# Manual
# deltawaveC-F/P

Ultrasonic flow and heat measurement
portable

Stationary

**Ver. 1.43.xx**

# Table of content

# 1 Preamble

Welcome to the team of deltawaveC-F/P users and many thanks for using an ultrasonic clamp-on flowmeter from systec Controls GmbH Germany.

deltawaveC-F/P was developed based on the KISS principle – “keep it safe and simple”.

That means maximum user friendliness paired with optimal and accurate measurements.

Our aim is to fulfil these aspirations both now and in the future. Our strength lies in continually improving and optimising our products and we want you to be part of this.

deltawaveC-F/P is an important product for us and not just one product on a long list of others.

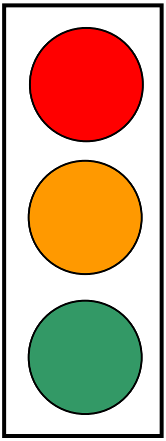
Thanks to your competent and constructive suggestions you have helped to co-create deltawaveC and contribute to its success.

Please don´t hesitate to share your expert knowledge about deltawaveC-F/P with us.

**We wish you all the best and great success with using deltawaveC-F/P!**

# 2 About this manual

You don't have much time for reading? Use the beacon!
**Next to the chapters you will find red, orange or green dots. They will help you to find a quick introduction to the deltawaveC-F/P**



**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.

**Advanced?**
You have occasionally used ultrasonic measuring equipment?
→ Start with chapter 10.1.3 "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.

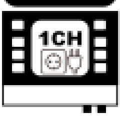
**Professional?**
You already have professional knowledge of ultrasonic measuring systems?
→ Start with the deltawaveC-F Getting Started (separate attachment)
→ You may also want to read the green dot chapters

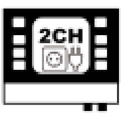
The fields identified with an exclamation mark contain important information that relates to the basic data and operation of the device.

The fields identified with the **"i"** contain supplementary and helpful information.

**The instruction manual describes the function of both deltawaveC-P and deltawaveC-F in 1-channel and 2-channel version. In addition to the chapters you will find the corresponding pictograms. This indicates which of the devices the chapter applies to.**


**deltawaveC-P**
portable deltawaveC (1 Channel)




**deltawaveC-F**
stationary deltawaveC
1CH = 1 Channel; 2CH = 2 Channel

# 3 deltawaveC-F/P & components

**deltawaveC-F/P** key points:

- deltawaveC-F/P is a clamp-on ultrasonic flow meter for liquids in completely filled pipelines.
- deltawaveC-F/P works based on the transit time method.
- deltawaveC-F/P provides heat measurement by default. Clamp-on Pt100 temperature sensors are available as an optional.
- The power is supplied via integrated AC-power supply. For deltawaveC-F DC-power supply is available.
- The device supports measurements on pipelines with diameters in the range DN10 to DN6000 (depending on the sensor used)
- Temperature range (fluid): –40°C to +150°C (equates the temperature range of the clamp-on ultrasound transducers)
- deltawaveC-F/P is equipped with an electrically isolated relay output, as well as 4 to 20 mA current and impulse outputs that can be operated in active and passive mode.
- The stationary deltawaveC-F can optionally be equipped with an RS232 or RS485 interface card as well as with two additional analogue inputs.

## 3.1 Approvals / EMC

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

2014/35/EU Low voltage directive
2014/30/EU Electromagnetic compatibility

**Inspection specifications:**

EN 55011 (2011-04)
EN 61000-4-2 (2009-12)
EN 61000-4-3 (2011-04)
EN 61000-4-4 (2013-04)
EN 61000-4-5 (2015-03)
EN 61000-4-6 (2014-08)
EN 61000-4-8 (2010-11)
EN 61000-4-11 (2005-02)

**Inspection requests:**

EN 61000-6-1 (2016-05)
EN 61000-6-3 (2011-09)

## 3.2 Scope of delivery deltawaveC-F / P basic package

**deltawaveC-F**

**deltawaveC-F & ultrasonic transducers**

- deltawaveC-F flow transmitter
- Ultrasonic transducers incl. signal cables (cable length according to order)
- Spacer bar for transducers, except for FW05
- Mounting belt – stainless steel
- Quick start Guide
- CD with manual
- Acoustic coupling pads

**deltawaveC-P**

**deltawaveC-P hard-shell case**

- Hard-shell case
- deltawaveC-P flow transmitter
- Plug-in power adapter, including an IEC appliance power cable
- RG 58 connector cable for transducer
- Ultrasonic transducer (as ordered by the customer)
- Mounting material and spacer bar for transducers
- Cable for 4mA to 20mA analogue output (Mini DIN, alligator clips)
- Quick start Guide
- CD with 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.
Every deltawaveC-F can be retrofitted with a serial interface board (optional). It can be connected either to an RS232 serial interface board or to a RS485 interface.

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.

An overview of accessories and available transducer can be found in the appendix.

## 3.3 Transducer

**Figure 1: deltawaveC-F/P – measuring converter and mounted ultrasound transducer; left: deltawaveC-F, right: deltawaveC-P**

Your deltawaveC-F / P essentially consist of the ultrasonic transducers mounted on your pipeline and the transmitter. The transmitter performs the signal processing and provides the user with the measurement results. The ultrasonic transducers transform the electrical energy into kinetic energy (acoustic wave). The ultrasonic transducer can also receive acoustic waves and convert these into electrical energy. An overview of the available converters can be found in the appendix.

The ultrasonic transducers will be mounted on the pipeline, they generate and receive the ultrasonic signals, by means of which flow rate will calculated in the transmitter.

⚠ As a result of the measuring principle, each transmitter is equipped with a pair of ultrasonic transducers (A & B). Make sure ultrasonic transducers are aligned with the direction of flow. Pay attention with the deltawaveC-F (screw terminals), the loop has to be at the correct position and correct polarity:

**( + ) = red cable (core)**
**( – ) = black cable (shield)**

**UP-Transducer** (upstream positioned transducer):
The ultrasound transducer, which the flow passes first, is connected at the UP-contacts.

**DOWN-Transducer** (downstream positioned transducer):
The ultrasound transducer, which the flow passes second, is connected at the DOWN-contacts.

## 3.4 Safety instructions

- The operating temperature of the transmitter from -20°C to 60°C must not be exceeded!
- The ultrasonic sensors are sensitive to strong mechanical impacts (irreparable damage possible)!
- The transmitter and ultrasound transducers are generally not approved for operation in potentially explosive atmospheres (request documents for ATEX equipment).
- The ultrasonic sensors must not exceed the specified operating temperatures.

## 3.5 Important instructions for the use of deltawaveC-P

The plug-in power supply is only suitable for indoor use! In the case of mechanical or electrical damage to the plug-in power supply unit or the 230V power supply cable, these must be completely replaced!
DeltawaveC-P is equipped with a nickel metal hydride battery (NiMH, 2300mAh). This battery power is sufficient for approximately 5 hours of network-independent operation.
To increase the battery life time, we recommend the following: Charge and discharge the battery 3 times completely as soon as you have received your deltawaveC-P.

➔ If the deltawaveC-P is not used for a long time, recharge the battery at least once every 3 ... 6 months.
➔ The deltawaveC-P is equipped with a deep discharge protection. A pop-up message informs you before the device switches off automatically.
➔ To avoid unnecessary stress to the battery avoid connecting the deltawaveC-P to a power supply if it is already charged completely.

deltawaveC-P is equipped with a quick-charge function. The quick-charge function is automatically activated for 20 minutes after deltawaveC-P is connected to the power supply. This allows for quick instant operation of the device.

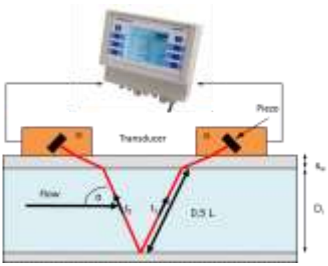
**General information about the charge states:**

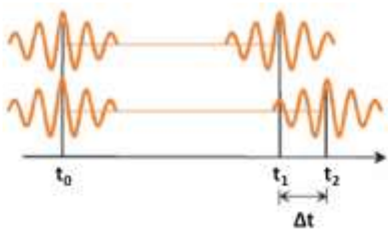
| | |
|---|---|
| | Charging |
| | 50-100% |
| | 25-49% |
| | 10-25% |
| | <10% |

The exclamation point in the battery indicator appears if the charge is too low, or if deltawaveC-P is busy determining the current charge status. Determining the charge level might take up to one minute.
If the exclamation mark persists, the battery actually has a capacity <10%.


If "Err" appears in front of the battery symbol and "x" in the battery symbol, this means that the battery is defective or there is a fault in the charging circuit. If you restart deltawaveC-P three times and the error message persists, please contact systec Controls.

# 4 Measuring principle




**Measuring principle:** Ultrasonic transit time difference method (Clamp-On)
For this purpose two ultrasonic transducers are mounted on the pipeline from outside and connected to the evaluation electronics.
The ultrasonic transducers work alternately as transmitters and receivers and send ultrasonic signals at each other. These signals are accelerated or decelerated by the medium flow. The resulting difference in the two signal propagation times is proportional to the flow rate and is used together with the pipeline geometry for the precise calculation of the flow rate.

**Signal evaluation by means of cross-correlation:**
The signal processing operates on the basis of a cross-correlation-based method, which enables signal detection even at a low signal-to-noise ratio. On the basis of the high-quality signal evaluation, measurements with gas input or solid load of the medium are also possible within certain limits.

Calculation of the flow velocity [m/s]:

$$\bar{v} = L \frac{(\Delta t)}{t_2 \cdot t_1 \cdot 2\cos\alpha} \cdot k_{\mathrm{Re}}$$

Calculation of the volume flow:

$$Q = L \frac{(\Delta t)}{t_2 \cdot t_1 \cdot 2\cos\alpha} \cdot k_{\mathrm{Re}} \cdot \frac{D^2}{4} \cdot \pi$$

**Integrated Reynolds-compensation ($k_{Re}$):**
The transit time difference method provides to determine the mean flow velocity along the measuring path. The mean flow velocity over the tube cross-section can be determined by means of a compensation factor which is dependent on the Reynolds number.
The Reynolds number is determined iteratively from the current flow rate, the pipe diameter and the kinematic viscosity of the fluid. For fluids of the device-internal material database the data is provided.
The configuration of a user-defined medium is possible. For this purpose, the sound velocity (can be practically determined by iterative approximation, see 13.2) and the kinematic viscosity of the medium must be parameterized. The input of density and heat capacity is additionally required for determining the heat quantity.

$$\mathrm{Re} = \frac{\rho \cdot \bar{v} \cdot D}{\mu} = \frac{\bar{v} \cdot D}{\upsilon}$$

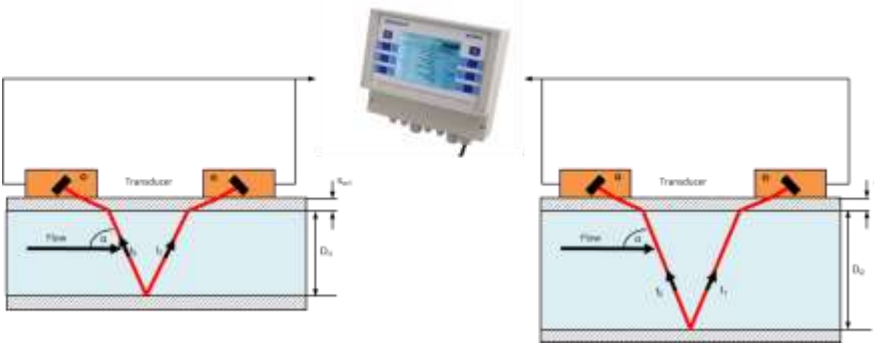
Re… Reynolds number,
$v$… flow velocity,
$D$… diameter,
$\rho$… density,
$\mu$… dynamic viscosity,
$\upsilon$… kinematic viscosity,

**Integrated temperature compensation / Automatic Fluid Control (AFC):**
Changes to the sound velocity of the liquid (temperature-dependent or when the medium changes) cause changes of signal path angles and path length. These deviations from the ideal path and the resulting measurement uncertainties are compensated automatically by a correction factor (qp factor) determined by deltawaveC-F / P without mechanical displacement of the transducers.

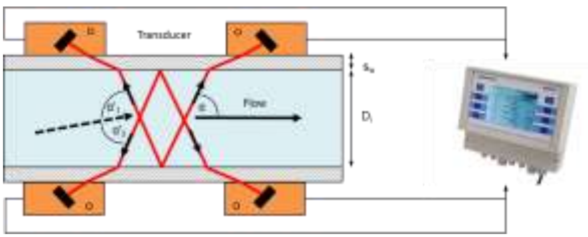
**Standard:**
The basis for the calculation is the VDI/VDE directive 2642: "ULTRASONIC FOW-RATE MEASUREMENT OF FLUIDS IN PIPES UNDER CAPACITY FLOW CONDITIONS" (12/1996)

## 4.1 2-channel device applications

The deltawaveC-F 2-channel transmitter enables the realization of exceptional measurement requirements for special applications. These are briefly described below.




Two measuring paths can be operated separately at two different measuring points. In addition to the separate results of measuring points (CH1 or CH2), the sum, the difference as well as the mean value of both measuring paths are provided additionally (CH1 + CH2, CH1 - CH2, (CH1 + CH2) / 2).

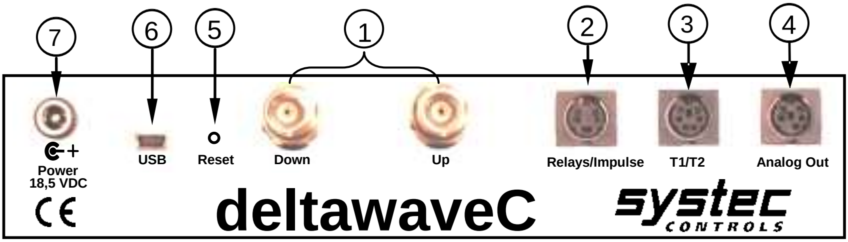



The mean value calculation is intended in particular for the use of both measuring paths at one measuring point. This utilization makes it possible to increase the accuracy and to reduce the effects of cross currents.

| |
|---|
| The heat quantity determination is limited to the use of two measuring paths at one measuring point (only one pair of Pt100 can be connected). The calculation is performed only for (CH1 + CH2) / 2.<br>A separate calculation only for CH1 and/or CH2 is not provided. |

# 5 deltawaveC-F/P Interfaces

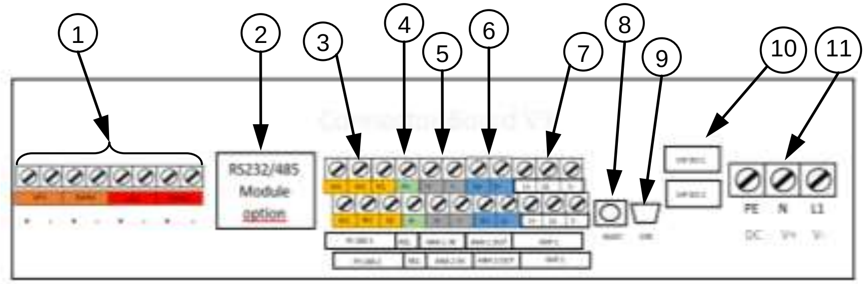
## 5.1 Overview deltawaveC-P




| Term | | Description |
|---|---|---|
| 1 | UP/ DWN | BNC-Inputs for ultrasonic transducer |
| 2 | Relays/ Impulse | Mini-DIN-4 connectors output: Relay connection (passive, potential-free); Digital output (open collector: 20, 40, 60 ms square pulses) |
| 3 | T1/T2 | Mini-DIN-6 connectors: 1 pair 3-conductor Pt100 (heat measurement): |
| 4 | Analog Out | 2 Analogue outputs: 4…20mA signal, 24VDC, active (optional passive) from CTRL 2.1 according to Namur NE43 (3.8-20.5 mA) |
| 5 | RESET | Hardware-Reset (Restart of the system) |
| 6 | USB | USB Interface (Mini-USB Type B), access to the integrated SD memory card Windows XP or later versions detect the SD Card as mass storage medium |
| 7 | Power | Plug-in power: 19 V/DC, 3,42 A |

## 5.2 Overview deltawaveC-F

The overview of the connection area and the terminal diagram corresponds to the connector board V3.0 (double-pole terminals with additional analogue inputs). Documentation for older versions can be requested.




| Term | | Connection | Description |
|---|---|---|---|
| 1 | UP1 | input for ultrasonic transducer measurement path 1 | |
| | DWN1 | **( + ) = red cable (core); ( – ) = black cable (shield)** | |
| | UP2 | input for ultrasonic transducer measurement path 2 | |
| | DWN2 | **Only 2-channel transmitter** | |
| 2 | RS232 / RS485 | optional + retrofitted (Digital Interface board X1 & X2)<br>Data transmission via serial communication or Modbus | |
| 3 | PT100 – 1 ($T_{input}$) | 1 pair 3-conductor Pt100 (heat measurement)<br>W terminals: Sense lines (cables of the same polarity / colour) | |
| | PT100 – 2 $T_{output}$ | R-Terminal: GND cable (different colour cable).<br>For 3-wire Pt100, bridging the sense connections. | |
| 4 | REL | Relay connection, passive, potential-free | |
| 5 | ANA 1 OUT<br>ANA 2 OUT | **Retrofitting requires CTRL-Board V2.2**<br>Analogue inputs: 4 ... 20mA Unit signal, 24VDC, active (optional passive) | |
| 6 | ANA 1 OUT<br>ANA 2 OUT | Analogue inputs: 4 ... 20mA Unit signal, 24VDC, active (optional passive)<br>from CTRL 2.1 according to Namur NE43 (3.8-20.5 mA) | |
| 7 | IMP 1<br>IMP 2 | Digital output (open collector: 20, 40, 60 ms square pulses)<br>**IMP2 Only 2-channel transmitter usable** | |
| 8 | RESET | Hardware-Reset (Restart of the system) | |
| 9 | USB | USB Interface (Mini-USB Type B), access to the integrated SD memory card<br>Windows XP or later versions detect the SD Card as mass storage medium | |
| 10 | DIP 1 DO<br>DIP 2 DO | DIP Switch for configuring IMP1 and IMP2<br>NPN, PNP, push-pull, active / passive<br>**IMP2 Only 2-channel transmitter usable** | |
| 11 | PE N L1<br>V+ V- | Two power supply options available:<br>alternating current 90 ... 240 V / AC, direct current 18 ... 36 V / DC | |

## 5.3 Connection notes

To access the deltawaveC-F cable space, please detach the cable both screws and remove the cover plate:

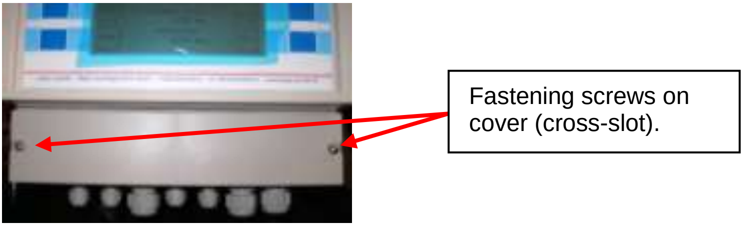



**Figure 2:** Remove cover from cable compartment

> 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.**
>
> **All in- and outputs (except relay) have defined potential on the internal devices ground. For potential free operation of the in- and outputs additional hardware is needed (with galvanic isolation). With the normal in- and output it is not possible!**
> - The analogue in- and outputs are active ex works 24V/DC (could be set in passive mode by systec controls)
> - The maximum permitted load of the relay is 45V, 0,25A

**Table 1: Recommendations for cable contacts**

| Terminal designation | description | recommendation | |
|---|---|---|---|
| X2 | In-/ Output | Cross-section: | 0,5 - 4,0 mm² |
| | | Diameter: | 0,8 - 2,3 mm |
| | | Contact length: | 8,0 mm |
| X5 | Power-supply | Cross-section: | 0,13 - 1,3 mm² |
| | | Diameter: | 0,4 - 1,3 mm |
| | | Contact length: | 6,0 mm |

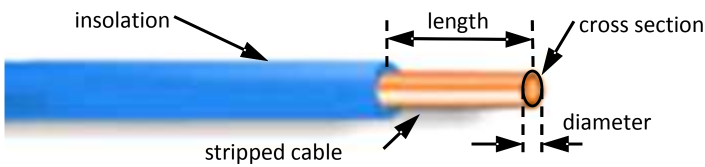
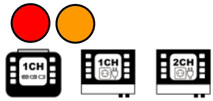
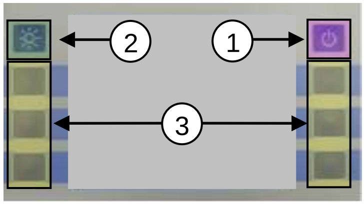



**Figure 3:** Cable assembly




# 6 Operating

## 6.1 Control Buttons




1. Switches the device On and Off. To shut down the device, press the button for duration of approx. 3 seconds and then release it. No function on deltawaveC-F
2. Switches the backlight On and Off
3. Multifunctional buttons: Activate the function displayed beneath the button.

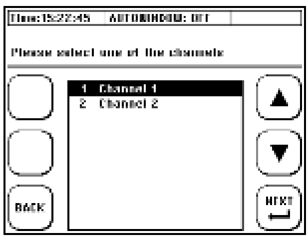
## 6.2 How to navigate

Use the corresponding multifunctional buttons:

| Button | Function | Button | Function |
|---|---|---|---|
| ▲ ▼ ◀ ▶ | Arrow buttons for navigation | | |
| ENTER | Confirms your entry | NEXT | Confirms your entries and opens the next window |
| BACK | Returns you to the previous window | XYZ | Triggers the XYZ function (variable, depending on the application) |
| + | Increases the value | – | Reduces the value |
| (empty) | No function | | |

## 6.3 Select measurement channel


The operation of the 2-channel transmitter differs from conventional operation only (in a large part) through an additional selection of the relevant channel / measuring path.

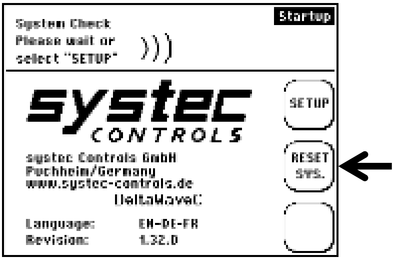


# 7 First Start

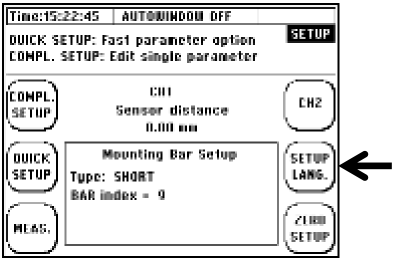
## 7.1 Basic settings, main menu, navigation

### 7.1.1 Adjustment of the display language

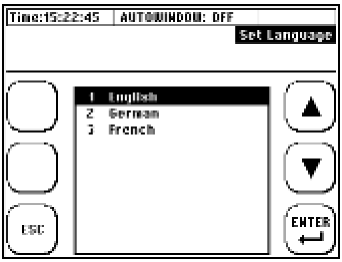
1. Plug in the device.
→During the starting sequence please press the multifunctional key next to the section “SETUP”.




