deltawaveVER2
deltawaveVER2 LEAN

User Manual for XUMB2 // LEAN
„multipath ultrasonic transmitter flowmeter“

Content

1 deltawaveVER2 Description

The deltawaveVER2 ultrasonic multimeter was developed specially for flow measurement of fluids in pipes, drains and sewers with a width of 0.2m – 100m. Measurements can take place in pressurised pipes up to 100 bar and under highly variable levels.

1.1 Measurement principle

Measurement of the flow speed is carried out at several levels according to the ultrasonic transit time method principle (time-of-flight). A big advantage of the transit time method is the absolute determination of the mean flow rate between two fixed sensors. This makes complicated and questionable calibrations unnecessary.

1.2 Applicable Standards

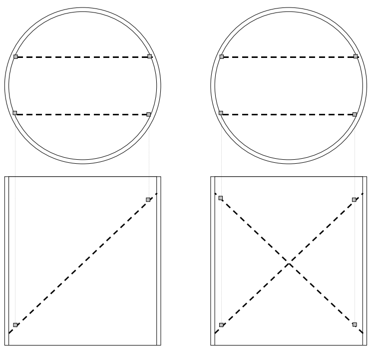
Partially Filled Conduits: ISO 6416
Filled Conduits: IEC41 / ASME PTC 18

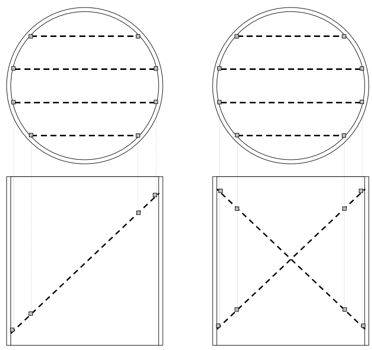
1.3 Measurement Accuracy

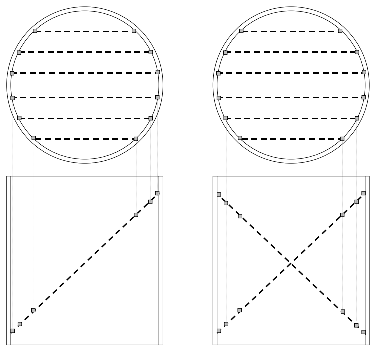
To prevent errors caused by sound velocity measurement of the medium to be measured, both the duration difference and the absolute duration of the ultrasound signals are determined in the flow velocity calculation.
The achievable measuring precision depends on the number of measuring paths used and the inflow conditions. The following table gives an overview of the maximum measuring deviations depending on the number of measuring paths. With shortened inflow routes the use of crossed paths is recommended, i.e. two intersecting paths are installed on one path plane.

Accuracy in % of the current flow value under different conditions	
6 (12) path, pressurised pipe, 10D (<5D) inflow	+/- 0.4 % of flow rate *
4 (8) path, pressurised pipe, 10D (<5D) inflow	+/- 0.5 % of flow rate *
2 (4) path, pressurised pipe, 10D (<5D) inflow	+/- 1.0 % of flow rate *
6 (12) path, partly filled pipe, 10D (<5D) inflow	+/- 1.0 % of flow rate *
4 (8) path, partly filled pipe, 10D (<5D) inflow	+/- 2.0 % of flow rate *
2 (4) path, partly filled pipe, 10D (<5D) inflow	+/- 3.0 % of flow rate *

* For flow velocities >0,003m/s


2(4)-path installation in pressure pipe


4(8)-path installation in pressure pipe


6(12)-path installation in pressure pipe

1.4 Specialised applications

- deltawaveVER2 can be used in spaces and areas liable to contain explosive atmospheres in compliance with the relevant regulations.
- The system can be converted to run on batteries.
- A variety of sensor forms and materials permit use under heavy mechanical load and in aggressive media with pH values from 3.5 to 10.

2 Specifications

2.1 Sensors

Temperature range:	operating temperature	0 °C to 50 °C
	ambient temperature	-18 °C to 65 °C
Pressure range depending on model		*see datasheets*
Water quality	pH	3.5 to 10
	Solid materials	0 to 2000 ppm (duration)
Frequency range		200 kHz-2MHz
Sensor power		approx. 90Vpp

2.2 Evaluation unit

Power supply	evaluation unit	100 to 240VAC 50 Hz to 60 Hz, 1.8A 24 VDC (alternative)
Temperature range	Ambient Temperature	-20°C to 60°C
	With heating	-40°C to 60°C
Dimension VER2		400 x 300 x 155 mm (wxhxd)
Dimension VER2 LEAN		260 x 240 x 120 mm
Weight VER 2		9.0 kg
Weight VER 2 LEAN		1.3 kg
Protection class VER 2		IP 66
Protection class VER 2 LEAN		IP 65

2.2.1 Acoustic path

Up to 12 (16 if no I/O board required) paths distributed across up to 4 measuring points, depending on the number of ultrasonic boards (4 paths / board)

Standard range	0.2m to 40m
Extended Range (on request)	up to 150m

2.2.2 Analogue inputs for water level sensors

The system provides 4 analogue inputs per I/O board to which independent water level sensors can be connected. The deltawaveLEAN can handle with two paths

Input range with 100Ω resistance	4 mA to 20 mA
Maximum resistance	250Ω
Maximum, relative voltage to earth	± 20V DC
Maximum voltage	240V rms
Power supply for external sensors	+ 24V DC max. 1A

2.2.3 Display with buttons

Graphic display with 8 buttons on the side
320 x 240
Back Light

2.2.4 Analogue outputs

The system provides one I/O-Board

2x 4mA to 20mA active or passive

Max. load	500 Ω 10 V
Resolution	0.005 mA (12bit)
Precision	±0.02 mA or 0.1 % of the measuring range final value
Overvoltage protection	±30 V DC

2 relays (VER2 LEAN 1 relay)

Breaking capacity	0.5 A , 110 V DC
Break time	40 ms
Insulation voltage	2000 V AC

2 Impulse outputs

2.3 Cable for ultrasonic transducers

Double-shielded RG58 Triaxial cable
Cable connections of more than 100m in length should be clarified in advance with systec Controls.

Cables should be broken into pieces only after consulting your systec dealer to avoid signal interference (echoes, attenuation).

The cables of two corresponding ultrasonic transducers should be the same length to avoid signal propagation time differences.

2.4 Certifications

2.4.1 Safety standards and EMC guidelines

The deltawaveVER2 Ultrasonic Multimeter has been designed and constructed in accordance with the following guidelines and standards.

Directive 2014/35 / EU Low Voltage Directive
Directive 2014/30 / EU Electromagnetic compatibility

Generic standards - Emitted interference (emission)
DIN EN 61000-6-3, VDE 0839-6-3: 2011/09, (B1: 2012-11) Residential area, business and commercial area as well as small businesses
DIN EN 61000-6-4; VDE 0839-6-4: 2011-09 Industry

Standards for EMC measurement regulations
DIN EN 55022; VDE 0878-22: 2011-12, B1: 2016-08: (CISPR 22: 2008 mod.) Antenna 30Mhz - 6Ghz
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
DIN EN 55011; VDE 0875-11: 2011-04, A1: 2015-11 Antenna 30Mhz - 6Ghz
Industrial, Scientific and Medical High Frequency Devices (ISM Devices) -
DIN EN 55014-1 VDE 0875-14-1: 2012-05, A1: 2016-03 Pliers 30 Mhz - 300Mhz Interference Power
Electromagnetic compatibility - Requirements for household appliances, power tools and similar electrical appliances - Part 1: Emitted interference

Generic standards - Immunity
DIN EN 61000-6-1 VDE 0839-6-1: 2016-05 Residential area, business and commercial area as well as small businesses
DIN EN 61000-6-2 VDE 0839-6-2: 2016-05, industrial sector

Product family standards for immunity
DIN EN 55014-2 VDE 0875-14-2: 2016-01 Electrical equipment (household appliances and power tools) Immunity requirements. CISPR 14-2
DIN EN 55024 VDE 0878-24: 2016-05, Information technology equipment.

Standards for EMC measurement regulations
DIN EN 61000-4-2 VDE 0847-4-2: 2009-12: Electrostatic discharges ESD
DIN EN 61000-4-3 VDE 0847-4-3: 2011-04: High Frequency Electromagnetic Fields (HFF)
DIN EN 61000-4-4 VDE 0847-4-4: 2013-04: Fast, conducted transients (burst)
DIN EN 61000-4-5 VDE 0847-4-5: 2015-03: Surges
DIN EN 61000-4-6 VDE 0847-4-6: 2014-08: Induced high-frequency fields, 150kHz - 80Mhz
DIN EN 61000-4-8 VDE 0847-4-8: 2010-11: Magnetic fields with energy-related frequencies
DIN EN 61000-4-11 VDE 0847-4-11: 2005-02: Voltage dip, short-term interruption, voltage fluctuation

2.4.2 2.4.2 Ex approval

Ex protection approvals

In particular, ultrasonic transducers with Ex approval for Zone 1 (500 kHz, type XUW-PC5- ...) and Zone 2 (type UW05 ..... EX1) are available on request. The ultrasonic transducers are approved for Ex zone 1 or 2 according to DIN EN 60079-0 and DIN EN 60079-18

II 2 G Ex mb IIB T6 (Zone 1)
II 3 G Ex mc IIB T6 (Zone 2)

The ultrasonic transducers are marked as shown in Figure 1 and Figure 2 Nameplate for ultrasonic transducers with Ex approval Zone 2, the operating temperatures must not fall below the range -30 ° C to + 60 ° C or -20 to + 60 ° C

systec CONTROLS

deltawave transducer (Ultraschallwandler)
Type:XUW-PC5-…..
SerNo: XX-XX-XX
Baujahr:XXXX
-30°C…60°C / IP69 / 10barü
CE 2004 Ex II 2G Ex mb IIB T6
Certificate-No.: EPS 09 ATEX 1 170 X

Picture 1 Transducers for use in Ex zone 1 – name plate

systec CONTROLS

deltawave transducer (Ultraschallwandler)
Type:UW05….EX1
SerNo: XX-XX-XX
Baujahr:XXXX
-20°C…60°C / IP69 / 10barü
Ex II 3G Ex mc IIB T6

Picture 2 Transducers for use in Ex zone 2 – name plate

Attention: The transducers must be operated in combination with a deltawaveVER2 electronic unit and are not allowed to operate with any other device.

2.5 Interface specifications (VER2 and VER2 LEAN)

2.5.1 Analogue inputs

4x 4-20 mA standardised signals can be connected to the analogue inputs. The potential difference of the signal terminals to the device earth must not exceed 20 V.

The I/O board provides a maximum of 24 V max. 1 for passive water level sensors.

The I/O board inputs and outputs can be switched actively or passively with micro-switches

Input signals smaller than the start of the measurement range and larger than 21mA are evaluated as defective.

2.5.2 Analogue outputs

The assigned variable is represented by a 4 -20 mA standard signal at the active analogue outputs. The output can be assigned to the outflow, the mean flow rate, the water temperature or various variables dependent on it. The measuring ranges can be freely configured by entering the full measuring scale.
If a variable is evaluated as defective the analogue signal is reset to <3.6 mA. For values outside the full measuring scale the output assumes the relevant extreme value (3.84 or 20.5mA).

2.5.3 Relay outputs

The existing relays (two per I/O board) can be assigned to the various sections and variables. The relays have both an NC and an NO connection. Functions such as the exceeding or falling short of outflow, water level or outflow total limit values or malfunction alarm can be allocated to the relays.

2.5.4 Pulse outputs

The existing pulse outputs (two per I/O board) can be assigned to the various variables. Functions such as metering pulse or throughput can be allocated to the pulse outputs.

2.5.5 USB interface

The USB interface allows the transmission of parameterization data as well as the reading out of data logger data. In addition, files for updates can be copied to the deltawaveVER2 via the USB interface. You can use a (supplied) USB cable for this purpose.

2.5.6 RS232 interface

deltawaveVER2 provides a serial interface. For using this feature, an extra module is required and can be retrofitted any time.

2.5.7 RS485 interface

deltawaveVER2 provides an RS485 interface that can be used as a MOD bus and MBus interface. For using this feature, an extra module is required and can be retrofitted any time. For using this feature, an extra module is required and can be retrofitted any time.

3 Flow calculation

deltawaveVER2 can be configured with up to 8 (2) acoustic paths. The configuration of a measuring point is defined by means of a parameter set.

The definition of the measuring point includes in particular its geometric and hydraulic description, the assignment of inputs and outputs and the specification of calculation settings.

The definition of a measurement path includes, in particular, the specification of the sensor position, the path length, the path angle and details of the sensor used.

3.1 Calculation algorithms

3.1.1 In "Partially filled/filled conduits, open channel" mode

Depending on the water level, the sensor position and possible individual sensor pair malfunctions one of five different calculation processes is automatically selected.

1. The outflow is set to 0 if the water level is below a certain value (user input via Parametersoftware, see chapter 5.11).
2. The outflow is determined via the Manning-Strickler equation if no path is working below a defined water level.
3. If only one path is in operation the throughput is calculated according to single path integration.
4. If several paths overflow the outflow is calculated according to the Mean Section, Mid Section or Smart Section method (user-defined). Both calculation criteria are described in ISO6416.
5. When the pipe is full up deltawaveVER2 automatically calculates according to the calculation model for filled pipes. The calculation criterium for this is ISO60041 (IEC41).

1. The outflow is set to 0

If flow rates for low levels are not to be recorded this can be set by entering the "*LowLevelCutOff"* parameter.

2. Manning-Strickler equation

Outflow calculation according to the Manning-Strickler equation uses the level measurement to calculate the outflow. Manning Strickler is used if no path measurement works below a defined level.

$v_m = nman * r_{hy}^{2/3} * Sman^{1/2}$ (equation 1)

vm: mean flow rate [m/s]

nman: Rate coefficient according to Strickler [m1/3 /s]

r_{hy}: Hydraulic radius [m] is calculated by deltawaveVER2

Sman: energy drop (slope) [-]

The following figures must be parametrised:

- Surface roughness coefficient nman

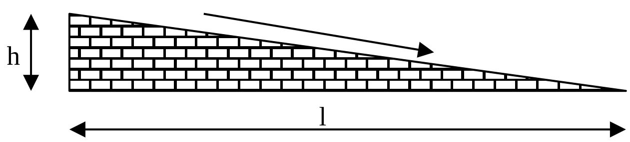
The surface roughness coefficient depends on the composition of the channel. The following table gives an overview for typical surfaces.

Channel types	n man
Earth	
Earth channels in firm material, smooth	60
Earth channels in firm sand with some clay or gravel	50
Earth channels with a floor of sand and gravel with rendered embankments	45–50
Earth channels made of fine 10/20/30 mm gravel	45
Earth channels made of medium-size 20/40/60 mm gravel	40
Earth channels made of rough 50/100/150 mm gravel	35
Earth channels made of large lumps of clay	30
Earth channels made with rough stones	25–30
Earth channels made of sand, clay or gravel, heavily overgrown	20–25
Rock	
Medium rough rock excavation	25–30
Rock excavated with careful blasting	20–25
Very rough rock excavation, large irregularities	15–20
Masonry	
Channels made of brickwork, bricks, also clinker bricks, well jointed	80
Rubble masonry	70–80
Brickwork channels (normal)	60
Normal (good) rubble masonry, hewn stones	60
Rough rubble masonry, stones only roughly hewn	50
Broken stone walls, rendered embankments with sand and gravel floor	45–50
Concrete	
Smooth cement finish	100
Concete using steel forms	90–100
Smooth rendering	90–95
Smoothed concrete	90
Good formwork, smooth undamaged rendering, smooth concrete	80–90
Concrete produced with wood formwork, without rendering	65–70
Compressed concrete with smooth surface	60–65
Old concrete, uneven surfaces	60
Concrete shells with 150-200 kg cement per m^3, depending on age and type	50–60
Rough concrete lining	55
Uneven concrete surfaces	50
Wooden	
New smooth channel	95
Planed, well-jointed boards	90
Unplaned boards	80
Older wooden channel	65–70
Metal	
Smooth pipes with countersunk rivet heads	90–95
New cast iron pipes	90
Riveted pipes, rivet not countersunk, overlapped several times in the circumference	65–70
Natual	
Natural riverbeds with firm floor, without irregularities	40
Natural riverbeds with moderate bed load	33–35
Natural riverbeds, weed-infested	30–35
Natural riverbeds with rubble and irregularities	30
Natural riverbeds, strong bed load	28
Wild streams with rough rubble (head-sized stones) with resting bed load	25–28
Wild streams with rough rubble, with moving bed load	19–22

Table 1 roughness coefficients for different channel materials

- Sman

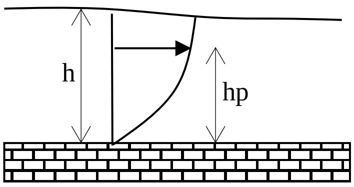
The energy drop (slope) can be calculated from the channel gradient. Sman = h/l



In practice both coefficients *Sman* and *nman* can be very precisely calculated from the flow measurement at normal levels with ultrasound measuring. Level and flow are stored in the deltawaveVER2 data logger with sufficient levels and then both Manning Strickler coefficients for dry weather flow are calculated with a curve fit, e.g. in Excel. Please ask your systec dealer for making the curve fit. The transferability of coefficients thus calculated on to the dry weather flow is very good at many measuring points.

