means that each signal is used for measurement even the bad (and maybe wrong) ones. Filtering of 100 would mean that filtering is very strict. Both values (0 / 100) are not recommended. Typical values are 50-75. When not getting measurement it might be useful to set quality lower (e.g. set to 20)

Table 6 Data in diagnostic menu 2

Diagnostic menu 3 / 3



T1/T2 (raw): Signal run times along complete signal path including pipe wall and transducer enclosure
dt (raw): Measured time difference of T1/T2 (raw)
XDCR (DCR=Transducer): Signal run time within transducer
Pipe delay: Signal run time within pipe wall
qp: Compensation factor considering changes in temperature (and therefore changes in speed of sound of fluid).
Coating delay: Delay in signal run time generated by coating (if applicable)
Lambda Corr.: Delay can be manually edited (not recommended, only for maintenance) by multiples of wave length of signal.
Delay Corr: **Shows Lambda Corr in useconds**

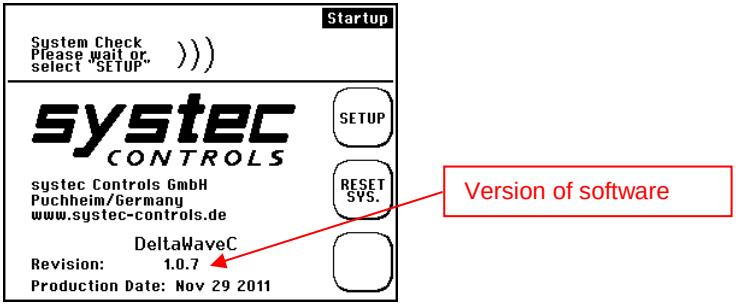
Table 7 Data in diagnostic menu 3

14.2. Software update

14.2.1. Check current software version

Before making an software update please check version of your software.

Switch off deltawaveC-F and restart it. During start you can find version at the bottom of start screen (e.g. 1.0.6c or similar). Please note this value.



When using software version 1.0.3 or higher you can upgrade your deltawaveC-F by yourself by using update files (provided by systec on request). When using software lower than 1.0.3. please send your deltawaveC-F to systec Controls for update.

14.2.2. Unpack update file

Systec provides update files which are usually zipped. The file name represents the version of software. E.g. V1.0.6c

Please unpack the file. You will get two files, readme.txt and sysctrol.hex.

README	5 KB	Textdokument	06.10.2011 14:47
SYSCTRL.hex	1.166 KB	HEX-Datei	06.10.2011 11:56

The file readme contains information of how to update your deltawaveC-F and also information about the new functions / changes to be made by this update.

14.2.3.Performing the update

6 steps to update your deltawaveC-F

1. Connect deltawave to power supply.
2. Switch on deltawaveC-F
3. Connect deltawaveC-F to PC using USB cable. deltawaveC-F should be detected as mass storage from your PC

What if deltawaveC-F is not detected from your PC? Depending on your PC operating system you might need to format deltawaveC-F (the SD card). If you get this prompt from your system you need to do this in order to use the SD card later. Please select FAT (not NTFS or others) from the format menu. All data stored on the SD card will be deleted when formatting the SD card.

4. Copy the file „Sysctrl.hex“ to deltwaveC-P (must be copied to root directory)
5. Switch off deltawaveC-F -P
6. Switch on deltawaveC-F -P. During start the update will start automatically. This might require some minutes. After update it will restart automatically. You can now check version in the lower most line of the start screen.

If you should face any problems while copying update files from PC to your deltawaveC-F (hang up) an update might fail since a part of the required file is missing. Please contact your systec dealer in that case.

Attention !
Please make software reset (see chapter reset) after update. To make software reset you can press button RESET SYS at start screen.

15. Media properties

Speed of sound and temperature of various liquids

Flüssigkeit	T°C	pg/cm³	Vm/s
Aceton	20	0.7905	1190
Anilin	20	1.0216	1659
Alkohol	20	0.7893	1168
Ether	20	0.7135	1006
Ethylen Glykol	20	1.1131	1666
N-Oktan	20	0.7021	1192
O-Xylol	20	0.871	1360
Chloroform	20	1.4870	1001
Chlorbenzol	20	1.1042	1289
Glyzerin	20	1.2613	1923
Essigsäure	20	1.0495	1159
Methylacetat	20	0.928	1181
Ethylacetat	20	0.900	1164
Cyclohexan	20	0.779	1284
Dithionsäure	20	1.033	1389
Deuteriumoxid	20	1.1053	1388
Tetrachlorkohlenstoff	20	1.5942	938
Quecksilber	20	13.5955	1451
Nitrobenzol	20	1.207	1473
Schwefelkohlenstoff	20	1.2634	1158
Chloroform	20	2.8904	931
n-Propanol	20	0.8045	1255
n-Pentan	20	0.6260	1032
n-Hexan	20	0.654	1083
Leichtflüssiges Öl	25	0.81	1324
Transformatorenöl	32.5	0.859	1425
Spindelöl	32	0.905	1342
Petroleum	34	0.825	1295
Benzin	34	0.803	1250
Wasser	13.5	1.000	1460
Meerwasser (Salzgehalt: 3.5%)	16	1.000	1510

