Manual deltawaveCoG-F/P

Gas flow measurement
portable

stationary

Table of content

1 Preamble

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

deltawaveCoG was developed based on the KISS principle – “keep it safe and simple“.

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

The deltawaveCoG team has set itself the goal of meeting and maintaining this demand. We take great pleasure in constantly optimising and developing the product.

deltawaveCoG 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 deltawaveCoG and contribute to its success.

Please don´t hesitate to share your expert knowledge about deltawaveCoG with us.

We wish you all the best and great success with using deltawaveCoG!

2 deltawaveCoG & components

deltawaveCoG key points:

- deltawaveCoG is a clamp-on ultrasonic flow meter for measuring gases in pipelines.
- deltawaveCoG works based on the transit time method.
- The power is supplied via integrated AC-power supply.
  A DC-power supply is also available as an option.
- The device supports measurements on pipelines with diameters in the range DN25 to DN700 (depending on the sensor used).
- Temperature range (gas): –40°C to +150°C (equates the temperature range of the clamp-on ultrasound transducers).
- deltawaveCoG is equipped with an electrically isolated output (relay), as well as 4 to 20 mA current (active and passive) and pulse outputs that can be operated in active and passive mode (with deltawaveCoG universally parameterizable).
- The stationary **deltawaveCoG** can optionally be equipped with a Modbus (RS485) interface card.

2.1 Approvals / EMV

CE

deltawaveCoG 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)

2.2 Scope of delivery deltawaveCoG basic package

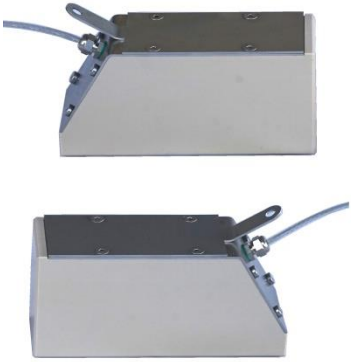
With a deltawaveCoG you always get:

- a flow transmitter

Transmitter for fixed installation

Transmitter for portable measurements

- a pair of ultrasonic transducers



- Necessary mounting material

Optionally, it is still possible to order:

- Pressure transducer for 4 – 20 mA
- Temperature sensor for 4 – 20 mA
- Clamp-on temperature sensor (3-wire PT100)

2.3 Transducer

Your deltawaveCoG 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 be calculated in the transmitter.

Make sure ultrasonic transducers are aligned with the direction of flow. Pay attention with the deltawaveCoG (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.

2.4 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!
- Protect the transmitter from impacts.
- Avoid cable kinks on the sensor cables.
- Make sure that the power supply is suitable.
- The power supply unit of the deltawaveCoG-P is not protected against moisture. Use it only in dry rooms.
- Before connecting the deltawaveCoG-F to your power supply, make sure that it is deactivated (e.g. fuse off).

2.5 Important instructions for the use of deltawaveCoG-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!
deltawaveCoG-P is equipped with a lithium-ion battery (Li-Ion 6000 mAh). This battery power is sufficient for approximately 22 hours of network-independent operation.

- ➔ If the deltawaveCoG-P is not used for a long time, recharge the battery at least once every 3 ... 6 months.
- ➔ The deltawaveCoG-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 deltawaveCoG-P to a power supply if it is already charged completely. A permanent connection to the power supply unit in the case of long-term measurements is possible, however.

deltawaveCoG-P is equipped with a quick-charge function. The function is automatically activated after the deltawaveCoG-P is connected to the power supply unit until a charge level of 80 % is reached.
This means that the unit can be operated again without connection to the power supply within a very short time

General information about the charge states:


Charging

50-100%

25-49%

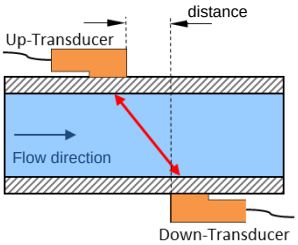
10-25%

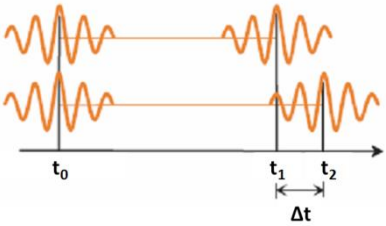
<10%

The exclamation point in the battery indicator appears if the charge is too low, or if deltawaveCoG-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 "x" appears in the battery symbol, this means that the battery is defective or there is a fault in the charging circuit. If the symbol is also displayed after a restart of the deltawaveCoG- P, please contact systec Controls.

3 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 based on a cross-correlation-based method, which enables signal detection even at a low signal-to-noise ratio.

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:

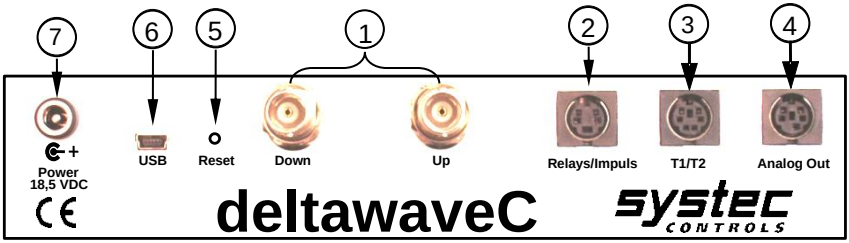
$$Q = L \frac{(\Delta t)}{t_2 \cdot t_1 \cdot 2\cos\alpha} \cdot k_{\mathrm{Re}} \cdot \frac{D^2}{4} \cdot \pi$$

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 (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

Integrated temperature compensation / Automatic Fluid Control (AFC):
Changes to the sound velocity of the gas (due to pressure or temperature or when changing the medium) 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 deltawaveCoG without mechanical displacement of the transducers.

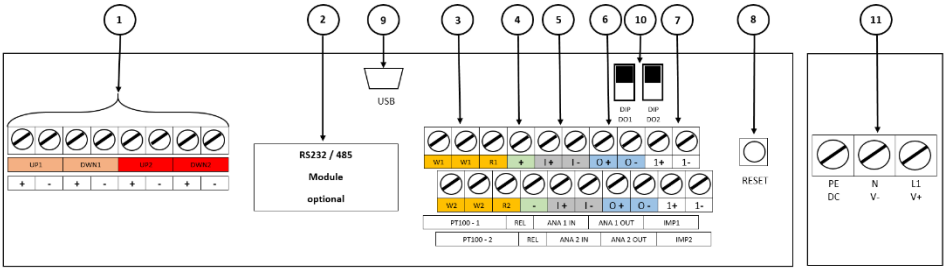
4 deltawaveCoG Interfaces

4.1 Overview deltawaveCoG-P



Term		Description
1	UP/ DWN	BNC-Inputs for ultrasonic transducer
2	Relay/ Pulse	Mini-DIN-4 connectors output: Relay connection (passive, potential-free); Digital output (open collector: 20, 40, 60, 100, 260, 500 ms square pulses)
3	T1/T2	Mini-DIN-6 connectors: 1 pair 3-conductor Pt100 (temperature compensation):
4	Analogue Out	2 Analogue outputs: 4…20mA signal, 24VDC, active (optional passive) 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: Automatic detection as mass storage medium)
7	Power	Plug-in power: 19 V/DC, 3,42 A

4.2 Overview deltawaveCoG-F



Term		Connection / Description
1	UP1 DWN1	input for ultrasonic transducer measurement path 1 **(+) = red cable (core), (–) = black cable (shield)**
	UP2 DWN2	input for ultrasonic transducer measurement path 2 **With deltawaveCoG only measurement path 1 available**
2	RS485	optional + retrofittable (plug-in board for pin headers) Data transmission via Modbus
3	PT100 – 1 PT100 – 2	Connection for 3-wire Pt100 W terminals: Sense lines (cables of the same polarity / colour) R-Terminal: GND cable (different colour cable) For 2-wire Pt100, bridging the sense connections
4	REL	Relay connection, passive, potential-free
5	ANA 1 IN ANA 2 IN	Analogue inputs: 4 ... 20mA Unit signal, 24VDC, active (optional passive)
6	ANA 1 OUT ANA 2 OUT	2 Analogue outputs: 4…20mA signal, 24VDC, active (optional passive) according to Namur NE43 (3.8-20.5 mA)
7	IMP 1 IMP 2	Digital Outputs: pulses (20, 40, 60, 100, 260, 500ms) **Only IMP1 available at deltawaveCoG**
8	RESET	Hardware-Reset (Restart of the system)
9	USB	USB Interface (Mini-USB Type B), access to the integrated SD memory card (Windows: Automatic detection as mass storage medium)
10	DIP 1 DO DIP 2 DO	DIP Switch for configuring IMP1 and IMP2 active / passive **Only IMP1 available at deltawaveCoG**
11	PE N L1 V+ V-	Two power supply options available: alternating current 90 ... 240 V / AC, direct current 18 ... 36 V / DC
Active: O + (+); O - (-) Passive: O + (-); O - (+)		

4.3 Connection notes

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

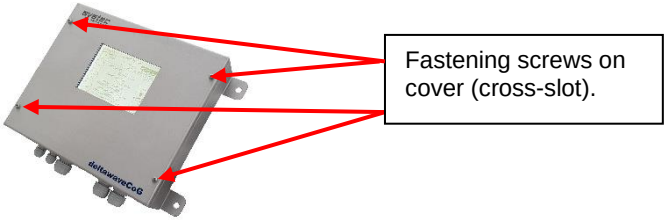


Figure 1: Remove cover from cable compartment

Please always make sure to put the correct voltage to your deltawaveCoG. 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

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

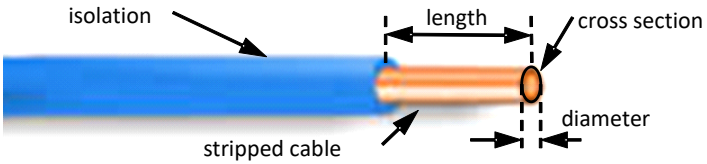


Figure 2: Cable assembly

4.4 Bus module (optional)

A bus module (currently RS485 Modbus) is available for the bus connection of deltawaveCoG, which can be optionally equipped. The bus module can also be easily retrofitted.

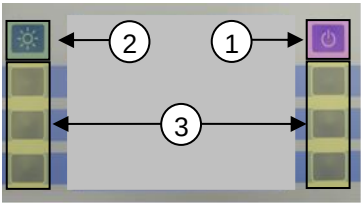
5 Operating

5.1 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 deltawaveCoG-F.

2 Switches the backlight On and Off

3 Multifunctional buttons: Activate the function displayed beneath the button.



5.2 How to navigate

Use the corresponding multifunctional buttons:

▲ ▼ ◀ ▶ 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

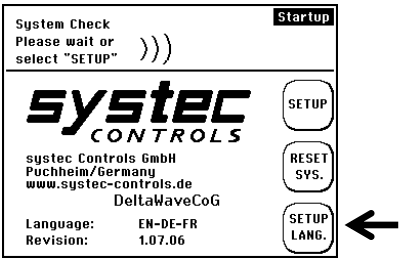
No function

6 First Start

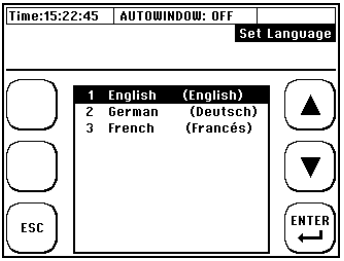
6.1 Basic settings, main menu, navigation

6.1.1 Adjustment of the display language

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



2. In the window choose the required display language using the arrow keys. Confirm your input by pressing “ENTER“. Leave the menu with „ESC“.



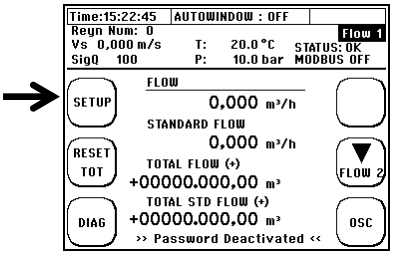
To change the language via the main menu, see Chapter10.7.3.

With the language setting, you change the language in the menus. The language in the boxes next to the multifunction buttons remains largely unchanged.

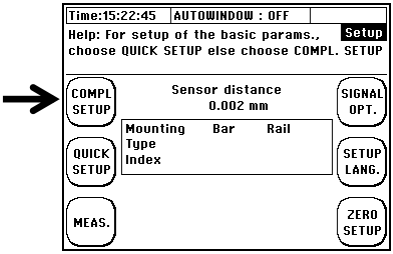
6.1.2 Navigation in main menu

After switching deltawaveCoG 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.

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

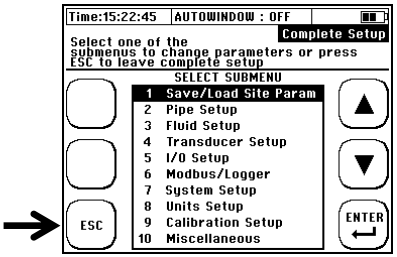


2. If you can see this window, please choose „COMPL SETUP“.



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“.



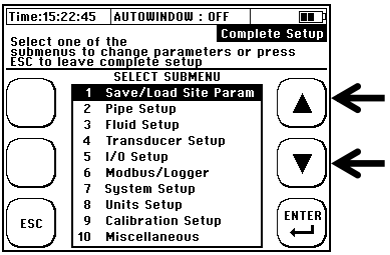
Now you have become acquainted with the basic operation of your deltawaveCoG.

