Dynasonics®
Ultrasonic Flow Meters

IS-6000 Doppler

Stationary area velocity flow meter for partially filled pipes or pressurized pipes and open channels

Area Velocity Sensor

Badger Meter

HYB-UM-03155-EN-03 (March 2021)

User Manual

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1. GENERAL INFORMATION

This user manual provides all necessary information for the operation and the efficient and safe use of the **IS-6000 Doppler** flow meter. It contains important information on product identification, storage, installation, commissioning, operation, maintenance and disposal of the device. Before putting the device into operation, read this user manual carefully. To prevent possible injuries to the user and damage, use the device only for the intended use described below. Always keep this document handy in the vicinity of the device! If you do not understand the contents of this document, contact the manufacturer. In no case may the manufacturer be held reliable for any damage or injury caused by misunderstanding of the information.

1.1. Copyright

All rights reserved. The contents and works in this document are subject to German copyright. Contributions from third parties are identified as such. No part of this documentation may be reproduced in any form, stored or transferred, neither electronically, mechanically, photo-technically, by recording on data media or otherwise, as long as no expressly written authorization from the publisher is present.

1.2. Data Protection and Security

All data should be backed-up prior to the installation of any peripheral storage device. The manufacturer will not be responsible for any loss of data resulting from the use or misuse of this or any other product from the manufacturer. Data security is given by personated login with username and password. Data will be saved on the server with appropriate security measures for protection against data loss, data abuse and unauthorized data modifications.

There are inherent security risks in transmitting data via the internet. It is not possible to safeguard completely against unauthorized access by third parties.

The use of contact data published within the framework of the imprint obligation by third parties for the transmission of not expressly requested advertising and information material is hereby expressly rejected.

1.3. Liability

In case of inappropriate or unintended use, no liability for the proper function of the device can be assumed. Improper installation and operation of the device will void the warranty. The manufacturer has made every effort to assure the accuracy of the contents of this manual and the software. However, the manufacturer can offer no guarantee that the information provided is accurate and/or free of error. The information provided in this manual is subject to change without notice at any time. The manufacturer reserves the right to alter designs, layouts or software without prior notification and will not be liable in any way for possible consequences of such changes.

1.4. EU Conformity Declaration

The manufacturer hereby declares that this product complies with Directive 2014/30/EU, 2014/35/EU, 014/53/EU, 2014/65/EU.

1.5. Warnings and Safety Symbols

Depending on the hazard level, warnings are displayed as follows.

⚠ DANGER	Immediate danger. Indicates a potentially or imminently hazardous situation which, if not avoided, *will* result in death or serious injury.
⚠ WARNING	Medium risk. Indicates a potentially or imminently hazardous situation which, if not avoided, *could* result in death or serious injury.
⚠ CAUTION	Minor risk. Indicates a potentially hazardous situation that *may* result in minor or moderate injury or damage.

IMPORTANT

Important handling instruction. Indicates a situation which, if not avoided, may cause damage to the device. Information that requires special emphasis.

NOTE: This symbol indicates helpful notes and information for handling the device.

2. GENERAL SAFETY INSTRUCTIONS

2.1. Requirements for Personnel

Installation, electrical connections, commissioning, operation, and maintenance of the device must be carried out by qualified, specially trained and authorized personnel.

Personal injuries and serious damage to the device are caused by insufficiently qualified personnel.

Qualified personnel:

- Are persons who, through their professional training and education, are familiar with the safety guidelines of electrical and automation engineering.
- Are persons who, as project, commissioning, and installation personnel, are authorized to commission, ground and label circuits and devices/systems in accordance with the standards of safety engineering.
- Must be able to safely assess the results of their work and must be familiar with the contents of these operating instructions.

Special trained personnel:

- Are persons, for example fitters or electricians, who can perform various tasks such as transport, assembly and installation of the product under the supervision of an authorized person. The persons must have experience in handling the product.

Authorized personnel:

- Are persons who are indented to work on the basis of legal regulations or have been approved by the manufacturer for certain activities.

The following requirements must be met:

- The user manual must be read carefully and fully understood by qualified personnel. Instructions must be followed.
- Qualified personnel must be trained and authorized by the plant operator.
- During work on and with the device, the required personal protective equipment must always be worn.
- All applicable national standards, safety requirements and accident prevention regulation have to be observed.

2.2. Intended Use

⚠WARNING

IMPROPER USE CAN SERIOUSLY COMPROMISE THE SAFETY OF THE DEVICE. THE DEVICE IS EXCLUSIVELY DESIGNED TO BE USED FOR PURPOSES AS DESCRIBED BELOW.

KEEP WITHIN THE SPECIFIED PRESSURE AND TEMPERATURE RANGE WHILE USING THE DEVICE.

RESISTANCE OF ALL FLUID-WETTED PARTS OF THE DEVICE AGAINST THE MEASURED FLUID MUST BE MADE SURE IN ORDER TO AVOID CORROSION AND ABRASION.

NOTE: The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The IS-6000 Doppler stationary pulse-Doppler System is a permanent velocity area flow meter that measures flow in full and partially full pipes with 4…80 in. (100…2000 mm) in diameter, and in open channels with water depths from 1.5…80 in. (0.04…2 m) .

2.3. Workplace Safety

During work on and with the device the required personal protective equipment must always be worn. All applicable national standards, safety requirements and accident prevention regulation must be observed.

2.4. Operational Safety

Operate the device in proper technical condition and fail-safe condition only. The operator is responsible for interference-free operation of the device.

2.5. Product Safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements. It has been tested and left the factory in a condition in which it is safe to operate. It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity.

2.6. Electrical Safety

⚠WARNING

DISCONNECT DEVICE

SINCE THE DEVICE CANNOT BE SWITCHED OFF AT THE HOUSING, IT IS ABSOLUTELY NECESSARY TO CONNECT THE SYSTEM TO AN EXTERNAL DISCONNECTING DEVICE.