2. Press the button “SETUP LANGUAGE“.




3. In the window choose the required display language using the arrow keys.
Confirm your input by pressing “ENTER“.
Leave the menu with “SETUP”.

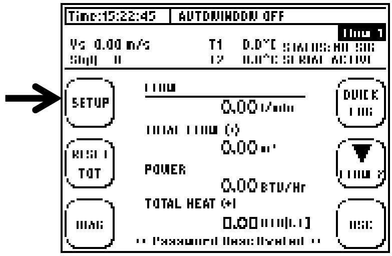



⚠ By setting the language you adjust the language used in the menus. The language in the boxes next to the multifunctional keys remains most widely unchanged.

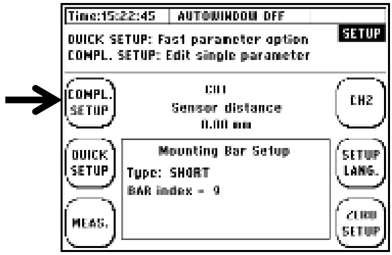
## 7.1.2 Navigation in main menu

After switching deltawaveC-F/P on and passing through the start screen, the measuring window “Flow 1” will appear automatically after few seconds. The measuring window “Flow 1” shows an overview of all necessary information for the measurement of flow and heat quantity.

1. Select “Setup“.
If the required window does not appear after pressing “Setup“, please check if the password function is deactivated.

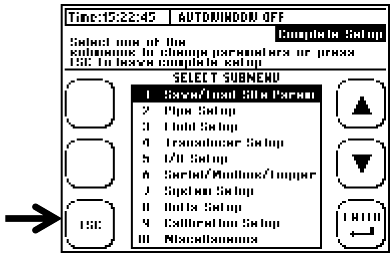



2. If you can see this window, please choose “COMPL” Setup“.




3. You are in the main menu now. From this menu all necessary functions of the device can be selected.

4. To return to the measuring window please proceed as follows:
Choose “ESC” -> in the following window please select “MEAS”.



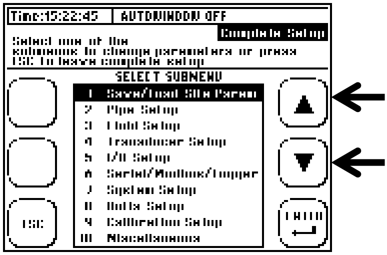

Now you have become acquainted with the basic operation of your deltawaveC-FP.

There is a trick to reach the main menu even faster after switching the device on: select “SETUP” during the start sequence right after switching your deltawaveC-F on. In the following window choose “COMPL” SETUP”.

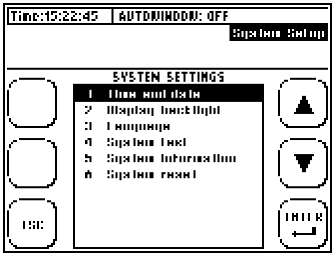
## 7.1.3 Setting time and date

Having chosen the language for the menu you are in the main menu of the device.

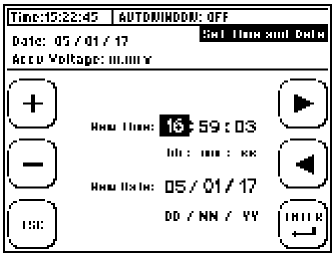
1. Select the menu item (7) System Settings using the arrow key.




2. In the following window choose menu item (1) Time and Date.




3. By using the arrow keys the position can be changed, by using +/- the value can be adjusted. Please enter the time in the following format:
**Hour(hh) : minute(mm) : second(ss)**
Afterwards, please enter the date in the following format:
**Day (dd) : Month (mm) : Year (yy)**
4. Subsequently, press “ENTER“ to confirm your input and return to the system settings.



# 8 Preparing for measurement deltawaveC-F/P

**Set-up your flow measurement in 5 steps**

**1. Choose suitable mounting position for your transducers**

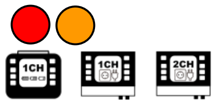
**2. Parameterize your flow transmitter**

**3. Mount ultrasonic transducers onto your pipe**

**4. Set zero point (if possible)**

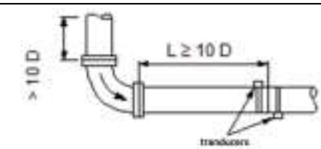
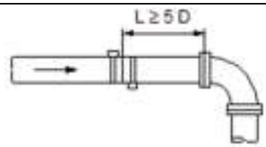
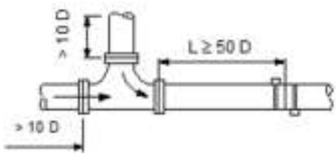
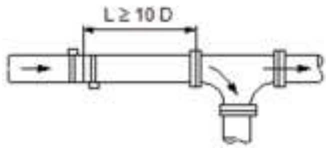
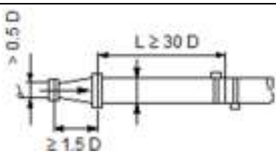
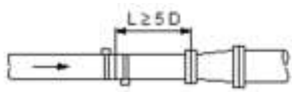
**5. Start your flow measurement**

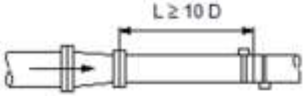
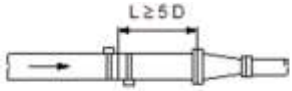
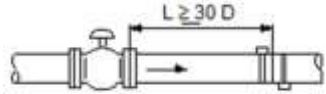
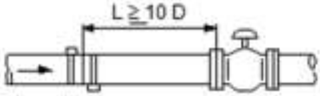
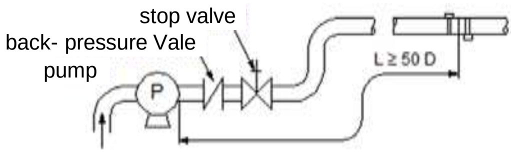
## 8.1 Preparation of the measurement / installation location




### 8.1.1 Inlet and outlet distances

The selection of the mounting location has a considerable influence on the quality of the measurement. Especially the inlet and outlet distance. Please consider the recommendations in the table below.
The letter "D" stands for the pipe diameter.

| Classification | Upstream side | Downstream side |
|---|---|---|
| 90° bend |  |  |
| Tee |  |  |
| Diffuser |  |  |

| Classification | Upstream side | Downstream side |
|---|---|---|
| Reducer |   |   |
| Control valves |   |   |
| Pump |   | |

The distance “L” is defined as the distance from a fitting (e.g. a 90° bend) to the middle of the position of the ultrasonic transducers.

Example: 90° bend (at upstream side) at the inlet, 90° bend (at downstream side) in the outlet.
Diameter of the pipe: 110 mm

Recommendation according to the chart.
Running-in distance: 10D inlet = 10 x 110 mm = 1100 mm
Running-out distance: 5D outlet = 5 x 110 mm = 550 mm

**What happens if the recommended inlet and outlet sections cannot be complied with?**

With simple pipe bends or T-pieces a reduction of inlet or outlet distances leads to a greater uncertainty of measurement. The closer to the fitting the transducers are mounted, the greater the measurement error will be.

With higher velocities of flow a shortened inlet section can also lead to lasting disturbance of the flow profile which can induce a measurement failure. If there is a temporary measurement failure and there is no possibility to change the mounting position of the ultrasonic transducers, then the recommendation is to use the next higher ultrasonic transducer type even with small pipe sizes:
F10 Transducer from DN32…DN200
F05 Transducer from DN200

Pumps or flaps/valves produce permanent disturbances of the flow profile, which are not improved by switching to a different transducer type. In this case, the recommended inlet/outlet distances should be adhered to consistently.

## 8.1.2 Basic principles for ultrasonic transducer assembly

**The pipe always has to be completely filled at the mounting positions of the ultrasonic transducers!**
**Measurement of partially filled pipes is not possible!**

The ultrasonic transducers can be mounted vertically or horizontally or in any other position. This is conditional on compliance with the possible mounting positions shown below:

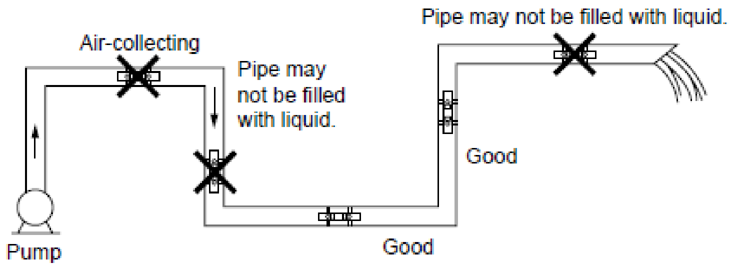



**Figure 4:** Preferable mounting positions for ultrasonic transducers (1)

## 8.1.3 Ultrasonic sensor Mounting on horizontal pipelines

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.

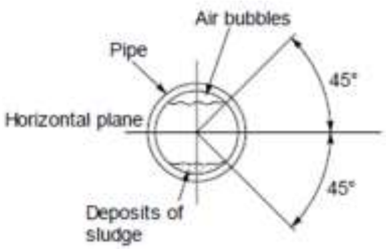



**Figure 5:** Preferable mounting positions for ultrasonic transducers (2)

Note on deposits in the pipeline, e.g. Lime:

The flow rate calculation of the deltawaveC-F / P is based on the following formula.

$$Q = L \frac{(\Delta t)}{t_2 \cdot t_1 \cdot 2\cos\alpha} \cdot k_{\mathrm{Re}} \cdot \boxed{\frac{D^2}{4} \cdot \pi}$$

The red-marked term can be seen that the deltawaveC-F/P the entire pipe cross-section includes in the calculation. Your deltawaveC-F/P calculates the pipe cross-section based on the parameterized values from your tube circumference or tube diameter and wall thickness. If lime scale deposits occur within the pipeline, they reduce the measurable cross-section through which the fluid flows. This will add an additional measurement uncertainty.

> Especially if the pipe is unknown and/or the documentation of the application is missing, measuring the thickness of the pipe wall can be reasonable. In this case, systec Controls offers you the precise pipe wall thickness measuring device deltawaveC-WD.

### 8.1.4 Ultrasonic transducer on uneven surfaces

Avoid mounting the sensors on uneven surfaces such as welds or deformations. For pipes with thick and uneven protective paint, remove it as far as possible at the points on which the ultrasonic transducers are mounted.

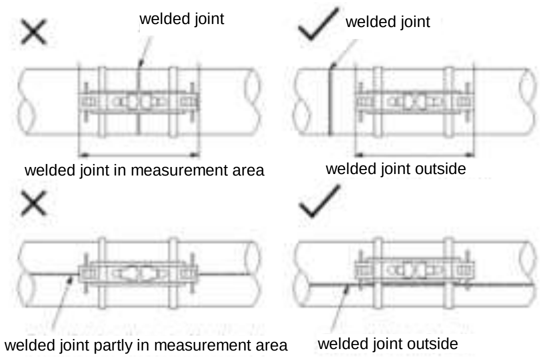



**Figure 6:** Preferable mounting positions for ultrasonic transducers (3)

## 8.2 Fundamentals of parameterization

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

1. **„QUICK SETUP“:** The Quick Setup guide offers step-by-step instructions on the essential tasks you have to complete for deltawaveC-F/P 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.

2. **„CMPL SETUP“**: The complete setup function enables access to all options and expert settings. Here, you can also directly access individual parameters via the main menu.

## What needs to be parameterized?

1. The pipe's outer diameter or circumference.
2. The wall thickness of the pipe. The material and thickness of the pipe lining, if such lining exits.
3. The pipe material
4. The medium
5. The type of ultrasonic transducers
6. The mounting mode for the ultrasonic transducers

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 deltawaveC-F/P has stored tables in which the sound velocities of materials and media are stored. If the material or medium is not listed in the tables, its sound velocity must be entered manually. At the end of this manual you will find tables with additional sound velocities for different substances.

## 8.3 Parameterization with the Quick Setup

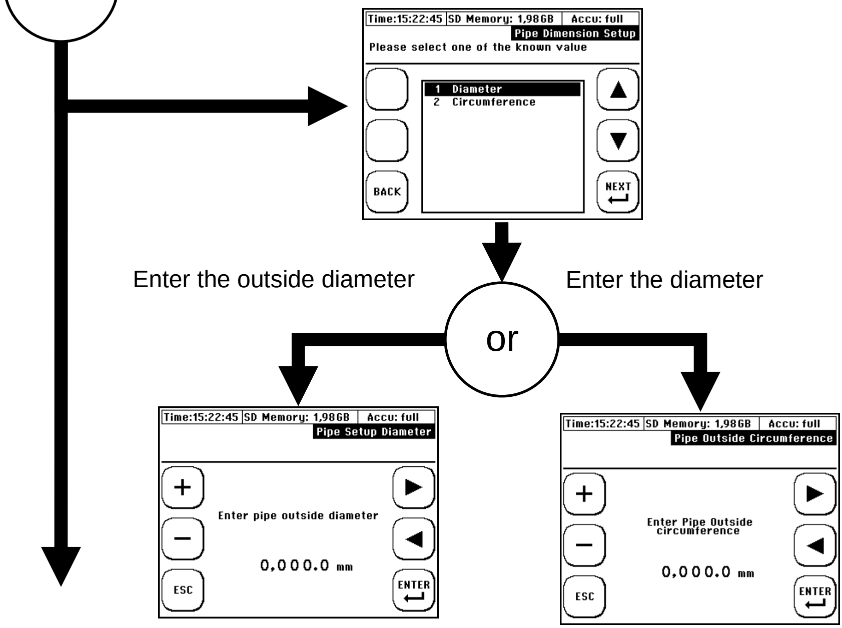
**How to access the parameterization dialog:**

**After power on:** Select „Setup“ → „Quick Setup“

**In the primary measuring window "Flow 1":** Select "Setup" → "Quick "Setup".

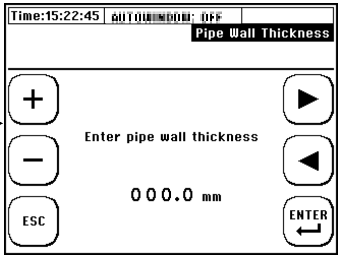
**1**

**Specify whether to enter the pipe circumference or outer diameter:**



**2**

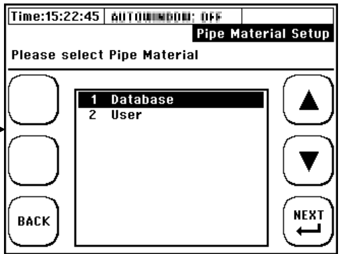
**Enter the pipe's wall thickness:**




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

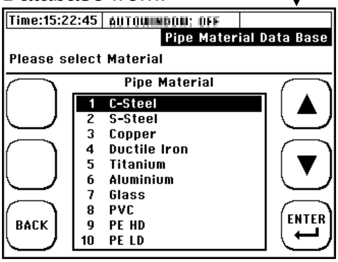
**3**

**Choose pipe material:**

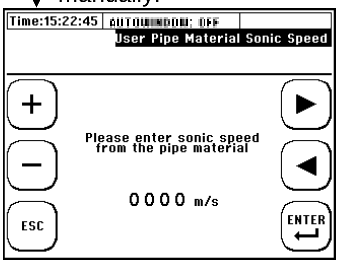


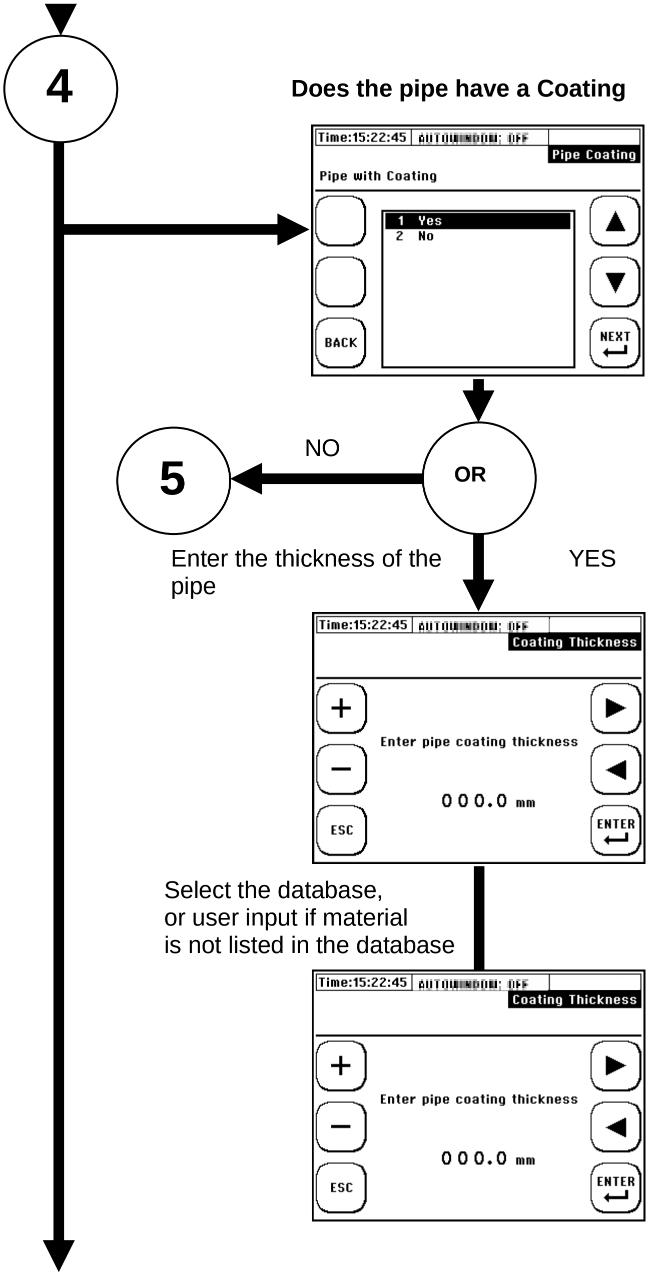

**OR**

Choose the pipe material from the database Database from:




Enter the sonic speed from the pipe material manually:

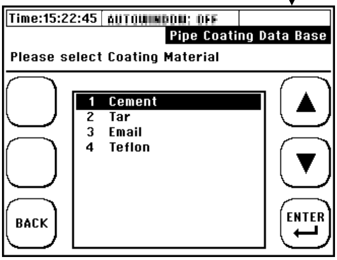


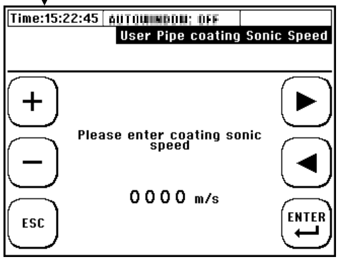

4
Does the pipe have a Coating
Time:15:22:45
Pipe Coating
Pipe with Coating
1 Yes
2 No
BACK
NEXT
NO
OR
5
Enter the thickness of the pipe
YES
Time:15:22:45
Coating Thickness
Enter pipe coating thickness
000.0 mm
ESC
ENTER
Select the database,
or user input if material
is not listed in the database
Time:15:22:45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

OR

Select the database, for coating material

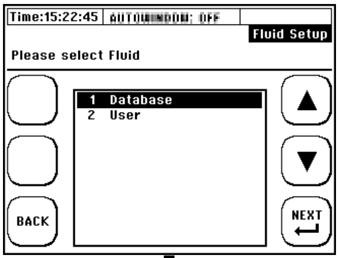
Enter the coating sonic speed of the material




5

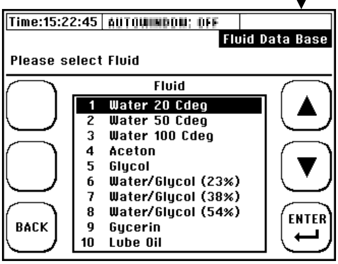
**Select the medium:**

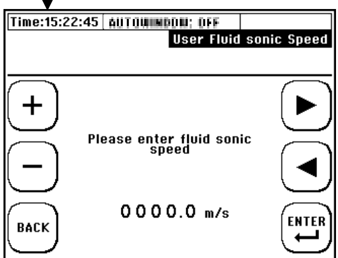



OR

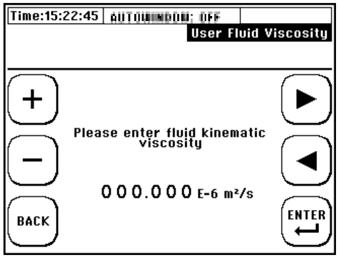
Select the fluid, from the database

Enter the fluid sonic speed manually

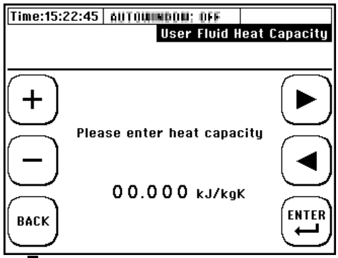


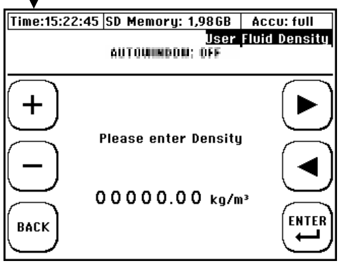
Enter the kinematic viscosity of the medium:




Enter the thermal capacity of the medium

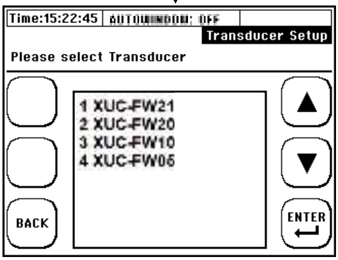



Enter the density of the medium



**6**

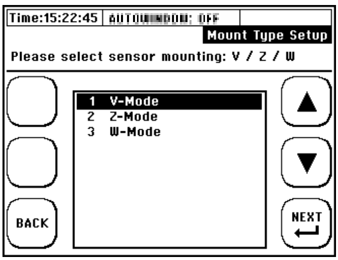
**Select a suitable ultrasonic transducer:**




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

**7**

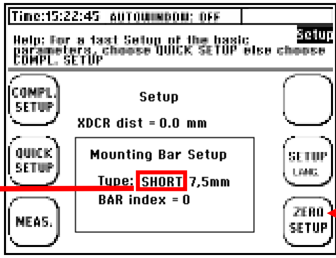
**Select a suitable mounting mode**



The standard mounting type is "V-mounting".
Information on the mounting types can be found in the chapter **"Preparation for measurement"**.

**8**

**Output of the distance between the ultrasonic transducers:**




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

END

**Important!**

Please do always take care which mounting bar for transducers is displayed. The displayed one bar must be used:

Short = 25cm, hole distance 7,5mm, (XUC-FW F21)
Long = 40cm, hole distance 15mm, (XUC-FW F10, F20)

The sensor distance in millimetres is always the distance between the front edge of the ultrasonic transducer 1 (UP) to the front edge of ultrasonic transducer 2 (DOWN) independent from the chosen method of mounting.