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 deltawaveCoG on. In the following window choose “COMPL” SETUP“.

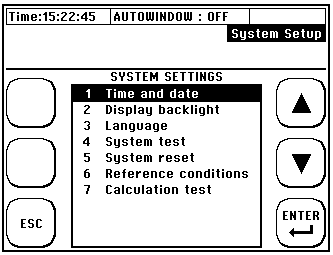
6.1.3 Setting time and date

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

1. Select the menu item (7) „System Setup" using the arrow key.

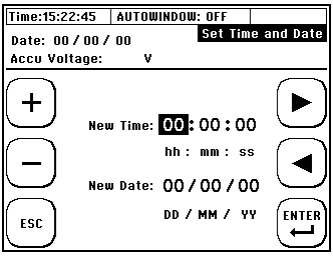


2. In the following window choose menu item (1) „Time and Date".



3. By using the arrow keys the position can be changed, by using +/- the value can be adjusted. Please enter the time and date according to the format displayed.

4. Subsequently, press "ENTER" to confirm your input and return to the system settings..



7 Preparing for measurement deltawaveCoG

Set-up your flow measurement in 5 steps:

1) Choose suitable mounting position for your transducers

2) Parameterize your flow transmitter (Quick-Setup)

3) Mount ultrasonic transducers onto your pipe

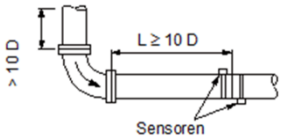
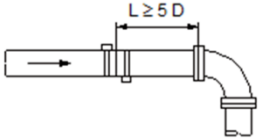
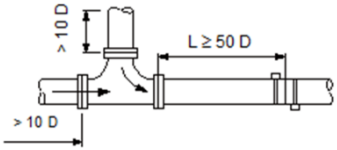
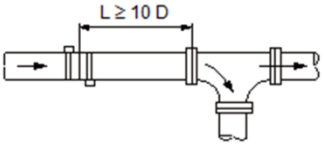
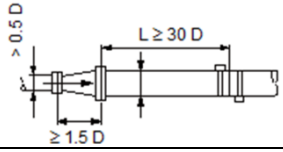
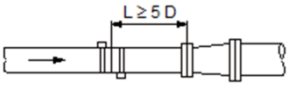
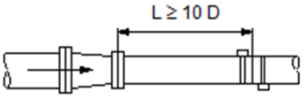
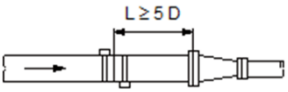
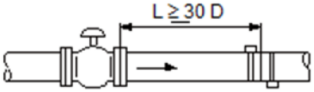
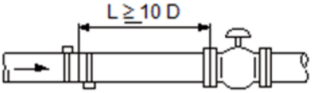
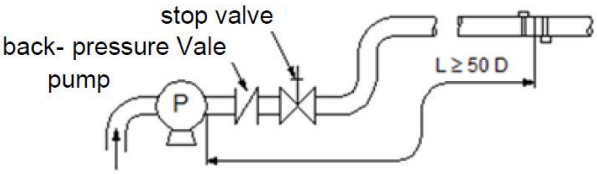
4) Set zero point (if possible)

5) Start your flow measurement

7.1 Preparation of the measurement / installation location

7.1.1 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		
Reducer		
Control valves	 Control valve on the upstream side	 Control valve on the downstream side
Pump		

The inlet distance is defined as the distance from a fitting (e.g. a 90° bend) to the middle of the position of the ultrasonic transducers. The outlet distance is defined as the distance from middle of the position of the ultrasonic transducers to the next disturbance point following in the direction of flow.

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: 10 D inlet = 10 x 110 mm = 1100 mm
Running-out distance: 5 D outlet = 5 x 110 mm = 550 mm

7.1.2 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.

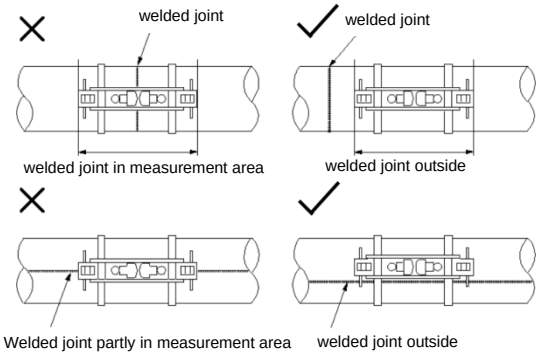


Figure 3: Ultrasonic transducer mounting / positioning

7.2 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 deltawaveCoG 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. **„KOMPL 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 process pressure (pressure of the medium within the pipeline)
2. The process temperature (temperature of the medium inside the pipeline)
3. The pipe's outer diameter or circumference
4. The wall thickness of the pipe.
5. The pipe material
6. The gas
7. The type of ultrasonic transducers

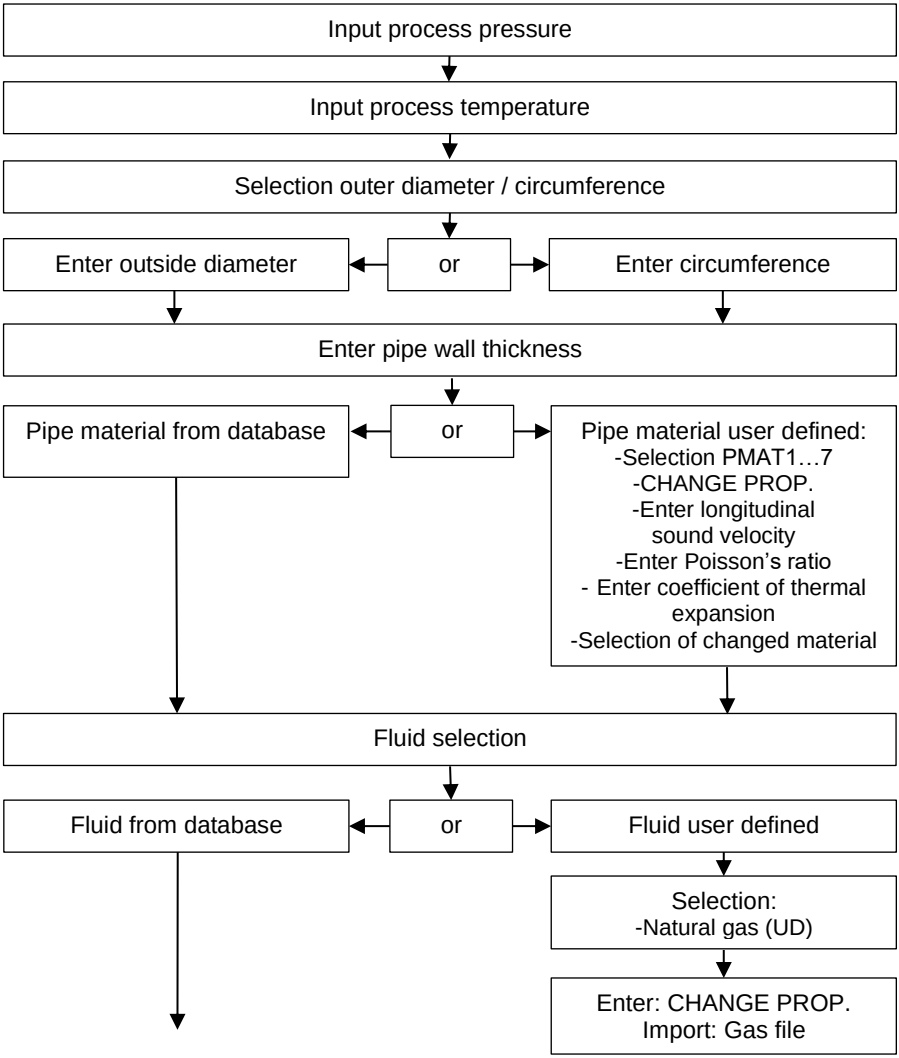
Ultrasonic measurement is based on the signal transit time process. The ultrasonic signals penetrate the piping and the gas. In order to calculate the signal transit time, each gas and each piping material will be assigned a sonic speed value, as well as the pipe diameter or circumference value.
deltawaveCoG 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.

7.3 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“.

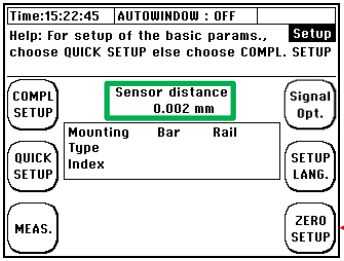


Selection transducer

↓

End of parameterization

Definition of sensor distance see chapter **Fehler! V**



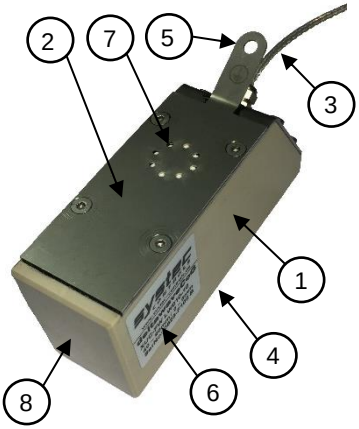
Before you start measuring we highly recommend a zero setup (if possible)

7.4 Sensor assembly / Sensor distance

The distance between the ultrasonic transducers is always measured between their opposing surfaces. 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. A negative sensor distance is to be understood as an "overlapping installation" of the ultrasonic transducers (Z-mounting).

7.4.1 Structure of ultrasonic transducers

Principle composition of the ultrasonic transducers:
Ultrasonic transducers (LW10, LW05 and LW03) is beige and made of plastic (PEEK).

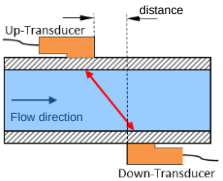


1) Basic body, PEEK
2) Cover
3) Connection cable (RG316, 10 m)
4) Acoustic transmission surface (Bottom side)
5) Grounding point cover
6) Nameplate
7) Ventilation
8) Front surface for sensor distance

7.4.2 Mounting-Type

Due to the minimal signal path, deltawaveCoG currently only supports mounting in Z Mode

Z-Mounting



7.4.3 Selection of transducer types

The decisive factor for the selection of converters is first and foremost the wall thickness of the pipeline to be measured. However, as the size of the tube increases, it is necessary to reduce the frequency of the transducer even with the same wall thickness.
Here you will find a guide:

Pipe wall thickness	LW10	2 – 5 mm
	LW05	4 – 9 mm
	LW03	7 – 15 mm
Internal pipe diameter	LW10	25 – 90 mm
	LW05	90 – 450 mm
	LW03	90 – 700 mm

7.4.4 Selection coupling media

There are basically two coupling compounds available for deltawaveCoG:

- ultrasonic coupling gel (Magnalube)
- acoustic coupling pads

The coupling gel allows a significantly better signal quality than the acoustic coupling pads. It is therefore particularly suitable for short-term installations or applications with low working pressure. 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 long-term stable and less sensitive to heat influences. However, since they deteriorate the signal quality, they should only be used in fixed installations with higher process pressures (depending on the application, min. 10 bar). For optimal signal coupling, a higher contact pressure is also necessary.

7.4.5 Transducer mounting

To mark the mounting points, use a plastic or paper stencil.

1. Position the plastic template horizontally at the position of the first transducer and wrap it once around the pipeline. Draw a circumference line along the created template using a felt pen.

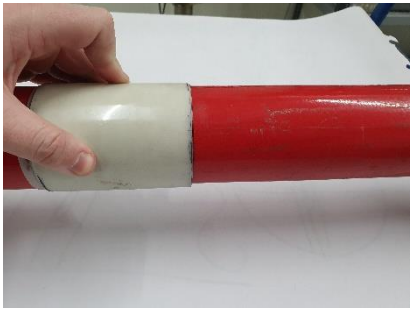


Figure 1: Attaching the plastic stencil 1

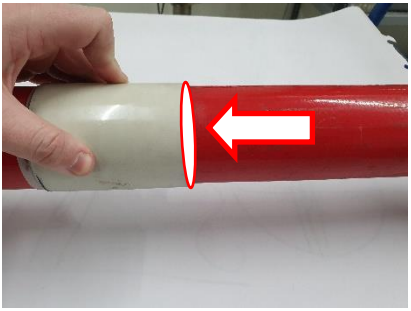


Figure 2: Marking a perimeter line

2. After successful parameterisation, the deltawaveCoG displays the axial distance between the two sensors (sensor distance). Starting from the first circumference line, now measure the displayed sensor distance according to the display of your deltawaveCoG and draw a second circumference line.

Figure 3: Determining the distance to the first line

Figure 4: Marking the mounting position of the second transducer using a template

3. Mark two exactly opposite positions on the circumference lines.

4. Starting from mark 2, measure half the circumference of the pipe along the circumference line and apply mark 3.

5. If there is a pipe coating, sand the contact surfaces for the transducers at the marked points.

6. Place the mounting rails centrally over the sanded surfaces.

7. Fix the opposite mounting rails on the left and right to the eyelets provided with a metal strap.

8. By measuring the distance between the top edges of the rails on both sides of the pipe, make sure that the mounting rails are exactly straight opposite each other.