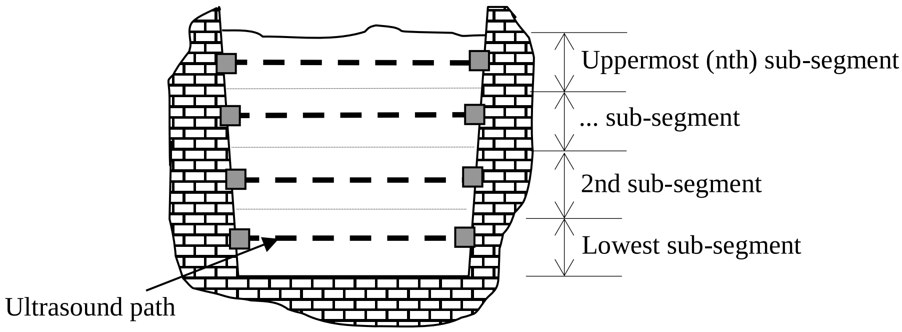
3. Single path interpolation

If just one single ultrasound path is in operation (or two intersecting paths), the flow speed calculation is performed according to ISO 6416. For this a calibration factor is calculated from the relative path height (path height hp/total level h) from which the mean speed can be calculated.



4. Multiple path interpolation

If several paths or several intersecting paths are in operation the flow is calculated according to a multiple path interpolation. Two flow equations are available, the mean section method or the mid-section method. Both models are described in detail in ISO 6416. The standard method is the mid-section method. With this method deltawaveVER2 forms sub-segments, calculates their mean speed and cross-sectional area and integrates therefrom the total flow in cross-section.



With the mid-Section method a weighting factor kR must be entered which takes into account friction on the channel floor. For extremely rough channels the value become a minimum of 0.2, for "friction-free" channels the value is 1. The table below shows reference values.

A weighting factor for the channel floor (kB, for standard values see the table below) must also be entered for the mean section method and in addition a weighting factor for the uppermost segment (kS). With the mean section method the speed at the surface of the uppermost sub-segment is calculated by interpolation. kS indicates how strongly this value is taken into account in the calculation. A value between 0 (no influence) and 1 (complete influence) can be selected. A standard value is 0.1. The influence of kS on the measurement result is especially small if several segments are working (3 or more).

Channel types	kR	kB
Earth channels		
Earth channels in solid material, smooth	0,58	0,48
Earth channels in firm sand with some clay or gravel	0,52	0,38
Earth channels with floor of sand and gravel with rendered embankments	0,52	0,38
Earth channels of fine 10/20/30 mm gravel	0,50	0,32
Earth channels of medium-sized 20/40/60 mm gravel	0,47	0,27
Earth channels of rough 50/100/150 mm gravel	0,44	0,22
Earth channels of large lumps of clay	0,41	0,16
Earth channels, made of rough stones	0,40	0,13
Earth channels of sand, clay or gravel, heavily overgrown	0,37	0,08
Rock channels		
Medium rough rock excavation	0,40	0,13
Rock excavated with careful blasting	0,37	0,08
Very rough rock excavation, large irregularities	0,34	0,03
Masonry channels		
Channels made of brickwork, bricks, also clinker bricks, well jointed	0,69	0,70
Rubble masonry	0,66	0,64
Channels made of brickwork (normal)	0,58	0,48
Normal (good) rubble masonry, hewn stones	0,58	0,48
Rough rubble masonry, stones only roughly hewn	0,52	0,38
Broken stone walls , rendered embankments with sand and gravel floor	0,51	0,34
Concrete channels		
Smooth cement finish	0,80	0,91
Concrete using steel forms	0,78	0,86
Smooth rendering	0,76	0,82
Smoothed concrete	0,75	0,80
Good formwork, smooth undamaged rendering, smooth concrete	0,72	0,75
Concrete produced with wood formwork, without rendering	0,62	0,56
Compressed concrete with smooth surface	0,62	0,56
Old concrete, uneven surfaces	0,58	0,48
Concrete shells with 150-200 kg cement per m3 , depending on age and type	0,55	0,43
Rough concrete lining	0,55	0,43
Uneven concrete surfaces	0,52	0,38
Wooden channels		
New smooth channel	0,78	0,86
Planed, well-jointed boards	0,75	0,80
Unplaned boards	0,69	0,70
Older wooden channel	0,62	0,56
Metal channels		
Smooth pipe with countersunk rivet heads	0,76	0,82
New cast-iron pipes	0,75	0,80
Riveted pipes, rivet not countersunk, overlapped several times in the circumference	0,62	0,56
Natural watercourses		
Natural riverbeds with firm floor, without irregularities	0,47	0,27
Natural riverbeds with moderate bed load	0,43	0,21
Natural riverbeds, weed-infested	0,43	0,20
Natural riverbeds with rubble and irregularities	0,41	0,16
Natural riverbeds, strong bed load	0,40	0,14
Wild streams with rough rubble (head-sized stones) with resting bed load	0,40	0,13
Wild streams with rough rubble, with moving bed load	0,36	0,07

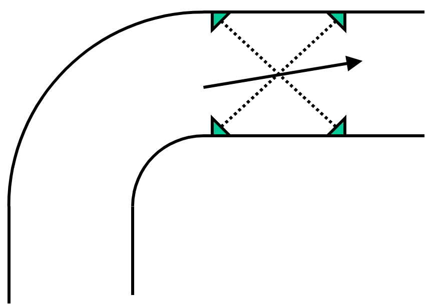
Table 2 roughness coefficients for calculation models mean-section and mid-section

1. Filled pipe in "Partly-filled pipe" mode

For this case the system can determine the flow with the same process as in “Filled pipe” mode.

3.1.2 Crossing paths

With shortened inflow routes we recommend the use of crossing paths Paths which are installed in one section at the same path height are automatically recognised by deltawaveVER2 as crossing paths. The measured velocities of two crossing paths are averaged. This reduces the influence of so called crossflow effects on the accuracy



Crossflows can arise with shortened inflow routes, e.g. when using deltawaveVER2 behind a bend. This means that the flow vectors are not yet parallel again to the channel or pipe axis after such disruptions. The influence of these crossflows can be compensated by the use of intersecting paths.

3.1.3 In “Full conduit” mode

In this mode your pipe/channel is always full and the flow is calculated from the product of the average flow rate and the pipe cross-section. The average flow rate arises from the measured individual rates, taking into account a position-dependent weighting factor.

The optimum positions for the ultrasonic transducers are stated in the IEC41 and suitable weighting factors are to be found in the chapter 8.1)

3.2 Water level measurement

Exact water level measurement is decisive for precise flow rate measurement in an open channel or partly filled pipe. For safety reasons up to two independent water level measurements can therefore be allocated to each section.

In normal operation the average of the two level measurements is calculated. If one of the level measurements should fail, the second measurement is used. In this case an alarm relay can also be switched.

4 Installation of the electronic unit

The measuring device should be fitted vertically on a wall or a mounting. To guarantee stability the load bearing capacity should not be less than 30 kg.

The location should be chosen so that the evaluation unit is not more than 100m from the measuring point, as the cables are limited in length. (systec Controls should be consulted about larger distances.) The converter cables can be extended in principle. We recommend a RG58 (Triaxial) cable as an extension. The cable insulation must be suitable for the operating location. When extending cables care must be taken that the insulated cable ends are kept as short as possible and the earth and both inner conductors are polarised correctly. We recommend the use of a suitable housing for the extension. Suitable housings should be used if the cable extension is to take place in an area liable to contain explosive atmospheres (Eex e or Eex d)

The evaluation unit must be within reach of power supply and data transfer cables.

The evaluation unit itself should be hung up outside the area liable to contain explosive atmospheres. If this is not possible pressure-sealed housings are available for the evaluation unit (please consult systec Controls).

To avoid interference with the measuring signals from electro-magnetic radiation all input and output cables should be laid in shielded cable channels separated in particular from power electronics cables.

4.1 Electrical connection

The following connections must be provided depending on equipment and device configuration.

- Power supply for the electronic part
- Sensor cable (required length can be stated with your order)
- Cable for water level sensors
- Cable for analogue outputs
- Cable for alarm contacts
- Cable for digital outputs
- Cable for interfaces (USB / RS232 RS485)

4.2 Power supply (AC)

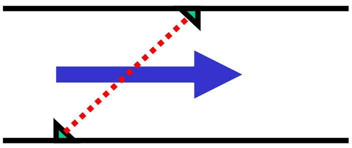
The measuring device power consumption depends on the path length (see table).

Cables with a cross-section of at least AWG 16 or 0.75mm^2 should be used for the power supply. The power supply should be suitably protected with safety cut-outs (min 1.8A). The power supply cables are connected via an angled rubber connector (supplied).

4.3 Ultrasonic board (only VER2)

The ultrasound board allows the installation of up to four pairs of ultrasonic transducers, ie eight individual ultrasound transducers. DeltawaveVER2 can be equipped with up to two ultrasonic boards. If more than one ultrasound board is installed in deltawaveVER2, the ultrasound paths 1 to 4 are located on the leftmost board and paths 5-8 on the right board.

When installing the ultrasound converter pairs there is an upstream sensor (code U) and the downstream sensor (code D). The position results from the arrangement in relation to the flow direction.



Connections Path 1-4		Connections Path 5-8	
Number	**Designation**	**Number**	**Designation**
1	MUS1_CH1_UP (1U+)	1	MUS2_CH5_UP (1U+)
2	MUS1_CH1_UP (1U-)	2	MUS2_CH5_UP (1U-)
3	MUS1_CH1_DOWN (1D+)	3	MUS2_CH5_DOWN (1D+)
4	MUS1_CH1_DOWN (1D-)	4	MUS2_CH5_DOWN (1D-)
5	MUS1_CH2_UP (2U+)	5	MUS2_CH6_UP (2U+)
6	MUS1_CH2_UP (2U-)	6	MUS2_CH6_UP (2U-)
7	MUS1_CH2_DOWN (2 D+)	7	MUS2_CH6_DOWN (2 D+)
8	MUS1_CH2_DOWN (2 D-)	8	MUS2_CH6_DOWN (2 D-)
9	MUS1_CH3_UP (3U+)	9	MUS2_CH7_UP (3U+)
10	MUS1_CH3_UP (3U-)	10	MUS2_CH7_UP (3U-)
11	MUS1_CH3_DOWN (3D+)	11	MUS2_CH7_DOWN (3D+)
12	MUS1_CH3_DOWN (3D-)	12	MUS2_CH7_DOWN (3D-)
13	MUS1_CH4_UP (4U+)	13	MUS2_CH8_UP (4U+)
14	MUS1_CH4_UP (4U-)	14	MUS2_CH8_UP (4U-)
15	MUS1_CH4_DOWN (4D+)	15	MUS2_CH8_DOWN (4D+)
16	MUS1_CH4_DOWN (4D-)	16	MUS2_CH8_DOWN (4D-)

With multiple path installations it is recommended that Path 1 is installed as the bottom path and the following paths then from bottom to top with subsequent numbering.

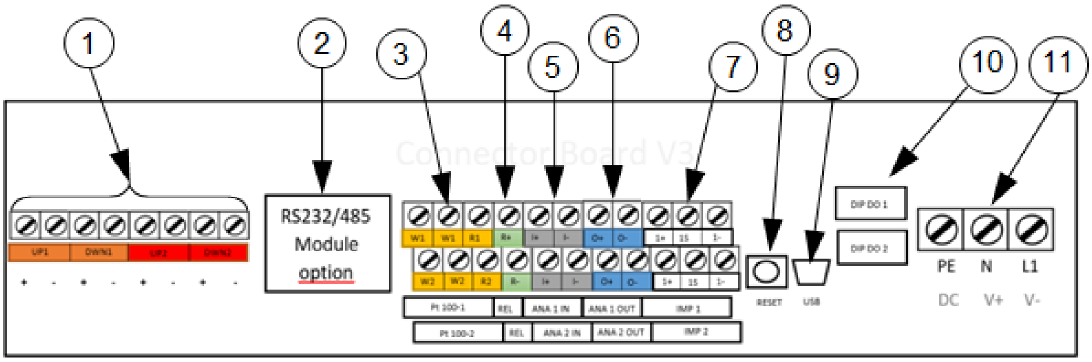
4.4 Connection terminals for inputs and outputs I/O (VER2)

Connection Numbers	Designation	
1	Relay (+)	**Relay, terminals 1 and 2:** The potential-free contact may be loaded with a maximum of 45V AC / DC and 0.25A. **Digital outputs, terminals 3 to 8**: The digital outputs can be connected (with passive operation) up to a maximum of 30VDC at 0.1A.
2	Relay (-)	
3	GND	
4	Digital Output 1 (+)	
5	Digital Output 2 (-)	
6	GND	
7	Digital Output 2 (+)	
8	Digital Output 2 (-)	
9	Analogue Output 1A (4..20mA)	The polarization of the analogue inputs and outputs change when **switching** from **active** and **passive**. Active: A (-); B (+) Passive: A (+); B (-)
10	Analogue Output 1B (4..20mA)	
11	Analogue Output 2A (4..20mA)	
12	Analogue Output 2B (4..20mA)	
13	Analogue Input 1B (4..20mA)	
14	Analogue Input 1A (4..20mA)	
15	Analogue Input 2B (4..20mA)	
16	Analogue Input 2A (4..20mA)	

4.5 Switch-Configuration (VER2)

SW1	Analogue Output 1	With the 8 red switches under the display, the outputs and inputs can be switched between external and internal power supply. Switch right: Internal power supply Switch left: External power supply
SW2	Analogue Output 1	
SW3	Analogue Output 2	
SW4	Analogue Output 2	
SW5	Pulse Output 1	
SW6	Pulse Output 2	
SW7	Analogue Input 1	
SW8	Analogue Input 2	

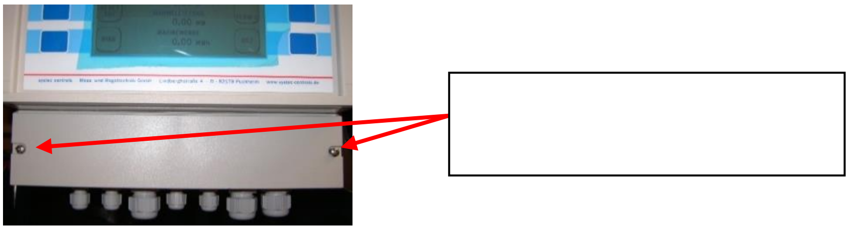
4.6 Connector Board (only LEAN)



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 **(+) = red cable (core); (–) = black cable (shield)**	
2	RS232 / RS485	optional + retrofitted (Digital Interface board X1 & X2) Data transmission via serial communication or Modbus and MBus	
3	PT100 – 1 PT100 – 2	Not in use	
4	REL	Relay connection, passive, potential-free	
5	ANA 1 OUT ANA 2 OUT	Analogue output 1: 4 ... 20mA Unit signal, 24VDC, active (optional passive) according to Namur NE43 (3.8-20.5 mA)	
6	ANA 1 OUT ANA 2 OUT	Analogue output 2: 4 ... 20mA Unit signal, 24VDC, active (optional passive) according to Namur NE43 (3.8-20.5 mA)	
7	IMP 1 IMP 2	Digital output (open collector)	
8	RESET	Hardware-Reset (Restart of the system)	
9	USB	USB Interface (Mini-USB Type B), access to the integrated SD memory card Windows XP or later versions detect the SD Card as mass storage medium	
10	DIP 1 DO DIP 2 DO	DIP Switch for configuring IMP1 and IMP2 NPN, PNP, push-pull, active / passive	
11	PE N L1 V+ V-	Two power supply options available: alternating current 90 ... 240 V / AC, direct current 18 ... 36 V / DC	

4.7 Connection hints (LEAN)

To access the cable compartment of the deltawaveVER2 LEAN, please solve the two screws and remove the cover plate:



Remove cover from cable compartment

⚠

Please always make sure to put the correct voltage to your deltawaveVER2 LEAN. Improper supply voltage might seriously damage the flow transmitter.
You can check the type of power supply at the name plate, printed on right side of enclosure of flow transmitter.

All in- and outputs (except relay) have defined potential on the internal devices ground. For potential free operation of the in- and outputs additional hardware is needed (with galvanic isolation). With the normal in- and output it is not possible!

- The analogue in- and outputs are active ex works 24V/DC (could be set in passive mode by systec controls)
- The maximum permitted load of the relay is 45V, 0,25A

Table 1: Recommendations for cable contacts

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

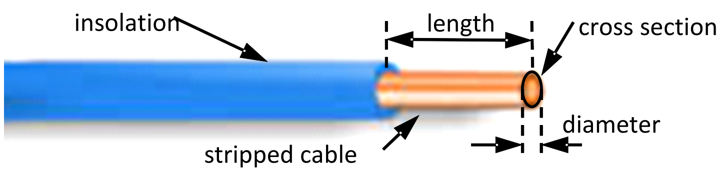
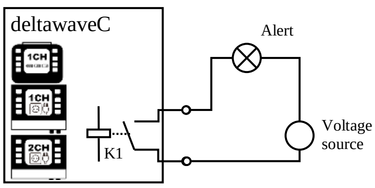


Figure 1: Cable assembly

4.8 *Function of the relay* (LEAN)

Your deltawaveVER2 LEAN 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.

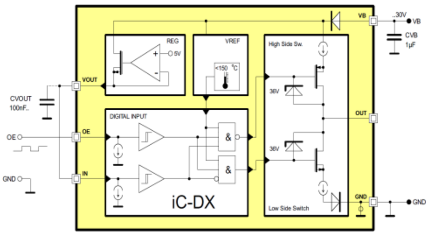


4.9 Parameterization of the pulse output (LEAN)

deltawaveVER2 LEAN is equipped with universally configurable pulse outputs. This allows a broad range of user is used. The deltawaveVER2 LEAN is used to parameterize the output form via the dip-switch on the connector board.