## 8.4 Sensor assembly / Sensor 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 Introduction to the installation of ultrasonic transducers

Principle composition of the ultrasonic transducers:
Ultrasonic transducers (F05, F10 and F20/F21) is beige and made of plastic (PEEK).

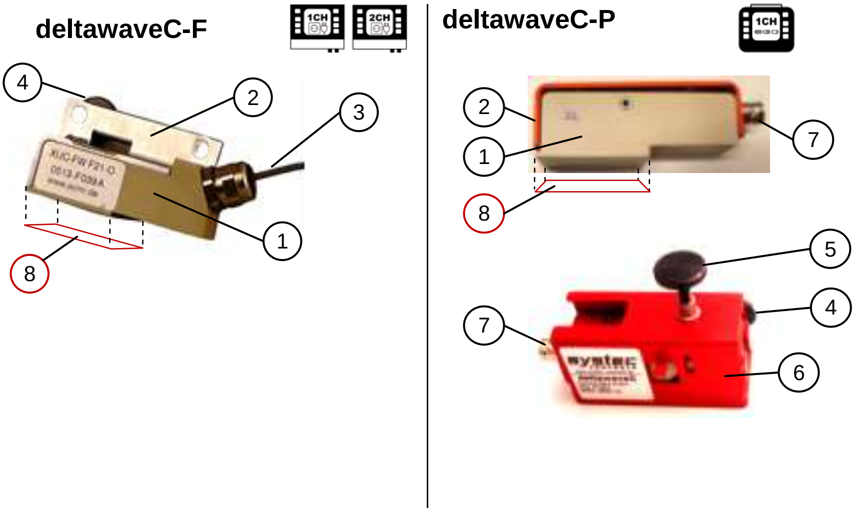
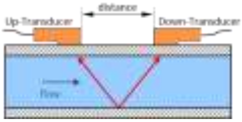



**Figure 7:** Principle composition of the ultrasonic transducers: 1: basic body, 2: cover, 3: connection cable (RG316), 4: knurled screws for fixing on the mounting rail, 5: knurled screw (variation of contact pressure), 6: support housing ("portable" type), 7: BNC connector (RG58, female, "portable" type), 8: projection of the acoustic transmission surface

## 8.4.2 Mounting ultrasonic transducer

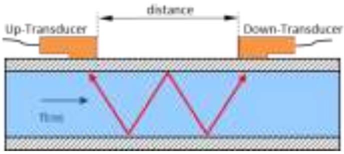
This chapter informs you of the possibilities for mounting the ultrasonic transducers. The V-mode is standard for most applications.

### V-Mounting



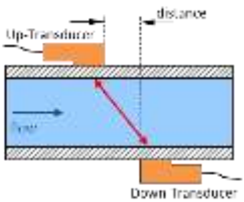

V-mounting results in a measurement in most applications and is often the best compromise achievable signal quality and accuracy.

### W- Mounting




W-Mounting assembly is used when a measurement result which is as exact as possible and/or a high resolution is to be achieved.
In the case of small pipe sizes, this mounting type can also be useful due to the signal sensor separation

### Z- Mounting




Z-Mounting assembly is due to the minimal signal path typically for large pipes or very dirty or gas-loaded media with high signal attenuation or signal dispersion for use contaminants.

**NO MOUNTING BAR**

In some cases Z-mounting results in successful measurements on small pipe diameters (< 20 mm) as well: if the received signals (pipe wall/V/W) can no longer be unambiguously unselected or when the correct reception signals in the measurement window cannot be uniquely positioned (look at 14.2.3)

**Figure 8: Z-mounting example, only possible without mounting rail (XUC-FW)**

**Figure 9: V- and W-mounting example with mounting rail (XUC-FW)**

### 8.4.3 Correct selection of transducer types

Below you will find a guide for the correct ultrasonic transducer selection, which has proven to be successful in practice.

| Pipe diameter | Transducer | Systematic | Comment |
|---|---|---|---|
| **D < 35 mm** | F21 Transducer | ( ** ) | |
| **35 mm > D < 110 mm** | F10 Transducer<br>F21 Transducer | ( ** )<br>( * ) | |
| **110 mm > D < 250 mm** | F10 Transducer | ( ** ) | |
| **250 mm > D < 400 mm** | F10 Transducer<br>F05 Transducer | ( ** )<br>( * ) | |
| **D > 400 mm** | F05 Transducer | ( ** ) | |

**Systematic: ( ** ) –Best selection; ( * )  second best selection**

### 8.4.4 Correct selection of mounting options

Below you will find a guide for the correct choice of mounting options, which has proven to be successful in practice.

| Pipe diameter | Mounting option | Systematic | Comment |
|---|---|---|---|
| **D < 40 mm** | W- Mounting<br>V- Mounting<br>Z- Mounting | ( ** )<br>( * )<br>( * ) | |
| **40 mm > D < 130 mm** | W- Mounting<br>V- Mounting<br>Z- Mounting | ( ** )<br>( ** )<br>( * ) | If the SNR good<br>Disturbed signal |
| **130 mm > D < 400 mm** | V- Mounting<br>Z- Mounting | ( ** )<br>( * ) | |
| **D > 400 mm** | V- Mounting<br>Z- Mounting | ( ** )<br>( * ) | If the SNR good |

**Systematic: (**) highest accuracy; (*) higher signal strength**

## 8.4.5 Mounting of the Transducer in V-Mode or W-Mode

After the parameterization of the measuring point, the transmitter shows the distance of the transducers in mm and the number of holes. The number of holes is a reference quantity of the distance with simultaneous application of the mounting rails for the ultrasonic transducers F10, F20 and F21.

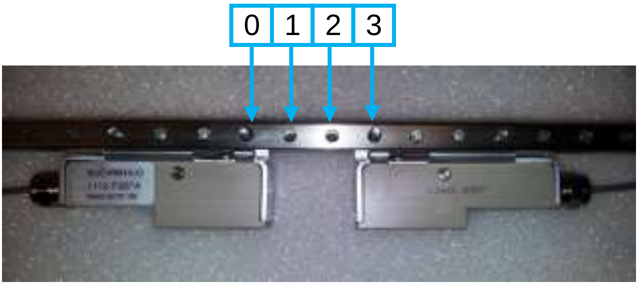
There are two different lengths of mounting bars with different grid dimensions:

> **Short Bar** = 40cm, hole distance 15mm (only for F10 and F20 Transducer)
> **Long Bar** = 25cm, hole distance 7,5mm (only for F21Transducer)

For example: The whole number is „3“, this corresponds to the number of holes between the ultrasonic sensors plus the position at which the thumbscrew of the opposing transducer is mounted. Mount the sensors on the rail as shown. Fix the transducers to the rail using the knurled screws (B).

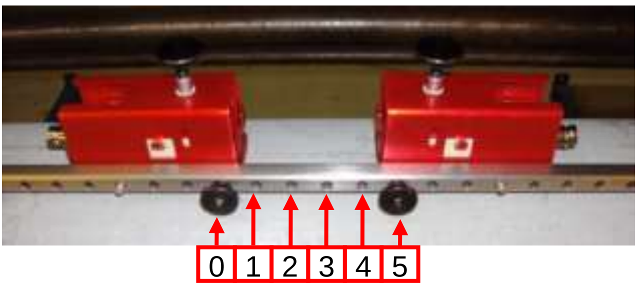
Example of the number of holes 3

deltawaveC-F




Example of the number of holes 5

deltawaveC-P




⚠ **If the wrong mounting rail is used or the wrong hole distance, the measurement does not work or incorrect values are displayed!**

## deltawaveC-F

For the long-term installation of transducers only the coupling pads are recommended.
Place **one** acoustic coupling pad between the acoustic transmission surface of the transducer and the pipeline for each ultrasonic transducer.
**Do not use any additional coupling media such as gels or pastes!**
Make sure that the coupling pads lie flat on the complete sensor surface.

**Figure 10: XUC-FW F10 with acoustic coupling pad**

## deltawaveC-P

Turn the thumbscrew max out, so that the transducer base is located below the lower edge of the sensor carrier (V-profile)
Apply a peanut-sized drop of ultrasonic coupling gel (Magnalube) to the acoustic transmission surface (offset downwards) and rub it slightly.

**Figure 11: Transducer with an approx. peanut-sized drop of coupling gel**

The coupling gel allows a significantly better signal quality than the acoustic coupling pads. However, high temperature signal, the coupling gel may run and the acoustic signal coupling can be lost.
In this case a thermally stable coupling gel or acoustic coupling pad can be used - contact systec Controls.

The coupling pads are stable long-term and allow for a sufficiently good signal quality in most cases when used correctly. Use acoustic coupling foil exclusively for ultrasonic transducers for fixed installation.
For optimum signal coupling, a higher contact pressure is necessary, which usually cannot be produced with the mounting means of the portable measuring device.

In rare cases it may happen that the use of an acoustic coupling gel proves to be more appropriate than the acoustic coupling pads:

- Pipe surface with high roughness
- rapid flow of the coupling gel at high thermal loads

### deltawaveC-F

The ultrasonic transducers are attached by stainless steel band on the pipeline. The stainless steel tensioning band is designed for the maximum diameter of the tube to be used for your ultrasonic transducer and tensioned via the tensioning buckle.
The tensioning band can be shortened easily for smaller pipes.

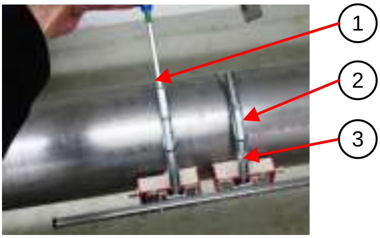



**Figure 13:** Mounting of XUC-FW with stainless steel band; 1: clamping tool, 2: clamping lock, 3: clamping band.

### deltawaveC-P

To attach the ultrasonic transducers (with or without the mounting rail), use the stainless steel chains or hook-and-loop bands.
The knurled screw is tightened in a clockwise direction until a slight pressure is applied

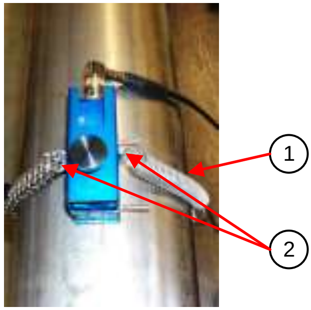



**Figure 12:** Mounting of XUC-PW with stainless steel chains; 1: tension spring, 2: hook for fastening

## 8.4.6 Mounting the ultrasonic transducers based on the Z method

Use a plastic or paper template to mark the mounting positions.

**1.** Wrap the plastic template once around the pipe at the mounting position of the first ultrasonic transducer. Using a felt tip pen, draw a line on the pipe along the template (corresponds with the pipe circumference)

**Figure 14:** Attaching the template tape

**Figure 15:** Mark the circumference

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

**Figure 16:** Mark the distance between transducer

**Figure 17:** Mark the circumference for the second transducer.

**3.** On the circumference lines, select two exactly opposite positions.

**4.** Mount the first sensor to the centre of mark 1.

**5.** Measure out the half of the pipe circumference along the circumference line from mark 2 and apply marking 3.

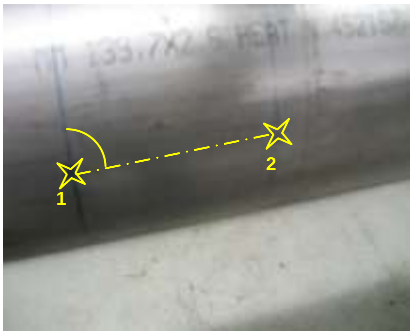
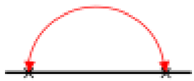



**Figure 18:** Opposed marks 1 & 2 at the circumference lines

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



**6.** Mount the second sensor to the centre of the sensor front (not the sensor) at mark 2 (see Figure 19 & Figure 20). The sensors are now exactly opposite.

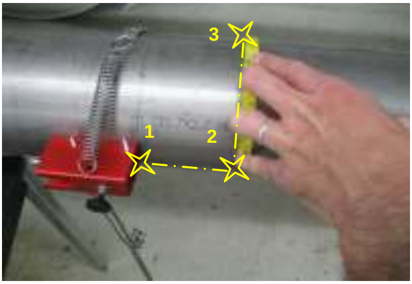



**Figure 19:** Mark the position of the second transducer at half circumferential distance

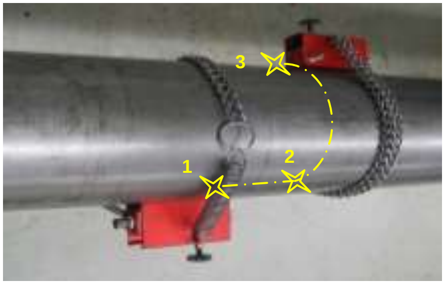
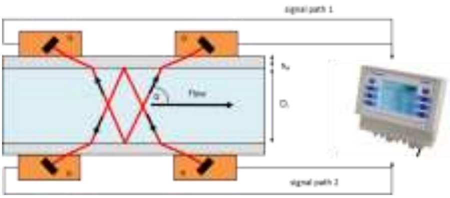
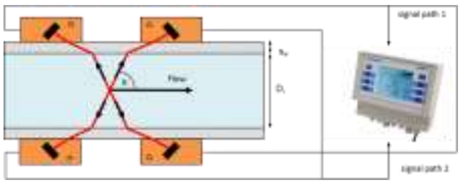



**Figure 20:** Mounted transducer, Z-mounting

## 8.4.7 Mounting the ultrasonic transducers at two crossed measuring paths





The mounting type of both pairs of transducers must be the same (V-mounting, W-mounting or Z-mounting). It is not possible to combine different mounting methods.

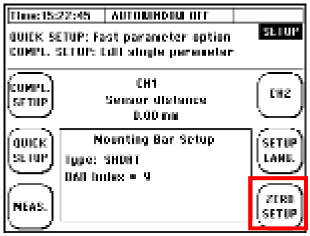
For Z-mounting the transducers of the respective pair must be offset by 180 °. For V and W mounting, the transducers of the respective pair are mounted on the same side of the tube. Installation instructions for the exact alignment at 180 ° offset can be found in the Z-type mounting aid (8.4.6).

## 8.5 Zero Setting

Before starting the measurement, we recommend performing a zero calibration.

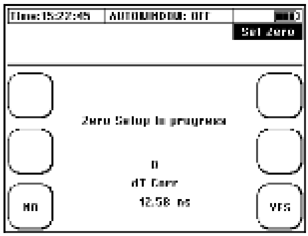
> ⚠ Prerequisites for zero-point calibration are:
> - that the device is configured correctly and that both ultrasonic transducers are mounted properly on the pipe and electrically connected to the transmitter
> - the line is completely filled
> - the flow rate is zero
>
> If all prerequisites are fulfilled, perform a zero-point calibration, otherwise, do not perform a zero-point calibration!
>
> An incorrect zero point adjustment will have a more negative impact on the measurement result than no zero adjustment!

Procedure:
1) Ensure zero flow
2) **Navigation after switching on:**
„Setup“ → „Zero- Setup“
**From the measuring window "Flow 1" outgoing:**
„Setup“ → „Zero Setup“
**From the main menu "COMPL. SETUP" outgoing:** „Miscellaneous“ → „Zero“ → „Set Zero“



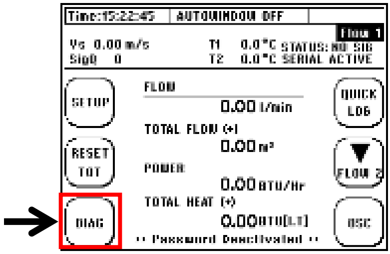

3) The zero point adjustment starts automatically. Wait until the counter reaches the value "0" again.

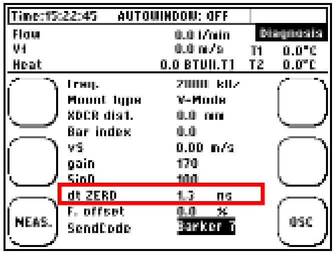
4) After confirming (ENTER) the time correction of the zero point adjustment, you are returned to the "Setup" window.




> ⚠ Typical values for the zero point adjustment are generally in single-digit range.
> If you receive a "time correction" in two-digit range (and more), you can assume that a (residual) flow was present during the zero-point adjustment.
>
> **The zero point will be automatically deleted when relevant parameters (parameters pipe, parameter medium and parameter converter) have been edited again.**

You can check the detected zero point by navigating from the "Flow 1" measurement window to the diagnostic window. In the measurement window, select “Flow 1“ → „DIAG“




The zero point remains stored in the device until it is automatically overwritten with a new zero offset or has been removed manually by "Delete zero".
The time correction value of the zero point adjustment is an essential part of the parameter structure (see 11.1 Saving/Loading parameter data).

The zero point will be automatically deleted when relevant parameters (parameters pipe, parameter medium and parameter converter) have been edited again

For zero-point calibration, your deltawaveC-F/P determines the run-time difference at zero flow, which can arise between the sensors and, if necessary, a flow which is still present.
This determined time (dt ZERO) is automatically compensated in the flow measurement. This increases the accuracy of your flow measurement. dt ZERO is sign-loaded - a subsequent exchange of up- and down-transducers would thus double the error. The ultrasonic sensors are paired at the factory and have a very low zero point error (typically <2 ns).

A zero flow rate cannot be guaranteed at every position of the pipeline system. When installed carefully, this error is in the range of 0.00-0.03 m / s flow velocity. The larger the pipeline is, the smaller is usually the zero point error.

# 9 Heat measurement

The integrated heat quantity measurement allows you to determine the heating or cooling power in your application using with the optionally available Pt100.

## 9.1 Introduction

The Pt100 No. 1 is mounted on the input side (T1 = Tin), Pt100 No. 2 at the output of the process section (T2 = Tout). The placement of the ultrasonic sensors is irrelevant as long as the volume flow is equal. There should be a pipe section to be selected with optimal inflow / outflow (look at chapter 8.1.1).

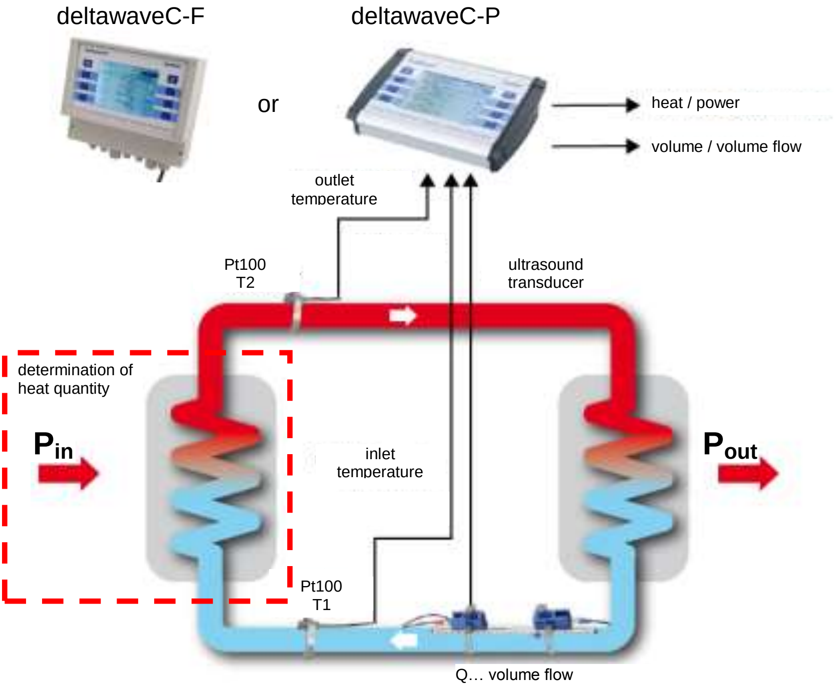



**Figure 21:** Scheme of heat quantity measurement

The deltawaveC-F/P shows you the heat output and the accumulated heat quantity.

### 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, [Tout – Tin]. The product defines thermal output [Q] in W units.

$$\boxed{Q = A \cdot v \cdot c_w \cdot \rho \cdot (T_{out} - T_{in})} \qquad Q = [kW]$$

**Calculating heat (quantity)**

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

$$\boxed{Q = \int \dot{Q} dt} \qquad Q = [J, kW/h]$$

## 9.2 Installing the Pt100

The Pt100 are mounted on the pipeline using the supplied stainless steel tapes.

**Figure 22**: **At pipe mounted Pt100**

It is irrelevant whether you attach the Pt100 to the pipeline with the longer or shorter side of the housing.

For the determination of the heat quantity the determination of the correct temperature difference is important (relative measurement). This means that the temperature readings can deviate absolutely relative to a reference (for example, against an immersion thermometer).
It is important to calibrate both Pt100 and to ensure that both Pt100 show the same measured value in a volume of the same temperature (the difference between the Pt100 before the installation on the pipeline should be zero degree).
The thermal insulation or the use of thermal grease during assembly of the Pt100 can significantly reduce the measurement uncertainties when determining the temperature difference.

## 9.3 Parameterization of the Pt100 for the heat quantity measurement

Before installing the temperature sensors on the pipeline, the temperature difference between both Pt100 should be approximately zero degree in a volume of thermal equilibrium.
We recommend that both temperature sensors be immersed in a tube with liquid for approx. 2...5 minutes (the liquid should be at room temperature) before the tubes are mounted on a pipeline. Avoid touching the probes in advance of the calibration.
To check the calibration, please use the display in "Measuring window 3", "Heat quantity", as the temperature difference between T2-T1 is displayed in this measuring window. After calibration, the temperature difference should **not be** > 0.2 ° C (2 / 10K). If the temperature difference is higher, repeat the calibration procedure.
**Further information on the parameterization of the Pt100 can be found in the chapters 11.9.2, 11.9.3 and 11.10.1.**

In addition to the zero adjustment, the individual temperature readings can be offset (adjustment to reference value / compensation of deviations).

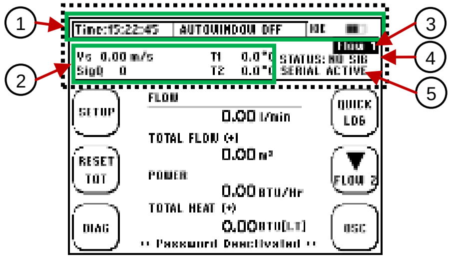
Example: In the pipeline there is a resistance thermometer which shows 80°C. However, your deltawaveC-F/P contact resistance thermometer Pt100 shows only 78.5 ° C. The difference can be corrected manually. In this case, you specify a default value of 80 ° C. The default value is an absolute value and no offset.

The parameterized clamped value is valid for both Pt100. The temperature measurement is clamped with one second (average value formation). For low measuring dynamics and small temperature differences between Pt100 No. 2 and No. 1, it is recommended to increase the Pt100 clamping value. An increase in the clamping has a positive effect on the stability of the temperature difference measurement.