⚠WARNING

DANGEROUS CONTACT VOLTAGES

- ***THE FUNCTIONAL EARTHING IS NOT IDENTICAL TO THE PROTECTIVE EARTHING ACCORDING TO DIN VDE 0100!***
- ***EMC GROUND CONNECTORS ONLY FULFIL SECONDARY MEASURES FOR PROTECTION AGAINST DANGEROUS CONTACT VOLTAGES.***
- ***THE GREEN-YELLOW WIRES OF THE PROTECTIVE CONDUCTOR (PE) FULFIL THE MEASURES FOR PROTECTION AGAINST DANGEROUS CONTACT VOLTAGES, BUT NOT THE REQUIREMENTS OF EMC DIRECTIVE 2014/30/EU.***
- ***WHEN EARTHING A SYSTEM, TAKE APPROPRIATE PROTECTIVE AND FUNCTIONAL MEASURES IN ACCORDANCE WITH DIN VDE 0100 AND EMC DIRECTIVE 2014/30/EU.***

⚠WARNING !

PROTECTIVE GROUNDING

SUITABLE MEASURES FOR ERROR PROTECTION MUST BE CARRIED OUT. THE CONDUCTIVE SYSTEM PARTS TO BE PROTECTED MUST BE CONNECTED TO A SUITABLE EARTHING CONDUCTOR VIA THE PE CONDUCTOR, SO THAT THE SYSTEM PARTS WITH A FAULT ARE SWITCHED OFF BY OVERCURRENT PROTECTION DEVICES.

Symbols	Description
⏚	Protective conductor connection This symbol refers to the protective conductor connection of the device. Depending on the type of installation, the device may only be operated with a suitable protective conductor connection in accordance with the applicable laws and regulations
L	Phase conductor
N	Neutral conductor

3. PRODUCT DESCRIPTION

The IS-6000 Doppler stationary ultrasonic flow meter continuously measures the flow of water and wastewater in pressurized and partially filled pipes and in open channels with water depths from 1.5…80 in. (0.04…2 m).

As a standard, the flow meter consists of a transmitter and an ultrasonic area velocity sensor for combined velocity and water level measurement (*see Figure 1*). Discharge is then calculated by multiplication of the average flow velocity and the wetted cross-sectional area. The transmitter allows connection of up to 3 ultrasonic area velocity sensors for simultaneous measurement at up to 3 different measurement spots in one cross-section.

Alternatively, additional external water level sensors (for example, a hydrostatic level sensor or an ultrasonic down-looking level sensor) can be connected to the system depending on specific site conditions, providing accurate water level measurement in case of water level fluctuations.

For discharge measurement in pressurized and partially filled pipes, insertion sensors are used. Insertion sensors are installed into the existing pipe work through ball valves allowing the installation and removal of the entire sensor for repair, replacement, or cleaning without dewatering the pipe.

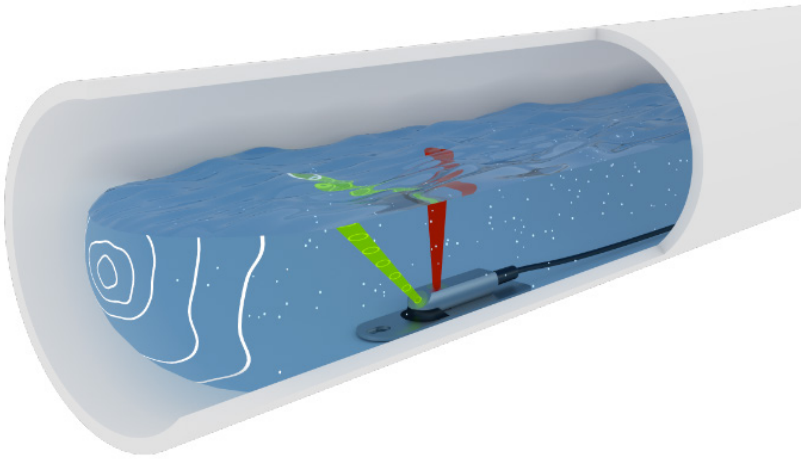


Figure 1: Combined ultrasonic velocity and water level measurement with an area velocity sensor (combination sensor)

The IS-6000 Doppler transmitter incorporates all the required algorithms and software for measurement accuracy and repeatability. Parameterization of the measurement site, data logging, visualization and data transfer is possible by using the browser-based control and management user interface, which can be run in any standard web browser via PC, notebook, tablet or smart phone, regardless of location, time and operating system.

Applications:

Based on the pulsed wave Doppler principle, the flow measurement of IS-6000 Doppler meter requires suspended particles or gas bubbles in the flowing liquid as reflectors of the acoustic signals. Therefore, the meter is ideally suited for continuous flow monitoring in slightly to heavily polluted media.

- Wastewater treatment plants (influent measurement, real-time process control, effluent measurement)
- Wastewater collection systems (infiltration studies, hydraulic model calibration, event notification, long term trend analysis)
- Urban drainage

3.1. Scope of Delivery

IMPORTANT

Check the packaging and the contents for damage. Check that delivery is complete and agrees with the shipping documents and your order. If damages occurred or any items are missing, please contact the manufacturer.

The scope of delivery

- IS-6000 Doppler transmitter
- Area velocity sensor or insertion sensor including cable
- User manual

Optional Accessories

- External hydrostatic level sensor or external ultrasonic level sensor
- Integrated LTE/HSPA+/GPRS (4G/3G/2G) modem incl. 4G/LTE dipole antenna
- Mounting systems (sensor mounting plates, in-pipe tension rings, scissors rings)

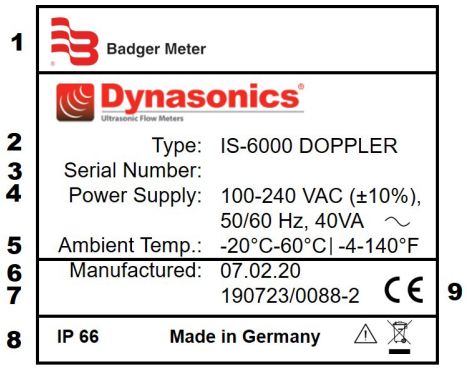
3.2. Storage

Store the equipment in a dry and dust-free place. Avoid durable exposure to direct sunlight. Store the device ideally in its original packaging. Storage temperature: -4…158° F (-20…70° C), ideally 68° F(20° C).