4.10 Parameterization of the deltawaveLEAN pulse output hardware (LEAN)

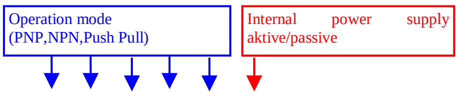
For the output of the pulses the IC-DX of IC House listed below is used in the deltawaveLEAN. The diagram below shows the layout of the pulse output. The pulse outputs are indicated by a "white" colour map.



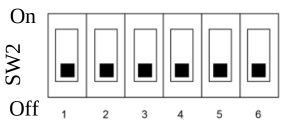
Layout: 1+ 1S 1 -

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

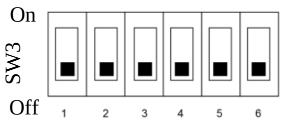
The deltawaveLEAN supplies three different operation modes:
- NPN (LOW SIDE)
- PNP (HIGH SIDE)
- PUSH PULL



Digital Out Config 1
(upper switch)



Digital Out Config 2
(lower switch):



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

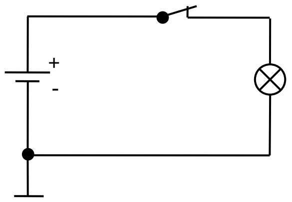
The first DIP **switches 1 to 5** will be used to setup the operation modes (High Side,
LOW Side, Push Pull).
The DIP **switch 6** is used to switch between active (12V internal voltage supply) and passive mode (external voltage supply 8 ... 30V).

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

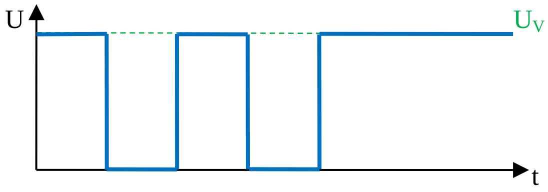
4.10.1 Operating mode 1: High Side (PNP-Switch) (LEAN)

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

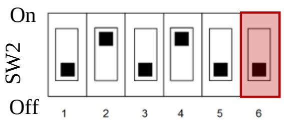
High Side switch:
Resting state: signal on +



U-t diagram

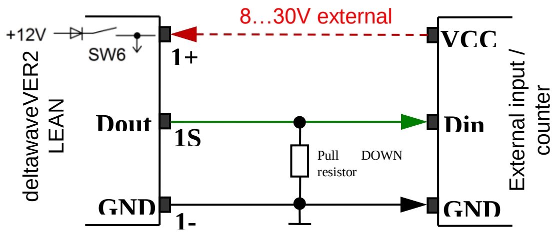


Switch setting (PNP)



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

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

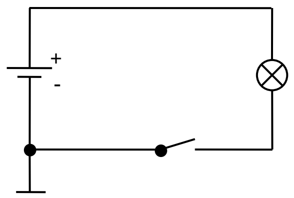


If the counter has a sufficiently high internal resistance, the resistor can be dispensed with.
As a guideline value (test with voltmeter), we recommend 4.7 kΩ for the pull DOWN resistor. In practice, the resistance value may deviate from the recommended value depending on the internal resistance or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

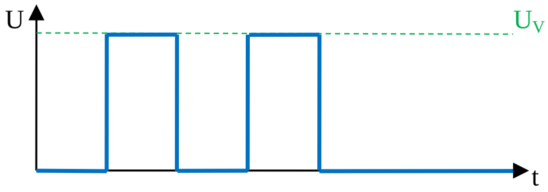
4.10.2 Operating mode 2: LOW Side (NPN-Switch) (LEAN)

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

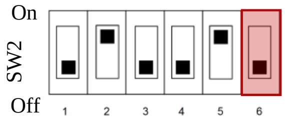
Low Side switch:
Resting state: signal on -



U-t diagram

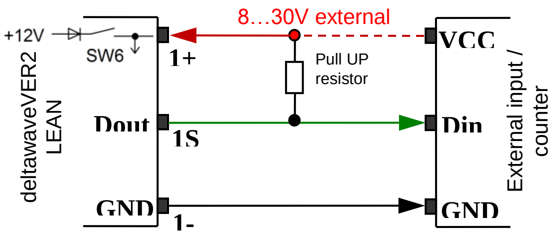


Switch settings (NPN)



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

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



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

4.10.3 Operation Mode Push-Pull

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

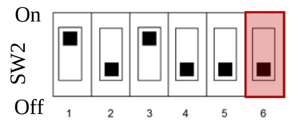
> Advantage: This operating mode requires no pull-up or pull-down resistor and has very short switching times. This makes it particularly suitable for functional tests.
>
> The IC used has a thermal protection circuit (shutdown: 151 ° C, release: 150 ° C). The output current is limited to 450 mA. Nevertheless,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

Push-Pull:

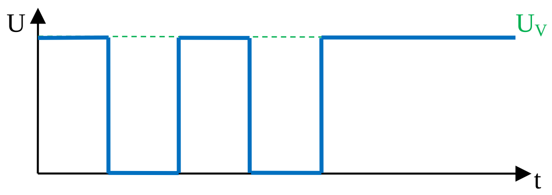
Resting state: signal on +
Transistor 1 closed
Transistor 2 open

Active state:
Transistor 1 open
Transistor 2 closed

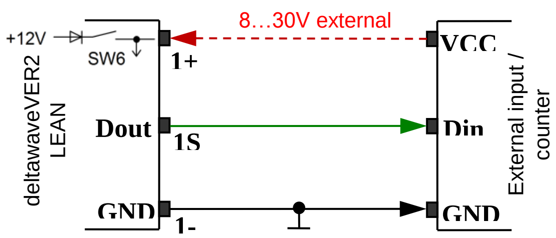
Switch settings (Push-Pull)



U-t diagram



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



4.11 Connecting the Ultrasonic Transducers

systec Controls produces a variety of different sensors which are fitted in different ways. Please observe the separate instructions provided when connecting sensors

Before the cables are connected the sensors and cables should be checked as follows.

1. Measurement of the sensor's electrical resistance. A multimeter with a measuring range of at least 30 MΩ can be used for this. The measurement should be performed directly at the sensor contact or as close to the sensor as possible. If one of the sensors has a resistance of less than 20 MΩ it is defective.
2. Checking the sensor extension cable for short circuits and continuity; a multimeter can also be used for this. The wires should be checked individually for short circuits. For the continuity check two wires each can short at one end.

The RG58 cables must be stripped to approx. 25cm on the equipment side. The braided shield can be shortened to some 2cm after the insulation. The deltawaveVER2 measuring transducer is supplied with special EMC cable screw connections. The cable is fed into the housing so that the polyurethane insulation lies in the cable screw connector rubber seal and the braided shield makes housing contact with the EMC screw connection metal tongues. Both approx 25cm long free cable inner conductors are now wound round the supplied ferrite ring four times and then connected to the ultrasound board.

4.11.1 Connection in areas liable to contain explosive atmospheres

Work in areas liable to contain explosive atmospheres is to be carried out exclusively by trained staff. Before starting work a check must be made that no explosive atmospheres or fluids are present at the measuring point. Approval should be obtained from the works security service.

Ultrasound converters which carry the Ex designation are available for installation in areas liable to contain explosive atmospheres. The ultrasound converters are protected by encapsulation (EExm). It is recommended that the transducer cable be fed out of the potentially explosive area and the measuring transducer hung up outside the potentially explosive area. If the sensor cables are too short they can be extended within the potentially explosive area; the cable join should be inside a protective housing with increased safety (EExe). During installation works the power cable and the ultrasound board connector should be disconnected from the measurement transducer.

4.12 I/O board (VER2)

The I/O board provides a range of analogue and digital inputs and outputs.

Connection plan Input/Output	
Number	**Designation**
1	Relay (+)
2	Relay (-)
3	GND
4	Digital Output 1 (+)
5	Digital Output 2 (-)
6	GND
7	Digital Output 2 (+)
8	Digital Output 2 (-)
9	Analog Output 1A (4..20mA)
10	Analog Output 1B (4..20mA)
11	Analog Output 2A (4..20mA)
12	Analog Output 2B (4..20mA)
13	Analog Input 1A (4..20mA)
14	Analog Input 1B (4..20mA)
15	Analog Input 2A (4..20mA)
16	Analog Input 2B (4..20mA)

The analogue inputs and outputs can be operated both actively (24VDC supply from deltawaveVER2) and passively (external 24VDC supply). The I/O board is delivered from the factory in active mode, i.e. deltawaveVER2 provides a 24VDC power supply. There are small switches on the I/O board with which the deltawaveVER2 auxiliary energy can be switched on (active) or off (passive)

WARNING! IF deltawaveVER2 is operated actively, i.e. with 24VDC auxiliary energy feed, no external auxiliary energy may be connected up. Double auxiliary energy causes damage to deltawaveVER2 and to connected peripherals. Please ensure that following maximum values are not exceed:
Relay: Umax=250V ; Imax=1A
Transistor: Umax=100V ; Imax=0.1A

If deltawaveVER2 is operated actively, i.e. with 24VDC auxiliary energy feed, the galvanic separation between the inputs and outputs is cancelled out. Please make sure that care is taken to provide a potential-free circuit when using the inputs and outputs. If necessary the use of separators is recommended.

4.13 Connection of water level measuring devices to the analogue inputs

Basically all water level measuring devices which emit an analogue 4-20mA output signal proportional to the water level can be connected to the system. The signal should be connected with a shielded cable to analogue input connectors. The analogue input can be freely selected, the allocation of the input to a section takes place in the parametrisation. The terminal allocation is covered in the chapter on the *I/O board.*

If the water level measurement is to be used in an area liable to contain explosive atmospheres a suitably protected water level measuring device must be used. When using intrinsically safe (Eex iA) two-litre fill level sensors, Ex barriers must be used between the analogue input at the measurement transducer and the water level measurement device.

4.14 Connection to the analogue outputs

The terminals for the analogue outputs are located on the *I/O board* (see below). Shielded cables must be used to wire the analogue outputs. The allocation of the analogue outputs to sections and physical magnitudes and the measuring ranges can be freely selected in the parametrisation.

4.15 Handling with Parameter-Files

4.15.1 Activating a transferred parameter file

After transferring of the parameter-file the new values will be automatically activate.

4.15.2 Downloading an active parameter file from deltawaveVER2 to USB memory stick

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

5 User-defined settings

deltawaveVER2 parametrisation is performed comfortably with the DeltawaveParam software. This is supplied with deltawaveVER2 and runs with all current Windows versions from WIN7. DeltawaveParam permits the creation, loading and storing of parameter files. When a record has been created it can be stored on a memory stick as param.par and uploaded by

5.1 General information on software use

5.1.1 Creating a new parameter file

You can start to create a new parameter file immediately after starting the program (see chapter 6.2ff).

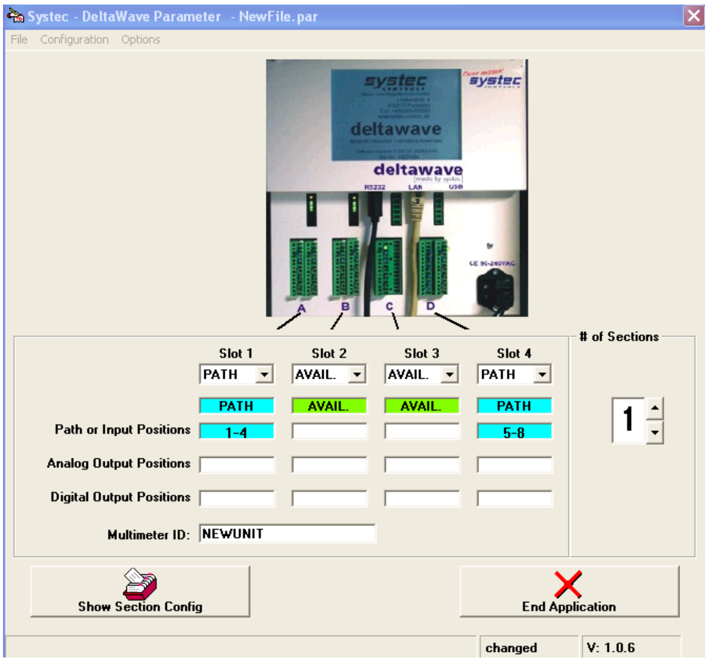
5.1.2 Loading a new parameter file

To edit an existing parameter file select File from the menu and the *Open parameter file* option.
Your parameter file can now be edited.

5.1.3 Language selection

The *DeltawaveParam* menu is available in German and English. To switch between the two languages select *Options* from the menu. Select the desired language under *Language*.

5.2 System configuration

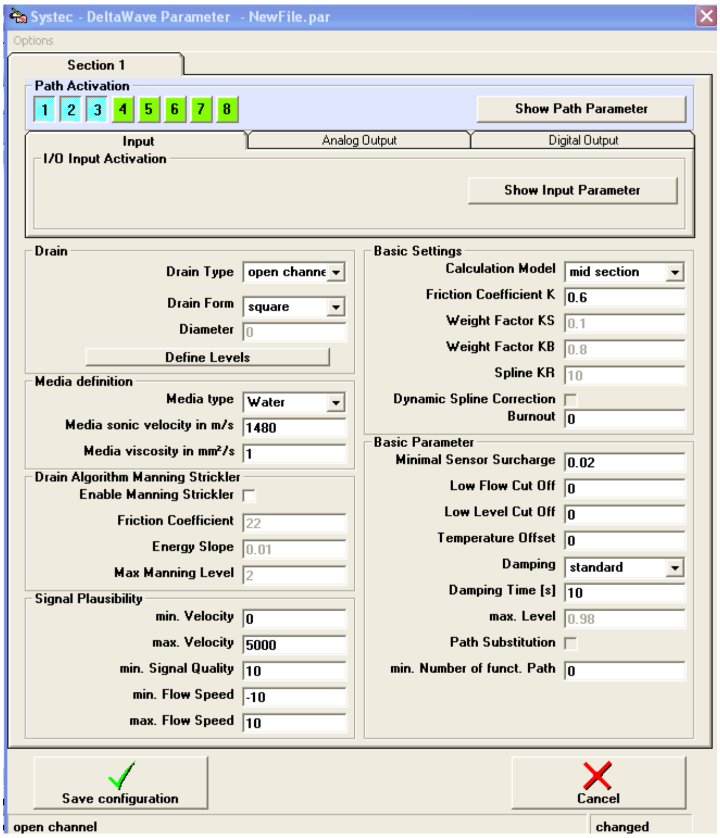


The following settings must be selected under system configuration:

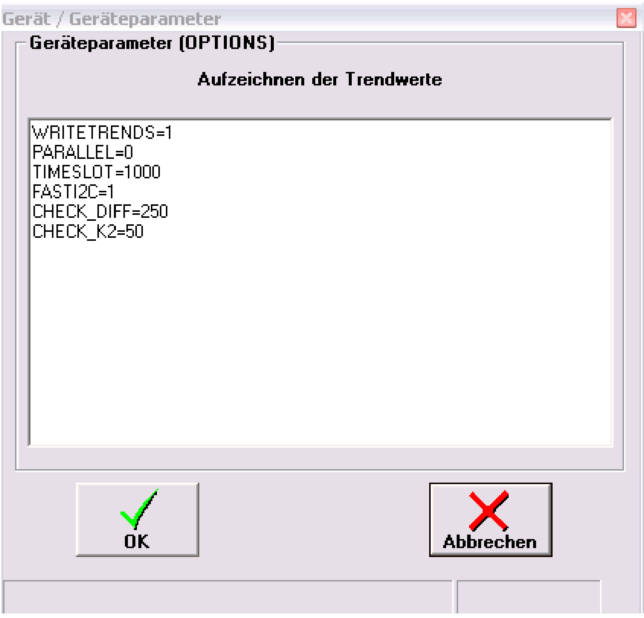
5.2.1 Definition of existing hardware

Select which hardware is in use in your deltawaveVER2 from the four listboxes. Please indicate what is fitted in the four expansion slots. PATH means you have an ultrasound board in this expansion slot. I/O means you have an I/O board in this slot. The software automatically shows you the path numbering and the analogue and digital inputs and outputs.

5.3 Section configuration



In the section configuration, all settings for the section (measuring point) are made



OPTIONS – options for all configured sections

If you press button *options* in the menu bar you can change some global parameters which are valid for all configured sections. There are reasonable default settings and you normally do not have to change them. Please change carefully or ask your systec dealer. Just for the sake of completeness the option parameters are described shortly in this manual.

- WRITTRENDS

With this parameter you can activate / deactivate the data logger (1=activated, 0=deactivated). We strongly recommend to activate it (already default setting) because data logger files can give useful hints in case of measurement errors.

- PARALLEL

With this parameter you can choose whether several ultrasonic boards (MUS boards) are working sequentially or parallel. (1=parallel, 0=sequential). Default value is 0 which can be used for every configuration and is already the default value. 1 can be chosen only in case you have different sites (e.g. 3 different channels) connected to your deltawaveVER2. Then e.g. all 3 ultrasonic boards are working parallel which boost up the measurement rate MQ (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) Please DO NOT choose parallel in case you have several boards for one site (e.g. 8 path measurement for one pipe). In that case the paths of the different boards might influence each other and create signal problems.

- FASTI2C

1=signal scans (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**) are read with high speed
0=signal scans are read with regular speed (default)

- TIMESLOT

Only applicable when PARALLEL=0 (see above). TIMESLOT gives the available measuring time per ultrasonic board in milliseconds. 1000 means that each board gets 1 second to measure (then this second is apportioned to connected paths (one paths can then make several measurements per second) before next board is activated.