# 10 Measuring windows deltawaveC-F/P

## 10.1 Headline

The header is the same for each of the three measurement windows and displays basic values and status messages:
1) General information
2) General measurement values
3) Name of the UI window
4) Status display
5) Status display for communication




| | Display | Explanation |
|---|---|---|
| Gen. Inform. | **Time** | Format: hh:mm:ss |
| | **AUTOWINDOW ON / OFF** | Auto window function |
| | **IOE** | Indicates that the memory for the pulse output is full and the pulse output is disabled (look at chapter 11.5.4). |
| | | Battery condition : Battery is charging ; 50-100%; 25-49%; 10-25%; <10% |
| Value | **Vs** | Sound velocity of medium in m/s |
| | **SigQ** | Signal quality (percentage of valid signals) |
| | **T1 / T2** | Temperature values of the Pt100 |
| Communication | **MODBUS ON MODBUS OFF** | Status for the MODBUS communication. Priority over SER SST. status. |
| | **SER. SST. ON SER. SST. OFF** | Status display for serial communication. Priority over LOGGER status. |
| | **LOGGER ON LOGGER OFF** | Status display for the data loggers. Priority over USB status. |
| | **USB ON** | Indicates that the USB interface is connected to an external master. |
| | **QLOGGER ON** | Indicates that the Quick Logger is active. |
| Measurement | **OK** | Everything OK. Valid signals are evaluated. |
| | **NO SIG** | No valid signals present. |
| | **Error** | Problems with the ultrasound board. Possible reasons: defective, DSP update necessary. |
| | **VS ERR** | 0.8 * Vs parameterized <Vs> 1.2 * Vs parameterized Possible reasons: wrong signal (W instead of V, V instead of W) |
| | **VP / VL ERR** | Error in the calculation of the signal propagation. |

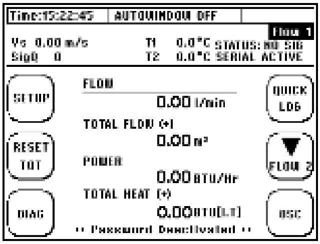
## 10.2 Measuring window "Flow 1"

In the flow measurement window 1 you get all the important information, compactly summarized for your flow, heat output and heat quantity measurement.

**Navigation in the User-Interface:**

1) Approximately 10 seconds after switching on, it will automatically switch from the home screen to the central measuring window "Flow 1".

2) **From the main menu, starting:** Select "ESC" → then "MEASURE."

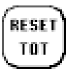



| Display | Explanation |
|---|---|
| **FLOW** | Displays the current volume flow |
| **TOTAL FLOW** | Totalizer flow = flow meter<br>(Summed up volume)<br>Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff) |
| **POWER** | Displays the current heat output. |
| **HEAT TOTAL** | Totalizer heat quantity = heat quantity counter<br>(Summed heat quantity)<br>Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff) |
| **Password activated/ deactivated** | Status of password protection. |


Switch to the setup window



ONLY portable: activates the Quick-Logger




Sets the totalizer (flow and heat quantity) to zero.


Change to measuring window "Flow 2".


Switch to diagnostic window.

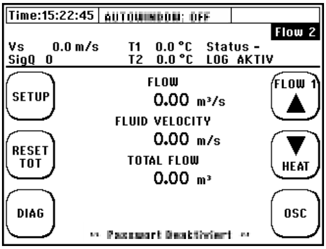

Switch to the oscilloscope window.

## 10.3 Measuring window "Flow 2"

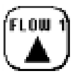
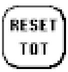
In the flow measurement window 2 you get all the important information, compactly summarized for your flow measurement (without heat measurement).

**Navigation in the User-Interface:**

From the main measurement window "Flow 1" outgoing: Select "Flow 2"




| Display | Explanation |
|---|---|
| **FLOW** | Displays the current volume flow |
| **Fluid VELOCITY** | Indication of the flow velocity of the medium in the pipe |
| **TOTAL FLOW** | Totalizer flow = flow meter<br>Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff) |
| **Password activated/ deactivated** | Status of password protection. |

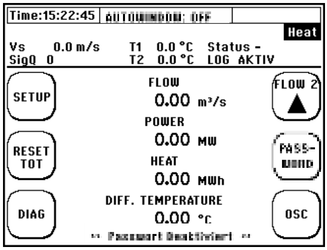
| | | | |
|---|---|---|---|
|  | Switch to the setup window |  | Change to measuring window "Flow 1". |
|  | Sets the totalizer (flow and heat quantity) to zero. |  | Change to measuring window "heat quantity". |
|  | Switch to diagnostic window. |  | Switch to the oscilloscope window. |

## 10.4 The measuring window "heat quantity"

In the "Heat quantity" measurement window, you get all the important information, compactly summarized for your heat quantity measurement.

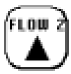
**Navigation in the User-Interface:**

From the main measurement window "Flow 1" outgoing: Select "Flow 2" → then „Heat“




| **Display** | **Explanation** |
|---|---|
| **FLOW** | Displays the current volume flow |
| **POWER** | Displays the current heat output |
| **HEAT TOTAL** | Totalizer heat quantity = heat quantity counter Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff) |
| **DIFF. TEMPERATURE** | Displays the currently measured temperature difference |
| **Password activated/ deactivated** | Status of password protection. |

Switch to the setup window



Change to measuring window "Flow 2".

Sets the totalizer (flow and heat quantity) to zero.

Switch to the password window (Activation / deactivation)

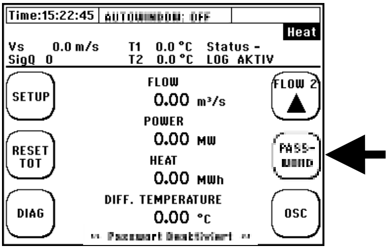
Switch to diagnostic window.

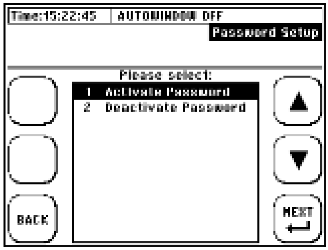
Switch to the oscilloscope window

## 10.5 Password protection

The deltawaveC-F/P is equipped with password protection. After enabling password protection, it is only possible to switch between the measurement windows and the password display. Parameters or totalizers cannot be changed when password protection is activated.

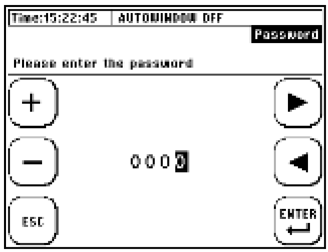
**Activation of the password:**
To access the password display, navigate to the last measurement window. The following screen is the password window.




Please select "Activate password" or "Deactivate password" and confirm the function with the "Enter" key.

Edit the number code by using the arrow (navigation), as well as "+" and "-" (zoom in / out) buttons. Press "ENTER" to confirm the entered password. For security reasons, a second password request is made. Re-Enter the code and confirm. After that the password protection is activated or deactivated depending on the function selected.




If you have lost/forgotten your password and you can´t deactivate password protection then please contact systec Controls.

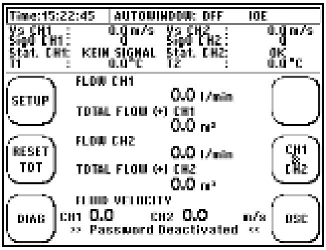
## 10.6 The measurement windows of the 2-channel deltawaveC-F

**Navigation in the User-Interface:**

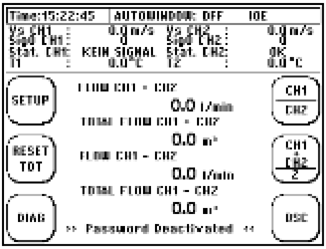
1) Approximately 10s after power-up the screen automatically switches from the start screen to the central measurement window "CH1 / CH2".

2) **From the main menu: Choose "ESC" → then "MEASURE."**

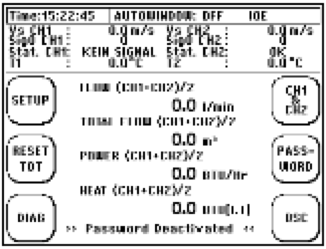
**CH1/CH2**



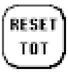

**CH1&CH2**




**(CH1+CH2)/2**




The individual results are shown in the individual measurement windows in terms of flow velocity, volume flow, totalizer (volume and heat quantity) and power. Either for the individual channel or according to the illustrated calculation (sum, difference or mean value)

| | | | |
|---|---|---|---|
|  | Switch to the setup window |  | Switch to the password window (Activation / deactivation) |
|  | Sets the totalizer (flow and heat quantity) to zero. |  | Switch the measurement channel „CH1&CH2“ |
|  | Switch the measurement channel „CH1/CH2“ |  | Switch the measurement channel „(CH1+CH2)/2“ |
|  | Switch to diagnostic window. (after CH-Selection) |  | Switch to the oscilloscope window |

# 11 The main menu (complete menu)

## 11.1 Loading, saving and managing parameter data

**Navigation in the User-Interface:**

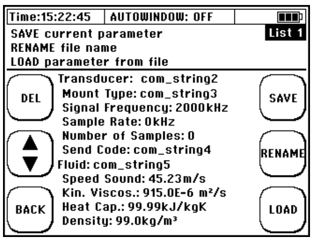
**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → select „Save/Load Site Param“


Your deltawaveC-F/P offers you the possibility to save, load and display all relevant parameters. This saves time when you need to perform measurements of recurring measuring points.

Via the **"file access",** up to **9 parameter** sets can be stored and made available as a parameter file "* .PAR" on the SD card. The format corresponds to a text file ("* .txt") and can be visualized and edited at any time via a text editor or a spreadsheet program.


To select a parameter set, use the arrow keys to select a memory location and confirm with "Next".

You now have the option to check all parameters before saving. The parameter data is distributed over 7 measurement windows. To switch between the parameter data, use the arrow key.




⚠ **IMPORTANT**

The parameter overview shows the current contents of the PAR file. To ensure that the content matches the current parameters, the current parameter set must first be saved in the corresponding file.

| | | | |
|---|---|---|---|
| ENTF | Resetting the PAR file name and content | SAVE | Save the current parameter data |
| ▲▼ | Switch between the overview windows | RENAME | Switch to edit file name |
| ZURÜCK | Back to file list | LOAD | Loading the PAR content |

**Edit the file name:**
1) Use the arrow keys to select characters that correspond to the PAR file name (**max. 7 characters**)
2) Press "ENTER" to confirm the selection of a character
3) "DEL" clears the last character.
4) Exit by navigating to "DONE" and confirm with "ENTER“


The new name is only accepted when the "Save" function is activated in Overview 1.

The "Default.PAR" file is regularly overwritten with the current parameters (cyclical saving of the current settings) so that this memory space should not be used.

The parameter data are stored from firmware 1.33.x on the device-internal SD memory card and can be exported via USB.

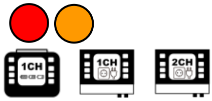
The copying / saving of parameter files from the device-internal SD card are only possible via the USB interface. As soon as the transmitter is connected to a PC via USB, the SD card is recognized as an external data memory and data can be exchanged.

The system **only registers "known"** PAR files.
If a parameter file is to be transferred from a deltawaveC-F/P (device 1) to a different device (device 2) via USB, it must be ensured that the name of the PAR file is assigned to one of the names from the list of Device 2 (see file access, e.g.: FILE1.PAR). The file (device 2) can then be directly replaced / overwritten.

Systec Controls recommends storing and backing up parameter sets of important or recurring applications. This saves time and enables fast, efficient assistance in cases support where support is needed

During the year 2017, a software tool will be available that allows convenient creation and editing of parameter files. If you are interested, please contact systec Controls.

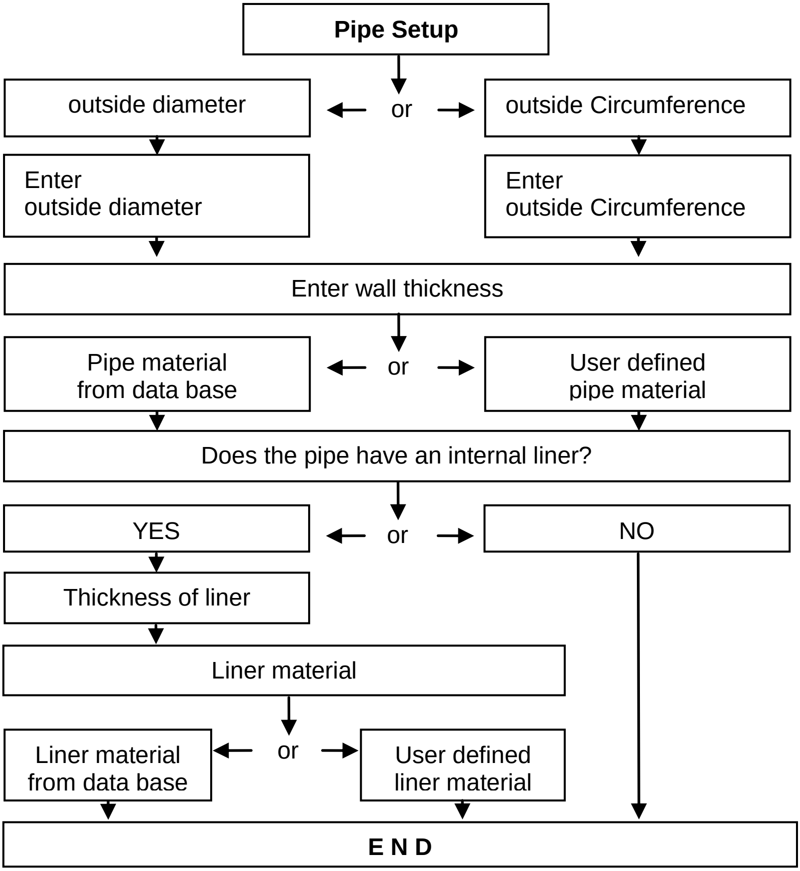
## 11.2 The pipe parameters



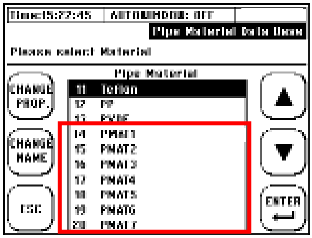

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → select „Pipe Setup“


The pipe parameters are part of the Quick Setup (mandatory parameters), but can also be edited individually via the main menu.

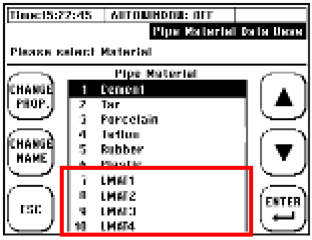


**Parameterization of a user-defined pipe material:**
Scroll down in the material database
Here are freely editable materials:
**Pipe:** **7x PMAT**
**Pipe Lining:** **4x LMAT**
Both the name and the properties can be changed with these materials.

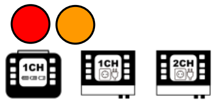


To edit a custom material, you need:

1) Sound velocity (longitudinal)
2) Poisson's ratio



## 11.3 The Fluid Setup



**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → select „Fluid Setup“

The fluid parameters are part of the Quick Setup (mandatory parameters), but can also be edited individually via the main menu.

Choose / enter the fluid (liquid)

Data base
1 Water 20°C
2 …

← or →

User defined:
1) Sound velocity
2) Kinematic viscosity
3) Heat capacity
4) Densiy

**E N D**

Currently, only one user-defined medium can be parameterized. The parameterization of several media via the database is planned for the future.

For a successful, correct determination of the flow velocity, only the input of sound velocity and kinematic viscosity is necessary. Heat capacity and density are only necessary for the determination of the heat quantity and can be parameterized with 1 if not required.

If the kinematic viscosity is not available, you can also calculate it from dynamic viscosity and density (see Chapter 4, Reynolds number). Pay attention to the units!

## 11.4 The Transducer Setup

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → select „Transducer Setup“


The transducer parameters are part of the Quick Setup (mandatory parameters), but can also be edited individually via the main menu.

According to the conditions of application or the availability here select the transducer and mounting types. General information about the transducers and their installation, see chapter 8.4.

General recommendations regarding selection of transducer and mounting type see chapter 8.4.3 & 8.4.4.

Particularly under unfavourable conditions (old pipes, possibly with deposits, liquids with high absorption or with scattering particles or bubbles), the Z-mounting should always be considered as a second option in case of poor signal quality.

**Transducer setup**

↓

Choose a suitable transducer

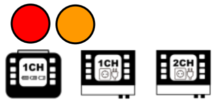
↓

Choose a suitable mounting type

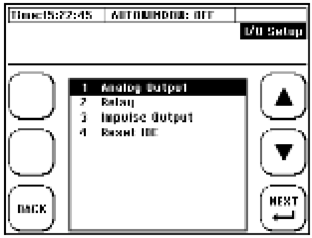
↓

**END**

## 11.5 Parameterization of the inputs and outputs



**Navigation in the User-Interface:**

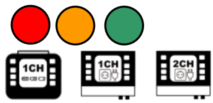



**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → select „I/O Setup“

Depending on the output you want to parameterize, select:

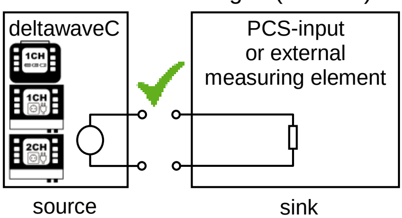
- Analog Output
- Relay
- Impulse Output

### 11.5.1 Parameterization of the 4-20mA outputs

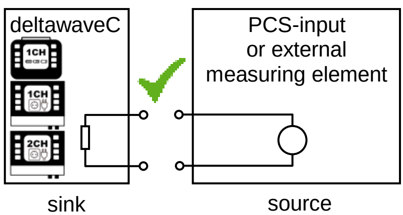


The deltawaveC-F/P has a total of two 4-20mA outputs. You have the option to assign the outputs different metrics.
The outputs are active at the factory. This means that the deltawaveC-F provides a voltage at the outputs. You can also operate the analogue outputs externally (passively).
If you want to switch the analogue outputs passive, the device must be opened. In this case, please contact systec Controls for further details. For external supply, the voltage may be within a range of 10 to 30V.
The analogue outputs are **not galvanically separated.** If the inputs of the evaluation unit require galvanic isolation, a feed separator must be connected between deltawaveC-F/P and the evaluation unit.

deltawaveC-F/P charges (ca. 24V)

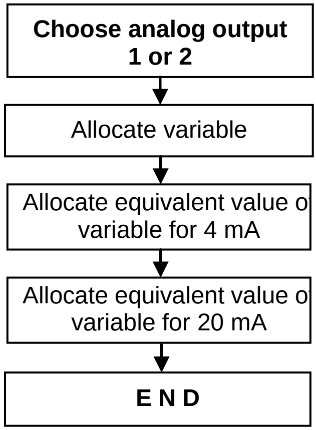



External unit charges (ca. 24V)



If the 4-20mA outputs of the deltawaveC-F / P are active and you connect the analogue outputs of the deltawaveC-F / P to an external device which also provides a voltage at the inputs, this can damage the deltawaveC-F / P or your external device. Before you connect the two devices, make sure that **only one of the devices is active!**

After you have decided to parameterize the analogue outputs, the navigation through further windows follows the sequence diagram on the right side.



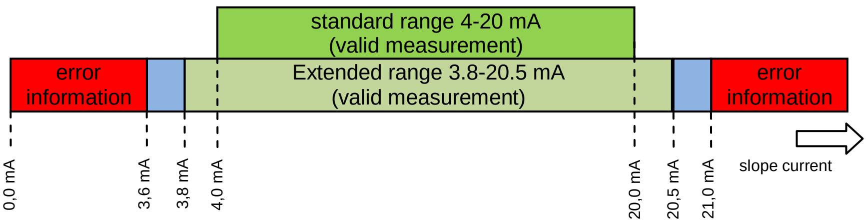

The following measured variables can be assigned to the analogue output:

- Flow
- Flow rate
- Differential temperature T2-T1
- Temperature T1 or T2
- Heat output
- Sound speed
- T1 and Δt

The measured value values are edited in the parameterized units.

Measured values for the 2-channel: All measured values (except for exceptions are temperature and power) can be output separately according to measuring path (CH1, CH2). Special measuring variables for flow: CH1, CH2, CH1 + CH2, CH1-CH2, (CH1 + CH2) / 2. The power calculation is only for average measurement paths possible (1 measuring point, 2 measurement paths).

Extended current range:

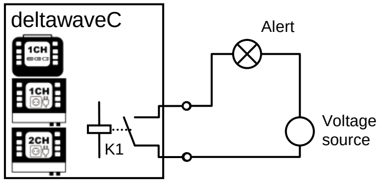



From hardware version CTRL 2.0 or higher (see System Information) is the deltawaveC-F/P able to output the current in an extended range (NAMUR NE 43). The fault current of the deltawaveC-F about 3.4 mA.

## 11.5.2 Parameterization of the relay

Your deltawaveC-F/P is equipped with a relay output. You have the option to assign the output of a function and a range.
For example, it is possible to couple an alarm function to the output, e.g. the sign of a certain minimum flow.

Example for external circuit:




The relay operates without parameterization NO (normally open), the relay function is parameterized, then it is protected against wire breakage. This means that the relay opens only when a parameterized relay function is triggered. This has the advantage that in the event of a power failure (battery empty, no power supply) an alarm is triggered. The polarity of the connections must not be neglected. The contact is potential free.

The navigation through the relay parameterization runs according to the sequence diagram on the right side. The measured variables are edited in the parameterized units.

The following measured variables can be assigned to the relay output:

- Flow
- Flow rate
- Differential temperature T2-T1
- Temperature T1 or T2
- Sound speed

For the 2-channel version, the assignment of special measuring variables is possible, see 11.5.1.

**Relay-setup**
↓
Allocate variable
↓
Allocate lower switch point
↓
Allocate upper switch point
↓
**E N D**

**Example:** In one application, a pump is operated where damage could occur when the flow under 150 $m^3/h$.
Ensure that flow rate is assigned to cubic meters per hour.
Relay parameterized as a minimum switching point at 0$m^3/h$ and a maximum switching point 150$m^3/h$. The relay contact is opened in the range of 0..150$m^3$ / h, the relay contact remains closed at> 150$m^3/h$.

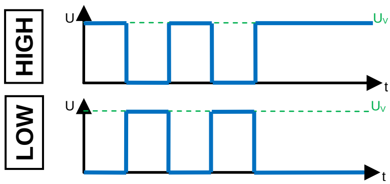
## 11.5.3 Parameterization of the pulse output

**deltawaveC-F**

DeltawaveC-F is equipped with universally configurable pulse outputs. This allows a broad range of user be used.
Older hardware versions have a classic Open Collector output. This principle must be supplied externally.
The deltawaveC-F is used to parameterize the output form via the dip-switch on the connector board (see12.3).

**deltawaveC-P**

The pulse output is available for deltawaveC-P harnesses' from January 2013.
The pulse output is implemented as a transistor output (open collector) and is basically passive with deltawaveC-P (external supply: 3 ... 30V / DC).
The output form of the pulse is parameterized with the deltawaveC-P via the user interface.