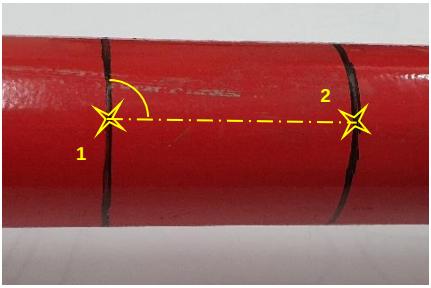


Figure 5: Markings 1 & 2 on the two circumference lines

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

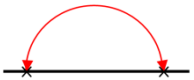


Figure 6: Ground contact surface of the transducer

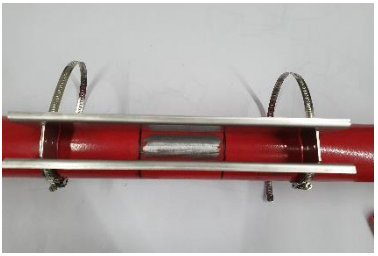


Figure 7: centrally placement of mounting rails

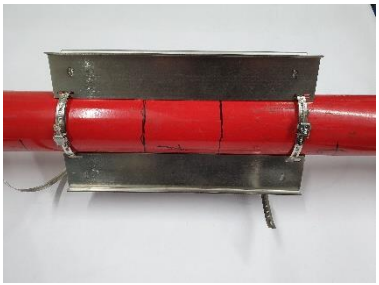


Figure 8: Fixation of the rails with metal tape

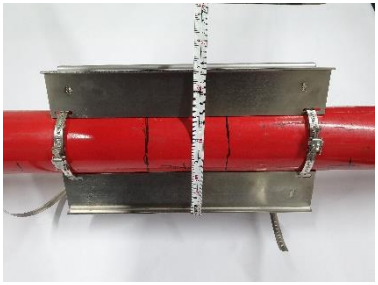


Figure 9: Checking the rail alignment by means of upper edge spacing

9. Apply a little coupling gel to the first sensor and place it with the centre of the **sensor front** (not the sensor) at marker 1.

Figure 10: Application of the coupling gel

10. Fix the sensor in this position with the mounting bracket.

Figure 11: Attaching the transducer to marker 1

11. Now, in the same way, mount the second transducer on mark 3. The transducers are now located exactly opposite each other.

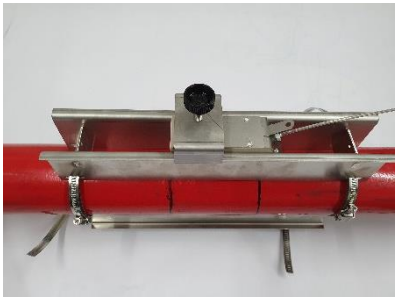


Figure 12: Transducer fixation with mounting bracket

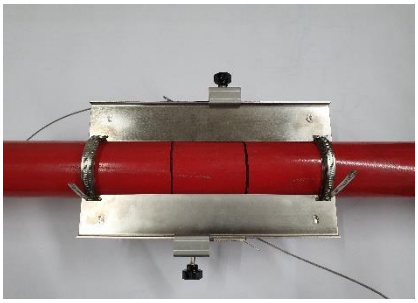


Figure 13: Attached transducers in positions 1 and 3

12. Tape the free areas between the mounting rails on both sides of the tube with a damping material.

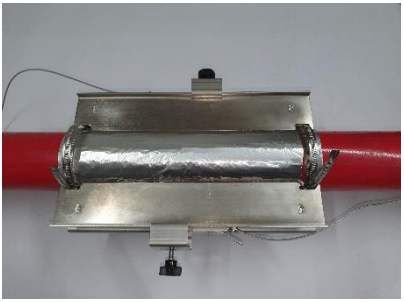


Figure 14: Attaching the damping material between the mounting rails.

13. Place an approx. 15 cm wide damping mat on both sides of the measuring point on the entire pipe circumference.

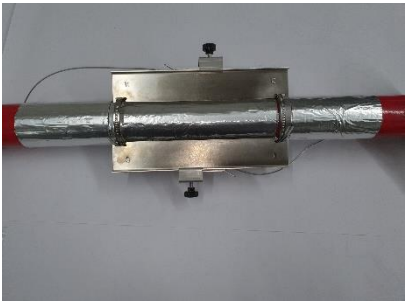


Figure 15: Attachment of the damping material on both sides of the measuring point.

14. If the signal quality requires it, the free space inside the mounting rails in front of or behind the transducer can also be covered with damping material.

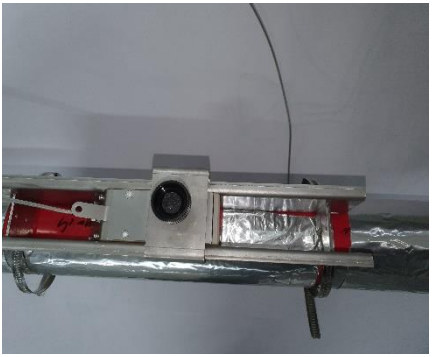


Figure 16: Gluing the free area inside the mounting rail.

7.5 Alternative sensor distance

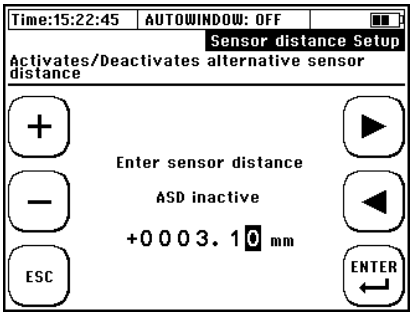
There are several reasons why you may need to change the sensor distance.
Be it due to lack of space or you get not a good signal at the calculated distance.
For this you can enter an alternative sensor distance.
This is how you get there:

From the main menu "COMPL. SETUP“:

10 „Miscellaneous“ → 5 „Sensor distance“

There, set ASD to "active” and enter the new distance.

With the "plus and minus buttons" you can activate and deactivate the alternative sensor distance and enter below the value.



Please note that you should not make any extreme changes from the original value because the signal will not be recognized correctly.

7.6 Zero Setting

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

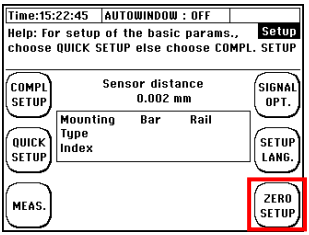
Prerequisites for zero-point calibration are:

- that the device is configured correctly and that both ultrasonic transducers are mounted properly on the pipe and electrically connected to the transmitter
- that the device is receiving a correct signal
- the flow rate is zero

If all prerequisites are fulfilled, perform a zero-point calibration, otherwise, do not perform a zero-point calibration!

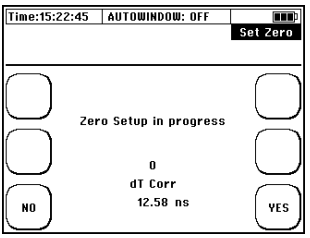
An incorrect zero point adjustment will have a more negative impact on the measurement result than no zero adjustment!

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



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

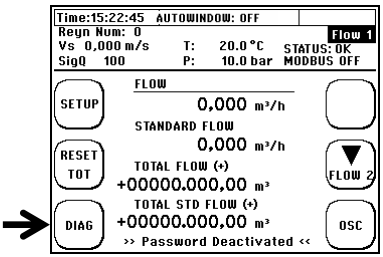
4) After confirming (ENTER) the time correction of the zero point adjustment, you are returned to the "Setup" window.

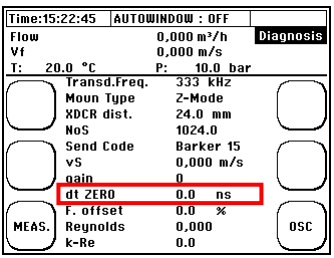


Typical values for the zero point adjustment are generally in single-digit range.
If you receive a "time correction" in two-digit range (and more), you can assume that a (residual) flow was present during the zero-point adjustment.

The zero point is automatically deleted when relevant parameters (pipe, medium, transducer, frequency, pressure, temperature or signal coding) have been edited again (in this sense, editing also includes a renewed confirmation without changing the values). A signal optimisation (with the exception of the zero point optimisation) also leads to the deletion of the zero point. Pay attention to this, e.g. when you carry out series measurements with different application data!

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 10.1 Saving/Loading parameter data).

The zero-point error results from tolerances in the transducers, the assembly aids and the pipe data.

For zero-point calibration, your deltawaveCoG-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).

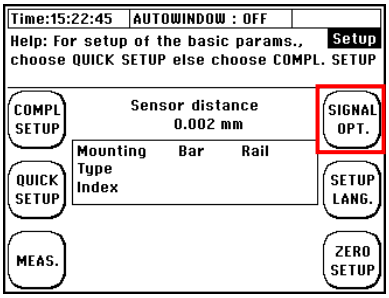
A zero flow rate cannot be guaranteed at every position of the pipeline system. When installed carefully, this error is in the range of 0.00-0.03 m / s flow velocity. The larger the pipeline is, the smaller is usually the zero point error.

8 Signal optimisation

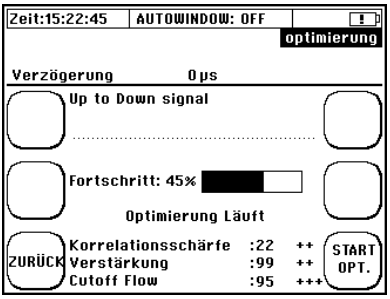
With the signal optimization feature, the deltawaveCoG also gets a grip on problematic measuring points.
Automatic signal optimization improves signal quality, making it easier to measure in unfavourable conditions.

8.1 Open signal optimisation

The signal optimisation of deltawaveCoG is located at the top right of the start screen.
Via the main menu, you will find the signal optimisation at „COMPL SETUP" →„10 Miscellaneous" → "8 Signal Optimisation"



8.2 Functionality Signal Optimisation



The signal optimization (SO) is an automated search in which the coding (Barker15; Barker11 etc.) and the frequency are modulated in order to achieve the most stable measurement.
The Correlation Clearness (CC value) and, depending on the mode, also the zero point or the gain are important for this.

You can see the process screen on the right.
After pressing "START OPT." the device automatically starts the search. As long as the optimization process is running, you cannot do anything on the device. The search takes between one and five minutes depending on the type of transducers used and the diameter of the pipe.

If the note “CC-Warn” appears on the display (see chapter 10.1) during a measurement, the value of the "Correlation clearness" falls below 10 (standard value). In this case, please carry out a signal optimization.

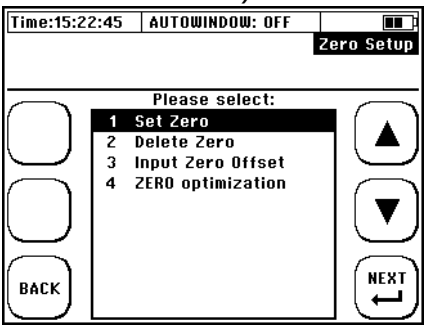
8.3 Gain-Optimization

(Can be used during flow of medium)

The gain-optimization can be activated as described in chapter 8.1.
During the gain-optimization it is applied a combination of coding and frequency, which requires the lowest gain AND has a CC value higher than 20.
This type of optimisation usually delivers the best results, which is why it has been placed on the start screen of the deltawaveCoG.

8.4 Zero-Optimization

(**Have to be used in absolute standstill of medium**)

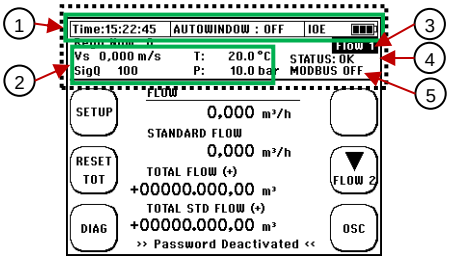


The zero-optimization can be found on the start screen under Zero Setup→ “4. ZERO optimization”.
In the case of zero-optimization, a combination of coding and frequency is applied that has the smallest deviation from the zero point AND has a CC value higher than 20. Before the zero-optimization is started, the medium should stand still for a reasonable time (e.g. in DN 80 pipe more than a minute) so that the optimization can run without any errors.

9 Measuring windows deltawaveCoG

9.1 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 / Logger



Display		Explanation
Gen. Inform.	**Time**	Format: hh:mm:ss
	AUTOWINDOW ON / OFF	Status of the autowindow function
	IOE	Indicates that the memory for the pulse output is full and the pulse output is disabled (look at chapter 10.5.4).
		Battery condition: Battery is charging; 50-100%; 25-49%; 10-25%; <10%
	No SD Card	No SD card detected. Possible reasons: Removed for data readout, defective, unsupported card size used.
Value	**Vs**	Sound velocity of medium in m/s
	SigQ	Signal quality (percentage of valid signals)
	T / P	Process temperature and process pressure
Communicati	**MODBUS ON** **MODBUS OFF**	Displays status for MODBUS communication. Priority over logger status or USB.
	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, wrong parameterization
	VP / VL ERR	Error in the calculation of the signal propagation. .
	CC-WARN	Correlation clearness value falls below the standard value of 10. Signal optimisation should be carried out.

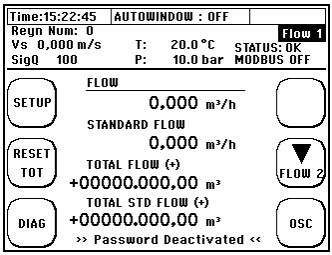
9.2 Measuring window „Flow 1“

In the flow measurement window 1 you get all the important information, compactly summarized for your flow 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 „MEAS.“.