- CHECK_DIFF

This parameter is an additional evaluation of signal plausibility which allows to filter out bad signals. Using this option is only recommendable in case of difficulties with your measurement.

deltawaveVER2 automatically measures signal run times upstream and downstream (T1, T2) and the time difference dt. deltawaveVER2 also calculates the difference (diff) between T2-T1 and dt (so formula is: diff=abs[(T2-T1)-dt]. With CHECK_DIFF you can define a range diff has to be into in order to use the measurement value as a valid value.

Ideally, diff should be 0 or very close to 0. Due to disturbed signals, however, the difference diff calculated from the signal propagation times can be different from the measured difference dt.

The entry CHECK_DIFF can now be used to specify an area within which the parameter diff must be in order to recognize the signal as valid.

The (time) range becomes a multiple of the inverse of the sampling frequency ADC. The following example should clarify this:

- Example: Transducer frequency=500kHz, ADC (=Sampling rate, see 5.4.1.5) = 5 MHz CHECK_DIFF=105
  - ➔ 1/5MHz*105= 21 us (micro seconds). That means that every measurement value with a calculated difference (diff) greater than 21 us will be filtered out

- CHECK_K2

For each (path) measurement there is calculated a parameter CHECK_K2 which can be also for evaluation of signal plausibility.

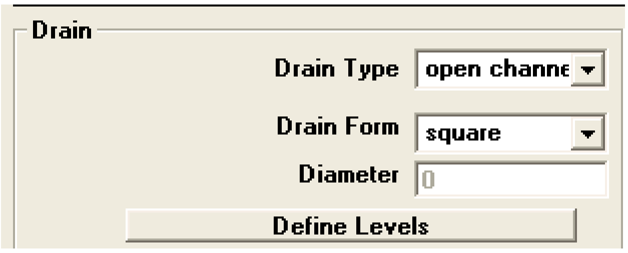
- Example: CHECK_K2=80
  -> Parameter K2 of each measurement has to be greater than 80000 in order to be used as valid measurement.

The parameter K2 is not shown on deltawaveVER2 display but is continuously stored in the data logger files. Reading out data logger files gives you an idea of the size of K2. This gives you an indication of setting value of K2 (e.g. if real K2=200000 you can set CHECK_K2=140).

We recommend to ask your systec dealer before change K2

All following settings for the individual sections (measuring points) are selected in the section configuration.

5.3.1 Geometric definition of your conduit (drain)



To calculate the correct flow rate deltawaveVER2 has to know what your conduit looks like. The geometric form of the conduit is defined in the channel window. For the channel type, first select the kind of application. There are four options to choose from.

5.3.2 not activated

If this setting is chosen deltawaveVER2 stops measuring.

5.3.3 open channel

Select this setting if you wish to measure a river or open channel, or if you have an enclosed pipe or channel which is never quite full (there is always a gas phase above the fluid). In that case normally a level meter is connected to your deltawaveVER2 or a constant level is parameterised (see chapter 5.5)

5.3.3.1 partially filled and/or filled pipe compound

Select this setting if you want to measure a closed line or a closed channel where both partial filling and full filling are possible. If this setting is selected, either a level meter should be connected

5.3.3.2 filled pipe/filled compound

Select this setting if you wish to measure an enclosed pipe or channel which is always full, i.e. there is no gas phase above the fluid. In this case no level measurement needs to be connected to deltawaveVER2.

5.3.3.3 Round

Select this channel type if your measuring point is in a circular pipe. Enter the inner diameter of your measuring point in the diameter field.

5.3.3.4 Square

Select this channel type if you wish to measure a rectangular, e.g. a square or trapezoid channel. These are typical concrete or brick-walled channels, e.g. in sewage works or power station inflows. The channel is geometrically defined in the "Define sampling point" submenu.

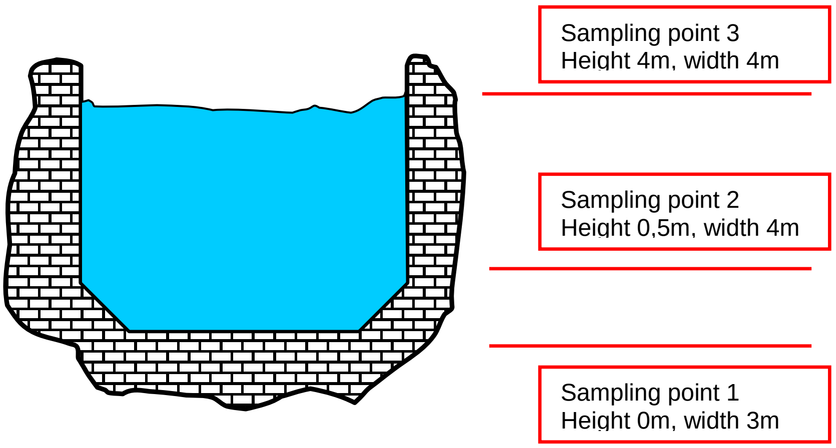
5.3.3.5 Round with Spline Interpolation

Select this channel type if your channel is neither circular nor rectangular, e.g. if you have oval or natural channel forms. The channel is geometrically defined in the "Define sampling point" submenu.

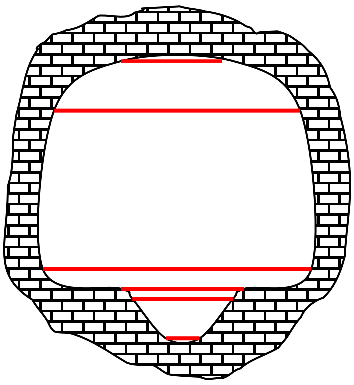
5.3.4 "Define sampling points" sampling point editor

If your measuring point has a cross-sectional form which is not circular (pipe) you must enter the geometric form for deltawaveVER2 as a level/width table. The individual level/width points are designated as sampling points.

If you selected the rectangular channel type, deltawaveVER2 connects the sampling points with straight lines. If you selected the Round over spline channel type, deltawaveVER2 draws an organic curve through the individual sampling points (see the following example).



Example for the definition of a rectangular channel with three sampling points.

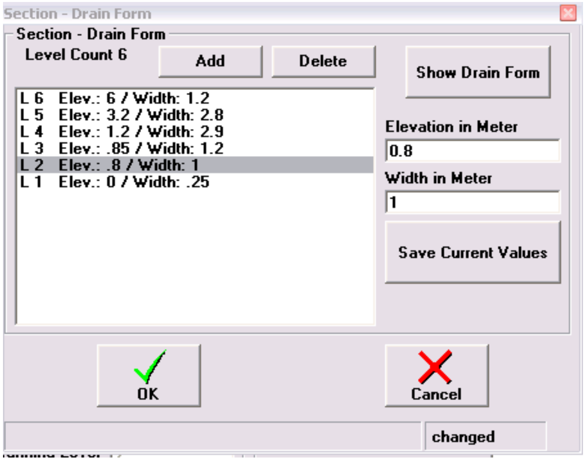


Point	Level [m]	Width
6	3.8	1.2
5	3.2	2.8
4	1.2	2.9
3	0.85	1.2
2	0.8	1
1	0	0.25

Example for the definition of a non rectangular channel using 6 sampling points.

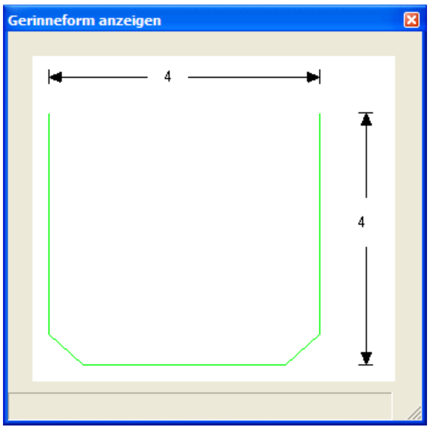
Please note: for the outflow calculation it does not matter whether the channel is mirror symmetrical or not. Non-mirror symmetrical channel forms are entered in the same way as mirror symmetrical ones.

The sampling points are entered in the "Section Drain Form" submenu. The rectangular channel depicted above is entered in the following window.



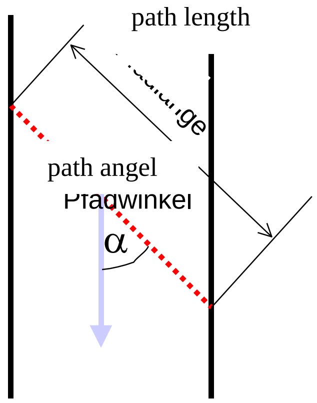
The minimum number of sampling points is two; by pressing the "Add" button you can add further sampling points (max. 128). Sampling point L1 must always be at the lowest level, L2 and the following must then have rising level values. The channel must therefore be defined from the bottom up. To edit the sampling points mark them with a mouse-click and then enter the level and width values in the two text fields on the right. By pressing the "Save current values" button you confirm your entries. With the "Show Drain form" button you can check your entries graphically.

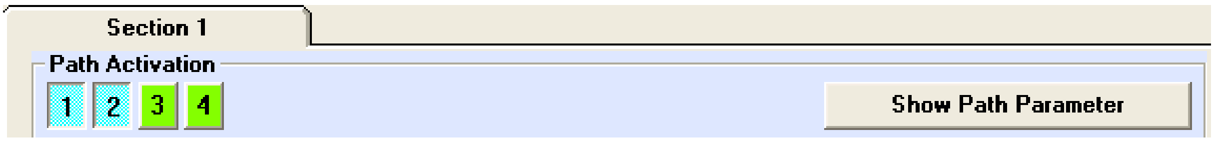
Please bear in mind that the display always shows "rectangular symmetrical channels", the depiction of spline-connected sampling points is not possible in the parameterising software.



5.4 Path configuration

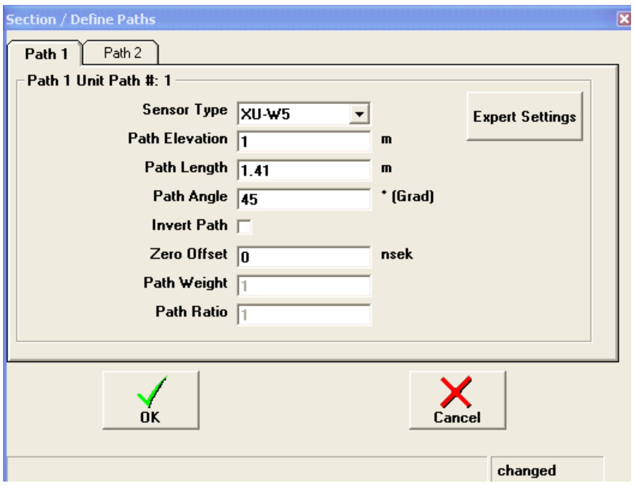
After the definition of the channel form the path parameters must be entered. After a path has been activated these are in particular the installation height, the path length, the path angle and the transmission frequency.





After paths have been allocated to a section (see chapter 6.3.2) these can be parameterised in the "Show path parameter" submenu.

Under sensor type please select the used sensor, (The numbers stand for x100kHz, 5 means 500kHz sensor).

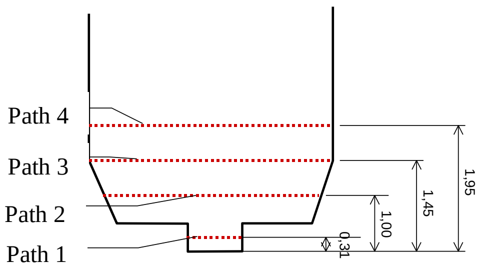


Please choose proper sensor type

If your sensor type is not in the selection, you can also make special parameter settings in the expert menu. We recommend using the expert menu, but only for trained service personnel.

Sensor Type	
XU-W2	250 kHz
XU-W5	500 kHz
XU-W10	1 MHz / 1MHz HD

Table 3 Selection of Transducers

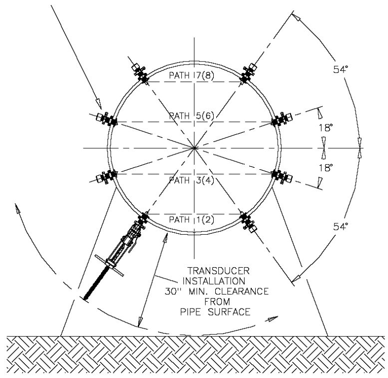


The path elevation is the height of the sensor with reference to the settings in the channel definition. In the example on the left the path heights are 0.31m/ 1.0m / 1.45m and 1.95m.

The following rules apply for the selection of path heights in open channels or partly filled pipes:

- All paths should be sufficiently covered at maximum level (see minimum coverage for ultrasound converters).
- Most paths should be sufficiently covered at normal level
- If possible, at least the lowest path should still be covered at the lowest level
- The lowest level must be a sufficient distance from the floor; this is equal to the minimum coverage for the ultrasound converter.
- The distances between the levels should be chosen so that the measurement segments cover similar areas.

In many cases not all of the above rules can be fulfilled simultaneously. A sensible compromise must then be sought.
If crossed paths are installed (see chapter 3.1.2) you have to enter equal values for *path elevation* in order to make sure that paths can be detected from deltawaveVER2 as crossed paths (even when real elevations are slightly different). If you do not enter equal path elevations deltawaveVER2 will not calculate with crossed paths but with two single paths.
In addition to that also only two adjacent paths can be detected as crossed path. That means you have to use path 1 and 2 as crossed or 3 and 4. But it is not possible to use for instance path 2 and 7. If so, these paths will be not detected as crossed paths and will be then only used as two independent single paths.



In the case of installation in a filled pipe there are recommendations for the converter installation which are to be found in ISO 60041. The standard installation according to ISO 60041 for 4 single or 4 crossing paths is shown on the right.
In this case the weightings given in Appendix 8.1 for the individual paths are entered in the *Path weight* input field. With a four-path installation the weighting for the first (lowermost) path is for example 0.347855

The relation of the flow speed measured along the path to the overall mean flow rate is entered under the *Path relation* button (see chapter 5.4). We recommend changing this value only after consultation with our trained service personnel.

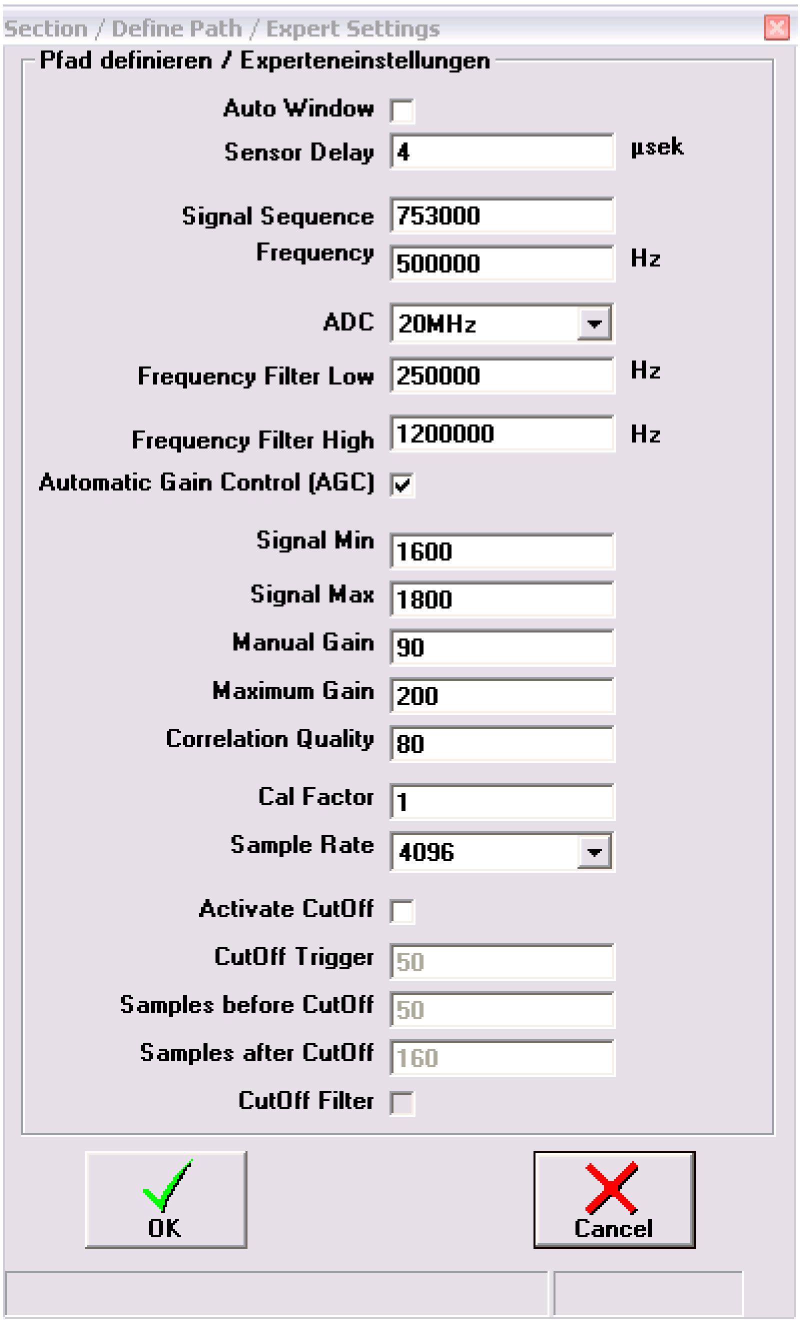
The path length is the precise distance between both sensor surfaces. The path angle is the angle of the path to the pipe or channel axis (flow direction).