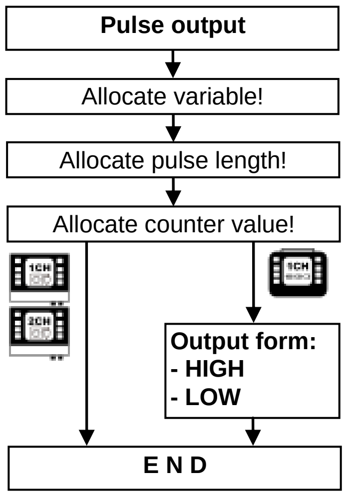

The navigation through the pulse parameterization runs according to the sequence diagram on the right. The measured variables are edited in the respective parameterized unit.

The following measured variables can be assigned to the pulse output:

- Flow rate (total volume)
- Heat quantity

Possible **pulse lengths**: 20, 40, 60ms

The 2-channel version has a second pulse output so that the totalizers can be assigned separately according to measuring paths (1CH, 2CH).



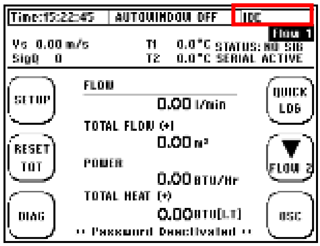

If the unit of the totalizer is changed after parameterization of the pulse output, the counter value is adapted. Numerical inaccuracies in the conversion can lead to deviations with frequent unit change.

### 11.5.4 Impulse-Overflow-Error; IOE

Occasionally, limiting cases can occur when using the pulse output: **The value of the selected pulse output parameter exceeds for a short time the maximum pulse number that can be emitted per second.** In this case the supernumerary pulses will be deposited in the internal pulse buffer of the device and emitted as soon as possible.

If the number of supernumerary pulses is bigger than the maximum size of the impulse buffer (max. 4096 impulses can be buffered), the impulse output will be deactivated and the error report **pulse Overflow Error (IOE)** will be displayed in the right column of the window header.

**As soon as the IOE error appears, no pulses will be output or buffered.** An IOE is an indicator that another pulse weight must be selected to make sure the pulse buffer will not be in overflow again.




The digital display of the transmitter (volume, heat quantity) is not affected by a pulse overflow. The summed amounts are also displayed correctly in the case of an IOE.

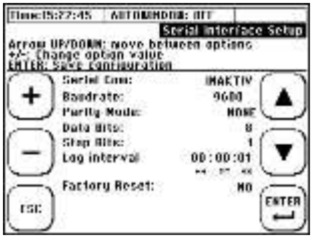
A reactivation of the pulse output is possible by resetting the "**Reset IOE**" error via the I/O settings.


## 11.6 Serial communication, Modbus & Logger

### 11.6.1 Serial data transmission

With the serial data transfer, the digital transmission of the measured data via RS232 / RS485 can be started in ASCII coding. The data is transmitted as a serial digital data stream with a fixed frame consisting of a start bit, five to a maximum of nine data bits, an optional parity bit for detecting transmission errors and a stop bit. This form of data transmission is only available for deltawaveC-F.

**Navigation in the User-Interface:**




**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „Serial/Modbus/Logger“ → then „Serial Interface Setup“

In this menu window, you can edit or view the basic parameters of the data transmission.

| Designation | Reset-Value | Other features |
|---|---|---|
| **Serial COM:**<br>Activation of data transmission | INACTIVE | ACTIVE |
| **Baud rate:**<br>Data bits per second | 9600 | 19200, 38400, 56000, 57600, 115200 |
| **Parity Mode:**<br>Error detection | NONE | ODD, EVEN |
| **Data Bits:**<br>Number of data bits. | 8 | not editable |
| **Stop Bits:**<br>Number of stop bits. | 1 | not editable |
| **Log Interval:**<br>Specifies the interval (time) between two consecutive records. | 00:00:01 | Format: hh:mm:ss<br>hh… hours (00-23)<br>mm…minutes (00-59)<br>ss…seconds (00-59) |
| **Reset:**<br>Resets the serial interface to factory settings. | NO | YES |

After activation, the following data is transmitted semicolon-separated:

| **Pos.** | **Designation** | **Format** | **Pos.** | **Designation** | **Format** |
|---|---|---|---|---|---|
| 1 | Date | JJJJ.MM.TT | 7 | Heat output | 2 DS |
| 2 | time stamp | hh:mm:ss | 8 | Heat quantity | 2 DS |
| 3 | Flow | 2 DS | 9 | Temperature T1 | 1 DS |
| 4 | Flow rate | 2 DS | 10 | Temperature T2 | 1 DS |
| 5 | Sound speed | 2 DS | 11 | Diff.-Temp. T2-T1 | 1 DS |
| 6 | Totalizer flow | 0 DS | 12 | Signal status | Text |
| | | | 13 | Signal quality | 0…100 |

To test the data transfer you can use the Windows own communication program Hyper terminal. If your PC does not have a serial interface, you can access a commercially available USB to RS232 adapter.

### 11.6.2 Modbus

The deltawaveC-F supports the digital transmission of the measured data via Modbus protocol (master / slave architecture). RTU and ASCII Modbus are supported via RS485. This form of data transmission is only available for deltawaveC-F.

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „Serial/Modbus/Logger“ → then „Modbus Setup“


In this menu window, you can edit or view the basic parameters of the data transmission.

| Designation | Reset-Value | Other features |
|---|---|---|
| **Serial COM:**<br>Activation of data transmission | INACTIVE | ACTIVE |
| **Slave Address:**<br>Of deltawaveC-F | 1 | 1… 247 |
| **Operating mode:** | ASCII | RTU |
| **Baud rate:**<br>Data bits per second | 9600 | 19200, 38400, 56000, 57600, 115200 |
| **Parity Mode:**<br>Error detection | NONE | ODD, EVEN |
| **Data Bits:**<br>Number of data bits. | 8 | not editable |
| **Stop Bits:**<br>Number of stop bits. | 1 | not editable |
| **Reset:**<br>Resets the serial interface to factory settings. | NO | YES |
| **Modbus Endian:**<br>Byte sequence | BIG ENDIAN | LITTLE ENDIAN |

i

The register overview can be found in the appendix. For additional information, please contact systec Controls

## 11.6.3 The Data Logger

Logging of data is the time-controlled recording (storage) of measured value data on the device internal memory.

With the deltawaveC-P, the data logger is freely available and included as standard.

With deltawaveC-F (1CH) the data logger can be ordered as an option. From firmware version 1.33.x (March 2016), the data logger is included and can be unlocked (if required). An update of the firmware to enable the data logger is enabled at any time. Please contact us if you are interested in a vacancy.

With the deltawaveC-F (2CH) no data logger is currently available. This feature will be available with new hardware from the middle of 2017 and can then be enabled as with the deltawaveC-F (1CH)

### 11.6.3.1 Activation of the data logger function:

The activation of the data logger is bound to a password. If you want to activate a data logger that is not activated ex works, please proceed as follows:
1. In the main menu navigate to sub menu “6 Serial/Modbus/Logger“.
2. In the sub menu select menu item “3 Data logger“.
3. Connect the transmitter to an external evaluation unit via a USB cable. _ The USB port is in the cable compartment. It can be reached by removing the cover on the cable space.
4. Having connected deltawaveC-F to your computer, the device will be recognized as mass storage device.
5. Now copy the file password.txt from the deltawaveC-F transmitter to your computer.
6. Please send the file password.txt to systec or open the file password.txt with a text editor and send the twelve-digit code to systec.
7. Subsequently you will receive a four-digit code for the activation which you enter as a password. Afterwards, the data logger function is permanently activated, even if you install a new firmware version on your measuring transducer.

### 11.6.3.2 Administration and structure of log data

The current hardware state (4GB SD memory) allows the recording of data up to one year (with a 10 s interval 10 years) when recording in a secondary interval.
The speed of the USB data transmission is limited by the maintenance of the measurement performance and is correspondingly slow. When exporting large amounts of data, the recommendation is to remove the SD card and to exchange the data directly via the corresponding slot on the PC.
Deleting log files can only be done via the USB connection to the PC. We recommend copying the data to an external storage medium before editing or visualizing data.

In the event of a power failure (for example, an empty battery at deltawaveC-P), the data is not lost. As soon as the device is powered up again, the data recording continues automatically (except the predefined duration of data recording has already been exceeded).

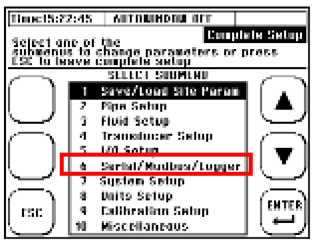
Structure of the Log-File

| | |
|---|---|
| Format | "*.csv"; Text separated by semicolon<br>Processing by text editors or spreadsheet programs (e.g., Microsoft Excel) |
| Headlines | Details of time control<br>Relevant details of the parameterization |
| Measurement data | Date, time, volume flow, flow rate, sound velocity, volume totalizer, heat output, heat dissipation titer, T1 [° C], T2 [° C], T2-T1 [° C], battery status, signal quality, status |

The measured values between two recording intervals are not averaged. The current measurement value is always recorded at the respective time.

### 11.6.3.3 Starting a time-controlled data record

**From the main measurement window "Flow 1":**
select „SETUP“ → then „COMPL SETUP“ → then „Serial/Modbus/Logger“ → then choose



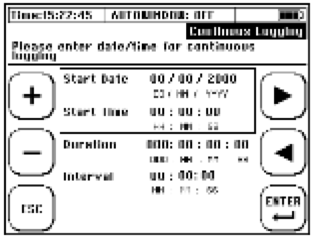

„Data Logger“

„Serial/Modbus/Logger“→“Data Logger“

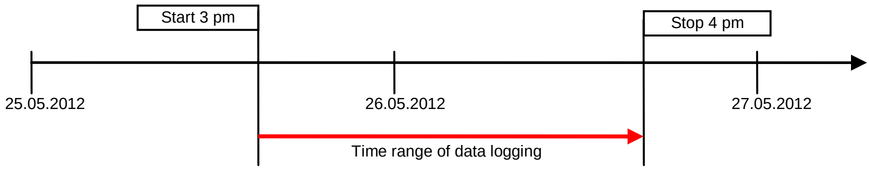
**Edit the file name:**
- Use the arrow keys to select characters corresponding to the PAR file name **(up to 5 characters).**
- Press "ENTER" to confirm the selection of a character
- Press "DEL" to clear the last character.
- Exit by navigating to "END" and confirming with "ENTER"


The name you have chosen (e.g. "12ABC") is provided with a 3-digit number (initial filename: "12ABC000.txt"). A maximum of 65536 lines are written per file. Then a new file is created and the number is incremented by one ("12ABC001.txt").

**Edit the time control**
- Use the arrow keys to navigate
- Change the values with the (+) and (-) buttons
- Press "ENTER" to confirm the edited values
- With "ESC" return to the editing of the file name




**Example:** It should every 60 seconds record data's between 25.05.2012, 3 pm and 26.05.2012, 14 pm is.

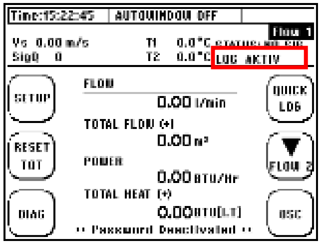



1. Enter 25.05.2012 as start date
2. Enter the start time at 3 pm
3. Enter 001: 01: 00: 00 as the duration
4. Enter the interval 00:01:00

Note that the timer recording is coupled to the system time of deltawaveC-F/P. If the system time or the system date is not set correctly, this directly affects your parameterized data recording!
System time is also reset during a system reset.
The beginning of the data logging should always be in the future in relation to the current system time of deltawaveC-F/P. Otherwise, the data logging will not start.

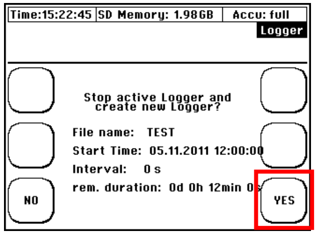
## 11.6.3.4 Cancelling a time-controlled data record

If the logger is active and records data according to the parameterization, this is indicated in the header line: "LOG ACTIVE". With the deltawaveC-F, serial communication and Modbus have priority and can block the display.




If you plan to stop the scheduled recording, please navigate as follows:

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „Serial/Modbus/Logger“ → then choose




„Data Logger“

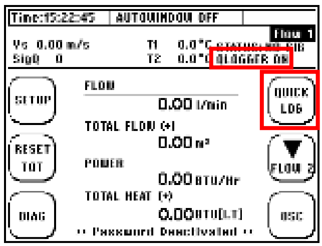
„Serial/Modbus/Logger“→“Data Logger“

To cancel the data recording, press "Yes"

> If the recording is terminated prematurely, the data recorded until then are retained on the SD card. Data is recorded up to the time of the exit.

## 11.6.3.5 Quick-Logger

The Quick-Logger function is only available for deltawaveC-P.
It allows a quick start of the data recording with standard settings:
The predefined file name oriented is made up of the current system time and the number appendix (Z): "hhmmsZZZ.txt"
(E.g. For 14:59:24 hrs: "14592000.txt"
**Duration:** endless
**Interval:** 10s
**Activation:** Press the "QUICK LOG" button for 3-4 seconds




> Press and hold the button for several seconds to prevent accidental starting. If the Quick Logger is active, "QLOGGER ON" is displayed in the communication status.

## 11.7 Systems Settings


**Navigation in the User-Interface:**

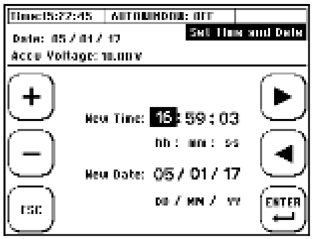
**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „System Setup “

The available submenus are shown on the right.


### 11.7.1 Editing the time and date

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „System Setup “→ „Time and date“



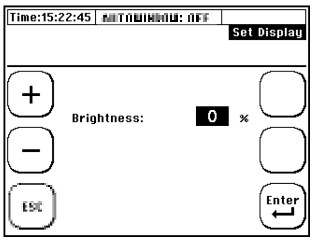

| | |
|---|---|
| ►◄: | Navigation / Selection |
| +/-: | Change of value |
| ESC/ENTER: | Cancel / Confirm |

Enter the current time (hh:mm:ss) and date (DD/MM /YY) and confirm.

### 11.7.2 Changing the indicator light

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „System Setup “→ „Display backlight“




| | |
|---|---|
| ►◄: | Navigation / Selection |
| +/-: | Change of value |
| ESC/ENTER: | Cancel / Confirm |

Set the display brightness and confirm.

### 11.7.3 Changing the menu language

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „System Setup “→ „Language“


| | |
|---|---|
| ►◄: | Navigation / Selection |
| ESC/ENTER: | Cancel / Confirm |

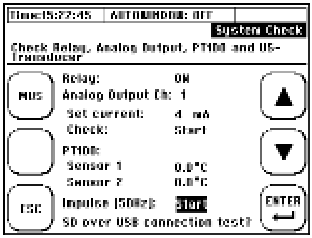
Select a language and confirm.

> Use the language setting to change the language in the menus. The language of the multifunction keys remains largely unchanged.

### 11.7.4 System test

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „System Setup “→ „System test“

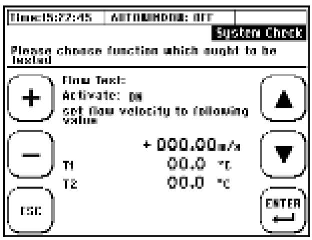



| | |
|---|---|
| ▲▼: | Navigation /Selection |
| ESC/ENTER: | Cancel / Change of function |
| MUS: | Switch to system test 2 |

The System Test 1 window allows you to directly test the deltawaveC F / P outputs.

| Description | Change with confirmation (ENTER) | Action on activation |
|---|---|---|
| Relay | ON/OFF | Open/close the relay |
| Power Activate | Start/Stop | Outputs the parameterized current in mA at the selected analogue output. |
| Pulse [50 Hz] | Start/Stop | Starts pulse output at 50 Hz. |

The System Test 2 window allows you to indirectly test the deltawaveC-F/P outputs by specifying a flow rate. Parameterize a measuring point and simulate a flow:




| | |
|---|---|
| ▲▼: | Navigation / Selection |
| +/-: | Change of value |
| ESC/ENTER: | Cancel / Confirm |

## 11.7.5 System information

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → then „System Setup “→ „System test“ → “MUS“

This window can be used to check the system's hardware and software.


| | |
|---|---|
| CTRL Firmware | Firmware version of the user interface (CTRL Board) |
| CTRL Hardware | Hardware version (CTRL Board) |
| CTRL Flash2 | Size of the Flash Memory 2 (CTRL Board) |
| MUS Firmware | Firmware version of the MUS Board |
| MUS Release Date | Release date of the MUS firmware |
| MUS Channels | Number of MUS channels: 1, 2 |
| Device | portable, fix |
| Languages: | Integrated voice pack of the CTRL firmware |
| Units | unit system |
| Compensation Mode | Internal, external (integrated compensation) |

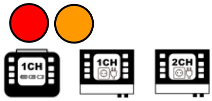
## 11.7.6 System Reset

**From the main measurement window "Flow 1":**
select „SETUP“ → then „COMPL SETUP“ → then „System Setup “→„System reset“

The system reset function resets all parameters to factory settings. If you receive a device with unknown history or if the device shows malfunctions, it is possibility to overwrite invalid settings.


⚠ All settings are overwritten by a system reset, both the parameterization of the measuring point, as well as the totalizer and the system time.

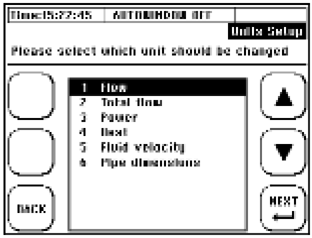
## 11.8 Unit selection



**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → “System Setup”

Choose the variable of which you want to change the unit!



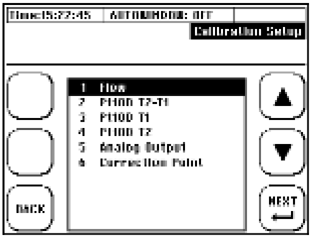

| Physical size | Units supported by deltawaveC-F/P |
|---|---|
| Flow | m³/s; m³/min; m³/h; l/s; l/min; l/h; gal/s; gal/min; gal/h; ft³/s; ft³min; ft³/h |
| Total Flow | m³; l; gal; ft³ |
| Power | MW; kW; W; BTU/Hr; J/Hr |
| Heat | MWh; kWh; Wh; BTU/Hr(i.t); J |
| Fluid velocity | m/s; ft/s |
| Pipe dimensions | mm; inch |

The unit "gal" is the US-American gallon.

## 11.9 Calibration

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → „Calibration “

Select the desired calibration option from the calibration menu.

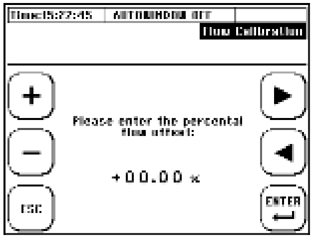



### 11.9.1 Flow-Offset

Select in the calibration menu **„Flow“.**

Enter the desired offset correction

Check the flow at 2-3 relevant flow rates to check whether the percentage correction is permissible. The offset remains stored in the device until it is overwritten by a new value.

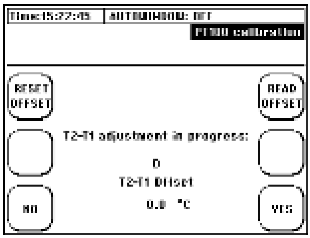



### 11.9.2 Matching the Pt100

Select in calibration **„PT100 T2-T1“**

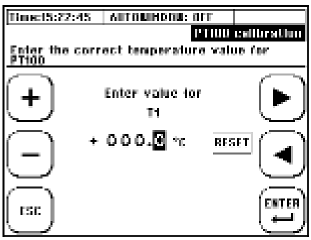
„Read OFFSET“:
Automatic calculation of the offset (T2-T1)
„RESET OFFSET“:
Resets the current offset to zero.

"YES": Confirmation of the calculated offset
"NO": Abort.




### 11.9.3 Pt100 Offset

In the calibration menu, select **"Offset T1 / T2"**
Now enter the actual temperature for T1 (default value). Attention! The default value is an absolute temperature and no offset with respect to the displayed temperature, press "RESET" to clear the default value. The Pt100 shows again the temperature without correction.



## 11.9.4 Calibration of analogue outputs

> The calibration of the analogue outputs is only possible for CTRL 2.0 or higher (see System Information). From this hardware version the deltawaveC-F/P is able to output the current in an extended range (NAMUR NE 43).

The calibration of the analogue outputs is based on a 2-point calibration.

**Procedure:**

**1)** Before coefficients for the correction of the analogue outputs can be calculated, it is necessary to measure the current currents for the present values 4 and 20 mA at the respective outputs with an admissible current measuring device. Use the **System test 1** window. (see 11.7.4).

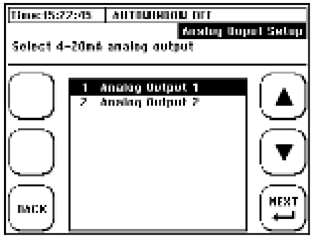
**2)** Now change to the calibration menu and select **"Analog output"**.

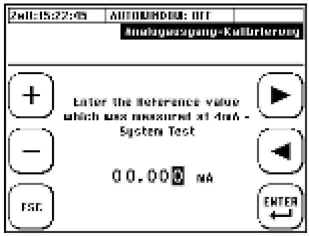
**3)** Select the analogue output to be calibrated.

**4)** Enter the **measured reference** value for **4 mA** and confirm.

**5)** Enter the **measured reference** value for **20 mA** and confirm.

The correction coefficients are now calculated automatically and stored in the system.



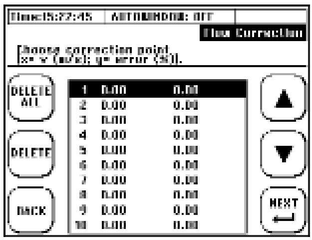



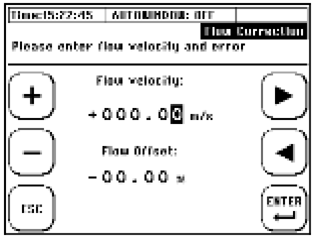

## 11.9.5 Parameterization of a flow velocity characteristic

In the "Flow Correction" submenu of the calibration menu, you can view the points of a configurable characteristic. Between the individual points is linearly interpolated.

Characteristics can only be created for individual measuring points and enable accurate measurements even beyond the recommended inlet and outlet distances.

| | |
|---|---|
| Delete ALL: | Set all points to zero |
| Delete: | Set a single point to zero |
| ▲▼: | Navigation / Selection |
| Next: | In the window for editing the points |



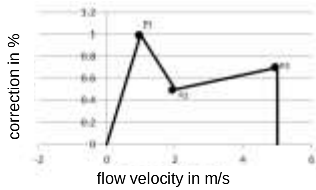



After a point has been selected, the flow velocity (in m / s) and the corresponding correction value (in%) can be entered.
Example: At +0.15 m/s a deviation of + 0.8% was determined. The corresponding correction point is (+0.15; -0.8)

| | |
|---|---|
| ►◄: | Navigation / Selection |
| +/-: | Changing value |
| ESC: | Return to overview |
| ENTER: | Confirm of the edited values |

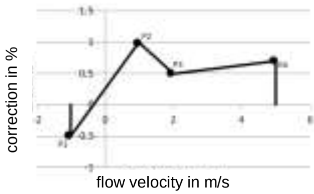
As soon as a point pair [x=v(m/s); Y=correction(%)], the correction is valid and the interpolation coefficients are internally recalculated.