Display:	Explanation:
FLOW	Display of the current volume flow
STANDARD FLOW	Display of the current standard volume flow
TOTAL FLOW	Totalizer flow = flow meter (accumulated volume) Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff)
TOTAL STD FLOW	Totalizer standard flow = STD flow meter (accumulated standard volume) Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff)
Password activated / deactivated	Status of password protection.

Switch to the setup window

Sets the totalizer (flow, standard flow and Mass) to zero.

Change to measuring window "Flow 2".

Switch to diagnostic window.

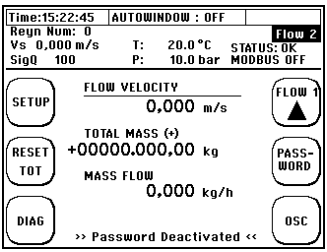
Switch to the oscilloscope window.

9.3 Measuring window "Flow 2“

In the flow measurement window 2 you get all the important information, compactly summarized for your flow measurement.

Navigation in the User-Interface:

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



Display:	Explanation:
FLOW VELOCITY	Display of the flow velocity of the medium in the pipe
TOTAL MASS	Totalizer mass flow= mass flow meter (accumulated mass flow) Parameterizable types: Sum counter (+), negative counter (-), absolute counter (+/- sum), difference counter (+/- diff)
MASS FLOW	Displays the current mass flow
Password activated / deactivated	Status of password protection.

Switch to the setup window

Change to measuring window "Flow 1“.

Sets the totalizer (flow, standard flow and Mass) to zero.

Switch to the password window (Activation / deactivation)

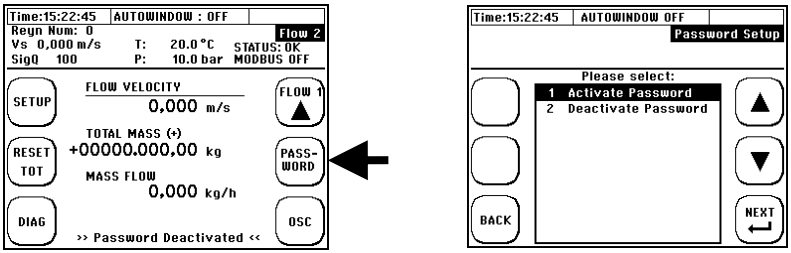
Switch to diagnostic window.

Switch to the oscilloscope window.

9.4 Password protection

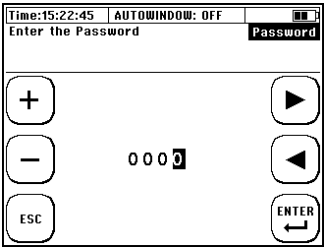
The deltawaveCoG is equipped with password protection. After enabling password protection, it is only possible to switch between the measurement windows and the password display. Parameters or totalizers cannot be changed when password protection is activated.

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 "-" (increase/reduce) 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.



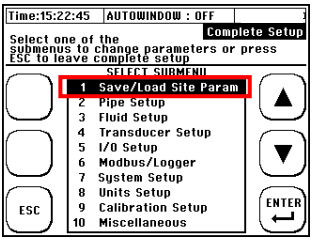
If you have lost/forgotten your password and you can´t deactivate password protection, then please contact systec Controls.

10 The main menu (complete menu)

10.1 Loading, saving and managing parameter data

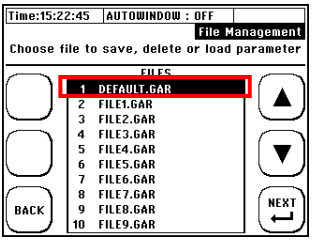
Navigation in the User-Interface:

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



Your deltawaveCoG 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.

With the portable deltawaveCoG, **up to 9 parameter sets** for different measuring points can be stored via **"file access"** and made available on the SD card as a parameter file "*.GAR". The format corresponds to a text file ("*.txt") and can be visualized and edited at any time using a text editor or spreadsheet program.

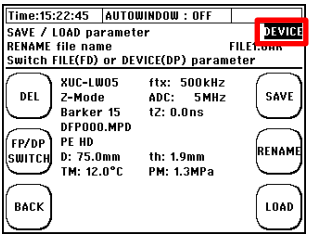


To select a parameter set, use the arrow keys to select a memory location and confirm with "Next".

The stationary deltawaveCoG only stores the parameter set of the installed measuring point. For this reason, the file selection is omitted here and you will be forwarded directly to the overview of the parameters.

You now have the possibility to check the most important parameters before saving or loading them.

!!!ATTENTION!!!
In the parameter overview, it is possible to switch between the contents of the GAR file and the current unit parameterisation. You can see which of the parameter sets you are shown by the display in the top right-hand corner.



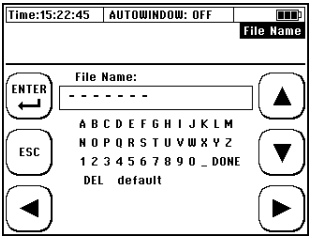
DEL	Reset GAR file name and content	SAVE	Saving the current parameter data
FP/DP ANZ.	Switch between display of unit and file parameters	RENAME	Switch to editing the file name
BACK	Back to the file overview	LOAD	Loading the GAR content

Edit the file name:
1) Use the arrow keys to select characters that correspond to the GAR 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 will not be applied until the "Save" function is activated in the parameter overview.

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

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

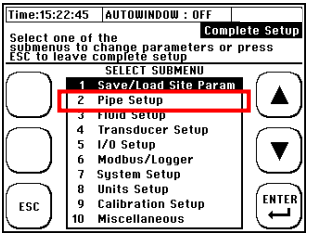
Systec Controls recommends storing and backing up parameter sets of important or recurring applications. This saves time and enables fast, efficient assistance in cases support where support is needed.

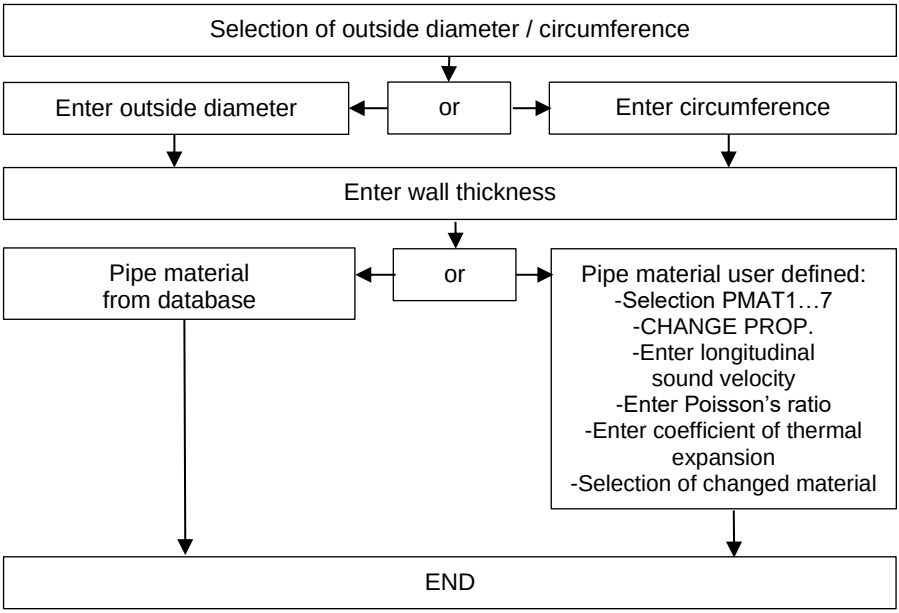
10.2 The pipe parameters

Navigation in the User-Interface:

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

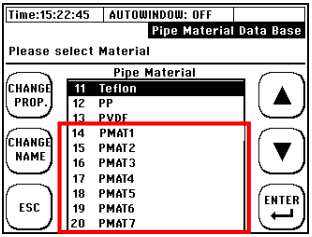
The pipe parameters are part of the quick setup (obligatory parameters), but can also be edited individually via the main menu.





Parameterization of a user-defined pipe material:

Scroll down in the material database
(tip: 1x arrow up).
Here are freely editable materials:
Pipe: 7x PMAT
Both the name and the properties can be changed with these materials. However, this option only becomes active when you use the arrow function keys to one of the freely editable materials.



To edit a custom material, you need:

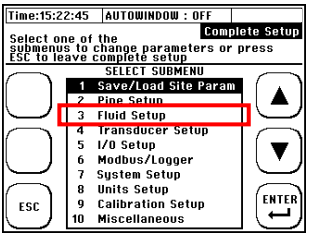
1) Sound velocity (longitudinal)
2) Poisson's ratio
3) Coefficient of thermal expansion

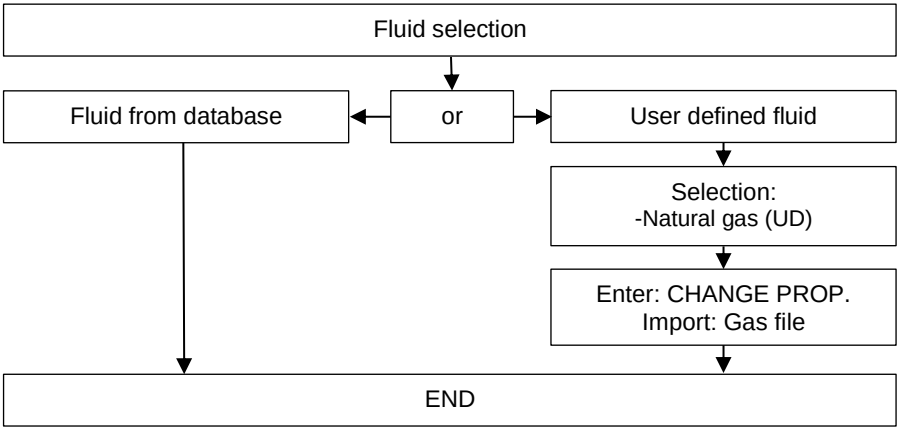
10.3 The Fluid Setup

Navigation in the User-Interface:

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

The parameters of the flowing medium are part of the quick setup (obligatory parameters), but can also be edited individually via the main menu.





Currently, 3 types of user-defined media can be parameterized or imported.

- Natural gas (UD):
  Up to 10 user-defined natural gas compositions (GMAT0 to GMAT9) can be parameterized and stored here.
- Pure gas:
  When the cursor reaches position 10, the "CUST SPEC" button appears on the left side. If this is activated, up to 10 user-defined gases (CFP000 to CFP009) can be imported in the following menu (CFP000 corresponds to the methanol displayed at cursor position 10 and should only be used for parameterization in exceptional cases).
- Refrigerant:
  When the cursor reaches position 10, the "CUST SPEC" button appears on the left side. If this is activated, up to 10 user-defined refrigerants (CFR000 to CFR009) can be imported in the subsequent menu (CFRR000 corresponds to the R178 displayed at cursor position 10 and should only be used for parameterization in exceptional cases).

For custom "Pure Gases" and "Refrigerants", material files must be created. These can be transferred to the device via USB and then imported via the respective menu.

User-defined natural gas compositions can be entered directly into the device. However, it is also easier to import a finished material file.

Do you have a custom gas for which you need a material file?

Please contact systec Controls. We will be happy to create the appropriate import files for you.

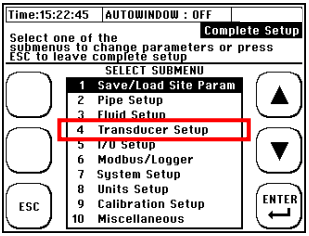
Custom media is only available on devices on which the corresponding import files have been stored.

Please note:
Only "known" material files are registered by the system. Therefore, when transferring material files, be careful not to change the file name.
If a parameter file with a user-defined medium is loaded into a unit in which the medium concerned is not stored, only the selection of the medium is set to the file name. If the property values of this medium are not parameterized, this can lead to incorrect measurements.

10.4 The Transducer Setup

Navigation in the User-Interface:

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



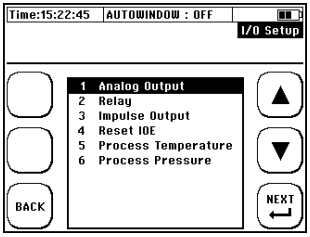
The transducer parameters are part of the Quick Setup (mandatory parameters) but can also be edited individually via the main menu.

According to the application's general conditions or the availability, select the corresponding transducer type here.