If the cables are connected the wrong way round (UP and DOWN interchanged) the flow rate calculation can be inverted by activating the "path inverted" checkbox.

If the converters are sufficiently covered with fluid and it has been ascertained that the flow rate is exactly 0m/s the determined offset can be corrected in the "Zero mark offset" input window. Please note that these offsets are normally very small and in practice mostly lead to a flow rate offset significantly below 1cm/s. Correction therefore only makes sense if the channel or pipe is absolutely still and has been standing long enough.

5.4.1 The expert menu

Further path-specific settings can be made here. Several of the parameters shown here have a large influence on system stability. All expert settings are initialised with sensible default values. We recommend changing the parameters in the expert menu only after consultation with our trained service personnel.



5.4.1.1 Auto Window

To receive the ultrasound signals deltawaveVER2 opens the predicted signal reception time according to an internally calculated signal run time. This depends amongst other things on the mean temperature and consistence. Since these parameters can change under certain circumstances it is possible to automatically adapt the time of reception to the mean conditions. This happens with the *Auto Window* Parameter. As a rule the reception window is however large enough to carry changed mean conditions without having to activate Auto Window.

5.4.1.2 Sensor delay

The sensor delay is a measurement for the ultrasound converter inertia, i.e. a very small time difference arises between applying the control voltage and the emission of the wanted signal. This is set here. The default value (4u sec) should not be altered.

5.4.1.3 Send sequence

The Send sequence indicates the signal coding. 753000 means that there is a phase change of 180° after seven oscillations. Five further oscillations follow and a renewed phase change of 180°. The last three oscillations then follow. An emitted signal in this example therefore consists of 15 oscillations.
Sensible sequences: 753000, 53300, 322000 (see)

5.4.1.4 Frequency

The ultrasound converter transmission frequency is set here. This is pre-defined by the hardware and should not be altered.

5.4.1.5 ADC

The sampling frequency of the analogue/digital conversion is set here. A sampling frequency ten times the signal frequency has proven itself in practice. This is pre-defined as default.

5.4.1.6 Frequency Filter Low

The signal is filtered before further processing to reduce the influence of external sources of interference. The lower filter frequency is set here. This should be significantly smaller than the signal frequency.
The default value should be altered upwards only in case of high EMC load. Please keep a distance of some 20% of the signal frequency from the signal frequency.

5.4.1.7 Frequency Filter High

The upper filter frequency is entered here. This should be significantly larger than the signal frequency. The default value should be altered downwards only in case of high EMC load. Please keep a distance of some 20% of the signal frequency from the signal frequency.

5.4.1.8 Automatic Gain Control (AGC)

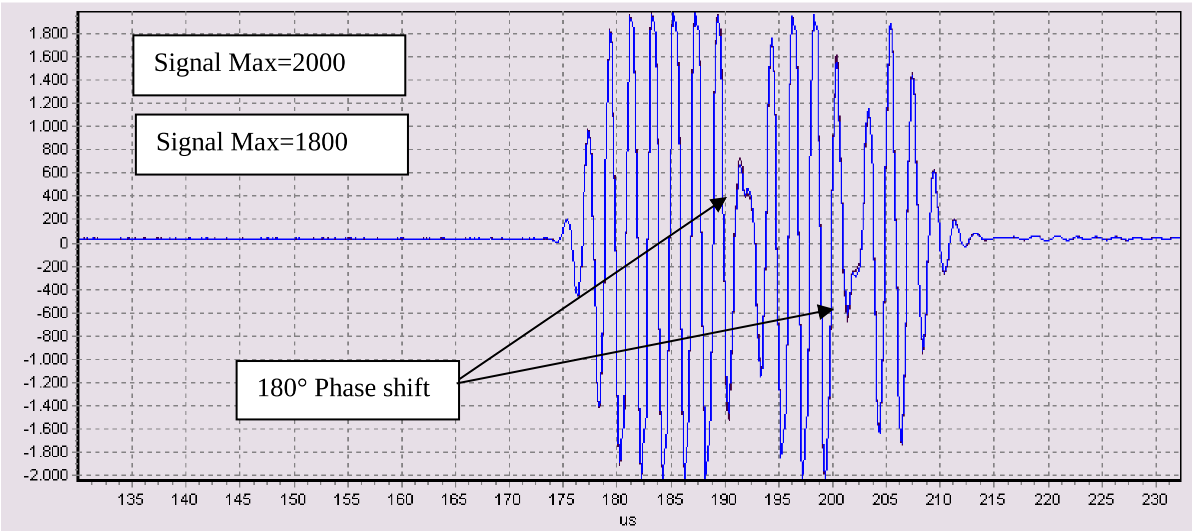
The Automatic Gain Control (AGC) causes the signal amplification to adapt automatically to changing medium conditions. The signal amplitude is thus immediately automatically adjusted to a favourable level. The level limits can be manually edited

5.4.1.9 Signal Min

The lower control limit for the amplitude control is set here. The minimum value is 0. The set default value is 1600. It is an internal value without unit.

5.4.1.10 Signal Max

The upper limit level for the amplitude control is set here. The maximum value is 2000. the set default value is 1800. It is an internal value without unit.



Sending Signal – Example (Sending Sequence 743000)

In the upper shown picture you see an example of a sending signal. You can see the 180° shift in signal phase. Signal Max=2000, Signal Min=1800 which means that signal Gain will be (automatically) adjusted in that way that signal keeps within that range.

5.4.1.11 Manual Gain

The signal gain is set here. Values from 1-255 are possible. If AGC is activated (see chapter 6.4.1.8) the gain is automatically adapted to the measuring conditions.
When AGC is deactivated, the gain to be set depends on the path length and medium. Values between 130 and 190 have proven themselves.

5.4.1.12 Maximum Gain

This limits the maximum gain which can be reached in case of activated AGC (see 5.4.1.8). Too high signal amplification (gain) can cause noise which influences the measurement. Gain values higher than 200-220 indicates a principle problem with signal transfer (e.g. echo's caused by gas bubbles, misalignment of transducers,etc…) and do not help to get better measurement.

5.4.1.13 Correlation Quality

The minimum quality (CQ, see chapter 5.1.4) indicates the quality of the correlation for every individual measurement. A quality value is set here which causes the corresponding individual measurement to be invalidated if it is undercut (i.e. this measurement is not taken into account in the flow rate calculation.
The value set should lie between 60 and 90.

We recommend to start with a lower level and then check values for CQ for each path (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**). This will give you an idea of typical values for CQ at your site. Then you can put these values (with a safety distance of about 10) in your parameterization.

5.4.1.14 Cal Factor

With this factor you can influence the flow rate calculation for the individual paths. The measured path speed is multiplied by this factor. Since every path measures with great precision (see chapter 1.2 Precision) manual recalibrations are not necessary as a rule.

5.4.1.15 PATH_XX_Samples

The number of samples which should be created by a received signal is depicted here. Three possible selections are available.
1024, 2048 and 4096.
Generally, the higher the number of samples, the greater the reception window and thus the probability of finding the signal. On the other hand a large number of samples also needs more computer power, which reduces the number of individual measurements per second.
The higher the medium's parameter fluctuations (see also temperature) the greater the number of samples selected should be. As a rule setting 2048 suffices.

5.4.1.16 Activate Cut Off

This function suppresses the influence of signal echoes which for example arise due to reflection at the surface. Interference of measurement by echoes is rare and the CutOff function does not normally need to be activated.
The function works thus: a certain range before and after the wanted signal is cut off and signal echoes (which normally appear behind the actual wanted signal due to the higher runtime) then disappear.
If activated, further settings must be also be undertaken, see chapter 5.4.1.17ff

5.4.1.17 CutOff trigger

The (amplitude) threshold is set here which signals the start of the wanted signal to the system.
This threshold value is relative to the maximum amplitude of the current received signal. A value around 50 (%) is recommended.

5.4.1.18 Samples before Cut Off

Here the number of sample values is determined which lie before the CutOff triggering and are not "cut off". A default value of 50 is set here.

5.4.1.19 Samples after Cut Off

Here the number of samples are determined which lie after the CutOff triggering and are not „cut off". Caution: if too low a number is selected a part of the wanted signal is also „cut off"". The minimum number can be calculated from the number of oscillations used (transmission sequence, see chapter 5.4.1.15) multiplied with the relationship of sampling frequency to signal frequency (see chapter 5.4.1.4, 5.4.1.5).

Example:
Signal frequency=500kHz, sampling frequency 5MHz,
transmission sequence=753000 (i.e.15 oscillations)

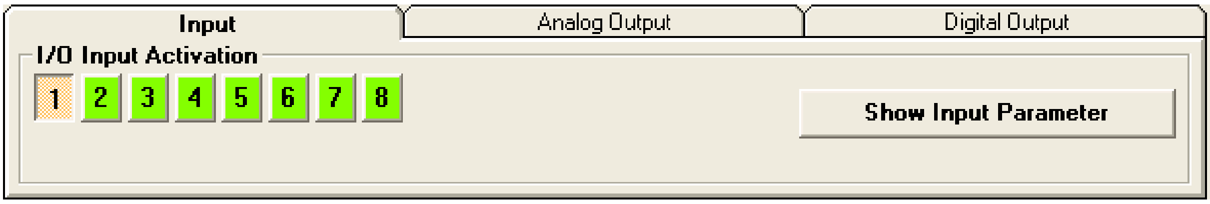
->sampling frequency/signal frequency=10
->10*15=150 = minumim number of CutOff samples afterwards

5.4.1.20 CutOff Filter

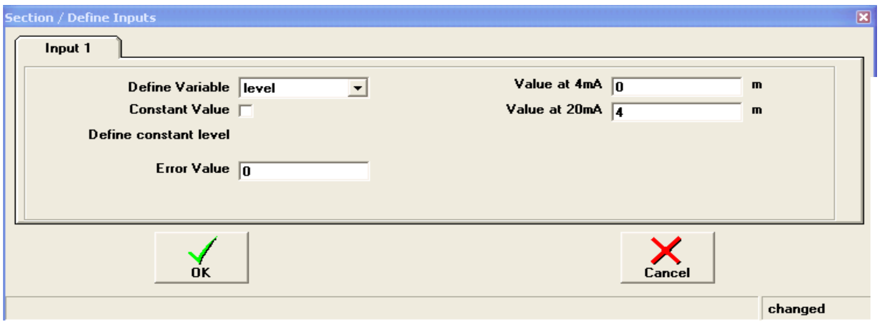
Signals (with enabled Cut-off function)are filtered

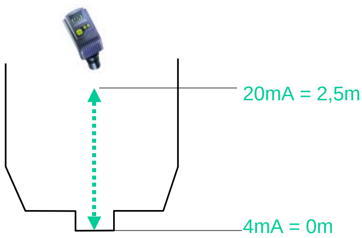
5.5 Level measurement configuration

If you are not measuring a constantly filled pipe and the level varies, a level measurement is needed to permit precise flow rate measurement. This is set after activation in the Show Input Parameters menu.



First allocate one of the analogue outputs to your section by pressing one of the buttons (see above, input 1). Then select the settings in the Display Input Parameters submenu.





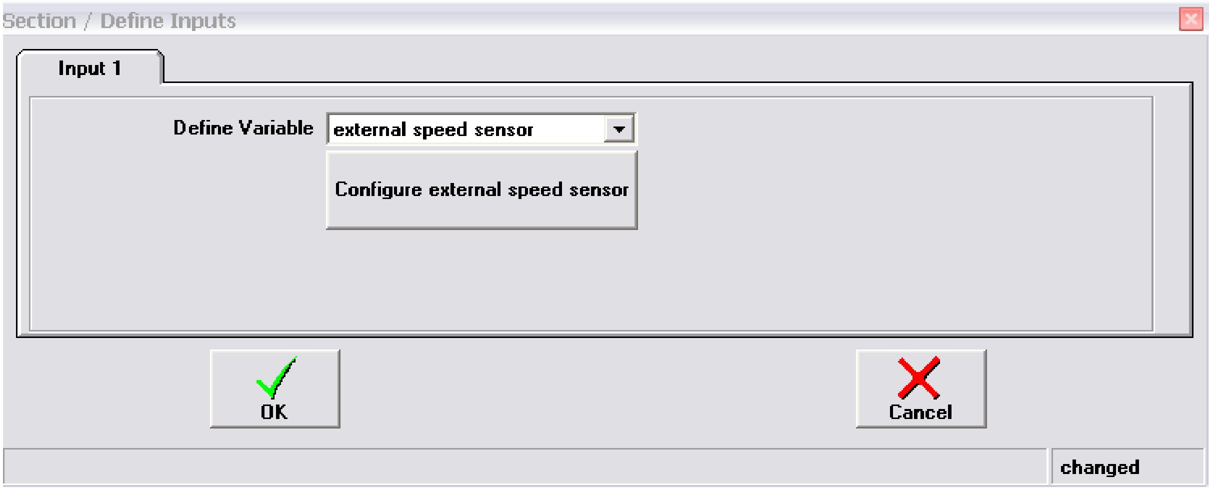
Define the input type as Level Measurement and define the measuring ranges for the 4..20mA-input signal. If the level is constant a constant value can also be entered.

A level value can be entered in the Error Value input field at which a level measuring device malfunction or failure is used as an alternative to the flow rate calculation. The error value will be set in case (input) current signal is <3.84mA or >22.8mA. Values between 3.84….22.8mA will be recognized as valid signals and will be displayed as regular level value.

5.6 Configuration of external speed sensor

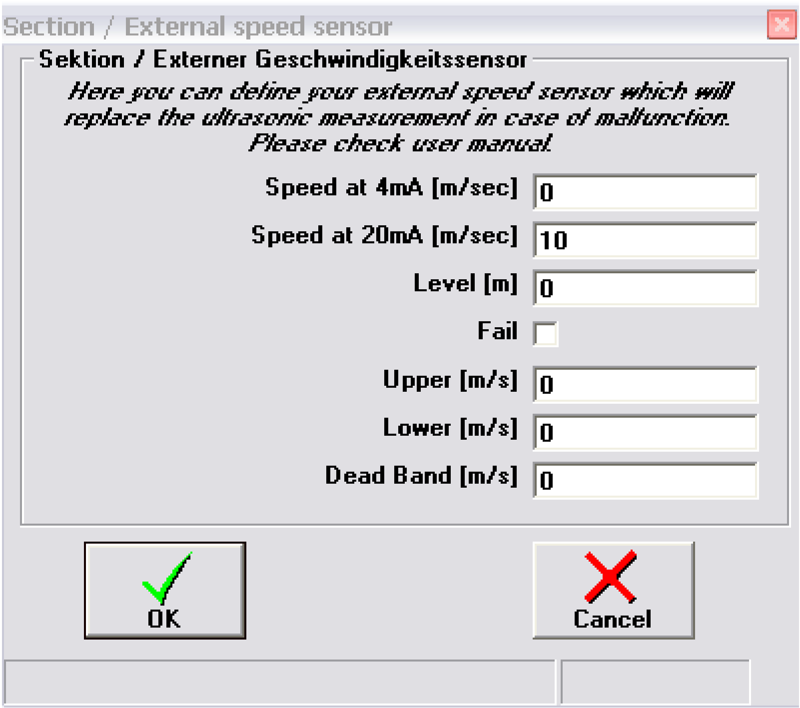
If there is a second (e.g. for redundancy) flow meter (speed sensor) installed you can connect it to your deltawaveVER2 using one of the analogue inputs. The value (flow speed) of the external sensor can then be used in case of malfunction of deltawaveVER2 or in case a defined range of flow speed has exceeded.
Attention: Only one external speed sensor can be defined for each section.

First you have to choose and activate an analogue input (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) by pressing the corresponding button.



Picture 3 Use of external speed sensor - setting

After pressing button *Show Input Parameter* you should choose then *external speed sensor* as input (see Picture 3). Please press button *Configure external speed sensor* to enter the configuration menu (see Picture 4).



Picture 4 Parameter setting of external speed sensor

Parameter	Designation
Speed at 4mA	Please enter the value of the flow speed your sensor gives at

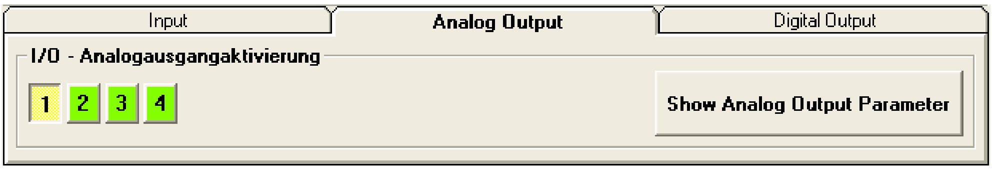
	4mA (in m/s)
Speed at 20mA	Please enter the value of the flow speed your sensor gives at 20mA (in m/s)
Level	Please enter the installation level of your external sensor (+ required coverage if applicable). Under this level the external speed sensor will not be used. Please enter „0“ if your external sensor should be used independently of the current water level.
Fail	<u>Activated:</u> The signal of the external sensor will be used when signal (value of speed) is within the defined limits (Upper and Lower) and/or in case of malfunction of deltawaveVER2 ultrasonic measurement. That means the signal from external sensor will be used in case of malfunction of deltawaveVER2 also when not fulfilling the limits *Upper and Lower*. <u>Not Activated:</u> The signal of the external sensor (value of speed) will be used only when signal meets the defined conditions (Upper / Lower) It will not be used in case of malfunction of deltawaveVER2.
Upper	0 = Do not use parameter Upper Please a value for flow speed (m/s). Signal of external speed sensor will be used only when measured flow speed (measured by external sensor) exceeds this defined value
Lower	0 = Do not use parameter Upper Please a value for flow speed (m/s). Signal of external speed sensor will be used only when measured flow speed (measured by external sensor) goes below this defined value
Dead Band	Cut-off function. Enter a value for flow speed (m/s). If measured flow speed goes below this value the signal of external speed sensor will not be used.