3.3. Nameplate

NOTE: Check the device nameplate to make sure that the device is delivered according to your order.

The nameplate (*see Figure 2*) indicates important data for identification and use of the measuring system.



1 Manufacturer name
2 Product name
3 Serial number transmitter (S/N)
4 Power supply data
5 Ambient temperature range
6 Manufacturing date mm/yyyy
7 Network number
8 IP protection class
9 CE mark

Figure 2: Nameplate (example)

3.4. Measuring System

3.4.1. Transmitter

The transmitter (*see Figure 3 on page 12*) is designed to operate ultrasonic velocity sensors and to calculate the flow rate. The flow computer incorporates all of the required algorithms and software to ensure accuracy and repeatability of the measurements. The IP66 (NEMA 4) compact flow display computer has a 4 lines × 20 characters alphanumeric LC display and a 4-button keypad. All configuration data, measurement data, and calculated data are stored on a 16GB Micro-SD card. It controls the measurements, calculates the flow rate and provides freely programmable current outputs, status alarm, frequency outputs and totalizer readings. .

NOTE: For use and installation of IS-6000 Doppler meter in potentially explosive atmospheres, the transmitter is connected to an explosion-proofed stationary Ex-flow rate module (according to ATEX Directive 2014/34/EU). The Ex-flow rate module comes with an area velocity sensor with an explosion-proof connection cable.
For detailed description of the Ex-flow rate module and the connection to the IS-6000 Doppler transmitter, an additional user manual is provided by the manufacturer.

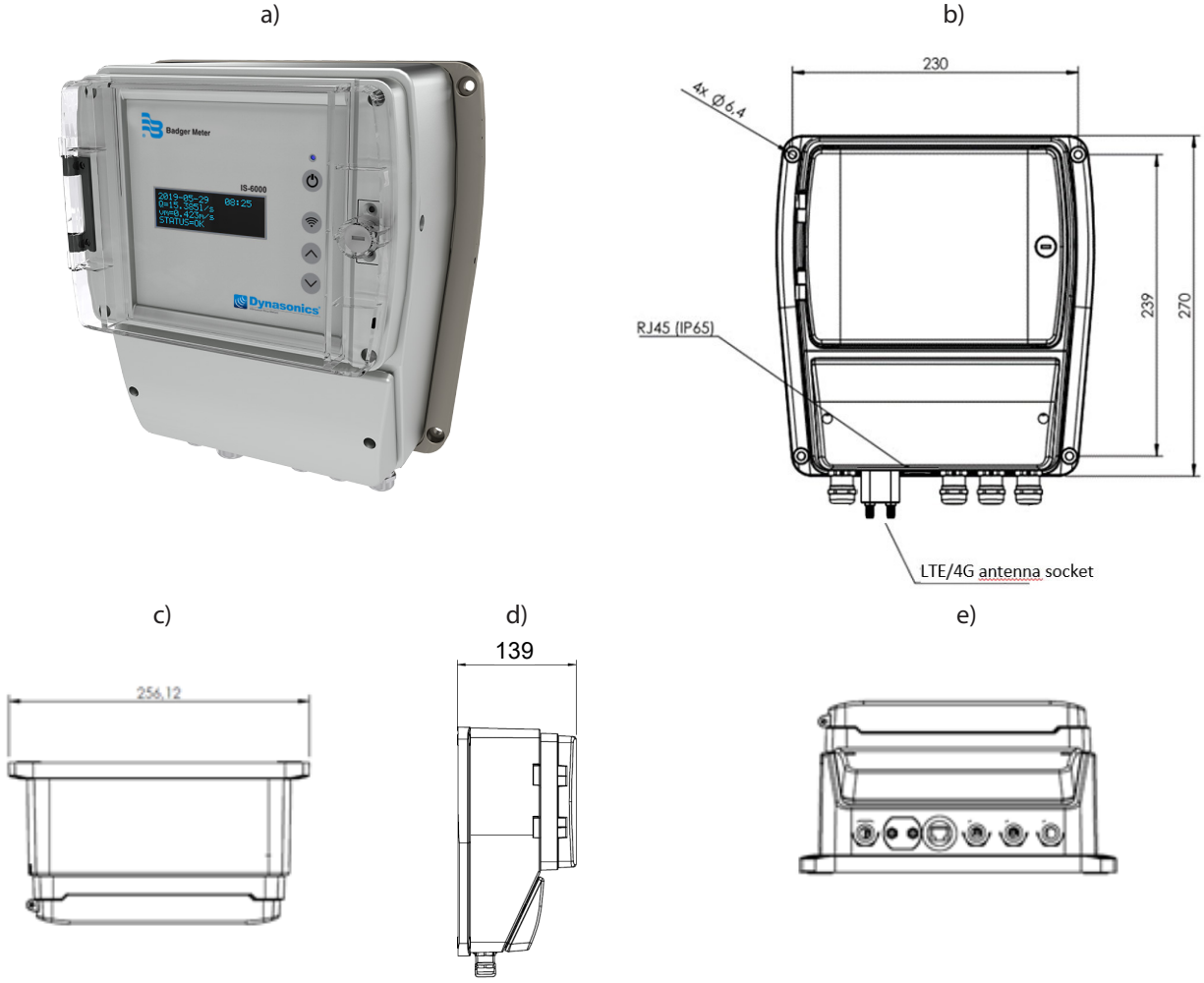


Figure 3: a),b) Front view of transmitter housing for wall installation, enclosure dimensions (in mm)
c),d) top view and side view, dimensions (in mm)
e) bottom view

3.4.2. Software

The IS-6000 Doppler flow meter is programmed and operated by a browser-based user interface that simply can be run via WiFi or LAN connection in any standard web browser via PC, notebook, tablet or smart phone, regardless of location, time and operating system.

The graphical user interface is menu-driven for rapid commissioning, easy parameterization of the measurement site and data visualization and management.

Main features are:

- Intuitive menu-driven user interface
- Direct communication (WiFi) with measuring system
- Automatic identification of measuring system via system-specific IP address
- Status information of measuring system, alarm functions
- Simple parameterization and commissioning of measuring system
- Flexible graphical data visualization (for example real-time zoomable data and time series, data history, velocity profiles)
- Data logging of incoming data and easy data transfer
- Remote system diagnostics, service and maintenance
- Protection from unauthorized access through individual access authorization

3.4.2.1. System requirements

- Network connection (WiFi, LAN)
- Standard latest web browser, for example: Internet Explorer, Firefox, Chrome, Safari, Opera, Android Browser.