10.5 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:

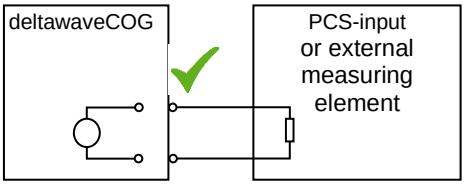
- Analogue Output
- Relay
- Pulse Output
- Reset IOE
- Process Temperature
- Process Pressure

10.5.1 Parameterization of the 4-20mA outputs

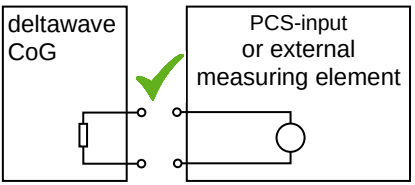
The deltawaveCoG has a total of two 4-20mA outputs. You have the option to assign the outputs different metrics.
The outputs are active at the factory. This means that the deltawaveCoG provides a voltage at the outputs. You can also operate the analogue outputs externally (passively).
If you want to 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 deltawaveCoG and the evaluation unit.

deltawaveCoG feeds (approx. 20V)

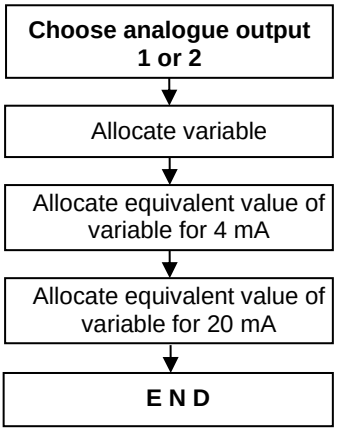


External unit feeds (approx. 24V)



If the 4-20mA outputs of the deltawaveCoG are active and you connect the analogue outputs of the deltawaveCoG to an external device which also provides a voltage at the inputs, this can damage the deltawaveCoG or your external device. Before connecting 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.

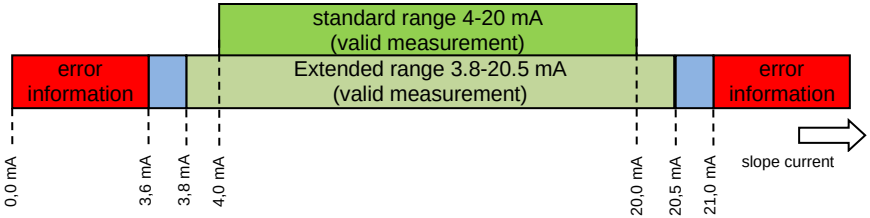


The following measured variables can be assigned to the analogue output:

- Flow
- Flow velocity
- Sonic velocity
- Mass flow
- Standard flow

The measured value values are edited in the parameterized units.

Extended current range:

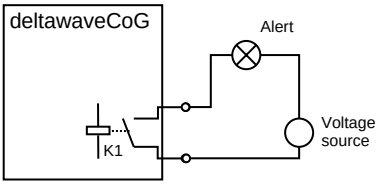


DeltawaveCoG is able to output the current in an extended range (NAMUR NE 43). The error current of the deltawaveCoG is about 3.4 mA.

10.5.2 Parameterization of the relay

Your deltawaveCoG 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.

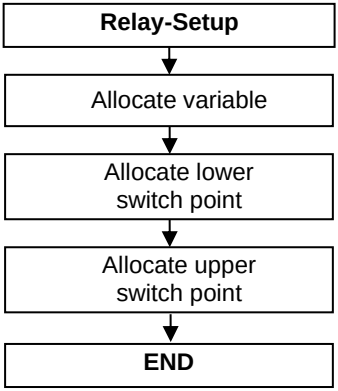
Example for external circuit:



The 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 velocity
- Temperature
- Pressure
- Sonic velocity
- Mass flow
- Standard flow

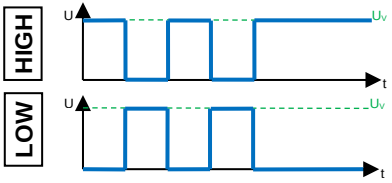


The relay operates without parameterization NO (normally open), the relay function is parameterized, then it is protected against wire breakage. This means that the relay opens only when a parameterized relay function is triggered. This has the advantage that in the event of a power failure (battery empty, no power supply) an alarm is triggered. The polarity of the connections must not be neglected. The contact is potential free. Max. Current: 0.5 A; Max. Voltage 50V

10.5.3 Parameterization of the pulse output

The pulse output is implemented as a transistor output (open collector) and is basically passive with deltawaveCoG-P (external supply: 3 ... 30V / DC).
With deltawaveCoG-F active operation of the pulse output is also possible.

The output form of the pulse is parameterized with the deltawaveCoG via the user interface.

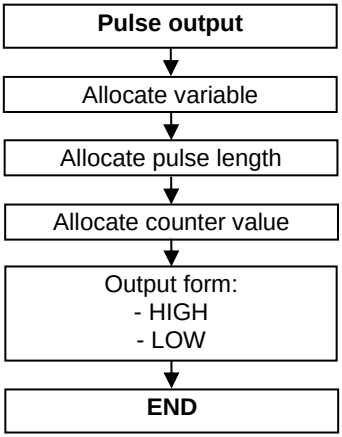


The navigation through the pulse parameterization runs according to the sequence diagram on the right. The measured variables are edited in the respective parameterized unit.

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

- Total flow
- Total standard flow
- Total mass

Possible **pulse lengths**: 20, 40, 60, 100, 260, 500 ms

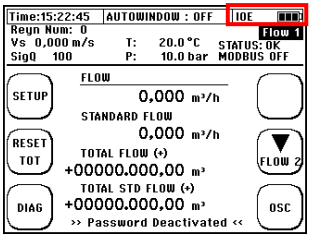


If the unit of the totalizer is changed after parameterization of the pulse output, the counter value is adapted. Numerical inaccuracies in the conversion can lead to deviations with frequent unit change.

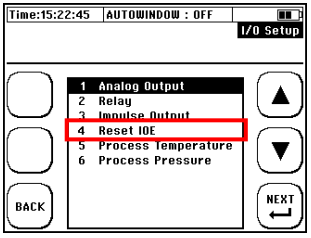
10.5.4 Pulse-Overflow-Error; IOE

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 pulse buffer (max. 4096 pulses can be buffered), the pulse 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 (total flow, total standard flow or total mass) 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.



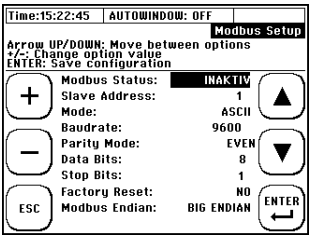
10.6 Data Transfer & Logger

10.6.1 Modbus

The deltawaveCoG 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 deltawaveCoG-F.
Navigation in the User-Interface:

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

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



Designation	Reset-Value	Other features
Modbus Status: Activation of data transmission	INACTIVE	ACTIVE
Slave Address: Of deltawaveCoG	1	1… 247
Operating mode:	ASCII	RTU
Baud rate: Data bits per second	9600	19200, 28800, 38400, 57600, 115200
Parity: Error detection	NONE	ODD, EVEN
Data Bits: Number of data bits.	8	not editable
Stop Bits: Number of stop bits.	1	not editable
Reset: Resets the serial interface to factory settings.	NO	YES
Modbus Endian: Byte sequence	BIG ENDIAN	LITTLE ENDIAN

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

10.6.2 The Data Logger

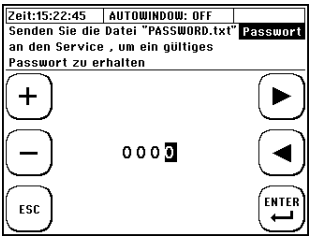
Logging of data is the time-controlled recording (storage) of measured value data on the device internal memory.

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

With deltawaveCoG-F the data logger can be ordered as an option. When ordering without data logger, this is included in the firmware (locked) and can be subsequently activated if required (subject to a charge).
If you are interested in an activation, please contact us.

10.6.2.1 Activation of the data logger

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 „Modbus/Logger“.
2) As soon as you select the sub-menu item 3 "Data logger“, you will be forwarded to a password query. At the same time, a random code is generated and stored on the SD card in the file "Passwort.txt". If you do not have the activation code, cancel the activation process ("ESC").
3) Connect the transmitter to a PC via USB (USB 2.0: Type A plug to Mini B plug). The USB connection is located in the cable compartment and can be accessed by removing the housing cover above the cable compartment.
4) The SD card inside the unit is recognised as a mass storage device. Now copy the file "Passwort.txt" from the deltawaveCoG to your PC.
5) 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.
6) 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 system.

10.6.2.2 Administration and structure of log data

The current hardware state (4GB SD memory) allows the recording of data up to one year when recording in a secondary interval (with a 10 s interval 10 years). For longer recording periods, the memory can be expanded. The deltawaveCoG supports SD memory up to 32 GB.
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 deltawaveCoG-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 Processing by text editors or spreadsheet programs (e.g., Microsoft Excel).
Headlines	Details of time control Relevant details of the parameterization
Measurement data	Date, time, flow, standard flow, mass flow, flow velocity, sonic velocity, total flow, total standard flow, total mass, temperature, pressure, gain, signal quality, status

The measured values between two recording intervals are not averaged. The current measurement value is always recorded at the respective time. Detailed instructions for the transformation from a *.csv file to a *.xls (x) can be found on the USB stick under the service instructions.

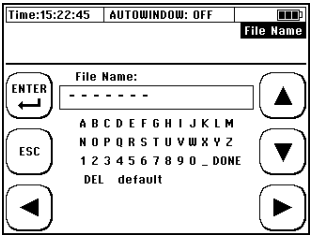
10.6.2.3 Starting a time-controlled data record

Navigation in the User-Interface:

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

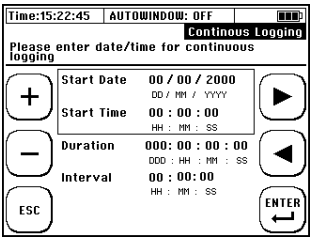
deltawaveCoG-F: „Modbus/Logger“ → „ Data Logger“
deltawaveCoG-P: „ Data Logger“

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 "ESC" and confirming with "ENTER"

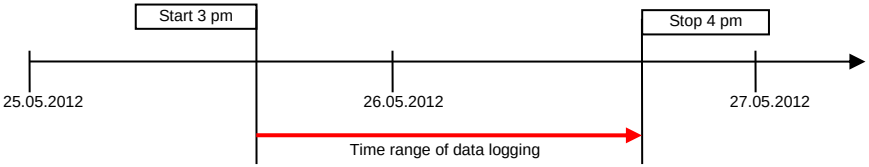


The name you have chosen (e.g.: "12ABC") is provided with a 3-digit number appendix (initial file name: "12ABC000.txt"). A maximum of 65536 lines are written per file. After that, a new file is created and the number attachment is incremented by one ("12ABC001.txt").

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: Data from 25.05.2012, 3:00 p.m. to 26.05.2012, 4:00 p.m. should be recorded every 60 seconds.

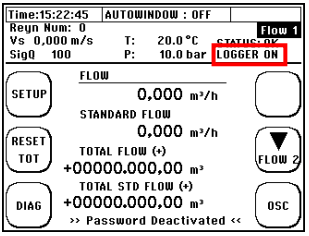


1. Enter 25.05.2012 as the start date
2. Enter the start time at 3 pm
3. For Duration, enter 001:01:00:00
4. Enter 00:01:00 as the interval

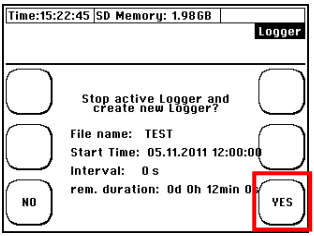
Note that the time-controlled recording is linked to the system time of the deltawaveCoG. If **the system time or date** is not set correctly, this will have a direct effect on your parameterized data recording!
The **start of recording should always be in the** future in **relation to the current deltawaveCoG system time**, otherwise the data recording will not start.

10.6.2.4 Cancelling a time-controlled data record

If the logger is active and records data according to the parameterization, this is displayed in the header: „LOGGER ON“. With deltawaveCoG, Modbus has priority and can prevent 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 choose:

deltawaveCoG-F:
„Modbus/Logger“ → „Data Logger“

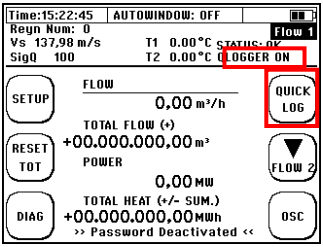
deltawaveCoG-P: „Data Logger“

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.

10.6.2.5 Quick-Logger

The Quick-Logger function is only available for deltawaveCoG-P. It allows a quick start of 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: „145924000.txt“
Duration: endless
Interval: 10 s
Activation / deactivation: Press and hold the "QUICK LOG" button for 3-4 seconds



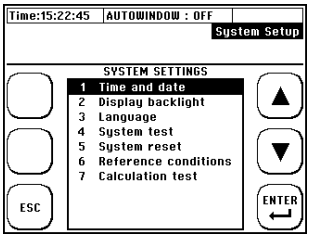
Press and hold the button for several seconds to prevent accidental starting. If the Quick Logger is active, "QLOGGER ON" is displayed in the communication status.

10.7 System 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.



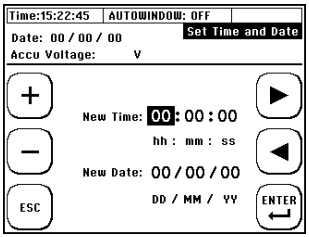
10.7.1 Editing the time and date

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.



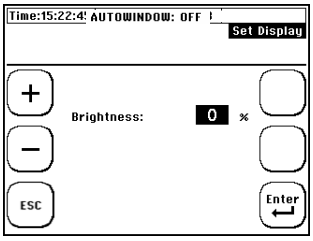
10.7.2 Changing the indicator light

Navigation in the User-Interface:

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

+/-:	Change of value
ESC/ENTER:	Cancel / Confirm

Set the display brightness and confirm.