T: Temperatur, p: Density, V: speed of sound

Speed of sound subject to change of temperature in water

T°C	Vm/s	T°C	Vm/s	T°C	Vm/s	T°C	Vm/s
0	1402.74						
1	1407.71	26	1499.64	51	1543.93	76	1555.40
2	1412.57	27	1502.20	52	1544.95	77	1555.31
3	1417.32	28	1504.68	53	1545.92	78	1555.18
4	1421.98	29	1507.10	54	1546.83	79	1555.02
5	1426.50	30	1509.44	55	1547.70	80	1554.81
6	1430.92	31	1511.71	56	1548.51	81	1554.57
7	1435.24	32	1513.91	57	1549.28	82	1554.30
8	1439.46	33	1516.05	58	1550.00	83	1553.98
9	1443.58	34	1518.12	59	1550.68	84	1553.63
10	1447.59	35	1520.12	60	1551.30	85	1553.25
11	1451.51	36	1522.06	61	1551.88	86	1552.82
12	1455.34	37	1523.93	62	1552.42	87	1552.37
13	1459.07	38	1525.74	63	1552.91	88	1551.88
14	1462.70	39	1527.49	64	1553.35	89	1551.35
15	1466.25	40	1529.18	65	1553.76	90	1550.79
16	1469.70	41	1530.80	66	1554.11	91	1550.20
17	1473.07	42	1532.37	67	1554.43	92	1549.58
18	1476.35	43	1533.88	68	1554.70	93	1548.92
19	1479.55	44	1535.33	69	1554.93	94	1548.23
20	1482.66	45	1536.72	70	1555.12	95	1547.50
21	1485.69	46	1538.06	71	1555.27	96	1546.75
22	1488.63	47	1539.34	72	1555.37	97	1545.96
23	1491.50	48	1540.57	73	1555.44	98	1545.14
24	1494.29	49	1541.74	74	1555.47	99	1544.29
25	1497.00	50	1542.87	75	1555.45	100	1543.41

T: Temperatur, V: Speed of sound

Dynamic Viscosity coefficient of various liquids

Flüssigkeit	T°C	pg/cm³	Vm/s	v (x10^{-6}m²/s)
Aceton	20	0.7905	1190	0.407
Anilin	20	1.0216	1659	1.762
Ether	20	0.7135	1006	0.336
Ethylen Glykol	20	1.1131	1666	21.112
Chloroform	20	1.4870	1001	0.383
Glyzerin	20	1.2613	1923	1188.5
Essigsäure	20	1.0495	1159	1.162
Methylacetat	20	0.928	1181	0.411
Ethylacetat	20	0.900	1164	0.499
Deuteriumoxid	20	1.1053	1388	1.129
Tetrachlorkohlenstoff	20	1.5942	938	0.608
Quecksilber	20	13.5955	1451	0.114
Nitrobenzol	20	1.207	1473	1.665
Schwefelkohlenstoff	20	1.2634	1158	0.290
n-Pentan	20	0.6260	1032	0.366
n-Hexan	20	0.654	1083	0.489
Spindelöl	32	0.905	1324	15.7
Benzin	34	0.803	1250	0.4 bis 0.5
Wasser	13.5	1.	1460	1.004 (20°C)

T: Temperatur, p: Density, V: Schallgeschwindigkeit, v: Dynamic Viscosity

Speed of sound of various pipe materials

Material	Vm/s
Eisen	3230
Stahl	3206
Duktiles Gusseisen	3000
Gusseisen	2460
Edelstahl	3206
Kupfer	2260
Blei	2170
Aluminium	3080
Messing	2050
Vinylchlorid	2640
Acryl	2644
FRP	2505
Mörtel	2500
Teer Epoxy	2505
Polyethylen	1900
Teflon	1240

V: Speed of sound

16. Specifications

- Operating voltage: 90-240 V/AC or 18-36VDC
- Power consumption: <10 W. Operating temperatures: -20 °C to 60 °C
- Degree of protection flow transmitter: IP65
- Flow transmitter weight: 1.3 kg
- Display LCD, 320x240, dimmable backlight
- Flow transmitter dimensions (l x b x t): 260 x 240 x 120 mm.
- Measuring range: -30... +30 m/s
- Signal attenuation: 0 to 100 sec (variable)
- Number of paths: 1, 2 on request

I/Os

- 2x ultrasonic transducer (4x for 2 path version on request)
- Analog outputs: 2 x 4mA to 20 mA,
- 1 x relay, NO, electrically isolated
- 1x Digital output (transistor), (2x Digital output on request)
- RS232 or RS485 (optional)
- USB Mini jack: Type B (for firmware update only)
- 2 x PT100 (3-wire

Available ultrasonic transducers

Typ		
XUC-FW-F21 (2 MHZ)	DN10….DN100	-40….150°C
XUC-FW-F20 (1 MHZ)	DN10….DN100	-40….150°C
XUC-FW-F10 (1 MHZ)	DN32….DN400	-40….150°C
XUC-FW-F05 (500 kHz)	DN200…DN6000	-40…80°C (150°C o.d.)

Table 8 List of available ultrasonic transducers

Notes:_____

Contact:

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