Table 4 Setting of parameters of external speed sensors

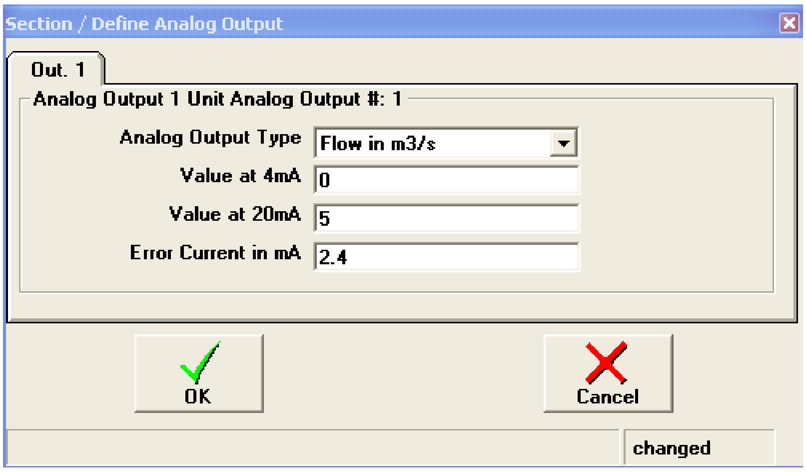
Please press button *OK* to confirm your settings.

5.7 Analogue Output Configuration

Allocate one or more analogue outputs to the desired section by clicking the buttons.

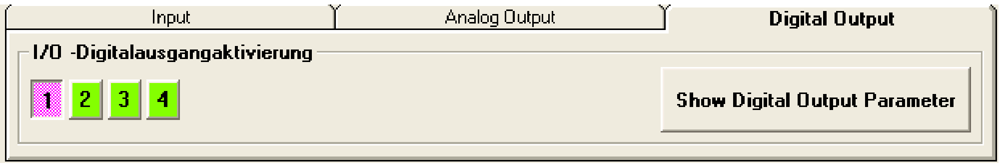


The analogue output can now be parameterised in the Display Analogue Parameters submenu.
First select which measurement variable you wish to depict at the selected analogue output. Then define the measurement range for the 4...20mA. Finally you can define a fault current which should be issued in case of error. 120 % (=23,2mA) or –10%(=2.8mA) are typical values.
deltawaveVER2 is able to detect back flows. It is possible to set a negative flow value for the 4mA parameter.
Example: 4mA = -5 m3/s ; 20mA = 5 m3/s
In This example, the analogue output shows 12mA if the flow is 0 m3/s



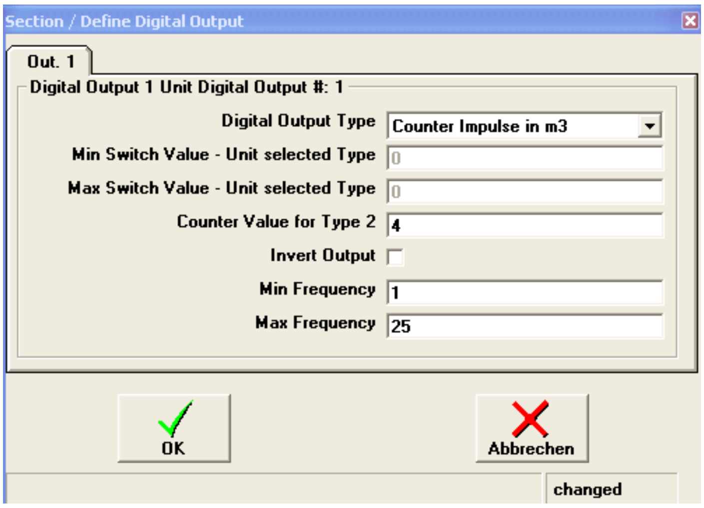
5.8 Digital Output Configuration

Allocate one or more digital outputs to the desired section by clicking the buttons.



Please note that digital outputs 1 and 2 are transistor outputs, digital outputs 3 and 4 are the relays. Relays and transistor outputs are treated identically for parametrisation.
You can parametrise the digital outputs in the Display Digital Output Parameters submenu.

Select which function the digital output should fulfil from the Digital Output Type drop-down menu. A large number of min-max limit values are available. The transmission of metering pulses (in the diagram to the right one pulse represents e.g. a flow quantity of $4m^3$) is just as possible as the switching of alarms in case of a system error (section alarm).



Limit values are defined in the min-max field, a count value in the count value window. By checking the Inverted Output checkbox you can invert the switching function. This permits e.g. an alarm in case of power failure because relays (outputs 3 and 4) then decrease in case of power failure.

You can set the minimum and maximum switching frequencies for the digital outputs (only for counter) in the *Min frequency* and *Max frequency* input fields. The maximum value for the relay outputs (transistor outputs) should not exceed 25 (250).
A maximum value of 25 means for example that a maximum of 25 count values per second can be issued. Reducing maximum values could be reasonable for instance in case when your process control system is not able to detect the stated number of pulses.
As a rule it is however not necessary to change the default values.

5.8.1 Constant Values

Select constant off or constant on in order to get constant output values (e.g. for testing signal transfer to PLC)

5.8.2 Counts

You can use digital outputs to count flow. You can define how many m3 a impulse should represent by putting this value into the input field *counter value for Type 2*. If you put e.g. 10 into that field you get one impulse (at your output) for every 10m3.

5.8.3 Section Alarm

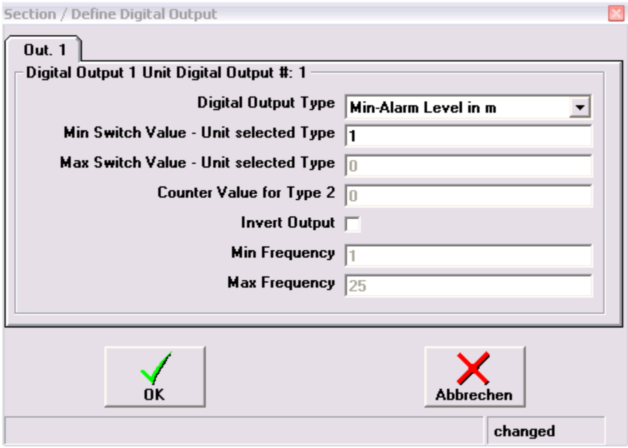
The section alarm signalize a general error of measurement. That means you get a section alarm when all requirements for measurement are fulfilled (e.g. surcharged transducers) but there is still no valid measurement. You get section alarm if

- Defined minimum number of working paths is under-run (see chapter 5.11.8)
- If you have sufficiently surcharged paths but you do not get valid measurement from them.

5.8.4 Min-Alarm, Max-Alarm, Min-Max Alarms

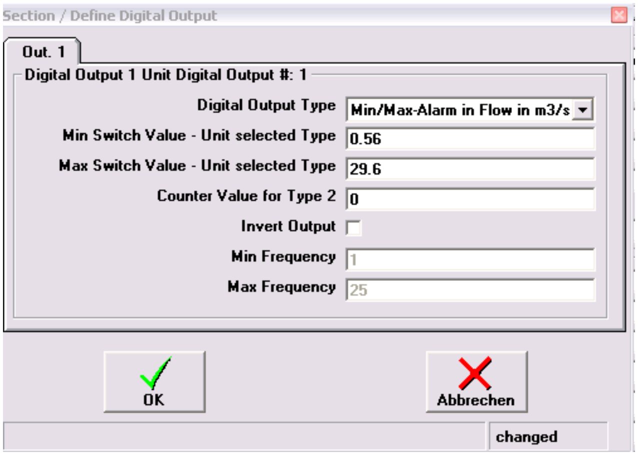
Min-Alarm means that you define a lower limit for the defined measurement value. If value falls down that limit you will get an alert. Max-Alarm means that you define a upper limit for the defined measurement value. If value exceeds this limit you will get an alert. Min-Max Alarm means that you can define a range the chosen parameter has to be in. If value of parameter is out of this range an alarm will be activated. You can define the following Min-Max Alarms.

<u>Example: Setting Min-Alarm for Level</u>



If you want to get an alarm when the measured level falls under the level of 1m please select *Min-Alarm Level in m* as digital Output Type. Then please put the value 1 (which then stands for 1m) into the input field *Min Switch Value – Unit selected Type*

<u>Exmaple: Setting Min-Max-Alarm for flow</u>



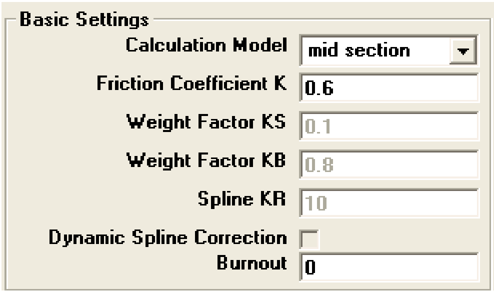
If you want to get an alarm when flow falls below 0.56m3/s or when flow exceeds 29.6m3/s please choose *Min/Max-Alarm in Flow in m3/s* as digital output type. Please then put these values into the fields *Min-Switch Value – Unit selected Type* and *Max-Switch Value – Unit selected Typ.e*

The following Min, Max, Min-Max-Alarms are available:

- Flow
- Level
- Temperature
- Speed

5.9 Basic Settings Configuration

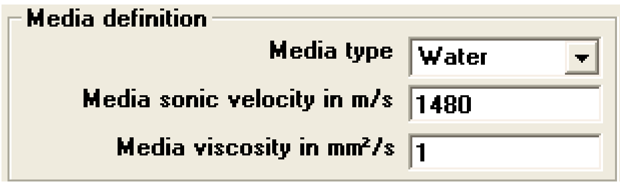
In the Basic Settings menu area you set the basis for calculations and constants for flow measurement in open channels or partly filled pipes. The settings have no influence on the measurement of filled pipes. In the case of a pipe which is alternately filled and partly filled, calculations are performed with this calculation basis if the pipe is partly filled (ISO 6416) and with the ISO60041 (=IEC41) calculation basis if the pipe is completely filled.



The different calculation models are described in the chapter 3. Tables with default values for the KB/KS constants for different channel materials which are queried in this menu window are also to be found there. Normally, no changes are required. If you are not sure about proper values please use default values. Influence on measurement is very little.

The *Burnout* option is intended for applications where there may be temporary interruptions to measuring. Such interruptions can for example be caused by strongly interfered signals, obstructions passing through the measuring path or other brief disruptions. To prevent such temporary, brief disruptions from causing alarms the last upcoming measuring values are held for the duration of the stop period value (in seconds).

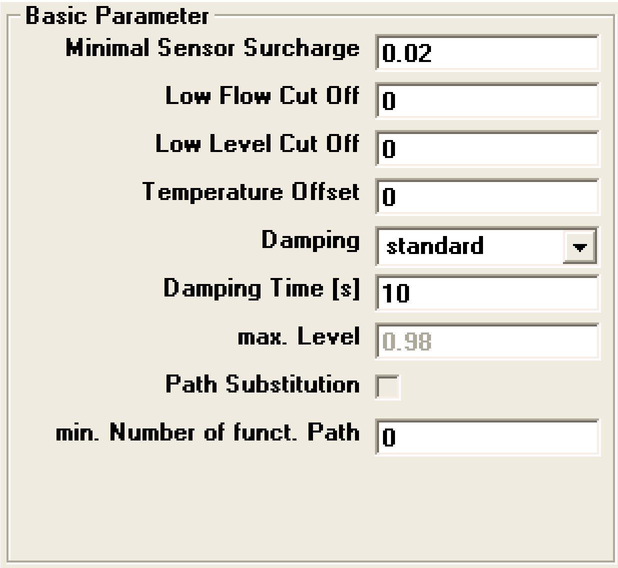
5.10 Medium Configuration



In the Medium Definition menu area settings for the medium can be made, namely the definition of the media sonic velocity and the viscosity. The following table shows typical values for a series of media.

5.11 Basic parameter configuration

In the Basic Parameters menu area various settings concerning the section are made.



5.11.1 Minimal Sensor Surcharge

To ensure that the runtime measurement works to the optimum the sensors should be sufficiently covered with fluid. Recommend values are:

Sensor frequency	Path length	Recommended minimum coverage
100kHz	>100m	0.9m
200kHz	>50m	0.43m
500kHz	>30m	0.21m
500kHz	>3m	0.065m
1MHz	>3m	0.045m
1Mhz	>1m	0.03m
1Mhz	<1m	0.025m
2Mhz	<1m	0.02m

Table 5 Minimum surcharge of ultrasonic transducers

5.11.2 Low Flow Cut Off

Flow rates lower in value than the value entered here (in m3/s) are set to zero. If e.g. 0.02 is entered, flow rates in the [-0.02..0.02] range are set to zero.

5.11.3 Low Level Cut Off

All flows below this level are set to zero. This prevents very small and therefore possibly erroneous level values being included in the calculation (e.g. “dirt effects” when using pressure sensors installed on the channel floor)

5.11.4 Temperature offset

deltawaveVER2 calculates the temperature of the medium from the measured sound velocity. This calculated temperature can deviate from the actual temperature through calibration errors or natural transducer imprecision. This offset can be corrected by means of this input value. The calculated temperature is an additional value which is calculated and can used e.g. by analog output. An offset of temperature does not influence the flow measurement and therefore should be only corrected (by input an offset value) in case the temperature signal should be use.

5.11.5 Damping

deltawaveVER2 provides two damping functions for the flow (measuring smoothing): the standard damping and Smartdamp. The standard damping is damping of the first order (T63), the corresponding time is entered in seconds in the Damping Time window. Damping value between 10 and 60 seconds have to be found reasonable for the most measurements. Smartdamp is an intelligent damping strategy which rapidly reconstructs volatile measuring value changes but still leads to good measuring values with natural measuring value fluctuations. Higher damping values lead to stronger measuring value smoothing; lower damping values lead to faster reactions.

5.11.6 Max. level

This input is only active for “alternately filled or partly filled” or “full pipe/full channel” channel types. The value set here represents the initial level value from which the pipe as regarded as full.
Example: selected channel type: filled pipe with 1.6 m diameter
Selected maximum level: 0.98
In this case the pipe is regarded as full from a level initial signal of (0.98*1.6m) = 1.568 m.
Entering a value is recommended for measuring points which are to calculate the flow rate in case of partial filling according to ISO 6416 (partly filled pipes) and in the case of complete filling according to ISO60041 (IEC41, filled pipes).
This ensures that with pipes which are actually full but where too low a level is still measured (which indicates only partial filling) calculations are actually made according to the model for filled pipes and the associated precision.

5.11.7 Path substitution

This input value is only active with “alternately filled or partially filled” (only if it actually filled) or “filled pipe/filled channel” channel types. By checking the checkbox the path substitution is activated, i.e. inoperative paths contribute to the flow rate calculation – with a calculated value.
Path substitution means that the path velocity necessary for the flow rate calculation is still available after a path has stopped working. This “substituted” flow rate can be calculated from the measuring data collected before the breakdown. In concrete terms the relationship of the measured path flow rate to the overall mean channel flow rate is examined. This relationship is entered separately for each path in the path parameter menu (see chapter 6.4 Path configuration).
We recommend consulting our trained service personnel before activation.

Here is the formula how the substituted velocity (v_substitute) is calculated:

$$v_{substitut} = \left[\frac{1}{\text{No. of working paths}} \sum_{\text{active paths}} \frac{v_{\text{of active path}}}{\text{Path Ratio}_{\text{of active path}}} \right] * \text{Path Ratio}_{\text{path to be substituted}}$$

5.11.8 Minimum number of func. paths

The number of paths which must function correctly is entered here. If less than the number of paths entered here are functioning correctly a section alarm is issued. A digital output should be correspondingly defined for this (see chapter 0)

A path is regarded as not working if the path status is -1 after the burnout has elapsed (see chapter 5.9) (no measuring results in that case).
An alarm can possibly also be issued with basically correctly functioning paths if the stop period selected and the temporary measurement interruption are small (e.g. due to obstructions in the medium).
The minimum number of functioning paths should therefore not be set too high.