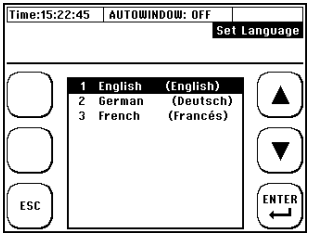
10.7.3 Changing the menu language

Navigation in the User-Interface:

From the main measurement window "Flow 1“: select „SETUP“ → „COMPL SETUP“ → „ 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.

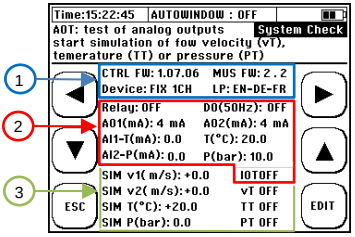
10.7.4 System test

Navigation in the User-Interface:

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

This compact window brings together 3 important components that can be used to check your device status:

1) Display of important system information
2) Direct test of inputs / outputs
3) Indirect system test by simulating flow, pressure and temperature



▲▼►◄: Navigation / Selection
ESC: Cancel
EDIT: Change value

Important System Information:	
CTRL Firmware	Firmware version of the user interface (CTRL Board)
MUS Firmware	Firmware version of the MUS Board
Device	Portable, Fix
Language Pack (LP):	Integrated language pack of the CTRL firmware

Direct test of inputs / outputs (hardware test)	
Relay	Triggers the switching process of the relay
DO (50 Hz)	Pulse output sends out 50 Hz pulses
AO1 & AO2	When "IOT" is activated: Output of set mA
AI1 & AI2	Shows applied mA and the equivalent in P&T

Indirect system test (simulation of flow, pressure and temperature)	
SIM v1	Input flow velocity for simulation
SIM T	Input temperature for simulation
SIM P	Input pressure for simulation
vT OFF	Activation simulation with v1 set
TT OFF	Activation simulation with set temperature
PT OFF	Activation simulation with set pressure

When the simulation is activated, a flow is simulated based on the entered flow velocity. Since the parameters set in the unit (pipe, medium, etc.) are used for this, the behaviour of the unit (e.g. switching of the relay, data transmission, etc.) can be tested.

The simulation of pressure and temperature can optionally be activated individually. If this is not activated, the unit uses the current values (e.g. connected PT100 or parameterised fixed value) for pressure and temperature compensation.

During a simulation, the measuring device shows separate totalizers and thus does not change the regular totalizers.

After the simulation is finished, deltawaveCoG shows the original totaliser values again.

Editing the parameters in the user interface:

In the System Test window, there are basically two types of editable fields:

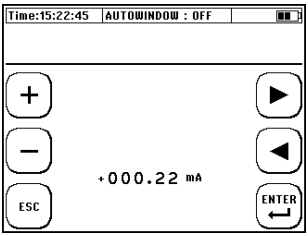
- ON / OFF fields
- Values – fields

Use the cursor to select the field you want to edit and then press "EDIT“.

If the selected field is an ON / OFF field, the setting of the field is changed directly, since only two options are available.

If the field is a value field, you will see the window on the right side.

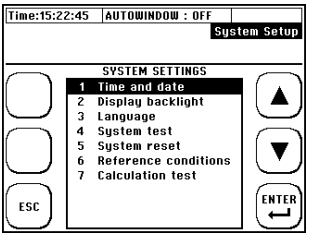
The desired values can be set here. The setting is done in the displayed units. Then confirm the value with "ENTER“.



10.7.5 System Reset

Navigation in the User-Interface:

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



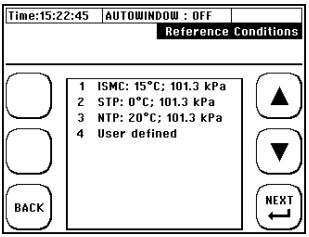
The system reset function resets all parameters to factory settings. If you receive a device with unknown history or if the device shows malfunctions, it is possibility to overwrite invalid settings.

Basic settings such as date and time are not affected by the system reset.

10.7.6 Reference conditions

Navigation in the User-Interface:

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



In this menu, you can set the reference conditions for pressure and temperature compensation.

Predefined, the following reference conditions are available:

- ISMC: 15°C; 101,3 kPa
- STP: 0°C; 101,3 kPa
- NTP: 20°C; 101,3 kPa

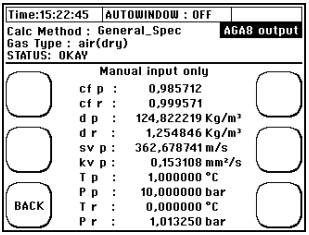
If you need other reference conditions, you can enter them under the menu item "User defined".

10.7.7 Calculation test

Navigation in the User-Interface:

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

In this menu, you can check the gas parameters calculated for your parameterization.

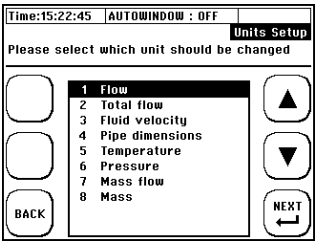


10.8 Unit selection

Navigation in the User-Interface:

From main measurement window "Flow 1“: select „SETUP“ → then „COMPL SETUP“ → In the main menu, navigate to 8 "Units"

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



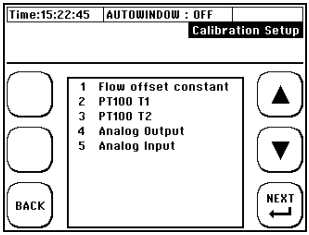
Physical size	Units supported by deltawaveCoG
Flow / standard flow	m³/s; m³/min; m³/h; l/s; l/min; l/h; gal/s (Imp.gal.), gal/min (Imp.gal.), gal/h (Imp.gal.), ft³/s, ft³/min, ft³/h, gal/s (US.liq.gal.), gal/min (US.liq.gal.), gal/h (US.liq.gal.)
Total flow / total standard flow	m³; l, gal (Imp.gal.), ft³, ml, gal (US.liq.gal.)
Fluid velocity	m/s; ft/s
Pipe dimensions	mm; inch
Temperature	°C; °F; K
Pressure	bar, MPa; kPa
Mass flow	kg/s, kg/min, kg/h, t/s, t/min, t/h
Total mass	kg, t

10.9 Calibration

Navigation in the User-Interface:

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

Select the desired calibration option from the calibration menu.

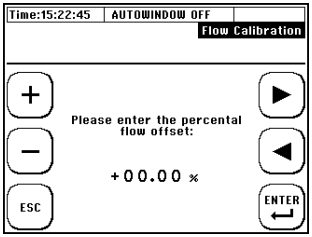


10.9.1 Flow-Offset

Select **„Flow offset constant“** from the calibration menu.

Enter the desired offset correction
(Attention: Span correction).

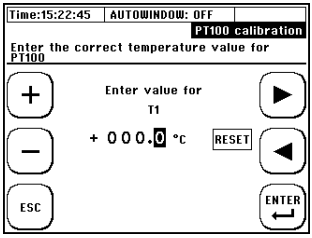
Check the flow at 2-3 relevant flow rates to check whether the percentage correction is permissible. The offset remains stored in the device until it is overwritten by a new value.



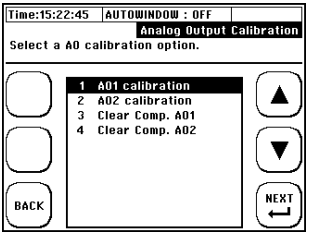
10.9.2 PT100 Calibration

Select **„PT100 T1“** or **„PT100 T2“** from the calibration menu.

Now enter the actual temperature for the PT100 in question (default value). Attention! The default value is an absolute temperature and not an offset with respect to the displayed temperature! Press "RESET" to clear the default value. The Pt100 shows again the temperature without correction.



10.9.3 Calibration of analogue outputs



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

Procedure:

1) Switch to the System Test window.

2) Using the IO simulation, output a value of 4 mA for the respective analogue output (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

3) Use a multimeter to measure the actual output mA value and make a note of it.

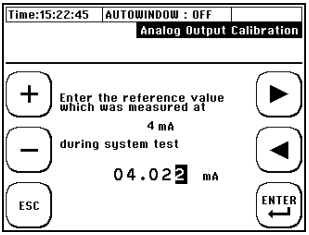
4) Repeat the procedure for 20 mA.

5) Now switch to the calibration menu and select **"Analogue Output".**

6) Select the analogue output you want to calibrate.

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

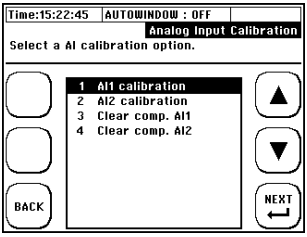
8) Enter the measured **reference reading for 20 mA** and confirm.



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

To delete a correction coefficient, select "Clear Comp.".

10.9.4 Calibration of analogue inputs



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

Procedure:

1) Switch to the System Test window.

2) Apply a value of 4 mA to the analogue input in question.

3) In the System Test window, read the mA value measured by deltawaveCoG at the relevant analogue input and make a note of it (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

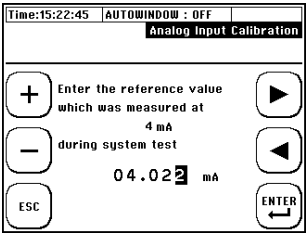
4) Repeat the procedure for 20 mA.

5) Now switch to the calibration menu and select "**Analogue Input".**

6) Select the analogue input to calibrate.

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

8) Enter the measured **reference reading for 20 mA** and confirm.



The correction coefficients are now calculated automatically and stored in the system.
To delete a correction coefficient, select "Clear Comp.".

10.10 Miscellaneous Parameters

Navigation in the User-Interface:

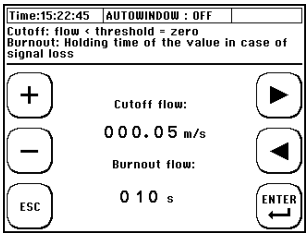
From the main measurement window "Flow 1“:
select „SETUP“ → „COMPL SETUP“ →10 „Miscellaneous“
The following options are available:

1	Cutoff and Burnout
2	Damping
3	Zero
4	Totalizer flow
5	Sensor distance

6	Pipe roughness
7	Sensor test
8	Signal optimization
9	Totalizer mass

10.10.1 Cutoff und Burnout

Select **„Cutoff and Burnout“** from the miscellaneous menu.

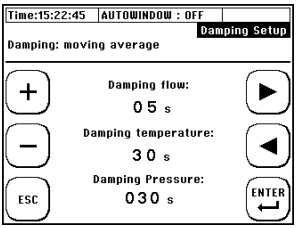


Cutoff flow:
Absolute flow velocities smaller than the edited flow threshold will be not considered (zero set).
Flow values which depending from the flow velocity (flow, standard flow, mass flow and so on.) are also affected by this parameterization.

Burnout Flow:
Low signal quality (SigQ < 25; headline top left) causes the measurement to be invalid and the measured values fall to zero. With the help of the burnout function, the last valid measured value (SigQ > 25) can be retained for the parameterized time duration (= burnout).

10.10.2 Damping

Select **„Damping“** from the miscellaneous menu.



With deltawaveCoG, you have the option of damping the signal output for different measured variables (time length of the mean value filter).
The greater the damping is selected, the more slowly deltawaveCoG reacts to changes, but the "smoother" the measured value curves are.

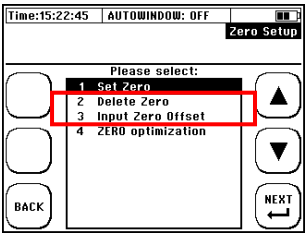
The following measured variables can be provided with an damping:

- Flow: Typical damping is in the range of 5-60 seconds.
- Temperature: Typical damping is in the range of 30-60 seconds.
- Pressure: Typical damping is in the range of 30-60 seconds.

The damping of a measured value, e.g. flow rate, also has an effect on the follow-up variables standard flow rate and mass flow rate.

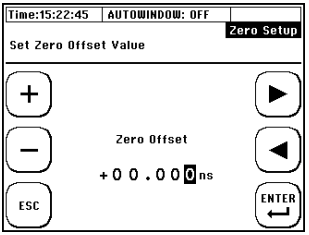
10.10.3 Zero

Select **„Zero“** from the miscellaneous menu.



Here you can set the zero point (see chapter 7.6), 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 if relevant parameters (pipe, medium, pressure, temperature, transducer, frequency or signal coding) are edited again (editing in this sense also includes a renewed confirmation without changing the values). A signal optimisation (with the exception of the zero optimisation) also leads to the deletion of the zero point. **Be careful, when you perform measurements with different application data!**

10.10.4 The totalizer (counters)

DeltawaveCoG has three counters: one for the volume flow, one for the standard volume flow and one for the mass flow. The counters for the volume flow and for the mass flow can be parameterised independently of each other with regard to their counting method. The counting method of the meter for the standard volume flow is coupled to the counting method of the volume meter. 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).

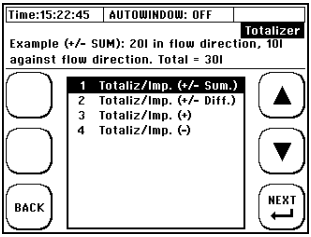
The pulse output of the transmitter behaves in line with the parameterization of the counting method of the respective counter.

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.