3.4.3. Sensors

As a standard, the IS-6000 Doppler meter comes with an area velocity sensor for ultrasonic flow velocity and water level measurement. Depending on the measurement task and site conditions external sensors for example for water level measurement such as a pressure sensor or a non-contact ultrasonic level sensor can be connected via 4…20 mA interfaces.

3.4.3.1. Area Velocity Sensors

The mouse-type area velocity sensor measures flow velocity and water level based on the pulse (echo) coherent method corrected by an embedded temperature sensor. The small sensor dimensions mean less interference resulting in more accurate velocity measurements, especially under low flow conditions.

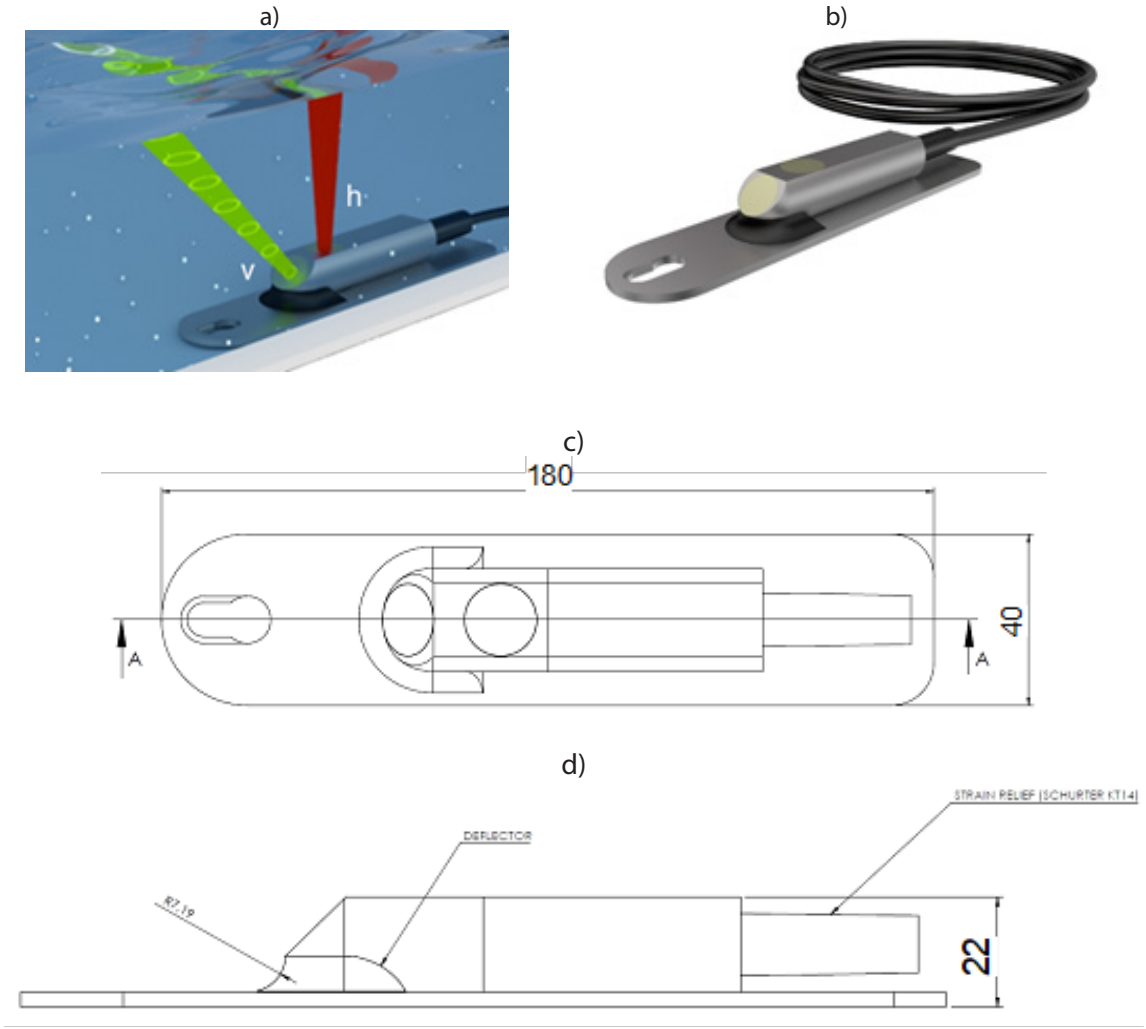
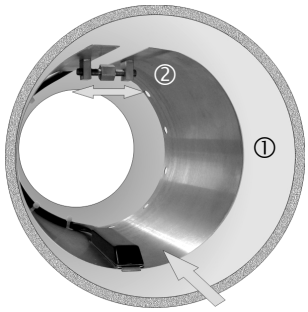


Figure 4: a) Scheme for combined ultrasonic velocity (v) and water level (h) measurement
b) Area velocity sensor incl. mounting plate
c) Dimensions (length, depth in mm), top view
d) Dimensions (height in mm), side view

3.4.4. Sensor Mounting Systems

All sensors can be attached to a mounting plate, spring or scissors rings. The sensor is first attached to a carrier to be slid onto any of the compatible mounting systems. This maintains a height suitable for measuring flow rates and velocities at very low water levels. To install the sensors in rectangular, trapezoidal or earthen channels, use the sensor mounting plate. Stainless steel spring rings simplify sensor installation in cylindrical pipes. Six standard diameter sizes from 8…24 in. (200…600 mm) are available. Before entering the manhole, the sensor and the cable can be fastened in place to the downstream edge of the ring. The self-expanding device sits tight by expanding the band for a friction fit inside the pipe. The adjustable scissors ring is installed in large diameter pipes from 20…57 in. (500…1450 mm). It consists of a base section and one or more pairs of extensions to fit the size of the pipe and a scissors mechanism.