**Standard Rules:**

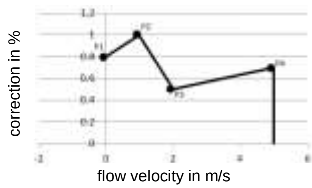



Example: Parameterization of 3 points (see figure on the right: P1, P2, P3).

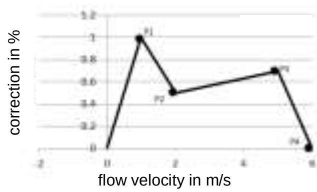
→ From the point with the highest or lowest flow rate. The correction is set to zero.
→ If a point with a different sign is not parameterized, the value is linearly interpolated between zero m / s and the first point.
→ If a point with a different sign is parameterized, this is linearly interpolated between this and the lowest beyond zero.
→ The parameterization of the zero point (0; 0) is not permitted,



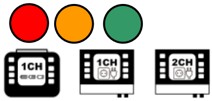

**Special rule 1:** The parameterisation of a correction ≠ 0% for 0 m s is permissible.
Example: Parameterization of the 3 standard points (see illustration on the right: P2, P3, P4) and P1 (0.0; 0.8%).
→ Linear interpolation between P1 and P2




**Special rule 2:** The parameterization of a deviation of 0% for ≠ 0 m / s.
Example: Parameterization of the 3 standard points (see figure on the right: P1, P2, P3) and P4 (6.0; 0.0%)
→ Linear interpolation between P3 and P4



## 11.10 Miscellaneous Parameters



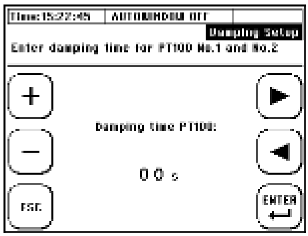
**Navigation in the User-Interface:**


**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → „Miscellaneous “

### 11.10.1 Damping & Burnout


Select in the menu Miscellaneous "Damping flow" or "Damping Pt100"

The editing of the **burnout** parameter is only possible for the flow parameter and can be found in the "Damping flow" menu item.




**Damping flow rate / Pt100:**

Here you have the possibility to damp the signal output (temporal length of the mean value filter). The larger the damping, the slower deltawaveC-F/P reacts to changes changing values. Typical attenuations range from 5-60 seconds.

**Burnout FLOW:**
Low signal quality (SigQ <50, headline top left) causes the measurement to be invalid and the measured values fall to zero. With the help of the memory function, the last valid measured value (SigQ> 50) can be retained for the parameterized duration (= memory).

| |
|---|
| This function can be used to eliminate temporary disturbances (for example short-term gas input or temporary disturbances of the flow profile). In practice, the use of this function is recommended for strongly fluctuating SigQ values / flow measurement values. |

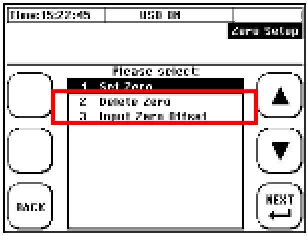
## 11.10.2 Cut off Flow

Select in the menu Miscellaneous "Cut off Flow"


Absolute flow velocities smaller than the edited flow threshold will be not considered (zero set).
Flow values which depending from the flow (flow rate, heat quantity, and so on) are also affected by this parameterization.

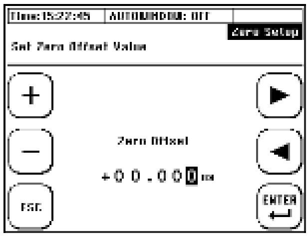
## 11.10.3 Zero

Select in the menu Miscellaneous "Zero"




Here you can set the zero point (see 8.5), delete and enter (manually edit based on documented values).

The zero point remains stored in the device until it has been automatically overwritten by a new zero offset or has been manually removed by "Delete zero".




The zero point is automatically deleted when relevant parameters (pipe, medium or transducer) are edited again. **Be careful, when you perform measurements with different application data!**

## 11.10.4 The totalizer (counters)

DeltawaveC-F/P has two quantity counters, one quantity counter for volume flow and one quantity counter for heat quantity. Both counters can be parameterized independently of each other in regard to their way of counting. The **parameterization of the totalizers** allows implementation of various applications considering the bidirectional flow rate. It is, for example, possible to consider only volume flows in a flow direction (positive or negative counter).
Particularly when parameterizing the heat quantity totalizers, pay attention the effects of the signs have to be pay attended:
(+) Volume flow x (+) Temperature difference = (+) Heat output,
(-) Volume flow x (-) Temperature difference = (+) Heat output,
(-) Volume flow x (+) Temperature difference = (-) Heat output.

**Example 1**: Both the positive and the negative flow on the pulse output should be detected on an external counter. In this case, the volume counter should be parameterized as an absolute counter (+/- sum). The directional detection (positive or negative) can then be carried via the relay and the difference in the evaluation unit can be calculated according to the detected change in the sign.

**Example 2:** Only the positive flow through the pulse output is to be detected by an external counter. In this case, the volume counter should be parameterized as a positive counter (+) (without directional detection via the relay).

⚠ The impulse output of the transmitter behaves in line with the parameterization of the counting method of the respective counter.

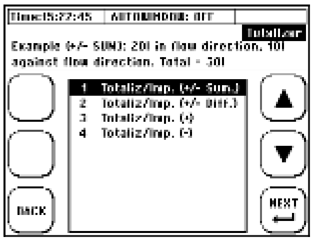
## Parameterization of the totalizers

| Type of Counter | Example |
|---|---|
| **1. Positive-Counter (+):** Volumes with a positive flow direction are summed up. | A flow of 30 litres in the direction of flow and 10 litres. In summary 30 pulses will be given out. |
| **2. Negative-Counter (-):** Volumes with negative flow direction are added up. | A flow of 30 litres in the direction of flow and 10 litres. In summary 10 pulses will be given out. |
| **3. Amount- Counter (+/- Sum.):** The amount of all volumes is added up. | A flow of 30 litres in the direction of flow and 10 litres. In summary 40 pulses will be given out. |
| **4. Different- Counter (+/- Diff.):** It is the sum formed from all volumes (considering the sign) | A flow of 30 litres in the direction of flow and 10 litres. In summary 20 pulses will be given out. |

**Navigation in the User-Interface:**

**From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → „Miscellaneous“ →Select now „Totalizer Flow“ or „ Totalizer heat“.

Now, parameterize the pulse output according to the requirements of the application as described above.



## 11.10.5 Sensor distance

The accuracy of the measurement results depends essentially on the fact that the actual sensor distance corresponds to the recommended sensor distance (see 8.4). Despite all this, it may be necessary that the sensor assembly deviates from the recommendation (lack of space, better signal quality, and so on). In this case, it is imperative to inform the different, "real" sensor distance to the system.


Measure the actual distance between the sensors (head-to-head, see 8.4).

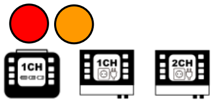
Select in menu Miscellaneous → "Sensor Distance"

| | |
|---|---|
| ►◄: | Navigation / Selection |
| +/-: | Change of value |
| ESC: | Return to overview |
| ENTER: | Confirm the edited value |

Enter the distance (in mm) and confirm.

# 12 Additional information about the hardware

## 12.1 Hardware and Software Reset




The deltawaveC-F/P distinguishes between two types of reset: hardware and software reset. The data on the device-internal SD card remain unaffected by a reset.

1. The Hardware Reset:
The hardware reset is an ON / OFF reset. The device is rebooted, and passes through a full initialization. The data and parameters in the internal flash memory are retained.
The hardware reset is used when the device is no longer responding (system time is stopped, no keyboard input is possible, and so on).

Section of deltawaveC-F Connector-board

Remove the cover over the cable compartment and press the Reset button shown above.

Section of deltawaveC-P backside

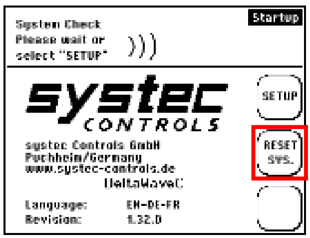

Use a pointed object to press the button located behind the opening on the back of the device.

2. The Software Reset

**Triggering a "Software Reset":**

1. **Immediately on the start:** "RESET SYS."
2. **From the main measurement window "Flow 1":** select „SETUP“ → then „COMPL SETUP“ → „System SETTING“ → „System reset“

In the case of a software reset, all values in the flash memory and in the RAM memory of the deltawaveC-F/P will be set to zero. The system is then reinitialized with the factory settings.




| |
|---|
| The software reset is applied when no or non-plausible values are displayed in display fields.<br>All parameters are reset (date, time, totalizer values, pipe parameters, etc.); Load a pre-stored parameter file or re-parameterize the transmitter. |

## 12.2 Data export and import

If the transmitter is connected via USB to a PC (see chapter 5), the SD card is recognized as an external data memory (as of Windows XP / MAC OS X.x) and data can be exchanged.

> The speed of the USB data transmission is limited by the maintenance of the measurement performance and is correspondingly slow.
> Tip: For optimal data exchange it is advisable to deactivate any digital data record (serial communication, Modbus, Logger).
> When exporting large amounts of data, it is recommended to remove the SD card and to exchange the data directly via the corresponding slot on the PC.

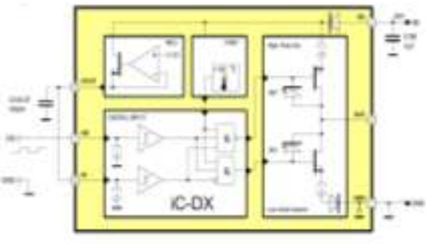
Deleting log files can only be done via the USB connection to the PC. We recommend copying the data to an external storage medium before editing or visualizing data.

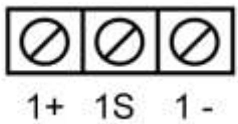
In the event of a power failure (for example, an empty battery at deltawaveC-P), the data's are not lost. As soon as the device is powered up again, the data recording continues automatically (except the predefined duration of data recording has already been exceeded).

> For mass storage> 2GB the detection can take some time. Please wait a minute.

## 12.3 Parameterization of the deltawaveC-F pulse output hardware

For the output of the pulses the IC-DX of IC House listed below is used in the deltawaveC-F.
The diagram below shows the layout of the pulse output. The pulse outputs are indicated by a "white" colour map.



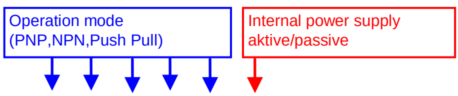




Layout:

| | |
|---|---|
| 1+ | External source 8 … 30V |
| 1S | Signal output |
| 1 - | Ground |

> deltawaveC-F has implemented two digital outputs. The second digital output (IMP 2) can only be used together with a two channel version.

**The deltawaveC-F supplies three different operation modes:**
- NPN (LOW SIDE)
- PNP (HIGH SIDE)
- PUSH PULL




Digital Out Config 1 (upper switch)


Digital Out Config 2 (lower switch):


To configure the operation mode of the digital output, 6 DIP switches are available for each digital output (SW2 for channel1 and SW3 for channel2).

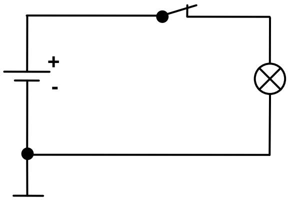
The first DIP **switches 1 to 5** will be used to setup the operation modes (High Side, LOW Side, Push Pull).
The DIP **switch 6** is used to switch between active (12V internal voltage supply) and passive mode (external voltage supply 8 ... 30V).

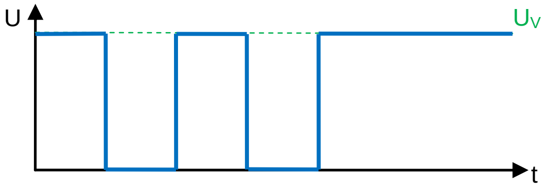
> Systec Controls recommends the PNP mode. This can be used in conjunction with most 2 conductor pulse counters. Function test (voltmeter without resistors) best with push-pull.

## 12.3.1 Operating mode 1: High Side (PNP-Switch)

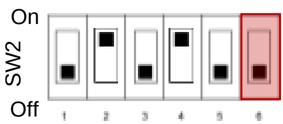
Description:
The switch is closed without impulse. The connection to the power supply is interrupted during pulse output.

High Side switch: U-t diagram
Resting state: signal on +



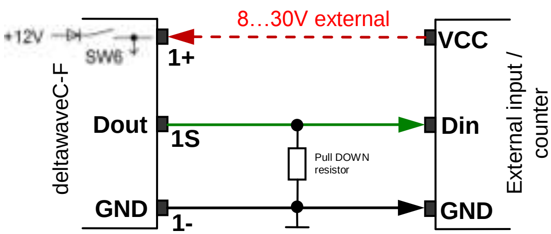




Switch setting (PNP)




| DIP switch configuration | |
|---|---|
| 1 | OFF |
| 2 | ON |
| 3 | OFF |
| 4 | ON |
| 5 | OFF |
| 6 | OFF Ext. VCC; ON: int. 12V |

Application:
According to the wiring example below, for this operating mode (1S) and (1-) must be connected to the external pulse counter. (1S) is connected to the digital input (DI) of your pulse counter, (1-) to the (GND) input of the external counter.

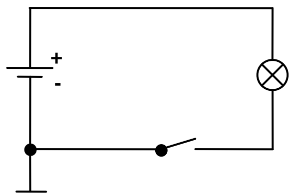



If the counter has a sufficiently high internal resistance, the resistor can be dispensed with.
As a guideline value (test with voltmeter), we recommend 4.7 kΩ for the pull DOWN resistor. In practice, the resistance value may deviate from the recommended value depending on the internal resistance or maximum permissible current.

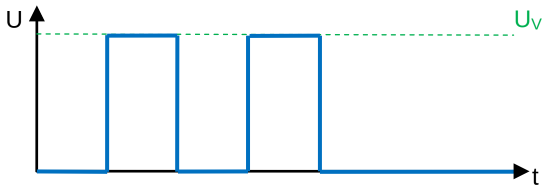
## 12.3.2 Operating mode 2: LOW Side (NPN-Switch)

Description:
The switch is open without pulse. In the case of pulse output, the connection to the voltage supply is closed.

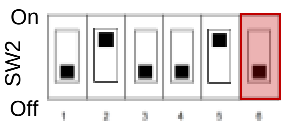
Low Side switch:
Resting state: signal on -




U-t diagram

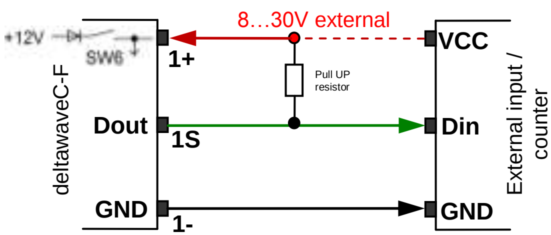



Switch settings (NPN)




| DIP switch configuration | |
|---|---|
| 1 | OFF |
| 2 | ON |
| 3 | OFF |
| 4 | OFF |
| 5 | ON |
| 6 | OFF Ext. VCC; ON: int. 12V |

Application:
According to the wiring example below, for this operating mode (1S) and (1-) must be connected to the external pulse counter. (1S) is connected to the digital input (DI) of your pulse counter, (1-) to the (GND) input of the external counter.




> The resistance is mandatory for NPN parameterization.
> As a guideline (test with voltmeter) we recommend for the pull UP resistor 4.7 kOhm. In practice, the resistance value may deviate from the recommended value depending on the internal resistance or maximum permissible current.

### 12.3.3 Operation Mode Push-Pull

Description:
A Push Pull configuration will be a complementary transistor pair in the output stage (n-channel and p-channel). One of the two transistors always blocks, while the other one is open.

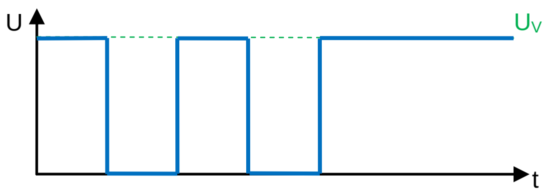
> Advantage: This operating mode requires no pull-up or pull-down resistor and has very short switching times. This makes it particularly suitable for functional tests.
>
> The IC used has a thermal protection circuit (shutdown: 151 ° C, release: 150 ° C). The output current is limited to 450 mA. Nevertheless, avoided connecting the push-pull directly with GND or + VDC.

Push-Pull:

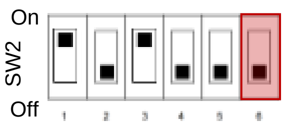
Resting state: signal on +
Transistor 1 closed
Transistor 2 open

Active state:
Transistor 1 open
Transistor 2 closed

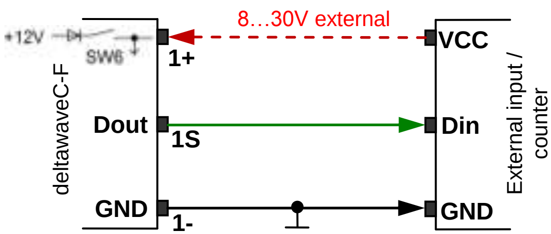
U-t diagram




Switch settings (Push-Pull)




| DIP switch configuration | |
|---|---|
| 1 | ON |
| 2 | OFF |
| 3 | ON |
| 4 | OFF |
| 5 | OFF |
| 6 | OFF Ext. VCC; ON: int. 12V |



## 12.4 RS232 / RS485 Interfaces

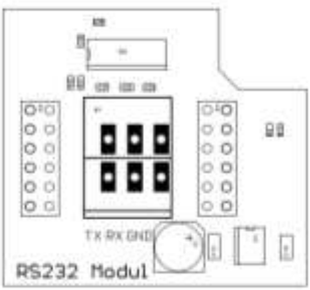
The firmware on your deltawaveC-F is already equipped with all necessary functions for data output of the measured values via an RS232 / RS485 interface. Each deltawaveC-F can be retrofitted with a serial interface card (option).

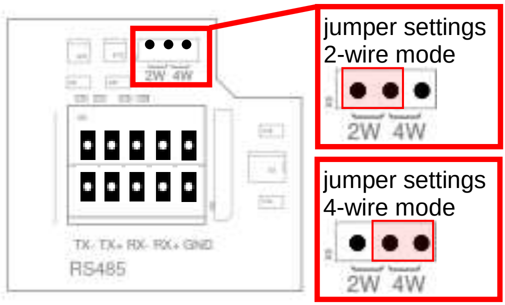
RS232 interfaces allow cable lengths up to approx. 20 m between deltawaveC-F and evaluation unit. RS485 interfaces allow cable lengths up to several 100 m between deltawaveC-F and evaluation unit. Additional, a Modbus communication can be realized via the RS485 interface card.

> The Modbus functionality of deltawaveC-F via RS485 interface is not discussed in this manual. For additional information, please contact systec Controls.

RS232 interface board:

The RS485 interface board is configurable for 2-wire or 4-wire communication mode (Jumper).




**Subsequent installation:**
Disconnect your deltawaveC-F from the power supply. Just put the serial interface board on the two free socket boards, that’s it.

**Connecting the serial interface board with a receiver (e.g. a PC) exemplary shown in case of a RS232 interface board:**

To establish a connection between deltawaveC-F and a PC, please produce a connection cable with the following plugs in case of a RS232 interface board:

SUB-D 9 pin

Solder side view


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

Several participants or the bridging of longer distances with the corresponding load with interfering signals may require the application of an appropriate termination.

# 13 Tips and Tricks

## 13.1 Measuring mixed fluids

If liquids are present as a mixture, then in a first step it is necessary to know the mixing ratio.
To draw conclusions on the actual values of a liquid mixture
The application of complex calculation models is normally required. In practice, the approach described below helps to achieve a reliable measurement result in pragmatic terms in most cases.

The following is an example of the mixture: 10% glycol; 90% water (20 ° C). To configure the fluid mixture, proceed as follows:

# A.) Material data

The substance data of the individual components are required. Material data for relevant media are stored in the deltawaveC-F / P database and can be found in the parameter overview or the substance data tables in the appendix of this manual.
The following data are required for the correct determination of the flow velocity:

- Sound velocity
- Kinematic viscosity

The following data are also required for the correct determination of the heat quantity:
- Heat capacity
- Density of the medium

For the above example, the following material data are obtained for 20°C.:

| | **Water 100%** | **Glycol 100%** |
|---|---|---|
| Vs [m/s] | 1486 | 1666 |
| Kinematic Viscosity [E-6 m²/s] | 1,003 | 21,11 |
| Density [kg/m³] | 998,20 | 1110,00 |
| heat capacity [kJ/kgK] | 4,182 | 2,400 |

# B) Linear approximation

Multiply the respective component fraction (mass fraction, volume fraction material fraction) with the component property, and add both.

Vs (mixture) = $\sum(Vs_{Components} * Quantity_{Components})$
Vs (mixture) = (1486 m/s * 0,9) + (1666m/s * 0,1)
Vs (mixture) = 1504 m/s

According to the example, the following material data are obtained for the mixture at 20°C:

| | Water 90%, Glycol 10% |
|---|---|
| Vs [m/s] | 1504 |
| Kinematic Viscosity [E-6 m²/s] | 3,0137 |
| Density [kg/m³] | 1009,38 |
| heat capacity [kJ/kgK] | 4,0038 |

# C) Parameterization of the medium

Afterwards please navigate from the main menu again to the menu option “Parameter medium”. Select users input now and enter the values you have calculated as user-defined values.

If the characteristics of the specific substance are not in the manual or the database of the device, data sheets of the producer of the fluid can give you information on its parameters.
Also useful in the search for substance data are specialized search engines (http://www.wolframalpha.com/).

As the parameter viscosity of a fluid is very often not given. In this case, the value of density and dynamic viscosity can be calculated. Be sure to enter the values on the units.
Helpful converter: http://www.cactus2000.de/de/unit/massvis.shtml

## 13.2 Measuring unknown fluids

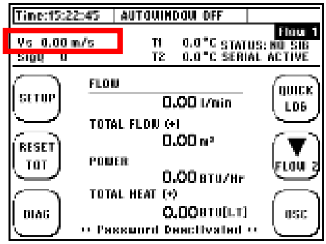
In practical applications it is quite possible that there is no information regarding sound velocity (or other material data) or composition for a specific fluid. As an example, the food industry (various beverages, for example apple juice) is mentioned here.

In order to determine the flow rate in the tube and thus the volume flow in the tube, the sound velocity of the medium is primarily important. The kinematic viscosity is necessary for correct Reynolds compensation (see chapter 4). The density and heat capacity are only important for the determination of heat output or heat quantity. To stay with our example: In the case of apple juice it is rarely necessary to carry out a heat quantity measurement.