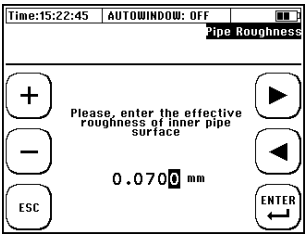
Navigation in the User-Interface:

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



Now parameterize the totalizer according to the requirements of the application as described above.

10.10.5 Pipe roughness



Select "Pipe roughness" in the Miscellaneous menu. Here you can set the effective roughness of the inner surface of the pipe. With this function, the surface roughness on the inside of the pipe is taken into account as a correction factor when determining the Reynolds compensation.

10.10.6 Sensor test

The deltawaveCoG offers you the possibility to test the ultrasonic transducers together with the signal cables. If, for example, the current measurement does not produce a result, a sensor test can be used to ensure that the ultrasonic transducers function correctly together with the signal cable. In this way, the error can be narrowed down to the application. Proceed as follows:

Make sure that the ultrasonic transducers are connected, and the correct transducer type (COMPL SETUP → Transducer Setup) is parameterised.

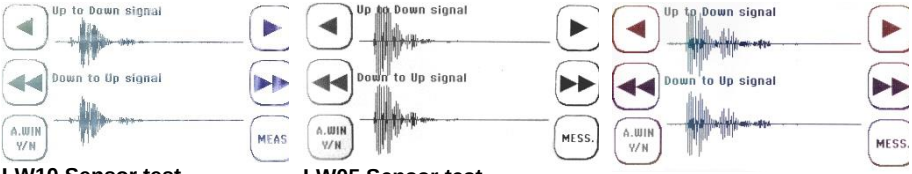
Select "Sensor test" in the Miscellaneous menu.
You now have the choice of performing the sensor test in Z-mode directly between two transducers, or in V-mode on a steel or PVC block.
Select the desired mode. The following description refers to the sensor test in Z mode.

After selecting the mode, you will be directed to the oscilloscope window:

1) Spread some acoustic coupling medium on one of the two transducers and position the ultrasonic transducers in relation to each other as shown on the right so that approx. 2/3 of the acoustic transmission area overlaps (Z-mode without tube).

2) If the ultrasonic transducers are functioning properly, the signal cables are undamaged and correctly connected, then from the beginning of the time window there is first an area without a signal (zero line), then a clear received signal (several signal packets with great similarity on both signal paths), possibly a swing-out behaviour and then a zero line again. As the deltawaveCoG allows the setting of a large combination of size of the time window, transmission coding and transducer frequency, the exact position, as well as the expression of the signal depends on the individual settings of your device (for examples, see the following illustrations).

However, it always remains with the mentioned sequence of the areas zero line, received signal, zero line.



LW10 Sensor test **LW05 Sensor test** **LW03 Sensor test**

3) In contrast, in the case of defective ultrasonic transducers or signal cables, ONLY the relicts of the transmitted signals can be seen immediately from the start of the measurement window. The signal characteristics range between Figure 23 and Figure 24. Transmitted signal relicts can also appear with correctly functioning transducers but are then small compared to the useful signals.

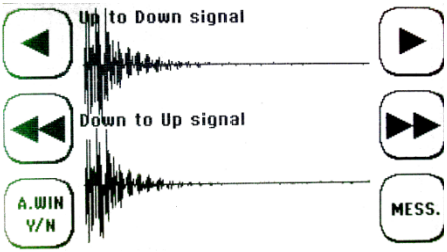


Figure 23: Transducer connected, no acoustic contact (without Magnalube)

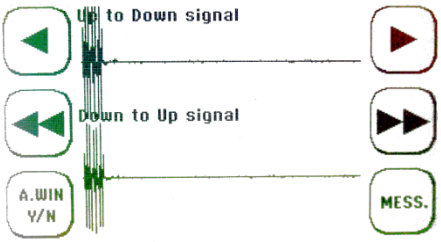


Figure 24: Transducer not connected (relics of the transmitted signals)

11 Additional information about the hardware

11.1 Hardware and Software Reset

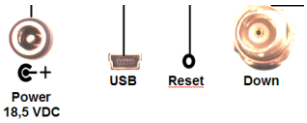
The deltawaveCoG distinguishes between two types of resets: hardware and software reset. The data on the device-internal SD card remain unaffected by a reset.

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 deltawaveCoG-F Connector-board

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

Section of deltawaveCoG-P backside



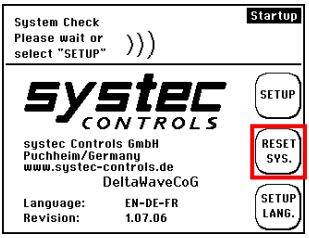
Use a pointed object to press the button located behind the opening on the back of the device.

2. The Software Reset:

Triggering a "Software Reset“:

1. **Immediately on the start:** „RESET SYS.“

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



In the case of a software reset, all values in the flash memory and in the RAM memory of the deltawaveCoG 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.
All parameters are reset (totalizer values, pipe parameters, etc.); Load a pre-stored parameter file or re-parameterize the transmitter.

11.2 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 storage device on Windows and MAC OS and data can be exchanged.

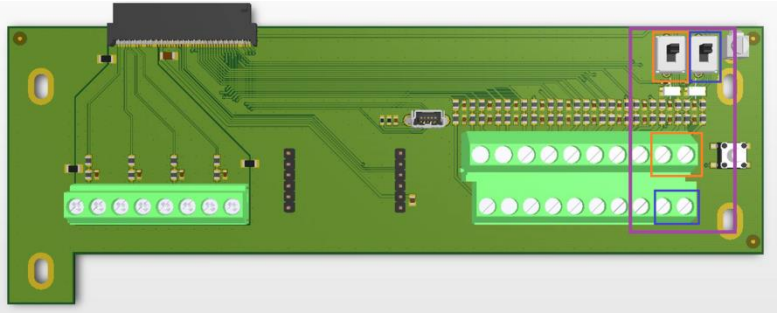
The speed of the USB data transmission is limited by the maintenance of the measurement performance and is correspondingly slow.
Tip: For optimal data exchange it is advisable to deactivate any digital data record (Modbus, Logger).
When exporting large amounts of data, it is recommended to remove the 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 deltawaveCoG-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).

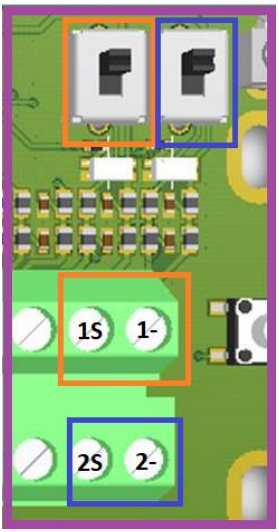
For mass storage> 2GB the detection can take some time. Please wait a minute.

12 Pulse outputs active/passive



There are now only switches IMP1 and IMP2 (pictures of the new CON2 have already been sent), with which the supply is configured:

ON = active = Vsupply: 12V internal = not potential free
OFF = passive = Vsupply: external = potential free



The pulse output is designed as a transistor output (open collector) and is always passive with deltawaveCoG-P (external supply: 3...12V/DC).

With the deltawaveCoG, the output form of the pulse is parameterized via the user interface.

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

- Total flow
- Total standard flow
- Total mass

Possible pulse lengths: 20, 40, 60, 100, 260, 500 ms

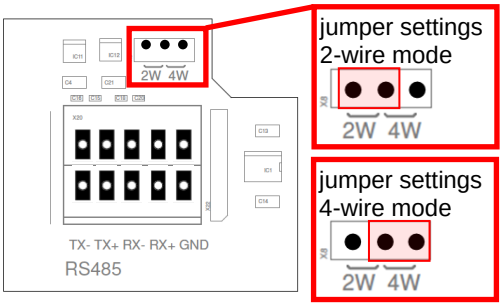
12.1 RS485 interface

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

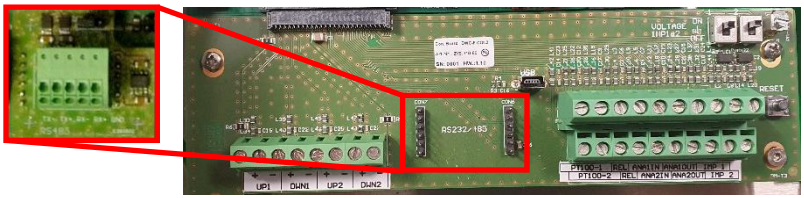
A RS485 interface allow cable lengths up to several 100 m between deltawaveCoG-F and an evaluation unit. Additionally, a Modbus communication can be realized via the RS485 interface card.

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

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



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



13 Fehleranalyse, Fehlerbehebung

You have parameterized a measuring point, the ultrasonic transducers are mounted and do not get any plausible results or the flow zero. Or you get meaningful results in the display of the deltawaveCoG but have difficulties transmitting the results analogue or digital.

This chapter provides a help guidance procedure for successful support:

A) Checklist: Use the checklist (see USB stick) 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 to keep a cool head in a difficult application and to systematically isolate 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 chapter10.1) and export the file (alternatively, you can take pictures of all windows of the **parameterization**).
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 chapter 13.1). Copy the WAV file via USB (alternatively, you can take a photo of the current signal window).
3) In addition, it is a good idea to take photos of **the ultrasonic transducers installed on the pipe**. If you have problems with the analogue or digital signal transmission, take a picture of the cable connection compartment or the cabling.

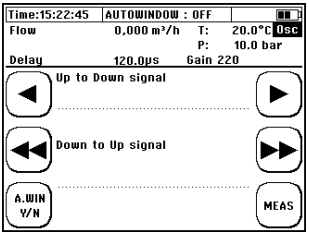
C) Contact systec Controls

089 / 809 06 0 and info@systec-controls.de
And submit the data to the assigned support (GAR file, WAV file and photos of the transducer installation)

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

13.1 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 delay or move to the left on the time axis

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

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

MESS. Return to the measurement window

From the standard header differing display:

Display		Explanation
Values	**Flow**	Flow
	T	Process temperature
	P	Process pressure
	Delay	Start value of the displayed signal window in µs
	Gain	Value of the signal gain for the displayed signal

The deltawaveCoG allows storing current signals (A-Scan) as a WAV file on the SD card. The **A-Scan export** can only be performed in the OSZ 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 name 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 deltawaveCoG to a PC (USB cable) and copy the desired WAV file.

13.2 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.

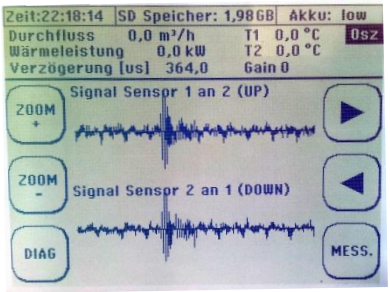
The following is a list of some measures for improving the useful signal quality:

- Pipe surface: Make a clean and smooth pipe surface, remove paint and rust.
- Coupling grease: Use sufficient coupling grease (Magnalube).
- Correct sensor alignment? The sensors must be exactly in axis and have the correct distance. Especially with small pipes, you have to make sure that the transducers are located in the middle of the pipe; If necessary, loosen the straps slightly and tilt the sensors slightly to the left and right while tracking the oscilloscope screen.
- Make sure that transducers are not mounted e.g. on welding seams.
- Select another pipe position.
- Make sure that the inlet section is sufficiently long and undisturbed.
- Use a different transducer (lower frequency)

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

- For the deltawaveCoG, ensure that the shield and core of the transducer cables are connected correctly (see 2.3).
- Check that your medium does not contain too many solids.
- Ensure that the sensor cable is sufficiently far from the power cables.
- Especially, keep your distance from pumps and frequency converters.

Figure 4a shows a signal with strong noise (unfavourable SNR). A clear noise can be seen on the time axis before and after the signal.
Figure 4b 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) 

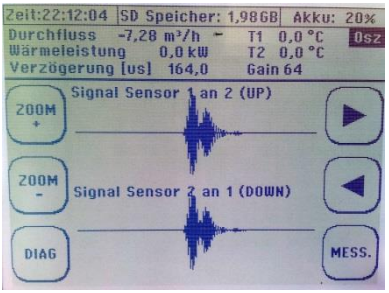
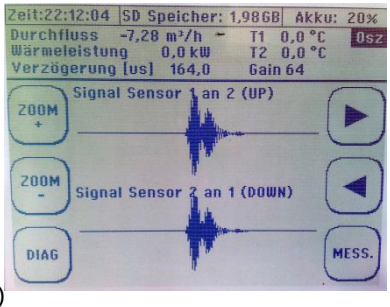
b) 

Figure 4: Sample signals (oscilloscope window) with different SNR

13.2.1 Signal sharpness

The signals from deltawaveCoG are coded to reliably identify the ultrasonic signals even in the case of very poor signal-to-noise ratios. For this purpose deltawaveCoG 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 5a 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 received signal clearly shows the coding of the transmission signal. This is not the case for the signal in Figure 5b. The amplitude increase is initially very small and only after the phase shift does a high amplitude modulation occurs.

a) 

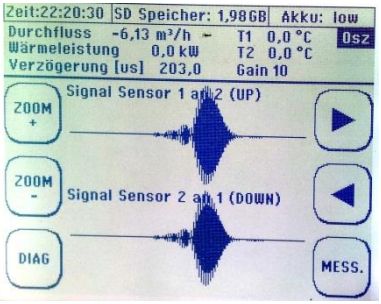
b) 

Figure 5: Sample signals concerning signal sharpness (oscilloscope window)

In addition to the general measures for improving the useful signal quality (see 13.2), 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

The highly developed signal evaluation of the deltawaveCoG 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.