① Pipe
② Tension ring with pre-drilled holes to fasten sensor cable to the ring
③ Area velocity sensor on sensor mounting plate

Figure 5: Example for sensor mounting system (tension ring) in a pipe

4. INSTALLATION

IMPORTANT

Be advised that possible mounting and connection errors and their effects are beyond our control. Therefore, the manufacturer cannot be held responsible for damages as a result of incorrect handling, installation and maintenance of the equipment.

4.1. Installation Location

For reliable, continuous stability and accuracy of the device, follow the instructions below:

- Choose a measuring site with a steady distribution of flow velocity over the cross-section, avoiding highly turbulent flow conditions.
- Avoid measuring sites with sediment accumulation or deposits.
- Always observe ambient temperature at the installation site. Avoid exposure to heat, frost, extreme temperature fluctuations and direct sunlight.
- Make sure that the device is protected from mechanical impacts and vibration.
- If using the device under corrosive or aggressive atmospheric conditions, make sure the location is well ventilated.
- Protect the transmitter from flooding.

4.2. Mounting the Transmitter

NOTE: Mount the transmitter in a position that is protected against direct sunlight and rainfall.

1. Select a proper position on a flat wall surface. Make sure to have a sufficient power supply in the vicinity of the transmitter. Make sure the cabling is safe.
2. Mark the upper drill hole at the positions of the upper hanger in the middle on top of the transmitter enclosure.
3. Drill a hole for corresponding wall plug for fixing screw at the marked point.
4. Mount the transmitter with fixing screw on the wall. Use suitable screws and plugs depending on the wall construction and installation conditions. Make sure the enclosure is aligned horizontally.
5. Then mark the holes for the last two drillings on the left and right site on the bottom of the enclosure and follow the procedure described above.
6. Be sure to tighten the screws firmly.

Temperature Strip

For monitoring ambient temperatures higher than 104° F (40° C), view the yellow self-adhesive temperature strip inside the transmitter enclosure.

An increase in temperature in the range of 104…160° F (40…71° C) will cause an irreversible change of color of the specific segment from light grey to dark grey. The dark color will remain even after subsequent cooling, indicating the maximum temperature that has been reached.

Indicated temperature segments: 104° F (40° C), 109.4° F (43° C), 114.8° F (46° C), 120.2° F (49° C), 129.2° F (54° C), 140° F (60° C), 150.8° F (66° C), 159.8° F (71° C).

NOTE: Always check temperature strip when opening the enclosure.
The temperature strip is for quality assurance and warranty demands. Removal of the strip invalidates the warranty.

4.3. Mounting the Sensors

⚠CAUTION

SENSORS IN USE MUST BE PROTECTED FROM MECHANICAL DAMAGE DUE TO IMPACTS OR ABRASION (FOR EXAMPLE FROM COARSE SEDIMENT LOAD OR ABRASIVE SEDIMENT MATERIAL).

Special mounting systems are available to make sensor installation easier and reduce installation time. Sensors are first mounted to carriers that can be easily attached to any of the compatible mounting system. The signal cable is already fixed at the sensor. The cable length has to be adapted to site conditions.

Always make sure that sensor cables connected to the transmitter are mounted firmly to the wall as tripping on the cables can cause both serious personal injury and permanent damage to cables and connectors. Check again, that the measuring window is not affected by the cables.

⚠CAUTION

ANY ADJUSTMENTS OF CABLE LENGTHS MUST BE CARRIED OUT SOLELY BY THE MANUFACTURER. PLEASE CONTACT OUR SERVICE TECHNICIANS.

4.3.1. Installating an Area Velocity Sensor

Normally, flow velocity is measured against the flow direction due to possible turbulences caused by the sensor itself and the cable that might affect the measurement.

However, the sensor measures flow velocity regardless of the flow direction (*see Figure 6*). Readings measured with sensors installed against the flow direction are registered as positive values (+v) and vice versa (-v).

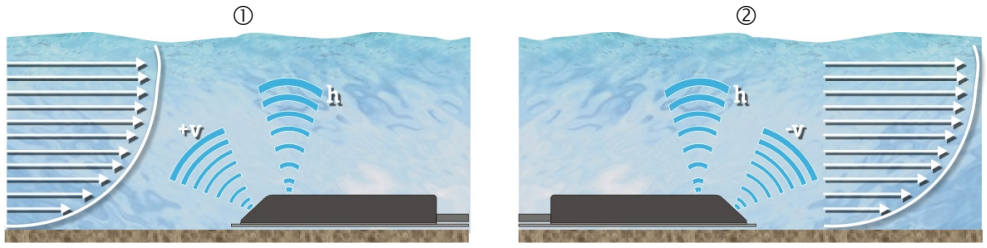


Figure 6: Installation of sensors against flow direction (1) and in flow direction (2)

4.4. Calibration

For all flow velocity measuring systems for partially filled cross-sections that are installed in existing pipelines, a calibration of the measuring site (measurement of network, tracer measurement) is recommended in order to receive an optimum measuring accuracy. During calibration, the water level at the measuring site should be at least 4 in. (10 cm). For instructions for calibration of measuring sites, see DIN EN ISO 748 [2].

NOTE: The calculation for calibration is performed via software in the calibration menu of user interface (▶ Parameter ▷ Calibration).

5. ELECTRICAL CONNECTION

⚠WARNING

- ***Improper connection can cause injury or death. The electrical connection must be carried out by a certified electrician.***
- ***Observe the national regulations for electrical installations! By handling products that are supplied by electrical voltage, you must observe the valid IEC instructions, especially IEC 60364, IEC 61558, IEC 60335, IEC 60598-1 and IEC 60065.***
- ***Before opening an instrument, pull off the main plug and make sure that the instrument is without power supply. Parts, construction groups or instruments must only be set into operation if they are built into a housing and protected against touching. During installation they must be without power. Only use tools at the instruments, parts or construction groups the devices are disconnected from the supply voltage and the electric loads stored in the construction groups inside the instrument are unloaded. Conducting cables or conductors that are connected to the instrument, part or construction group must be checked continuously for isolation faults or sites of fractures. If a fault is found in the supply line, the instrument must be switched off immediately until the defective line has been replaced.***
- ***By using construction elements or groups please make sure that the features for electrical sizes are observed according to the respective description. In case it is not possible to clarify clearly for a non-commercial end-user which electrical variables are valid for a part or a construction group, how external wiring is to be undertaken, which external components or additional devices can be connected and which connection values these external components may have, always contact an expert for respective information.***
- ***Before operation, generally check if the instrument or construction group is suitable for the field of application. If there is any doubt, you must confer with a technical expert or the manufacturer of the used construction group.***
- ***Compare specifications on the nameplate and check for the correct supply voltage on the nameplate.***
- ***Feed the power supply cable and signal cables through the appropriate cable entries.***