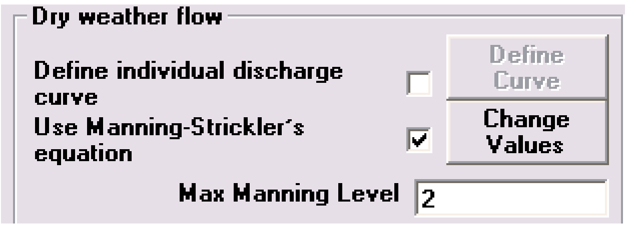
5.12 Dry weather flow configuration

In principle deltawaveVER2 only measures the flow when at least on path is surcharged properly with water. In order to provide a flow value also in case of dry weather flow (no paths surcharged properly) deltawaveVER2 is able to calculate the flow depending on the current water level. For that you can define an individual discharge curve which you can get e.g. from your customer or you can use the well-known formula "Manning Strickler"

The calculation models are not only used in case of dry weather flow but also if you have surcharged paths but without valid signals (that's the case when status of path is not 1, see chapter Fehler! Verweisquelle konnte nicht gefunden werden.**)**

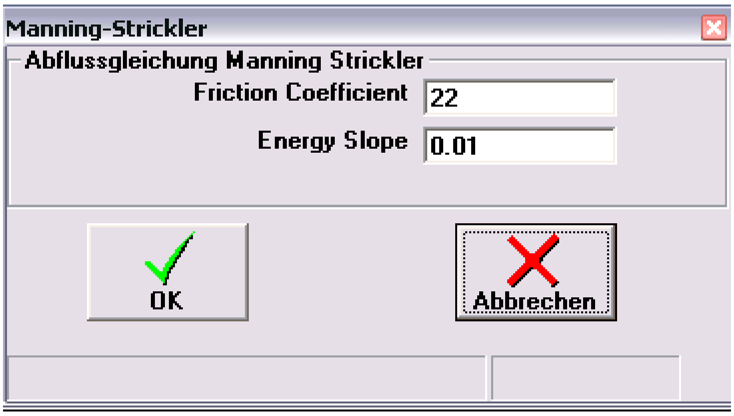
Using Manning-Strickler's Equation

Please activate "use Manning-Strickler's equation". Please put the maximum level until Manning-Strickler's equation is used in the corresponding input field. If you put e.g. 2 into the input field then deltawaveVER2 calculates the flow using Manning-Strickler's equation just when the level doesn't exceed 2m. (if level exceeds 2m and there is still no surcharged paths or no path with valid signals you do not get flow value) Max Manning Level could be e.g. the channel height.



Then press button Change Values to enter the following sub menu

5.13 Dry weather flow configuration with Manning-Strickler



In the "Manning Strickler" sub menu the necessary constants for the q-h flow equation are entered. (rawness coefficient and energy drop (slope)) are to be found in the chapter 2 and Table 1

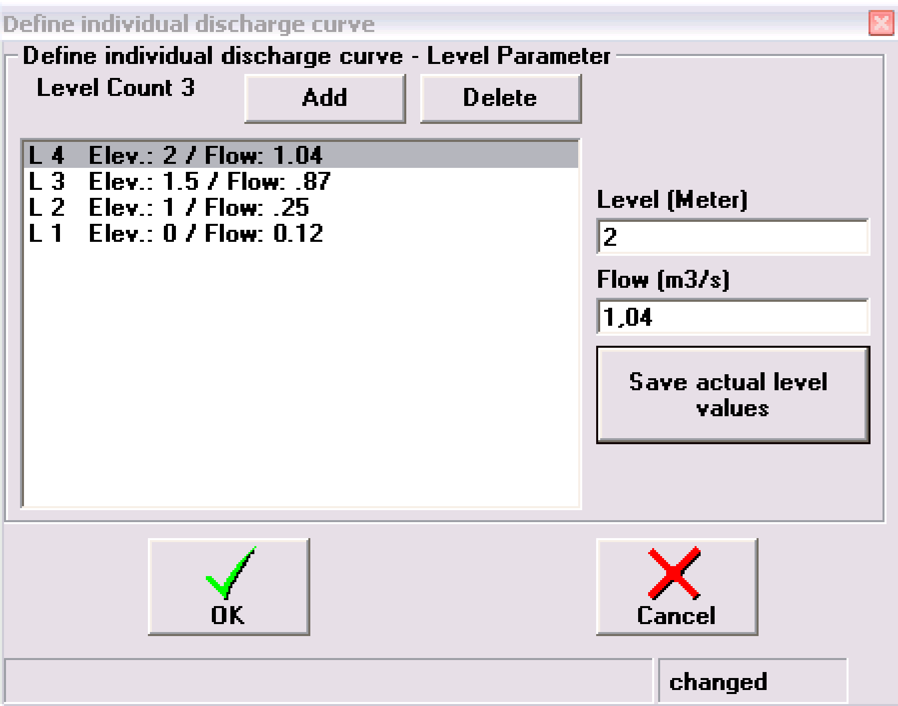
deltawaveVER2 uses the q-h equation according to Manning Strickler if the following conditions are fulfilled (see also chapter 3.1 Calculation algorithms):

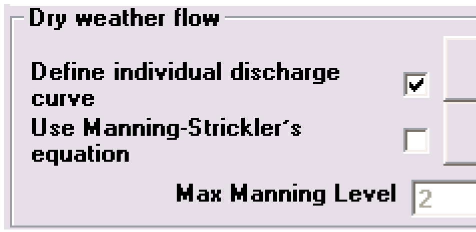
- The "Use Manning Strickler" option must be selected
- The measured level is below the set "max. Manning level" value
- No acoustic path in the section is functioning any longer OR
- There is no path which is surcharged properly

Please note: If Manning Strickler is activated and the above conditions are fulfilled no section alarm is issued, even if no covered path is functioning correctly.

5.13.1 Using individual discharge curve

If you want to implement your own discharge curve please mark the corresponding check-box (see **Picture 5**)





Picture 5 Using individual discharge curve

Then press button *Define Curve* in order to enter the following sub-menu

Picture 6 Defining your individual discharge curve

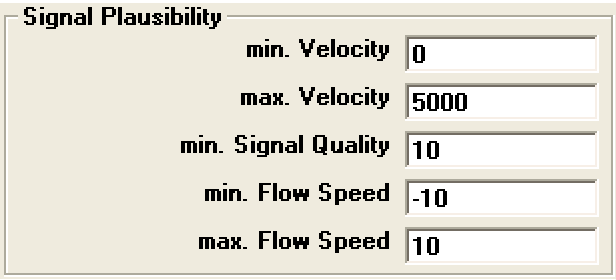
Here you can define up to 15 different sampling points. One sampling point always consist of level and the corresponding flow. The lowest point (0m) is already implemented (you can not see it) and is rated with a flow of 0.

Sampling point L1 must always be at the lowest level, L2 and the following must then have rising level values. After entering values please always press the save button.
Flow values between two sampling points will be calculated using linear interpolation.

See **Picture 6** for example.

5.14 Signal plausibility

Every path performs many individual measurements per second (up to 120). Temporary disruptions (medium discontinuity e.g. due to gas contamination) can mean that from time to time single defective measurements are included in the flow rate calculation.
In order to exclude these defective measurements from the flow rate calculation various parameters can be set which check the plausibility of the measuring values.



5.14.1 Min. and max. velocity

deltawaveVER2 calculates the sound velocity (vs) of the medium with every run from the signal runtimes. In the *minimum* and *maximum sound velocity* input fields limit values are defined within which the calculated sound velocity must lie if the single measurement is to be regarded as valid.

The sound velocity of water depends mainly on temperature. E.g. vs at 0°C is 1402m/s, at 60°C vs is 1551 m/s. That means if temperature of your water is within the range of 0…60°C calculated vs should be within 1402…1551m/s.

Sound velocity of water also depends (little) on salinity and particle load. Therefore we recommend to maintain a safety distance of about 50…100m/s from the theoretical velocities of sound.

Reasonable minimum (maximum) values for water could for example be 1350 (1600).

5.14.2 Min. signal quality

A lower limit value for the signal quality (SQ) can be defined in the *min. signal quality* input field.
The signal quality consists of the signal-to-noise ratio and the signal energy and amplitude values.
Values between 30 and 100 indicate good signal transmission. Values less than 10 indicate difficult measuring conditions or temporary disruptions.
A value between 25 and 70 is recommended.

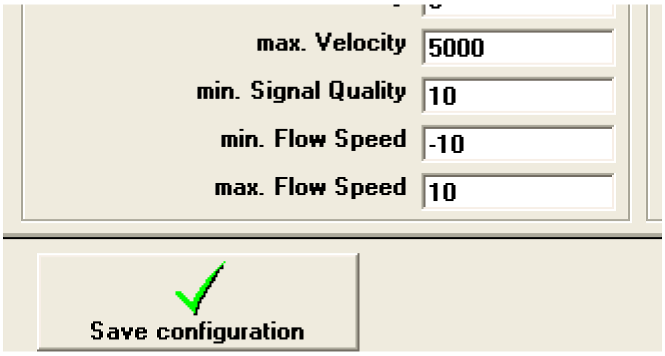
We recommend to start with a lower level and then check values for SQ for each path (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**). This will give you an idea of typical values for SQ at your site. Then you can put these values (with a safety distance of about 10) in your parameterization.

5.14.3 Min. and max. flow speed

The individual path flow rates are balanced out to a mean overall flow rate for the measuring point.
Limit values are defined in the *minimum* and *maximum flow rate* input fields within which the calculated sound velocity must lie in order for the overall flow rate to be regarded as valid.

If you have an idea of the expected minimum and maximum flow rates please enter these values in the corresponding fields.

5.15 Creating the parameter file



After finishing your entries confirm them by clicking the *Save Configuration* button.
A familiar window for saving files appears to save the parameters. Please note that in deltawaveVER2 only files named *param.par* can be loaded.

6 Operation and Display

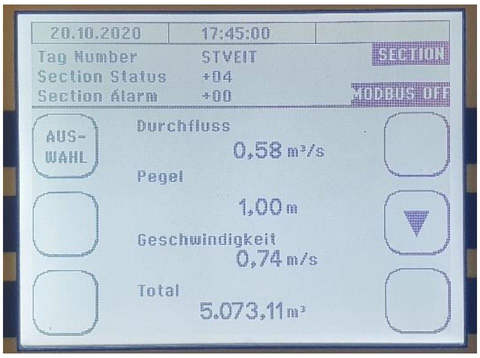
deltawave2 offers a number of Display and Setting Options after Setup. The Operation is easy to understand and operate..

6.1 Splash-Up-Screen

After power up or after pressing the reset button, the splash-up-screen will be shown for app. 10 sec. The screen indicates the firmware-version and offers the possibility to directly enter the language selection menu.

6.2 Masurement (section) Screen

In this screen, the actual measured values of your section are indicated (flow, level, hydraulic area, temperature velocity of sound, …) press the arrow down button, to indicate page 2.



In the header you can see the TAG-number of your site and the section status and alert status. This indicates the oeration status of your meter on the first sight.

6.2.1 Section status

The displayed number of the status indicates the operation mode of your measurements.

Status	Section operation
0	Not activated / not setup
1 bis 8	Section in measurement mode, inidacted positive number = number of working paths (only submerged paths will operate)
-1	Section in measurement mode, flow calculated by manning strickler equation via level meter
-2	Section in measurement mode, flow calculated by q-h-curve via level meter
-3	Section in measurement mode, flow calculated by activated speed sensor
-99	Invalid parameter set

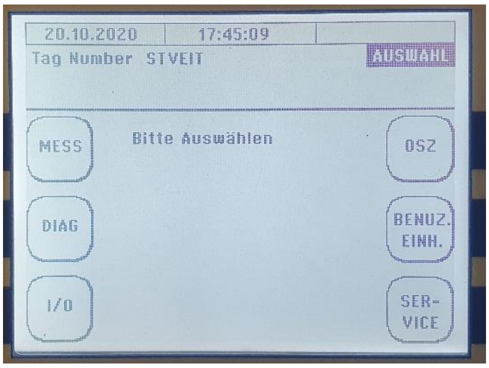
6.2.2 Sektion alarm

In case of a malfuction, the section alarm gives more infromation about the malfunction

Section alarm	Description
0	No alarm 7 normal operation
1	Min-Good-Path criteria not fulfilled. The number of operationg paths is lower than the MIN_GOOD_PATH setting
40	No path operating, speed sensor is used
41	No path operationg, flow calculation by level sensor is used

6.3 MAIN-Screen

In the MAIN-Screen you can select additional subscreens:

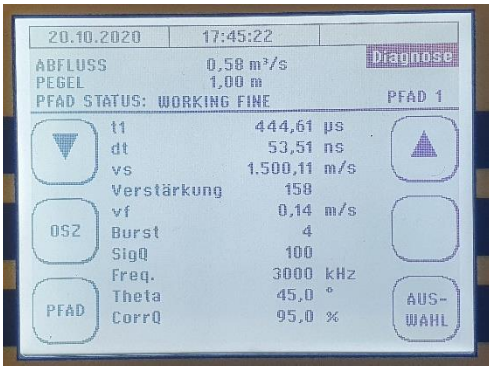


Select-button	
MEAS	Back to the measurement screen
DIAG	Diagnosis screen with comprehensive path information
I/O	Information and claibration menu for analogue and digital in- and outputs
OSZ	Oscilloscope screen for optical analysis of recieved signals
USER UNITS	Selections menu for indicated physical units
SERVICE	Sumbenu with extended meter settings

6.4 Diagnosis-Screen

(MAIN/DIAG)

After selecting the acoustinc path, one can oberve comprehensive diagnostic data of each operating path.



The header indicates the actual section flow and level and the path status:

Path status	
111	Path setup incorrect
10	Path not used in the acatual measurement cycle
2	Path in OSZ-operation, currently not used for flow metering
1	Path working fine
0	Path is deactivated (e.g. not submerged)

-1	acoustic signal bad
-10	Quality of acoustic signal is lower than accepted (SIG_Q or CORR_Q settging too high)
-20	Flow velocity too low (vf<VF_MIN setting)
-21	Flow velocity too high (vf>VF_MAX setting)
-22	Sonic velocity too low (vs<VS_MIN setting)
-23	Sonic velocity too high (vs>VS_MAX setting)

These values are indicated in the DIAG screen:

Value	
t1	Transit time from upstream to downstream sensor
dt	Time difference between upstream- and downstream signal
vs	velocity of sound of the fluid, (water typically between 1450 and 1540 m/s)
Verstärkung	Gein factor of the singnal amplifier, values 180 and lower are good.
vf	Average fluid velocity oft he measured path
Burst	Selected signal burst type
SigQ	Number of valid signals in the measurement cycle
Freq	Sending signal frequency
Theta	Path angle
CorrQ	Quality of the recieved signal, values >75% are good

6.5 Oszilloscope-screen

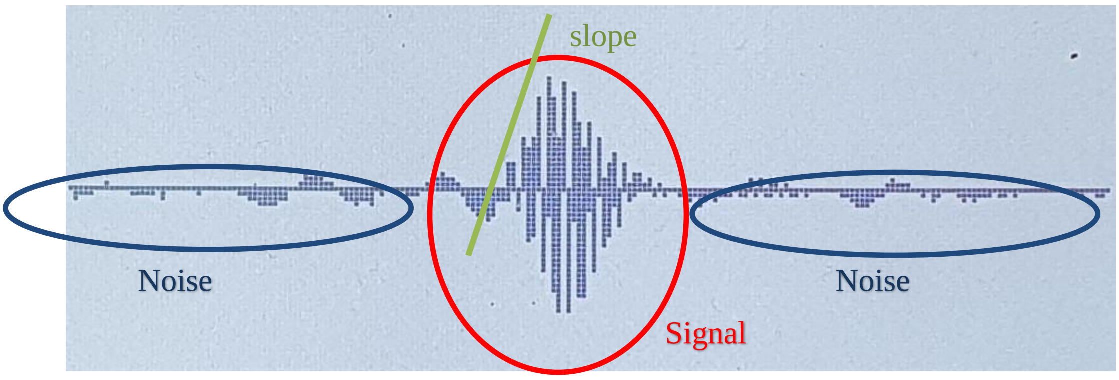
(MAIN/OSZ)

In the Oszilloscope-Screen, you may dircetly visualize the recieved acoustic signal of the up- and downstream path. You should be able to identify the received signal similar to the picture below.

The header indiactes the section and path status

.

The oscilloscope screen should show a signal with an acceptable signal to noise ratio (better 5:1) and a signal with a steep slope. There should be no or low visible reflections or disturbing random peaks.



Tipp: the idicated signal can be saved in high resolution to the SD-card in a WAV-format. These WAV-files can be used for detail analysis and remote support.

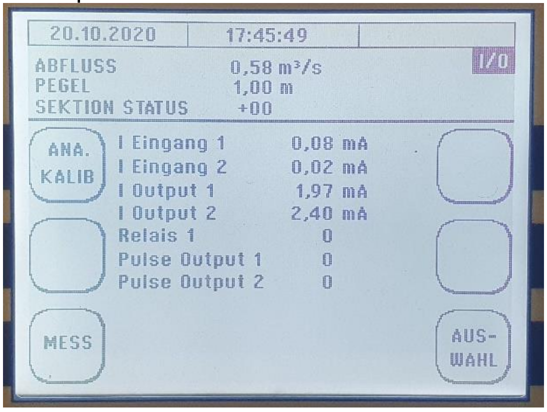
So save the actual indicated OSC-signal, simply press the backlite button (top left) for five seconds. Storing the wav-file will need some seconds.

The wav-files can be donwloaded via USB-port or you may simply remove or replace the SD-card (see chapter 6.10)

6.6 I/O-Screen

(MAIN/I/O)

In the I / O window you can monitor the status of the analog and digital inputs and outputs and calibrate the analog inputs and outputs.



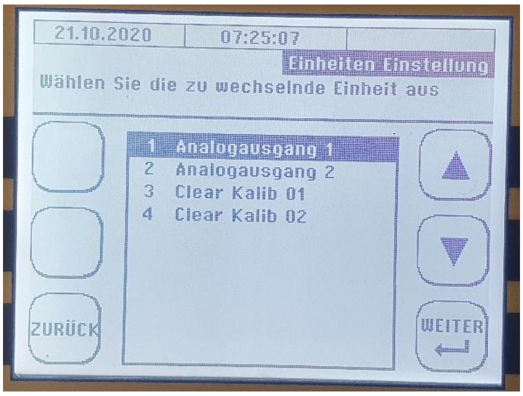
You can check the inputs and outputs in the display window with a multimeter or on your process control system. If there are deviations, you can calibrate the analog inputs and outputs with the ANA.CALIB submenu.