Furthermore, it is sufficient for watery solutions to assume the values of water in a first approximation. For hydrocarbons, the values of oil or gasoline, depending on the application.
Example: You do not know the exact composition of your medium, but you can assume that it is an aqueous solution.

Proceed as follows:

1. Parameterize your deltawaveC-F/P according to the application (quick setup, pipe dimensions, and so on).
2. As soon as you select the liquid, select the medium which is the most similar to the medium to be measured from the deltawaveC-F / P database. In this case water (20 ° C).
3. Now install the ultrasonic transducers according to the sensor distance output.
4. Now change to the measurement window 1. The sound velocity of the medium is displayed at the top left.
5. Now run the Quick setup again. When selecting the medium, select user input and edit the sound velocity according to the value displayed in measurement window 1 (leave all other values).




6. Complete the Quick setup now. In the setup window, you will now see a sensor distance corresponding to the parameterization.
7. If a different sensor distance is recommended, change the installation of the ultrasonic transducers accordingly
8. Start again from point 4. Repeat the procedure until the sensor distance output from deltawaveC-F / P no longer changes.

In rare cases it might happen, that the measuring inaccuracy is not satisfactory even if you have followed the procedure above.
In this case, we recommend compensation using an offset correction. Reset the Totalizer value ("RESET TOT"), start the flow and catch the flow of the fluid in a container. Determine the volume (directly or via mass determination and density) and compare the value with the deltawaveC-F/P display.
Now parameterize the corresponding compensation value:
From the measuring window 1 outgoing → Complete setup → Calibration → Flow offset. Now enter the percentage of deviance between the reference quantity and the measured quantity.

# 14 Troubleshooting

You have parameterized a measuring point, the ultrasonic transducers are mounted and do not get any plausible results or the flow zero. Or you can get meaningful results in the display of the deltawaveC-F/P, but have difficulties on transmitting the results analogously or digitally.

This chapter provides a help guidance procedure for successful support:

**A)** **Checklist:** Use the checklist (see 14.6) for troubleshooting and work through this point by point. If this is not successful, continue with B.

> Print out the checklist and work through it step by step. This helps you keep a cool head during a difficult application and systematically limit the error.

**B)** **Preparation for the support:**

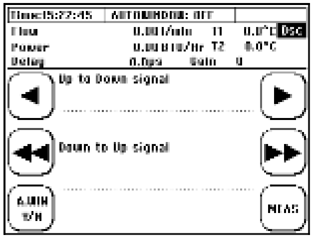
1) An extensive evaluation of the device parameterization is essential for successful support. To ensure this, the simplest and safest method is to save the current parameter set (see chapter 11) and export the file (alternatively, you can take pictures of all windows in the parameter overview).
2) If you do not receive plausible flow data, an image of the current signal window should also be sent to the support. Navigate to the oscilloscope window and perform an **A-Scan export** (see chapter14.1). Copy the WAV file via USB (alternatively, you can make a photo of the current signal window).
3) In addition, it is possible to take pictures of the ultrasonic transducers installed on the tube. If you are experiencing problems with the analogue or digital signal transmission, you also have a picture of the cable connection space or the wiring.

**C)** **Contact systec Controls**
089 / 809 06 0 and info@systec-controls.de
And submit the data to the assigned support (PAR file, WAV file and photos of the converter installation)

> If you do not have the option to send the data electronically (email), please provide the following information: pipe material, pipe diameter, wall thickness, medium, medium temperature, type / length of the inlet sections, sensor type.

## 14.1 The Oscilloscope Window

The oscilloscope (OSC) window can be accessed via the OSC button in the measurement windows or in the diagnostics window.
The OSC window provides the signal analysis, the most powerful diagnostic tool. The currently evaluated signal window is displayed. In particular, the signal shape, the signal sharpness, the signal-to-noise ratio (SNR) and the type of noise are of particular interest.




◄/◄◄ Slow / fast decrease of the deceleration or on the time axis to the left

►/►► Slow / fast increase the delay or move to the right on the time axis

**A.WIN Y/N** Auto window: Turn the function on / off

**MEAS** Return to the measurement window

From the standard header differing display:

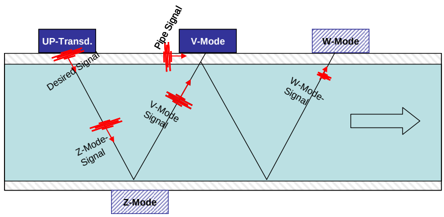
| **Display** | | **Explanation** |
|---|---|---|
| **Values** | **Flow** | Flow rate |
| | **Power** | Heat output |
| | **T1 / T2** | Temperature values of the Pt100 |
| | **Delay** | Start value of the displayed signal window in µs |
| | **Gain** | Value of the signal gain for the displayed signal |

The deltawaveC-F/P allows storing current signals (A-Scan) as a WAV file on the SD card. The A-Scan export can only be carried out in the OSC window:

1) Press and hold the backlight button for about 5 seconds.
2) The OSZ screen freezes and it appears at the bottom of the screen: "A-Scan Export in progress". The A-scan takes approximately 2-3 seconds. After completion, the following appears: "A-Scan Exported to SD-card".
3) A corresponding "* .wav" file has now been stored on the device-internal SD card. The file drawing is generated automatically based on the current system time. For the system time (hh: mm: ss) and date (YYYY.MM.TT), the name "TThhmmss.wav" is given.
4) Connect your deltawaveC-F / P to a PC (USB cable) and copy the desired WAV file.

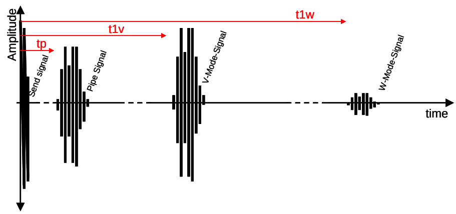
## 14.2 Signal analysis

The deltawaveC-F/P provides powerful diagnostics capabilities that allow the skilled user to make reliable measurements even in difficult applications. The oscilloscope window allows you to quickly assess the quality of your signals. This is especially helpful if you do not get any, or doubtful results. Two signal parameters are particularly important for a good measurement: the signal-to-noise ratio and the signal sharpness.
In order to fully exploit the possibilities of signal analysis, the understanding of wave propagation and signal processing is helpful.
The diagram schematically illustrates various ways that an ultrasound signal can take in the pipeline.
The refraction and reflection at the phase boundary surfaces is determined by the combination of the material properties.




The **UP transducer** (upstream transducer) emits an ultrasonic signal downstream. This signal splits up and is transmitted directly in the pipeline (pipe wall signal) as well as reflected in the medium (Z-mounting signal, V-montage signal, W-mounting signal).
Depending on the mounting position (Z, V or W mounting) and the signal propagation time, the **DOWN transducer** (downstream transducer) receives the most diverse signals in varying time windows.

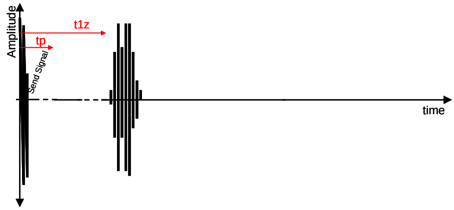
After the reception signal is recorded, the transmitter and receiver functions are exchanged and the transmission-reception cycle is repeated. This time, however, the send signal is sent upstream.
The signal propagation time is the time that a signal spends on the signal path associated with it. It depends on the path length and sound velocity in the media being traversed.
After a time “tp” can see the signal that has travelled directly to the pipe wall along.



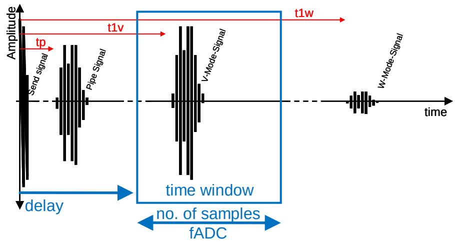

This is usually the first signal on the time axis at the V- or W-position because it has the shortest path length and the sound velocity of the tube wall material is generally higher than that of the liquid. Then, at time t1v, the V-mount signal comes (simple reflection) and after approximately twice the time, t1w the W signal (double reflection).
In the case of highly sound conducting piping material (metals) and small pipelines, the piping signal has high amplitude, similar to that of the V-mounting signal. In the case of damping pipeline materials (plastics), the pipe wall signal is often

significantly weaker. The V-mount signal is usually much stronger (higher amplitude) than the W-mount signal. The W signal returns approximately twice the path in the flowing medium. Thus, it is exposed to the signal attenuation phenomena (absorption and scattering) over a longer distance in the medium.

In the case of the Z-mount, a different image is obtained. Here, in addition to the send signal, only the Z signal (at t1z) can be seen itself.




In the oscilloscope window itself, only a small time interval is displayed. The position of this measurement window is defined by the delay. The length is determined by the number of recorded measuring points (no. Of samples) and the measuring rate (fADC).




In the oscilloscope window, you usually only see the signal required for the evaluation (for example, the V-mount signal).

## 14.2.1 Signal-to-noise ratio (SNR)

The signal-to-noise ratio (SNR) is an indication of the influence of interference signals on a defined useful signal. The more clearly the signal is detected, the more stable the digital evaluation of the useful signal.

A similarly poor signal-to-noise ratio can be caused by various phenomena:

1) A bad acoustic signal (with low noise level)
2) A high level of acoustic interfering signals (scattering signal of particles or bubbles)
3) A high level of electrical noise (EMC problems)

In any case, an improvement in the signal quality can be achieved either by an improvement in the acoustic useful signal or by avoiding interference signals.

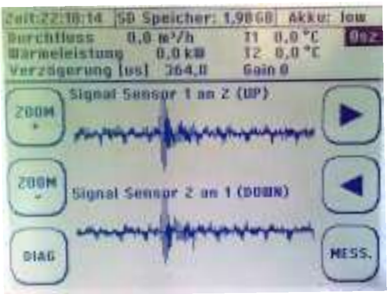
The following is a list of some measures for improving the useful signal quality:

- 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-P. Please also make sure that centre of transducers touches the pipe sufficiently (might be problem with very small pipes). You can check the oscilloscope while mounting the transducers.
- Make sure that transducers are not mounted e.g. on welding seams
- Select another pipe position, e.g. A rising pipe (ensuring a fully filled pipe).
- Make sure to provide sufficient straight run
- Minimize the signal path (Z- instead of the V- or V- instead of the W-mount)
- Use a different transducer (lower frequency)

The following is a list of some measures to avoid interfering signals:

- For the deltawaveC-F/P, ensure that the shield and core of the converter cables are connected correctly (see 3.3).
- Check whether your media is sufficiently vented and does not contain too many solids.
- Ensure that the sensor cable is sufficiently far from the power cables.
- Especially keep the pump and frequency inverter apart.

Figure 23shows a signal with strong noise (unfavourable SNR). A clear noise can be seen on the time axis before and after the signal.
Figure 23b shows signal examples with "good" SNR. On the time axis virtually no more noise can be seen, the signal is ideally on the time axis.

a) 

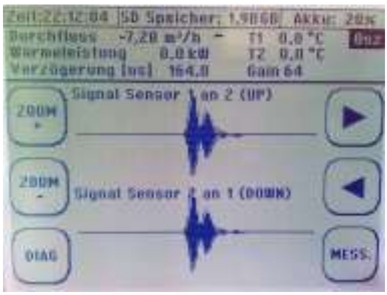
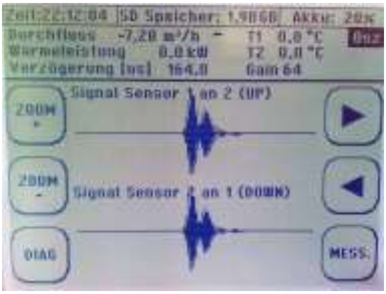

b) 


**Figure 23: Sample signals (oscilloscope window) with different SNR**

### 14.2.2 Signal sharpness

The signals from deltawaveC-F / P are coded to reliably identify the ultrasonic signals even in the case of very poor signal-to-noise ratios. For this purpose deltawaveC-F / P uses phase shifts in the transmit signals. The more clearly these phase shifts can be seen in the receive signal, the more stable your measurement will be under unfavourable measuring conditions. Figure 24a shows a signal with very high signal sharpness

One can clearly recognize approximately 5 oscillations with increasing amplitude and then a reduction amplitude (phase shift) and then again increasing amplitude. The reception signal clearly shows the coding of the transmission signal. This is not the case for the signal in Figure 24b. The amplitude increase is initially very small and only after the phase shift does a high amplitude modulation occur.

a) 

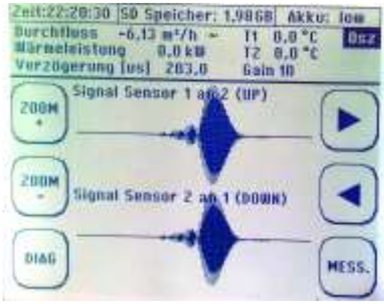

b) 


**Figure 24: Sample signals concerning signal sharpness (oscilloscope window)**

In addition to the general measures for improving the useful signal quality (see 14.2.1), the following possibilities for improving the signal sharpness can be checked:

- Select an installation location with another pipe (other material, other dimensions).
- Try other signal encodings (see 14.3)

> The highly developed signal evaluation of the deltawaveC-F/P also allows for permissible measurement results even with very unfavourable signal sharpness.
> Nevertheless, the user should always try to ensure the best possible signal of sharpness, since this reduces the scattering of the measured values in case of additional disturbances.

### 14.2.3 Signal decoupling on small pipelines

In the case of small pipelines (<50mm), the times between the signals are very short or in the worst case the signals can even overlap (with pipe signal, also with W signal). The graphic on the right shows how the different signals can appear in this case.

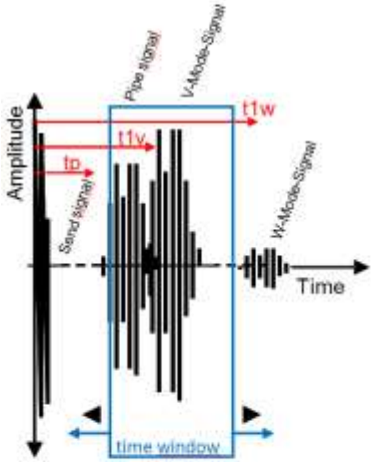



**Figure 25: Signal superimposition for small pipelines**

In the case of a signal overload, there are different ways of doing so:

- Use W-Mode rather than V-mode (first counter-measure)
- Use Z-Mode rather than V-mode (when W-mode does not work)
- Disable auto-window function and manual positioning of the measurement window
- Alternative signal coding tests for a narrower / sharper signal ("Barker5" or "Pulse" instead of "Barker7")
- Use a higher frequency converter to obtain a narrower and sharper signal.

When using a 2MHz transducer instead of a 1MHz transducer, signals are only half as long and thus easier to analyse (see right).

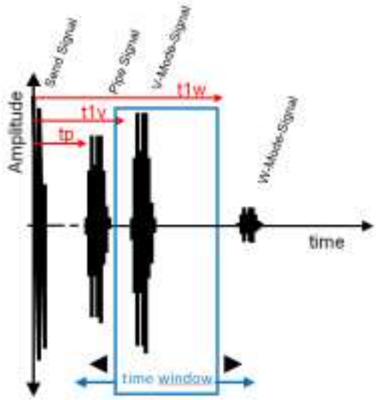



**Figure 26: Signal decoupling through higher transducer frequency**

For manual positioning, you must always check your settings using the measured medium sound velocity. If this is too high or too low (> 20%), you can assume that you have the wrong signal in the measurement window (for example V signal instead of W signal or vice versa).

The deltawaveC-F/P has very powerful signal unbundling algorithms. These are applied when you enable the Auto-Window function.
Nonetheless, signal superimposition may occur in particular in the case of very small pipelines and / or unsafe pipe dimensions. In this case, the user can manually remove the signals in the oscilloscope window.

## 14.2.4 The Auto window function / AFC-Technology

The positioning of the ultrasonic transducers is essentially based on the basic data of the parameterization. This also means that a variable sound velocity of the medium flowing in the tube would have to bring about a permanent repositioning of the ultrasonic transducers.
Practically speaking, this is relevant to:

1) Temperature variation: The sound velocity of a medium is temperature-dependent.
2) Medium change: Depending on the application it is possible that alternating different liquids are passed through the same pipeline.
3) Changes in concentration: Depending on the application, it is possible that concentration components will vary from the liquid component. This, albeit to a small extent, is caused by changes in sound velocity.

The algorithms of deltawaveC-F / P take into account the currently evaluated sound velocity for the calculation. This means that changes in the sound velocity as well as the invariable position of the ultrasonic transducers are iteratively taken into account in all subsequent calculations. This leads to a continuous correction of the variable boundary conditions "fluid" and is referred to **as AFC technology (Automatic Fluid Control).**

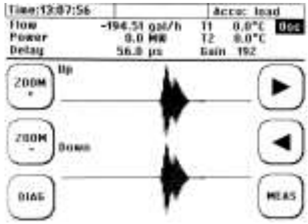
In general, it is not always useful to evaluate the total signal during ultrasonic measurements (interference signals, high memory requirements, high signal processing expenditure, and so on). The deltawaveC-F/P places a measuring window according to the parameterization in which the useful signal is expected (see 14.2). Only in this range is the signal recorded and evaluated.

All signals appearing in the measurement window are compared with the send signal. The signal is accepted as valid and a corresponding evaluation is carried out.

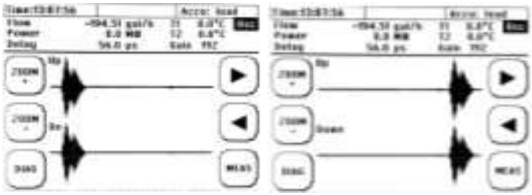
Variant properties of the liquid have not only effects on the calculations, but also on the position of the useful signal (valid receive signal) within the measurement window. A higher sound velocity means that the signal arrives earlier (shifting to the left on the time axis) a lower sound velocity is the opposite.
If these effects were not taken into account, the signal might migrate out of the evaluated measurement window in the event of a strong change in the liquid properties (medium change, temperature or concentration changes).

The **auto window function** cyclically checks the position of the useful signal in the measurement window and adjusts the measurement window position (if necessary, the adjustment of the delay value) to the current conditions.

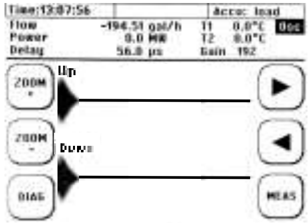
**Optimal position** of time window:




**Not optimal (BUT uncritical) position** of time window:



**Critical (incorrect) position** of time window:

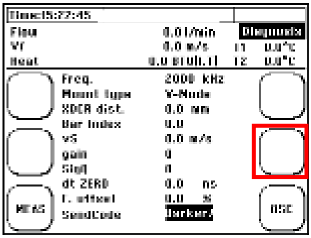



The Auto window function is activated and deactivated in the OSC window (see 14.1). The Auto window function status is displayed as a general header information.


An activated auto window function always tries to keep the measurement windows at the position calculated by deltawaveC-F/P as the ideal position. If you want to manually position the measurement window using the arrow keys in the OSZ window, you must deactivate the auto window function.

## 14.3 The diagnosis window of the deltawaveC-F/P

**Navigate to one of the measurement windows:**
→ „DIAG“




The diagnose window gives an overview of all relevant application and signal parameters. As well relevant results of the signal processing are shown.

The function button above the OSC-button (mid button on the right side) can be used to switch between the available send signal codes.

| **Parameter** | **Description** |
|---|---|
| **Freq.** | Central frequency of the send signal: 500kHz (XUDC05), 1000kHz (XUDC10), 2000kHz (XUDC20) |
| **Mount type** | V-, W- or Z-mode (see 8.4.2) |
| **XDCR dist.** | Mounting distance between the transducer front areas |
| **Bar index** | Whole index for the installation with mounting bar. |
| **vS** | Sound velocity of the medium |
| **Gain** | Current gain of the received signal (see 14.1) |
| **SigQ** | Percental amount of  der prozentual of as valid recognitioned signal pairs. Typical value might be in the range 75-100%. |
| **dt ZERO** | Currently parameterized value of the ZERO point calibration (siehe 8.5) |
| **F.-Offset** | Shows the value currently parameterized for the flow offset (see 11.9.1). |
| **Send Code** | Encoding of the send signal. The send code can be changed manually. Following codes are available: „Puls“, „Burst4“, „Barker5“ and Barker7“.<br>For most of the applications it is not recommended to switch from “Barker7“ (default setting) to any other send code. In some cases (small pipes or unreasonable signal sharpness, see 14.2.2) it might be useful to test the “Barker5“ code. |

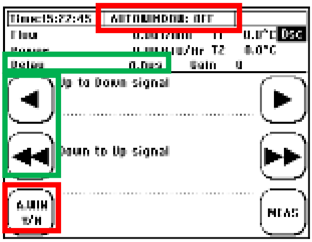
## 14.4 Integrated sensor test function

The deltawaveC provides the option to test the operation of the ultrasonic transducers in combination with the signal lines. For example: if you do not measurement results from your actual application measurement you can test, your ultrasonic transducers and signal lines are intact and the loss of measurement is caused by the application itself.

**Navigate to the oscilloscope screen:**

1) Ensure that the AUTOWINDOW-function is deactivated (see 14.1)

2) Reduce the delay to 0 µs via arrow buttons. Now the output „SENSORTEST" is shown, the flow will no longer be determined anymore.

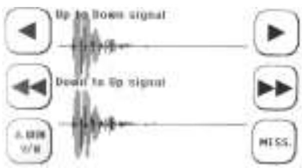



3) If not completed already connect the transducer and parameterize the correct type (main menu → transducer setup)

4) Put on one of the two transducers a little acoustic coupling grease. Put both ultrasonic transducers together as shown in the picture to the right. Approximately 2/3 of the acoustic transmission surface should overlap (Z-mode without pipe).

5) If both ultrasonic transducers, the signal lines and the electronics are intact shortly after the beginning (NOT immediately at the start) of the measurement window signal wavelets will appear which are transmitted from one to the other transducer (see figures below).


**F21 sensor test**




**F10 sensor test**


**F05 sensor test**

6) In contrast, defective ultrasonic transducers or signal lines, only the relics of the transmitting signals can be seen immediately from the beginning of the measurement window. The signal characteristics will be like shown in Figure 27, or Figure 28, or somewhere in between. Send signal characteristics can also occur when testing intact transducers with intact signal lines, but they are small compared to the received signal wavelets.

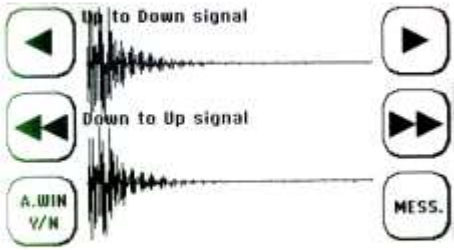



**Figure 27: Transducer connected but no acoustic contact (without Magnalube)**

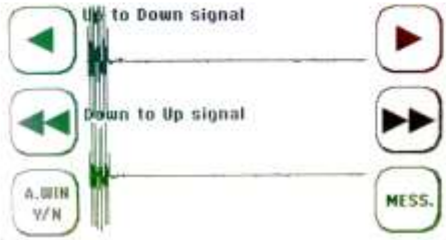
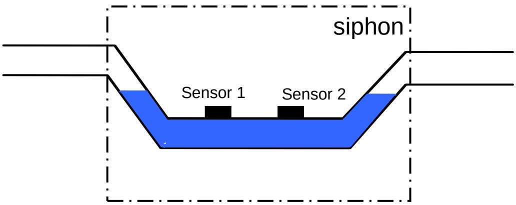



**Figure 28: Transducer not connected (relics of the sending signals)**

## 14.5 What to do if the pipe is not fully filled?

If you cannot simply separate the piping (e.g. plastic piping) 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.