5.1. Terminal Compartment

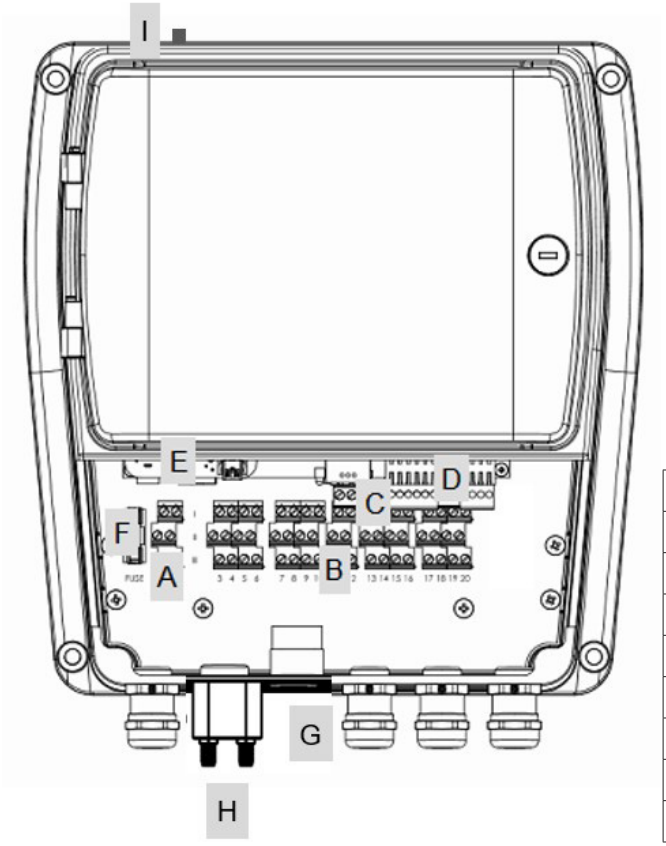
⚠WARNING

RISK OF ELECTRIC SHOCK! SWITCH OFF POWER SUPPLY BEFORE OPENING THE DEVICE. DO NOT INSTALL OR WIRE THE DEVICE WHILE IT IS CONNECTED TO THE POWER SUPPLY. DISREGARDING COMPLIANCE WITH THIS PRECAUTION MAY RESULT IN IRREPARABLE DAMAGE TO THE ELECTRONICS.

IMPORTANT

- ***Protective grounding:*** *Suitable measures for error protection must be carried out. The conductive system parts to be protected must be connected to a suitable earthing conductor via the PE conductor, so that the system parts with a fault are switched off by overcurrent protection devices*
- ***Electronic Discharge:*** *Electronic components can be destroyed by electrostatic discharge during in-stallation. Avoid high electrostatic charges by using suitable grounding measures.*
- ***Disconnecting device:*** *The device must be connected and disconnected to the mains by means of a disconnecting device.*
- ***Power / connection cable:*** *Upon delivery, the transmitter power cable is already connected. If necessary, use a strain relief for the connected cable to prevent accidental disconnection.*
- *The system has no on / off switch. It is therefore imperative to attach the system to an additional circuit breaker (at least 2A) to disconnect the system from the power supply in the event of a fault or repair. The circuit breaker should be within easy reach.*
- *It is necessary to connect the system to an external overvoltage protection device (for example, a circuit breaker).*

The terminal configurations have been set by the manufacturer depending on the specifications ordered. For individual wiring of additional components, see *"5.1.1. Pin Assignments" on page 20*. To open the terminal compartment, unscrew the enclosure cover.



A	Power supply (AC/DC)
B	Connectors I/Os, relay outputs
C	Sensor connection block
D	MODBUS (RS-485, RS-232)
E	LAN, RJ45, SIM Card
F	Fuse
G	Cable entries blocks
H	LTE/4G antenna socket
I	WiFi antenna socket

Figure 7: Overview terminal compartment

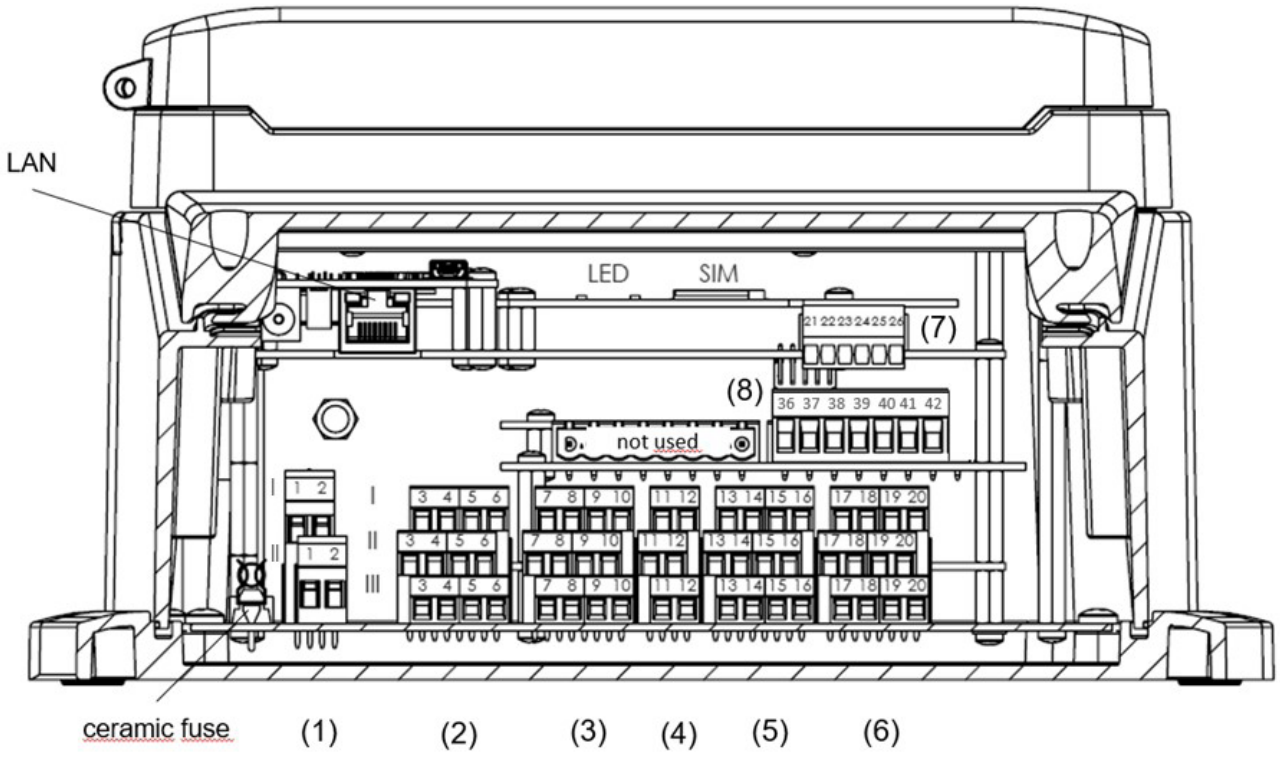
NOTE: The 4G/LTE dipole antenna is connected via the antenna connector on the enclosure bottom next to the cable entry blocks.