Tip: The analog inputs and outputs are the only analog parts in your measuring system. The flow measurement is based on a digital time measurement and is therefore not subject to any relevant long-term drift. A recalibration according to ISO 9000ff standrds of your deltawave2 can therefore be done on-site with a calibrated multimeter or a calibrated 4..20mA source. We recommend a recalibration interval of 5 to 10 years for the flow measurement and 2 to 5 years for the analog outputs.

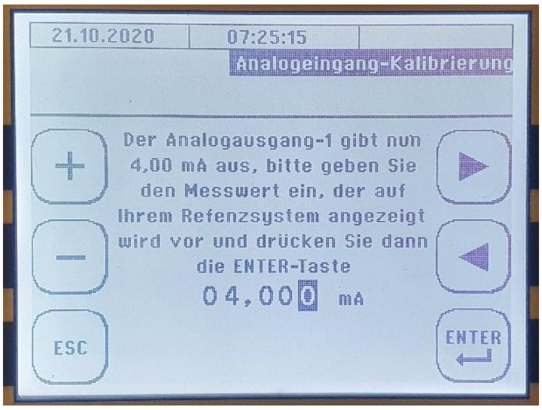
6.7 Analog-Calibration-screen

(MAIN/I/O/ANA.KALIB.)

In the analog calibration screen you will be guided through the calibration process step by step. First you have to select which analog output (for this you need a calibrated current meter) or which analog input (for this you need a calibrated current source) you want to calibrate.



In the windows you also have the option of deleting incorrect calibrations. In the following, you will be asked in two steps to check the 4 and 20 mA or to enter the deviations on the device.

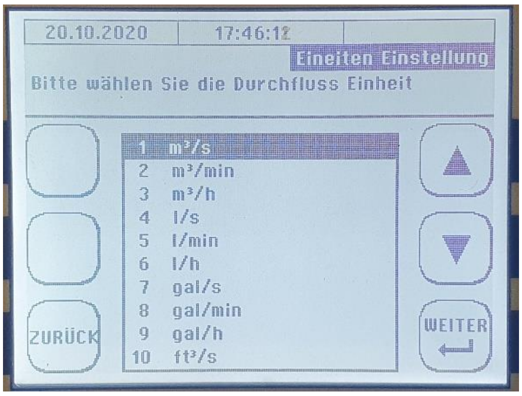


After the calibration has been carried out, you can check the values in the I / O window

6.8 Units Screen

(MAIN/USER UNITS)

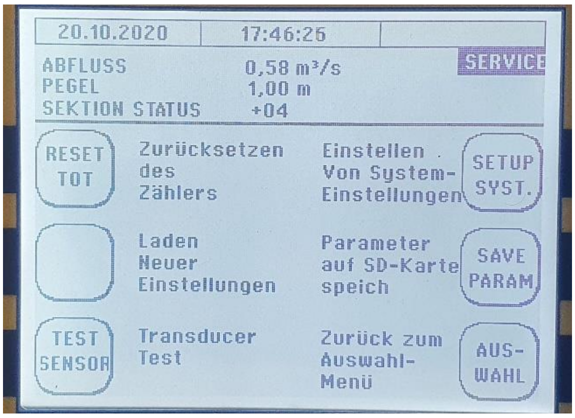
In the units screen, you have the option of changing the display units on the device. To do this, first select the displayed size (flow rate / level / meter, hydraulic area), then select the desired physical unit. Please note, that this only influences the displayed units. The setup (PARA.PAR) will always have to be done in SI-units.



6.9 Service-Screen

(MAIN/SERVICE)

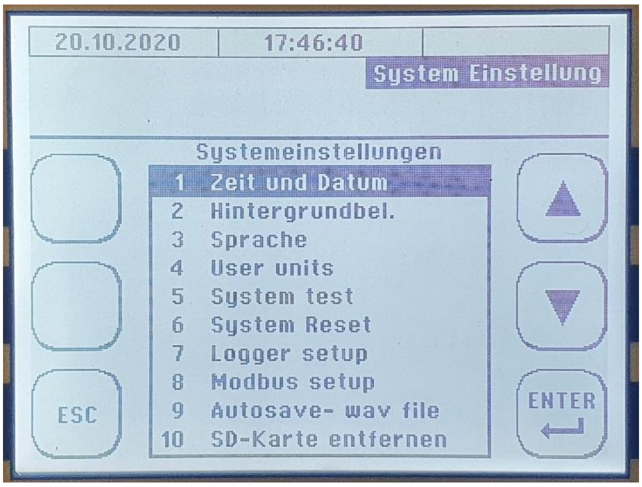
In the service window the counters (totalizer) can be reset (RESET TOT), new parameters - if available - can be loaded (LOAD PARAM) the current parameters can be saved on the SD card (SAVE PARAM) and various system settings (SETUP SYST.)



6.10 System-Setup-Screen

(MAIN/SERVICE/SETUP SYST.)

Various display, data log and system settings are made in this window. The submenus are largely self-explanatory.



Time and date: The system time is set here. This setting is used for the display and for the data logs. Please note that due to the consistency of the data logs, a daylight saving time / vintner time change does NOT take place. We recommend using summer time.

Backlight: Here you can set the strength of the backlight.

Language: Here you can select the display language.

User units: In this submenu you can select the displayed units (see also chapter 6.8)

System test: Here you can test the analog outputs and thus the transmission to your PLS by manually specifying a flow rate and level

System Reset: The system can be reset in this menu, in which case all settings and parameters are lost.

Logger setup: The logger can be activated and the log interval set in this menu.

Modbus setup: The settings for the (optional) Modbus are set here.

Autosave-wav file: If this function is activated, deltawave automatically saves wav files of the received signals in the event of a loss of the measurement path signal (see also chapter 6.5). This function can be useful for analyzing problematic measuring points with temporary measuring interruptions. However, saving the wav files on the SD card requires high system resources and slows down the measurement significantly.

Remove SD card: You can exchange the SD card if necessary or read out data directly with a USB-connected PC. So that removing the SD carde does not collide with the storage activities of your deltawave2, you should deactivate the SD storage in this menu before removing the card. After an SD card is reinserted, saving will start automatically again.

7 Contact

Manufacturer, sales and technical support:

systec Controls Mess- und Regeltechnik GmbH
Lindberghstraße 4
82178 Puchheim
Tel.: +49 89-80906-0
Fax.: +49 89-80906-200
E-Mail: info@systec-controls.de
Web: http://www.systec-controls.de

Please see our website to find your local systec dealer

8 Appendix

8.1 Weighting of the paths with filled cross-sections in accordance with ISO60041 (IEC41)

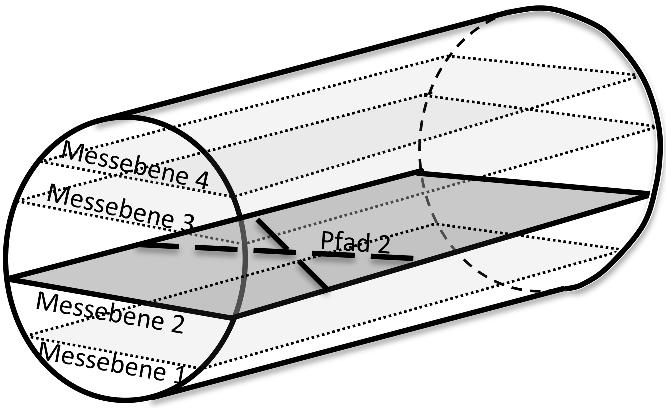
8.1.1 Path arrangement and Path weights for filled round conduits

There are different calculation models to obtain best accuracy when using multi path arrangements in filled, round pipes. Three models are mostly used: In ISO60041 or ASME PTC18 Gauss-Jacobi or Gauss-Legrander Models are described. A Option is the OWICS model developed from ETH Zurich.

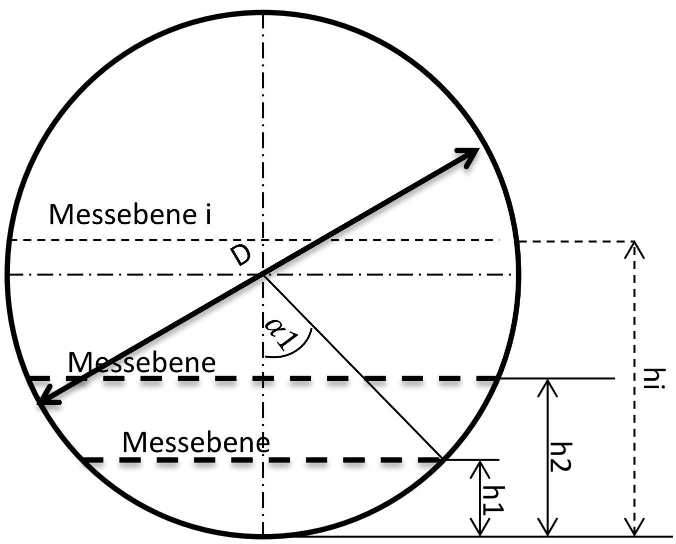
For ISO or ASME conform measurements (turbine performance testing), we recommend to use the Gauss-Jacobi-Model, since this is described in these Standards.

For best accuracy and stability against inlet variations and miss-arrangement of the transducers, OWICS has advantages and should be used. OWICS is robust against these influences.

ISO and ASME recommend 4 parallel measurement planes with one single or two crossed ultrasonic paths as shown in the sketch below.



But there are other Arrangements with more or less than 4 measurement planes possible. DeltawaveVER2 offers up to 8 path configuration, therefore the weights and positions (sketch below) of the transducers are listed in the table 12 below.



	Gauss-Legrandre			Gauss-Jacobi			OWICS		
No of planes	hi/D	wi	alpha i	hi/D	wi	alpha i	hi/D	wi	alpha i
1	0,5	1,5708	90,00	0,5	1,5708	90,00	0,5	1,5134	90,00
2	0,7887	1	125,26	0,75	0,9069	120,00	0,744	0,8908	119,21
	0,2113	1	54,74	0,25	0,9069	60,00	0,256	0,8908	60,79
3	0,8873	0,5556	140,77	0,8536	0,5554	135,00	0,8478	0,5537	134,08
	0,5	0,8889	90,00	0,5	0,7854	90,00	0,5	0,7687	90,00
	0,1127	0,5556	39,23	0,1464	0,5554	45,00	0,1522	0,5537	45,92
4	0,9306	0,3479	149,44	0,9045	0,3693	144	0,9045	0,3719	143,1
	0,67	0,6522	109,88	0,6545	0,5977	108	0,6545	0,5882	107,68
	0,33	0,6522	70,124	0,3455	0,5977	72	0,3455	0,5882	72,315
	0,0694	0,3479	30,556	0,0955	0,3693	36	0,0955	0,3719	36,904
5	0,9531	0,2369	154,98	0,933	0,2618	150,00	0,9293	0,2654	149,15
	0,7692	0,4786	122,58	0,75	0,4534	120,00	0,7466	0,4489	119,56
	0,5	0,5689	90,00	0,5	0,5236	90,00	0,5	0,5158	90,00
	0,2308	0,4786	57,42	0,25	0,4534	60,00	0,2534	0,4489	60,44
	0,0469	0,2369	25,02	0,067	0,2618	30,00	0,0707	0,2654	30,85
6	0,9662	0,1012	158,82	0,9505	0,1947	154,29	0,9475	0,1984	153,50
	0,8306	0,2224	131,39	0,8117	0,3509	128,57	0,8084	0,3489	128,08
	0,6193	0,3137	103,81	0,6113	0,4375	102,86	0,6098	0,4322	102,69
	0,3807	0,3137	76,19	0,3887	0,4375	77,14	0,3902	0,4322	77,31
	0,1694	0,2224	48,61	0,1883	0,3509	51,43	0,1916	0,3489	51,92
	0,0338	0,1012	21,18	0,0495	0,1947	25,71	0,0525	0,1984	26,50
7	0,9746	0,1295	161,64	0,9619	0,1503	157,50	0,9595	0,1537	156,77
	0,8708	0,2797	137,86	0,8536	0,2777	135,00	0,8504	0,2771	134,49
	0,7029	0,3818	113,94	0,6913	0,3628	112,50	0,6893	0,3593	112,24
	0,5	0,418	90,00	0,5	0,3927	90,00	0,5	0,3882	90,00
	0,2971	0,3818	66,06	0,3087	0,3628	67,50	0,3107	0,3593	67,76
	0,1292	0,2797	42,14	0,1464	0,2777	45,00	0,1496	0,2771	45,51
	0,0254	0,1295	18,36	0,0381	0,1503	22,50	0,0405	0,1537	23,23
8	0,9801	0,1012	163,80	0,9698	0,1194	160,00	0,9678	0,1225	159,33
	0,8983	0,2224	142,81	0,883	0,2244	140,00	0,8802	0,2225	139,49
	0,7628	0,3137	121,70	0,75	0,3023	120,00	0,7477	0,3002	119,69
	0,5917	0,3627	100,57	0,5868	0,3438	100,00	0,5859	0,3403	99,90
	0,4083	0,3627	79,43	0,4132	0,3438	80,00	0,4141	0,3403	80,10
	0,2372	0,3137	58,30	0,25	0,3023	60,00	0,2523	0,3002	60,31
	0,1017	0,2224	37,19	0,117	0,2244	40,00	0,1198	0,2225	40,51
	0,0199	0,1012	16,20	0,0302	0,1194	20,00	0,0322	0,1225	20,67

Table 1 Positions and weights of transducers for filled round pipes

8.2 The RS232 Interface

8.2.1 General

deltawaveVER2 has an RS232 interface, which output the measured data as an ASCII string.

8.2.2 Data which can be transferred via RS232

The following data can be transferred via RS232. You can transfer the following data:

- Date
- Time
- Flow
- Accumulated Flow (counter)
- Level
- Velocity
- Temperature
- Hydraulic Area (optional)
- Alert
- Status of Section

In addition to that you can choose start and end signs.

9 EG -Declaration of Comformity

EG declaration of conformity

For the device

deltawaveVER2 XUMB2

multipath ultrasonic transmitter flowmeter

including the accessories of the ultrasonic transducers

UW02 ...; UW05 ...; UW10 ...; UWHD10 ...; UWHD05 ...; UWHT10 ...;

is hereby confirmed to comply with the essential protection requirements set out in the following Council Directives on the approximation of the laws of the Member States:

Directive 2014/35 / EU Low Voltage Directive
Directive 2014/30 / EU Electromagnetic compatibility

This declaration applies to all copies and loses their validity in the case of changes not agreed with us.

Generic standards - Emitted interference (emission)
DIN EN 61000-6-3, VDE 0839-6-3: 2011/09, (B1: 2012-11) Residential area, business and commercial area as well as small businesses
DIN EN 61000-6-4; VDE 0839-6-4: 2011-09 Industry

The following standards were used to assess the product with regard to electromagnetic compatibility:

Standards for EMC measurement regulations
DIN EN 55022; VDE 0878-22: 2011-12, B1: 2016-08: (CISPR 22: 2008 mod.) Antenna 30Mhz - 6Ghz
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
DIN EN 55011: 2018 Antenna 30Mhz - 6Ghz
Industrial, Scientific and Medical High Frequency Devices (ISM Devices)
DIN EN 55014-1 2018 Pliers 30Mhz - 300Mhz Interference Power
Electromagnetic compatibility - Requirements for household appliances, power tools and similar electrical appliances - Part 1: Emitted interference

Generic standards - Immunity
DIN EN 61000-6-1 VDE 0839-6-1: 2016-05 Residential area, business and commercial area as well as small businesses
DIN EN 61000-6-2 VDE 0839-6-2: 2016-05, industrial sector

Product family standards for immunity
DIN EN 55014-2 VDE 0875-14-2: 2016-01 Electrical equipment (household appliances and power tools) Immunity requirements. CISPR 14-2
DIN EN 55024 VDE 0878-24: 2016-05, Information technology equipment.

Standards for EMC measurement regulations
DIN EN 61000-4-2 VDE 0847-4-2: 2009-12: Electrostatic discharges ESD
DIN EN 61000-4-3 VDE 0847-4-3: 2011-04: High Frequency Electromagnetic Fields (HFF)
DIN EN 61000-4-4 VDE 0847-4-4: 2013-04: Fast, conducted transients (burst)
DIN EN 61000-4-5 VDE 0847-4-5: 2015-03: Surges
DIN EN 61000-4-6 VDE 0847-4-6: 2014-08: Induced high-frequency fields, 150kHz - 80Mhz
DIN EN 61000-4-8 VDE 0847-4-8: 2010-11: Magnetic fields with energy-related frequencies
DIN EN 61000-4-11 VDE 0847-4-11: 2005-02: Voltage dip, short-term interruption, voltage fluctuation

Conformity to the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS) is fulfilled

ROHS Directive (2011/65 / EC)

The conformity of the device is ensured

Manufacturer:

systec Controls
Mess- und Regeltechnik GmbH
Lindberghstraße 4
82178 Puchheim

10 References

- EN ISO 6416: Measurement of liquid flow in open channels -- Measurement of discharge by the ultrasonic (acoustic) method
- IEC41 (=ISO60041): Field acceptance tests to determine the hydraulic performance of hydraulic Turbines, storage pumps and pump-turbines
  [Describes the flow measurement in filled conduits]
- ASME PTC 18: Hydraulic Turbines and Pump-Turbines
  [Describes the flow measurement in filled conduits, mainly used in UK and USA]
- deltawaveVER2 product brochure
- Installation guide for ultrasonic transducers