## 14.6 Checklist

# deltawaveC-F/P application checklist

## A. No flow measurement possible:

| | |
|---|---|
| **1A. Is the pipeline fully-filled without any doubt?**<br>• Mount the ultrasonic transducers on a horizontal pipe at nine ‘o clock. If you subsequently obtain a result of measurement, this could be an evidence for an incomplete filling of the pipeline.<br>• To avoid partly filled pipes, try to mount the transducers on a vertical pipe (rising pipe: flow from bottom to top). | ☐ |
| **2A. Can you exclude a gas load in the fluid?**<br>Guideline: up to 15% volume gas proportion can be acceptable.<br>• **Water-glycol mixtures:** Examine a fluid sample. If the fluid is blurred and clears after a view minutes, this is an evidence of gas bubbles. → Try to deaerate<br>• Did you mount the transducers at nine ‘o clock on the pipe? Gas often accumulates at the pipe top (twelve ‘o clock).<br>• If there is a heavy gas load: If possible, try to mount the transducers on a vertical pipe (rising pipe: flow from bottom to top). | |
| **3A. Are sediments in the fluid? How big is their proportion?**<br>• Guideline: more than 10 g of sediments per litre can result in a failure of the measurement. | ☐ |
| **4A. Is the flow profile heavily disturbed?**<br>• Have the upstream and downstream distances after a disturbance (pump, bend, etc.) been observed?<br>• Sustained disturbances of the flow profile in the pump outlet or of flaps / slides can cause strongly fluctuating measuring results. If possible install the ultrasonic transducer in front of the pump, or in front of a slider.<br>• If possible, use F10 starting from DN32 and F05 from DN200. | ☐ |

| | |
|---|---|
| **5A. Did you enter the <u>outside diameter</u> or <u>circumference</u> of the pipeline?**<br>• Both parameters are mistaken quite often during the input, so please check again the values.<br>• The syntax of the input is as follows:<br>deltawaveC → 0,000.000 [unit]<br>For example: the circumference is 1253.56 mm; that means it must be edited as 1,243.560 [mm] | ☐ |
| **6A. Composite pipes: Can the acoustic signal transmission be ensured at the transition between the composite materials (for example, concrete inner lining on steel)?**<br>• If there is an air gap between the material transitions, the measurement will not work. | ☐ |
| **7A. Have you selected a suitable ultrasonic transducer for your application with regard to the pipeline size?**<br>Please check again if the correct transducer has been selected and parameterized (tolerable temperature -40….150°C):<br>DN10…DN100: F21<br>DN32…DN400: F10<br>DN200…DN6000: F05 | ☐ |
| **8A. Which mounting method did you choose?<br>The standard mounting is V-mounting. Do you see valid signals or just acoustic noise on the Oscilloscope screen?**<br>• If you see signals that are multiplexed by a heavy noise floor, try Z-mounting. | ☐ |
| **9A. Did you choose the correct mounting distance for the transducers?**<br>• If using a mounting bar:<br>You always have to count one hole less between the ultrasonic transducers on the mounting bar than displayed by the transmitter. Example: bar index 5 means four empty holes on the mounting bar between the ultrasonic transducers.<br>• If no mounting bar is used, the distance between the front faces is to be measured in millimetres.<br>• With small nominal diameters and Z mounting, negative distances can be calculated by the transmitter as well. This is correct and the ultrasonic sensors must be positioned respectively to each other according to the displayed value. | ☐ |

| | |
|---|---|
| **10A. Does the pipeline have a thick coating with paint, maybe multilayer, or is the surface of the pipe heavily rusted?**<br>• If yes, please try to remove the protection coating or to even the surface of the pipe (e.g. by using sandpaper).<br>• As a matter of principle it is usually not possible to measure through pipe insulation. | ☐ |
| **11A. Is there an acceptable signal transmission from ultrasonic transducer into pipeline surface?**<br>• deltawaveC-P: is enough coupling gel applied to the sensor faces of the ultrasonic transducers??<br>• deltawaveC-F: do the coupling foils rest accurately on the sensor areas of the transducers? Are the transducers mounted on the pipe with enough contact pressure? | ☐ |
| **12A. Are nearby strong sources of disturbances like transformers, inverters or electric motors??**<br>• Are the ferrites (clamp-on) mounted to the signal cables of the transmitter?<br>• You can recognize EMV sources of disturbances in the Oscilloscope screen as horizontal narrow-band interfering signals with high amplitude. | ☐ |

## B. Imprecise measurements:

| | |
|---|---|
| **1B. Have you followed the upstream/downstream conditions?**<br>The shorter the upstream/downstream distances, the higher is the expected measurement uncertainty after a fault point. | ☐ |
| **2B. Was a zero calibration performed?**<br>No flow occurred during the zero point calibration. | ☐ |
| **3B. Deviations from the parameterisation (in particular the inner diameter) cause directly measurement deviations in the volume flow. Check again:**<br>• diameter + wall thickness (if applicable measure)<br>• materials + sensor distance<br>• deposits / fouling? | ☐ |

# Appendix A – Material data

**Table 1: Material data of different liquids: density ρ, kinematic viscosity *ν* and sound velocity $v_S$**

| Liquids | T [°C] | ρ [g/cm³] | $v_S$ [m/s] | *ν* ($10^{-6}$ m²/s) |
|---|---|---|---|---|
| acetone | 20 | 0.7905 | 1190 | 0.407 |
| aniline | 20 | 1.0216 | 1659 | 1.762 |
| alcohol | 20 | 0.7893 | 1168 | 1.52 |
| fuel | 20 | 0.780 | 1280 | 0.35 |
| chloroform | 20 | 1.4870 | 1001 | 0.383 |
| chlorobenzene | 20 | 1.1042 | 1289 | 0.681 |
| cyclohexane | 20 | 0.779 | 1284 | 1.256 |
| deuterium oxide | 20 | 1.1053 | 1388 | 1.129 |
| diesel | 20 | 0.850 | 1250 | 0.40 |
| acetic acid | 20 | 1.0495 | 1159 | 1.162 |
| ether | 20 | 0.7135 | 1006 | 0.336 |
| ethyl acetate | 20 | 0.900 | 1164 | 0.499 |
| ethylene glycol | 20 | 1.1131 | 1666 | 21.112 |
| glycerine | 20 | 1.2613 | 1923 | 1188.5 |
| methyl acetate | 20 | 0.928 | 1181 | 0.411 |
| nitrobenzene | 20 | 1.207 | 1473 | 1.665 |
| n-hexane | 20 | 0.654 | 1083 | 0.489 |
| n-pentane | 20 | 0.6260 | 1032 | 0.366 |
| n-propanol | 20 | 0.8038 | 1255 | 2.861 |
| n-octane | 20 | 0.7021 | 1192 | 0.538 |
| O-xylene | 15 | 0.883 | 1360 | 0,917 |
| oil (transformator) | 20 | 0.895 | 1425 | 12 (40°C) |
| oil (spindle) | 20 | 0.871 | 1342 | 30-73 (40°C) |
| petroleum | 34 | 0.825 | 1295 | 2 |
| mercury | 20 | 13.5955 | 1451 | 0.114 |
| carbon disulfide | 20 | 1.2634 | 1158 | 0.290 |
| carbon tetrachloride | 20 | 1.5942 | 938 | 0.608 |
| water | 20 | 0.9982 | 1483 | 1.004 |
| seawater (salt content: 3.5%) | 16 | 1.000 | 1510 | 1.360 |

**Table 2: Sound velocities of water as a function of the medium temperature (0 to 100°C)**

| T [°C] | v [m/s] | T [°C] | v [m/s] | T [°C] | v [m/s] | T [°C] | v [m/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: temperature, v: sound velocity

**Table 3: Material data of different pipe and liner materials: longitudinal sound velocity $v_P$ and Poisson's ratio $\nu$**

| Material | $v_P$ [m/s] | $\nu$ [unit less] |
|---|---|---|
| Carbon steel | 5890 | 0.2831 |
| Stainless steel | 5660 | 0.2818 |
| Copper | 4660 | 0.3462 |
| Cast iron | 4600 | 0.2653 |
| Titanium | 6100 | 0.3229 |
| Aluminium | 6196 | 0.3316 |
| Glass | 5640 | 0.2445 |
| Lead | 2170 | 0.4410 |
| Brass (70-30) | 4700 | 0.3750 |
| Cement | 4190 | 0.2022 |
| Tar | 2540 | 0.2322 |
| Porcelain | 4800 | 0.2832 |
| Teflon (PTFE) | 1350 | 0.4048 |
| Rubber | 1800 | 0.1932 |
| Plastic | 2300 | 0.3517 |
| FRP (Fiber Reinforced Plastic) | 2505 | 0.3-0.6 |

**Table 4: Typical material data of varying plastic materials: longitudinal sound velocity $v_P$ and Poisson's ratio $\nu$**

| Material | $v_P$ [m/s] | $\nu$ [unit less] |
|---|---|---|
| PVC | 2380 | 0.4004 |
| PE HD | 2430 | 0.4075 |
| PE LD | 1950 | 0.4568 |
| Teflon (PTFE), ETFE, FEP | 1350 | 0.4048 |
| PP | 2660 | 0.4516 |
| PVDF | 2300 | 0.3372 |
| Polyamide (PA / Nylon) | 2582 | 0.3960 |
| Polycarbonate (PC) | 2286 | 0.3700 |
| PET (Mylar, Polyethylene Terephthalate) | 2540 | 0.3800 |
| PMP (Polymethylpenten) | 2180 | 0.3374 |
| POM (Polyoxymethylen) | 2470 | 0.3972 |
| PS (Polystyrene) | 2400 | 0.3510 |
| PSU (Polysulfone) | 2240 | 0.3700 |
| SAN (Styrol-Acrylnitril, Lustran) | 2510 | 0.33-0.36 |
| EPDM (Rubber) | 1450 | 0.3000 |
| NBR (Nitrile Butadiene Rubber) | 1500 | 0.48-0.496 |

# Appendix B – Technical data

| **Method** | **Transit time (ultrasound)** |
|---|---|
| **Measured variables** | flow velocity, volume flow, heat (opt.) |
| **Counter** | heat, volume |
| **Measurement range** | -30…+30 m/s |
| **Languages** | EN-DE-FR; EN-ES-FR; EN-RU-CH |
| **Units** | metric, imperial |
| **Handling** | Intuitive via 8 soft keys |
| **Operating temperature** | -20…60°C |
| **Power consumption** | ca.10 W |
| **Integrated data memory** | Micro-SD Card, 4 GB (other sizes possible) |
| **Display** | LCD 320x240 (Backlight: LED edge, dimmable) |
| **Signal damping** | 0…100 sec (adjustable) |
| **Diagnose functions** | Sound velocity, signal strength, SNR, signal quality, amplitude, energy, signals can be displayed graphically |

| | **deltawaveC-F** | **deltawaveC-P** |
|---|---|---|
| **Power supply** | 90-264VAC<br>18-36VDC (opt.) | Input: 90-264 V/AC<br>Output: 19 V/DC (max. 3,42 A)<br>NiMH – accumulator pack:<br>battery longevity (fully charged, new): 3.5h (5h without backlight) |
| **International Protection Marking** | IP65 | IP40 |
| **Housing** | PVC, wall mounting | Aluminium (portable) |
| **Weight** (kg) | 1.3 | 1,5 |
| **Size** (WxHxD, mm) | 260 x 240 x 120 | 265 x 190 x 70 |
| **Inputs** | 2x Pt100 (3-wire) | 2x Pt100 (3- wire) |
| **Outputs**<br>(not potential-free, exception: relay of deltawaveC-P) | 1x USB-jack (Mini B)<br>2x transducer (2CH : 4x)<br>2x 4…20mA (active/passive)<br>1x Pulse (2CH : 2x)<br>1x Relay<br>RS232/RS485 (optional) | 1x USB- jack (Mini B)<br>2x transducer (BNC, 50 Ohm)<br>2x 4-20mA (active/passive)<br>1x Pulse (open collector, passive)<br>1x Relay (normally open, potential free) |

**Ultrasonic transducer**

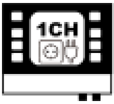
| Type | Pipe diameter | Temperature |
|---|---|---|
| F21 (2 MHZ) | DN10….DN100 | -40…150°C |
| F20 (2 MHZ) no longer available, replaced by F21 | DN10….DN100 | -40…150°C |
| F10 (1 MHZ) | DN32….DN400 | -40…150°C |
| F05 (500 kHz) | DN200…DN6000 | -40…150°C |

| Pipe diameter / flow velocity | Measurement accuracy |
| --- | --- |
| 10-25mm | +/- 0.05 m/s |
| 0…2 m/s | |
| 2…30 m/s | 2.5% of measurement reading |
| 25 – 50 mm | +/- 0.03 m/s |
| 0…2 m/s | |
| 2…30 m/s | 1.5% of measurement reading |
| 50 – 300 mm | +/- 0.02 m/s |
| 0…2 m/s | |
| 2…30 m/s | 1% of measurement reading |
| 300 – 6000 mm | +/- 0.02 m/s |
| 0…2 m/s | |
| 2…30 m/s | 1% of measurement reading |

# Appendix C – Modbus register overview

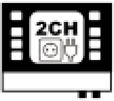
The total Input Register size is 125 double words (250 byte). The MODBUS register address will start from 0 up to 124. At the current sate only the first 17 double words contain valid results (1 channel device).

## 1 channel device (Big Endian)




| Parameter | Input Register Address (Hex) | Number of Input Registers (Decimal) | Format (Big Endian) |
|---|---|---|---|
| Flow | 0x0000 - 0x0001 | 2 | Float AB CD |
| Flow **Unit Code** | 0x0002 | 1 | unsigned |
| Fluid velocity | 0x0003 - 0x0004 | 2 | Float AB CD |
| Sonic velocity | 0x0005 – 0x006 | 2 | Float AB CD |
| Fluid velocity **Unit Code** | 0x0007 | 1 | unsigned |
| Total Flow | 0x0008 - 0x0009 | 2 | Float AB CD |
| Total Flow **Unit Code** | 0x000A | 1 | unsigned |
| Power | 0x000B – 0x00C | 2 | Float AB CD |
| Power **Unit Code** | 0x000D | 1 | unsigned |
| Heat quantity | 0x000E – 0x000F | 2 | Float AB CD |
| Heat quantity **Unit Code** | 0x0010 | 1 | unsigned |
| Temperature A | 0x0011 – 0x0012 | 2 | Float AB CD |
| Temperature B | 0x0013 – 0x0014 | 2 | Float AB CD |
| Temperature difference (T2-T1) | 0x0015 – 0x0016 | 2 | Float AB CD |
| Temperature **Unit Code** | 0x0017 | 1 | unsigned |
| Signal Quality | 0x0018 – 0x0019 | 2 | Float AB CD |
| Device status | 0x001A | 1 | unsigned |
| Reserve | 0x001B to 0x007C | 98(0x62) | |

## 2 channel device (Big Endian)




| Parameter | Input Register Address (Hex) | Number of Input Registers (Decimal) | Format (Big Endian) |
|---|---|---|---|
| Flow CH1 | 0x0000 – 0x0001 | 2 | Float AB CD |
| Flow CH2 | 0x0002 – 0x0003 | 2 | Float AB CD |
| Flow **Unit Code** | 0x0004 | 1 | unsigned |
| Fluid velocity CH1 | 0x0005 – 0x0006 | 2 | Float AB CD |
| Fluid velocity CH2 | 0x0007 – 0x0008 | 2 | Float AB CD |
| Sonic velocity CH1 | 0x0009 | 2 | Float AB CD |
| Sonic velocity CH2 | 0x000A – 0x000B | 2 | Float AB CD |
| Fluid velocity **Unit Code** | 0x000C | 1 | unsigned |
| Total flow CH1 | 0x000D – 0x000E | 2 | Float AB CD |
| Total flow CH2 | 0x000F – 0x0010 | 2 | Float AB CD |
| Total flow **Unit Code** | 0x0011 | 1 | unsigned |
| Power (CH1+CH2)/2 | 0x0012 – 0x0013 | 2 | Float AB CD |
| Power **Unit Code** | 0x0014 | 1 | unsigned |
| Heat (CH1+CH2)/2 | 0x0015 - 0x0016 | 2 | Float AB CD |
| Heat **Unit Code** | 0x0017 | 1 | unsigned |
| Temperature A | 0x0018 - 0x0019 | 2 | Float AB CD |
| Temperature B | 0x001A – 0x001B | 2 | Float AB CD |
| Temperature difference | 0x001C - 0x001D | 2 | Float AB CD |
| Temperature **Unit Code** | 0x001E | 1 | unsigned |
| Signal quality CH1 | 0x001F– 0x0020 | 2 | Float AB CD |
| Status CH1 | 0x0021 | 1 | unsigned |
| Signal quality CH2 | 0x0022 - 0x0023 | 2 | Float AB CD |
| Status CH2 | 0x0024 | 1 | unsigned |
| Reserve | 0x0025 - 0x007C | 88(0x58) | |

# Appendix D – Transducer type overview

### deltawaveC-F

**XUC-FW F20 (2 MHz)**
Pipe diameter: DN10…DN100
Temperature: -40°C…150°C

Modell nicht mehr lieferbar

XUC-**FW20** was replaced by the successor model XUC-**FW21**

### deltawaveC-P

**XUC-PW F20 (2 MHz)**
Pipe diameter: DN10…DN100
Temperature: -40°C…150°C


Modell nicht mehr lieferbar

XUC-**PW20** was replaced by the successor model XUC-**PW21**

### deltawaveC-F

**XUC-FW F21 (2 MHz)**
Pipe diameter: DN10…DN100
Temperature: -40°C…150°C

### deltawaveC-P

**XUC-PW F21 (2 MHz)**
Pipe diameter: DN10…DN100
Temperature: -40°C…150°C

**XUC-FW F10 (1 MHz)**
Pipe diameter: DN32…DN400
Temperature: -40°C…150°C

**XUC-PW F10 (1 MHz)**
Pipe diameter: DN32…DN400
Temperature: -40°C…150°C


**XUC-FW F05 (0,5 MHz)**
Pipe diameter: DN200…DN6000
Temperature: -40°C…150°C


**XUC-PW F05 (0,5 MHz)**
Pipe diameter: DN200…DN6000
Temperature: -40°C…150°C

# Appendix E – Mounting equipment and accessories

## Mounting rail for ultrasonic transducer


| mounting rail | | transducer compatibility | | |
|---|---|---|---|---|
| | | **F10** | **F20** | **F21** |
| **SHORT** | length: 25 cm;<br>Hole grid increment: 7,5 mm | | | X |
| **LONG** | length : 40 cm;<br>Hole grid increment : 15 mm | X | X | |

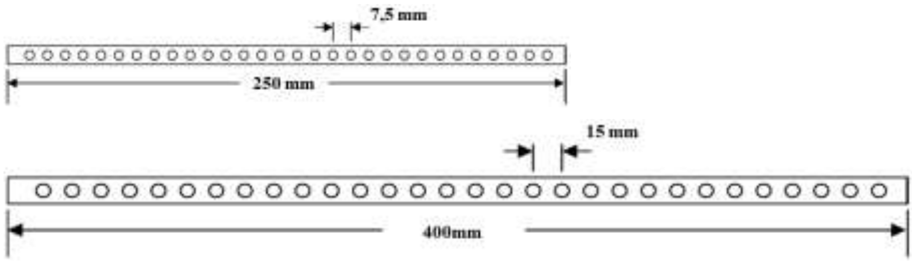



**Figure 29:** Mounting rail; top: "short", below: "long"

⚠ The **"short"** rail is exclusively compatible with the ultrasonic transducer type **F21**, not with F20 and F10!
The ultrasonic transducer type F05 is mounted on the pipe without a rail by means of a textile or stainless steel belt.

# Stainless steel belt for ultrasonic transducer and Pt100

Included in deltawaveC-F purchased parts package (varying sizes).

**Figure 30:** Stainless steel belt for ultrasonic sensors XUC-FW10 and XUC-FW20

# Mounting accessories for XUC-PW-transducer

**Figure 31:** Mounting chain for XUC-PW10 and XUC-PW20

**Figure 32:** Hook-and-loop tape for XUC-PW10 and XUC-PW20

# Mounting accessories for F05-transducer

**Figure 33:** Textile tension bands are recommended for the assembly of the XUC-PW-F05 transducers (temperature limitation)

**Figure 34:** Stainless steel belts can also be used (“endless” belt) for the permanent installation of XUC-PW-F05

## Ultrasonic coupling gel

Included in deltawaveC-P purchased parts package.
Optional accessories for deltawaveC-F.


**Figure 35:** The ultrasonic coupling gel is applied between the ultrasonic transducer and the pipe. It ensures the acoustic signal coupling (Can be referred to as "Magnalube" for systec controls).

## „Solid-Coupling“ – Acoustic coupling pads

Included in deltawaveC-F purchased parts package.

**Figure 36:** Acoustic coupling pads are used for permanent installations instead of the coupling gel. The acoustic coupling pad is long-term stable and does not have to be renewed at recurring intervals.

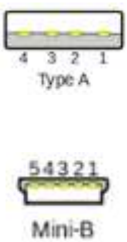
## Pt100 Temperature sensor

Optional accessories for determination of heat.

**Figure 37:** Pt100 contact temperature sensor for heat quantity measurement

## USB-connection cable

Included in deltawaveC-P purchased parts package.




Connection cable for
SD memory card access.

USB 2.0
Type A plug to
Mini B (5 Pin) plug

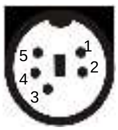
## Accessories for deltawaveC-P

Included in deltawaveC-P purchased parts package.

BNC-measurement connection (blue/red)
[ BNC-plug to BNC-plug]

Power supply unit (19V, 3.42A)

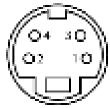
4-20 mA analog output cabel (4 crocodile clamps)




Current direction is from IxB to IxA

| | |
|---|---|
| pin 2 – red | I1B (output 1) |
| pin 3 – black | I1A (output 1) |
| pin 4 – white | I2B (output 2) |
| pin 5 – green | I2A (output 2) |

Connection cable for potential-free relay and pulse output (4 crocodile clamps)




| | |
|---|---|
| pin 1 – green | relay A |
| pin 2 – yellow | relay B |
| pin 3 – black | pulse (–) |
| pin 4 – red | pulse (+) |

# Notes:

**systec- Controls**
**Mess- und Regeltechnik GmbH**
**Lindberghstraße 4**
**82178 Puchheim**

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