IMPORTANT

Specification for cables for wiring:

- *Use copper cable only*
- *Temperature: min. 158° F (70° C)*
- *Cable diameter: 0.04 in.² (1 mm²)*

5.1.1. Pin Assignments



(1) Pins # 1-2 Power supply (AC / DC)
(2) Pins # 3-6 Relays outputs
(3) Pins # 7-10 Digital inputs /outputs
(4) Pins # 11-12 Service interface (RS-485)
(5) Pins # 13-16 Analog outputs
(6) Pins # 17-20 Analog inputs (e.g. for connection of level sensor)
(7) Pins # 21-26 MODBUS (RS-485, RS-232)
(8) Pins # 36-42 Connector block area velocity sensor

NOTE: Upon delivery, the enclosure cover is grounded with a green-yellow grounding cable.

Figure 8: Overview pin assignment

Block	No. (row) (no.)	Name	Description	Cable Color
(1) AC Power Supply (100…240V AC)	(I) (1)	L Phase*	Power supply	Brown or Black
	(II) (1)	PE	Protective earth; grounding terminal	Green/Yellow
	(I) (2)	N Neutral*	Power supply	Blue
	(II) (2)	PE	Protective earth; grounding terminal	Green/Yellow
(1) DC Power Supply (9…36V DC)	(I) (1)	+ DC In	Power supply	Red
	(II) (1)	PE	Protective earth; grounding terminal	Green/Yellow
	(I) (2)	- DC In	Power supply	Black
	(II) (2)	PE	Protective earth; grounding terminal	Green/Yellow

* L = external conductor, N = neutral conductor

Block	No. (row) (no.)	Name	Description
(2) AC/DC Relay Outputs	(I) (3)	NO1	Relay 1
	(II) (3)	COM1	normally closed (NC) or normally open (NO) contact available
	(III) (3)	NC1	max. 40V / 1A AC, max. 60V / 1A DC
	(I) (4)	NO2	Relay 2
	(II) (4)	COM2	normally closed (NC) or normally open (NO) contact available
	(III) (4)	NC2	max. 40V / 1A AC, max. 60V / 1A DC
	(I) (5)	NO3	Relay 3
	(II) (5)	COM3	normally closed (NC) or normally open (NO) contact available
	(III) (5)	NC3	max. 40V / 1A AC, max. 60V / 1A DC
	(I) (6)	NO4	Relay 4
	(II) (6)	COM4	normally closed (NC) or normally open (NO) contact available
	(III) (6)	NC4	max. 40V / 1A AC, max. 60V / 1A DC
(3) AC/DC Digital Inputs / Outputs	(I) (7)	+DO1	pulse output 1 (+) pulse width / frequency adjustable
	(II) (7)	- DO1	pulse output 1 (-)
	(III) (7)	+24V DC*	—
	(I) (8)	+DO2	pulse output 2 (+) pulse width / frequency adjustable
	(II) (8)	- DO2	pulse output 2 (-)
	(III) (8)	GND	—
	(I) (9)	+DI1	digital input 1 (+) max. 30V
	(II) (9)	- DI1	digital input 1 (-)
	(III) (9)	+24V DC*	—
	(I) (10)	+DI2	digital input 2 (+) max. 30V
	(II) (10)	- DI2	digital input 2 (-)
	(III) (10)	GND	—
(4) AC/DC Service Interface RS-485	(I) (11)	A	not connected
	(II) (11)	B	not connected
	(III) (11)	Y	not connected
	(I) (12)	Z	not connected
	(II) (12)		not connected
	(III) (12)		not connected
(5) AC/DC Analog Outputs	(I) (13)	+AO1	analog output 1 (+) active, 4…20 mA, load < 550 Ω
	(II) (13)	-AO1	analog output 1 (-)
	(III) (13)	+24V DC*	—
	(I) (14)	+AO2	analog output 2 (+) active, 4…20 mA, load < 550 Ω
	(II) (14)	-AO2	analog output 2 (-) 0/4…20 mA
	(III) (14)	GND	—
	(I) (15)	+AO3	analog output 3 (+) active, 4…20 mA, load < 550 Ω
	(II) (15)	-AO3	analog output 3 (-) 0/4…20 mA
	(III) (15)	+24V DC*	—
	(I) (16)	+AO4	analog output 4 (+) active, 4…20 mA, load < 550 Ω
	(II) (16)	-AO4	analog output 4 (-) active, 4…20 mA, load < 550 Ω
	(III) (16)	GND	—
(6) AC/DC Analog Inputs	(I) (17)	+AI1	analog input 1(+) 4…20 mA
	(II) (17)	-A1	analog input 1(-)
	(III) (17)	+24V DC*	—
	(I) (18)	+AI2	analog input 2 (+) 4…20 mA
	(II) (18)	-AI2	analog input 2 (-)
	(III) (18)	GND	—
	(I) (19)	+AI3	analog input 3 (+) 4…20 mA
	(II) (19)	-AI3	analog input 3 (-)
	(III) (19)	+24V DC*	—
	(I) (20)	+AI4	analog input 4 (+) 4…20 mA
	(II) (20)	-AI4	analog input 4 (-)
	(III) (20)	GND	—