13.2.2 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). The graphic on the right shows how the different signals can appear in this case.

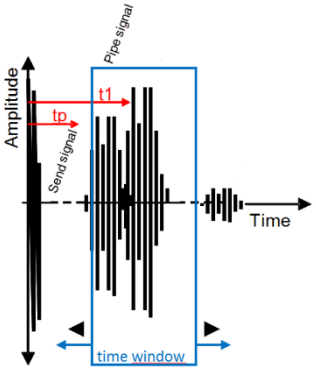


Figure 6: Signal superimposition for small pipelines

In the case of signal overlapping, there are various remedial options:

- Deactivate the auto-window function and manual positioning of the measurement window.
- Test alternative signal codes for a narrower/sharper signal ("Barker7" or "Pulse" instead of "Barker15").
- Use a higher frequency transducer to get a narrower and sharper signal.

When using a 1 MHz transducer instead of a 500 kHz transducer, the signals are only half as long and therefore easier to unbundle (see right).

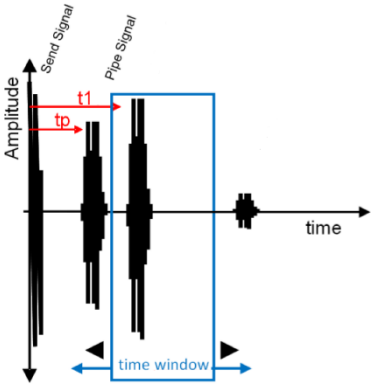


Figure 7: Signal decoupling through higher transducer frequency

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.

The deltawaveCoG has very powerful signal unbundling algorithms. These are applied when you enable the Auto-Window function.
Nevertheless, signal overlaps can occur, especially with very small pipes and/or unsafe pipe dimensions. In this case, the user can manually unbundle the signals in the oscilloscope window.

13.2.3 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 pipe would have to bring about a permanent repositioning of the ultrasonic transducers.
Practically speaking, this is relevant to:

1) Temperature variation: The speed of sound of a medium is temperature dependent.
2) Pressure variation: The speed of sound of a medium is pressure dependent.
3) Medium change: Depending on the application, it is possible for different gases to be alternately fed through the same pipeline.
4) Changes in concentration: Depending on the application, it is possible that the concentration fractions of the gas components vary. This causes, albeit to a small extent, changes in the speed of sound.

The algorithms of deltawaveCoG 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 **AFC technology (Automatic Fluid Control)**.

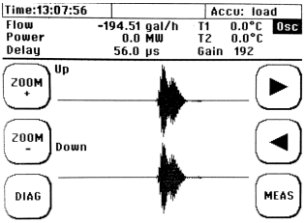
In general, it is not always useful to evaluate the total signal during ultrasonic measurements (interference signals, high memory requirements, high signal processing expenditure, and so on). The deltawaveCoG The deltawaveCoG places a measuring window according to the parameterization in which the useful signal is expected. Only in this range is the signal recorded and evaluated.
All signals that appear in the measurement window are compared with the transmitted signal. If the signal pattern and coding match the transmitted signal, the signal is accepted as valid and a corresponding evaluation is carried out.

Variable properties of gases have an impact not only on the calculations, but also on the position of the useful signal (valid receive signal) within the measurement window. A higher speed of sound means that the signal arrives earlier (shifts to the left on the time axis), a lower speed of sound means the opposite.

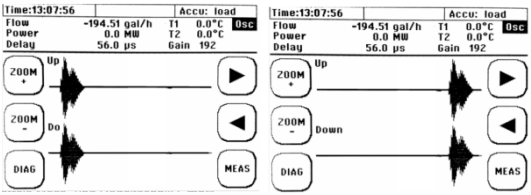
If these effects are not taken into account, the signal could migrate out of the evaluated measurement window in the event of strong changes in the gas properties (medium changes, changes in temperature, pressure or concentration).

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.

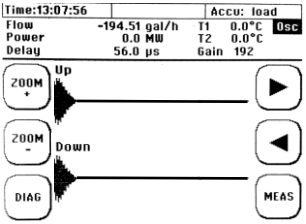
Optimal position of the measuring window:



Not optimal (BUT uncritical) position of the measuring window:



Critical (incorrect) position of the measuring window:

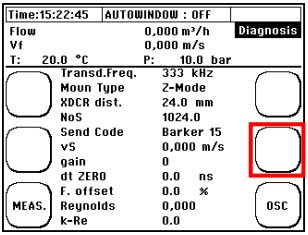


The Auto window function is activated and deactivated in the OSC window (see 13.1). The Auto window function status is displayed as a general header information.

An activated auto window function always tries to keep the measurement windows at the position calculated by deltawaveCoG 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.

13.3 The diagnosis window of the deltawaveCoG

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
Transd.Freq.	Central frequency of the send signal: 333kH, 500 kHz, 1000kHz
Moun Type	Z-Mode
XDCR dist.	Installation distance between the front surfaces of the ultrasonic transducers
NoS	Number of Samples (256, 512, 1024, 2048, 4096)
Send Code	Encoding of the send signal. The send code can be changed manually. Following codes are available: „Burst9-9“, „Burst4“, „Barker5“, „Barker7“, „Barker8“, „Barker11" and „Barker15“
vS	Sound velocity of the medium
Gain	Current gain of the received signal (see 13.1)
dt. ZERO	Currently parameterized value of the ZERO point calibration (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).
F. Offset	Shows the value currently parameterized for the flow offset (see 10.9.1).
Reynolds	Displays the current Reynolds number.
k-Re	Shows the current value of the Reynolds correction factor

Appendix A – Material specifications

Material data of different pipe and liner materials: longitudinal sound velocity v_P and Poisson's ratio *v*

Material	v_P [m/s]	*v* [unit less]
Carbon steel	5890	0.2831
Stainless steel	5660	0.2818
Copper (rolled)	3700-3850	0.3462
Copper (cast)	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

Typical material data of varying plastic materials: longitudinal sound velocity v_P and Poisson's ratio *v*

Material	v_P [m/s]	*v* [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	**Ultrasonic transit time difference**
Measured variables	Volume flow, flow velocity, standard volume flow, mass flow
Counter	Volume, standard volume, mass
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	approx. 10 watt
Integrated data memory	Micro SD card, 4 GB (more possible)
Display	LCD 320x240 (Backlight: LED, dimmable)
Signal damping	0…60 sec (adjustable)
Diagnose functions	Sound velocity, signal strength, SNR, signal quality, amplitude, energy, signals can be displayed graphically
Accuracy (volumetric flow)	± 1...3 % of mv ±0.01 m/s application dependent ± 0.5 % of mv ±0.01 m/s for field calibration
Reproducibility	0.15 % of mv ±0.01 m/s

	deltawaveCoG-F	**deltawaveCoG-P**
Power supply	90-264VAC 18-36VDC (opt.)	Input: 100-240 V/AC Output: 19 V/DC (max. 3,42 A) Li-Ion-Akku: Runtime: approx. 22 h
Protection class	IP66	IP40
Housing	stainless steel, wall-mounted	Aluminium (portable), PVC
Weight (kg)	4,1	1,5
Dimensions (WxHxD, mm)	360 x 290 x 82 mm	265 x 190 x 70
Inputs	2 x 4...20 mA (active/passive, opt.) 2 x Pt100 (3-wire)	2 x Pt100 (3-wire)
Outputs (all with potential-related, Exception: Relay at deltawaveCoG)	1x USB socket (Mini B) 2x Transducer 2x 4…20mA (active/passive) 1x Puls (active/passive) 1x Relay (max 50V; 0,5A) Modbus/RS485 (optional)	1x USB socket (Mini B) 2x Transducer (BNC, impedance 50 ohms) 2x 4…20mA (active/passive) 1x Puls (passive) 1x Relay (max 50V; 0,5A)

Specifications ultrasonic transducer

Housing: PEEK with stainless steel cover
Type code:

XUC-LW10:	Frequency range 1000 +/- 300 kHz
XUC-LW05:	Frequency range 500 +/- 200 kHz
XUC-LW03:	Frequency range 300 +/- 150 kHz

Mounting rails: stainless steel, clamp-on mounting
Protection class: IP54
Dimensions (WxHxD, mm): 110 x 70 x 35
Weight: approx. 0,5 kg per transducer
Cable: coaxial cable10 m (other lengths opt.)
Operating temperature: -40 … 150 °C
Ex: Ex q (G)/ Ex tb (D) (optional, deviating temperature range)

Transducer selection			
Pipe wall thickness	LW10	2 – 5 mm	
	LW05	4 – 9 mm	
	LW03	7 – 15 mm	
Internal pipe diameter	LW10	25 – 90 mm	
	LW05	90 – 450 mm	
	LW03	90 – 700 mm	
Mounting mode	Z-mode (mounting rails fixed with steel straps)		
Minimal Media pressure (absolute) Depending on application, typical range of use for natural gas, compressed air	Min. pressure	Metal	Plastic
	LW10	10 bar (ID > 60 mm) 5 bar (ID < 60 mm)	2 bar
	LW05	15 bar (ID > 120 mm) 10 bar (ID < 120 mm)	2 bar
	LW03	15 bar	2 bar
	(Lower pressures only with developmental support)		

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. In the current status, only the first 19 double words contain valid values.

Parameter	Input Register Address (Hex)	Number of Input Registers (Decimal)	Format (Big Endian)
Flow	0x0000 - 0x0001	2	Float AB CD
Standard flow rate	0x0002 - 0x0003	2	Float AB CD
Flow velocity	0x0004 - 0x0005	2	Float AB CD
Speed of sound	0x0006 - 0x0007	2	Float AB CD
Volume	0x0008 - 0x0009	2	Float AB CD
Standard volume	0x000A - 0x000B	2	Float AB CD
Mass flow	0x000C - 0x000D	2	Float AB CD
Mass	0x000E – 0x000F	2	Float AB CD
Temperature	0x0010 – 0x0011	2	Float AB CD
Pressure	0x0012 – 0x0013	2	Float AB CD
Signal Quality	0x0014 – 0x0015	2	Float AB CD
SC Device status	0x0016	1	unsigned
UC Flow	0x0017	1	unsigned
UC Flow velocity	0x0018	1	unsigned
UC Volume	0x0019	1	unsigned
UC Mass flow	0x001A	1	unsigned
UC Mass	0x001B	1	unsigned
UC Temperature	0x001C	1	unsigned
UC Pressure	0x001D	1	unsigned
Reserve	0x001E - 0x007C	95	

UC … unit code
SC … status code

For further information, see **"Supplementary Manual dwCoG-F MODBUS“**.

Appendix D – Technical accessories

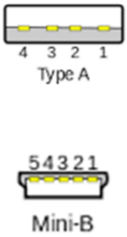
Acoustic coupling

deltawaveCoG-F	
Standard:	Ultrasonic coupling gel Magnalube: Better signal coupling, must be renewed regularly for permanent installation
Optional:	Acoustic coupling pads for permanent installation Long-term stable (only suitable at higher pressure))

deltawaveCoG-P	
Standard	Ultrasound coupling gel Magnalube (can be obtained from systec Controls under the designation "Magnalube" if required)

USB-connection cable

Included in deltawaveCoG-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 deltawaveCoG-P

Included in deltawaveCoG-P purchased parts package:

- Power supply unit (19 V, 3.42 A)
- Analogue output cable (4 crocodile clips)
- Connection cable for potential-free relay and pulse output (4 crocodile clips)

Wiring diagram (pin assignment) deltawaveCoG-P

4-20 mA analogue 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)

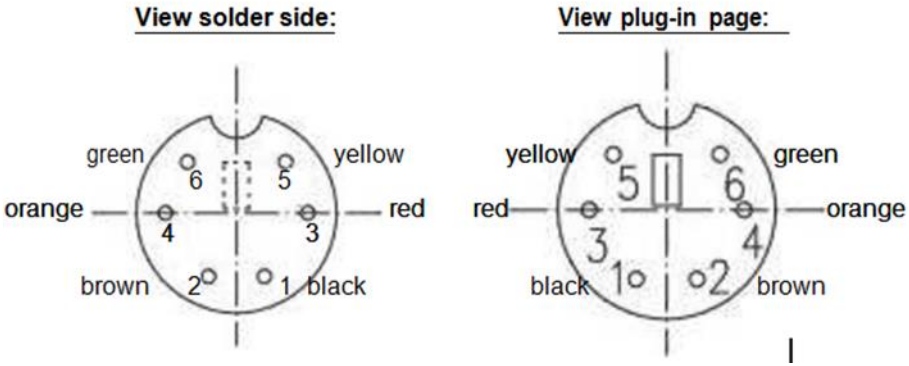
pin 1 – green	relay A
pin 2 – yellow	relay B
pin 3 – black	pulse (–)
pin 4 – red	pulse (+)

Pt100 Temperature sensor

Optional accessories for temperature compensation

Figure 8: Pt100 contact temperature sensor for temperature compensation

Mini-DIN-Plug 6-pol.	Colour of wire	PT100 Num. 1	PT100 Num. 2
PIN 1	black	red	
PIN 2	brown		red
PIN 3	red	white	
PIN 4	orange		white
PIN 5	yellow	white	
PIN 6	green		white



Notes:

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