* max. 200 mA = auxiliary supply (sum) for all connected sensors

Block	No. (row) (no.)	Name	Description		Cable Color
(7) AC/DC MODBUS			**RS-485**		**RS-232**
			4-wire	**2-wire**	
	(21)		-TX	-D	TXD
	(22)		+TX	+D	NA
	(23)		-RX	NA	NA
	(24)		+RX	NA	RXD
	(25)		GND	GND	GND
	(26)		SH	SH	SH
(8) AC/DC Connection area velocity sensor	(36)	T-	Temperature -		pink
	(37)	T+	Temperature +		grey
	(38)	h-	Water level -		yellow
	(39)	h+	Water level +		green
	(40)	v-	Velocity -		white
	(41)	v+	Velocity +		brown
	(42)	shield			

IMPORTANT

Input/output data (I/O values) are programmed in the software in the I/O main menu.

Additional elements

SIM card slot	Slot for SIM card insertion / removal
LAN	RJ45 socket for Ethernet connection / local LAN via RJ45 cable
LED	LED control light flashes during GSM data transfer
Fuse	AC version: Fuse T2A (slow blow fuse) / 250V 5 × 20 DC version: Fuse T2A (slow blow fuse) / 250V 5 × 20

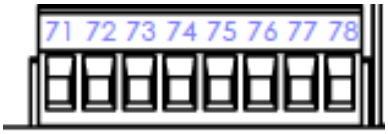
5.2. Connecting the Sensors

Sensors are connected to the connector blocks according to the specific sensor types. The voltage supply of the sensors is provided by the transmitter.

⚠CAUTION

- ***Before connecting or disconnecting the cable, be sure the power is switched off.***
- ***Sensor connection must be carried out in accordance to wiring diagram, for instance the cable colors must match with pin assignment.***
- ***For connecting the cable sheath should only be removed for a maximum length of 1.6 in. (4 cm).***
- ***The stripped length of the cable has to be shorter than 0.3 in. (7 mm).***
- ***Stranded ends should be either provided with ferrules or tinned.***
- ***Avoid too tight clamping when attaching the cable to the transmitter. Compression of the converter cable might lead to short-circuit between the signal and the shielding and might damage the transmitter.***
- ***After connecting the cable, the cable bushing underneath the enclosure should be tightened.***
- ***All cables must be installed in order to protect cables from mechanical destruction. Mount the cables firmly to the wall, without any loops and crossovers and in sufficient distance to moving parts to avoid accidents caused by stumbling.***

5.2.1. Connecting Area Velocity Sensor



No.	Name	Cable Color
(71)	Not used	—
(72)	Not used	—
(73)	Sensor - h - B	Yellow
(74)	Sensor - h - A	Green
(75)	GND	—
(76)	GND	Black
(77)	Sensor – v - B	White
(78)	Sensor – v - A	Brown

v: velocity (measured by velocity sensor)
h: height (water level measured by water level sensor

Figure 9: Pin assignment (# 71-78) for the connection of area velocity sensor

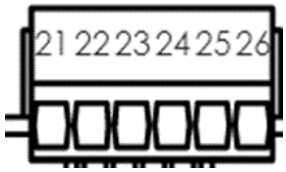
5.2.1.1. Connecting Multiple Area Velocity Sensors

The IS-6000 Doppler meter allows the connection of up to 3 area velocity sensors for flow velocity measurements at up to 3 measurement spots in one cross-section. For the connection of multiple sensors, additional boards have to be installed. Depending on the transmitter enclosure type, an additional enclosure might be needed. Costumer-specific connection diagrams will be provided regarding the number of sensors and enclosure type. The connected sensors are identified by definition of specific sensor IDs and can be parameterized individually via the software.

5.2.2. RS-485 /RS-232 Modbus Configuration

NOTE: The 120-Ohm termination resistor is only needed for the last participant / device on the bus.

Upon delivery, the dip switch settings at the MODBUS module are set to RS-485 4-wire (standard setting). For other customer specific settings, please contact our service engineers.



	No.	Name / Description		
		RS-485 4-wire (standard)	RS-485 2-wire	RS-232
(7) AC/DC	(21)	-TX	-D	TXD
	(22)	+TX	+D	NA*
MODBUS	(23)	-RX	NA*	NA*
	(24)	+RX	NA*	RXD
RS-485 /	(25)	GND	GND	GND
RS-232	(26)	SH	SH	SH

* NA: not assigned/used

Figure 10: Pin assignments # 21-26 for connection on RS-485 2-wire / 4-wire and RS-232 (pin assignment for aluminium enclosure – integrated 4G/3G/2G modem)

5.3. Final Check of Electrical Connections

On completion of the electrical wiring and before connecting the device to the power supply, make sure that the supply voltage matches the specification on the name plate and check the following instructions:

IMPORTANT

- *Visual inspection for damages on transmitter, cables, sensors, and cables glands.*
- *Make sure the enclosure is properly fitted, clean and undamaged. All screws must be firmly tightened.*
- *All cable glands must be installed, tightened, and sealed.*
- *Use blind plugs for unused cable entries.*
- *Lay the cables in a downward hanging loop just before the cable entry so that possible moisture can collect in the loop and does not reach the cable entry.*
- *Adjustment of cables must be carried out by the manufacturer only.*
- *Mounted cables must have adequate strain relief.*
- *Do not bend cables to avoid cable breaks.*
- *Defective cables must be replaced by the manufacturer only.*

NOTE: For devices with external 3G/2G router or integrated 4G/3G/2G modem, it is recommended to insert the SIM card and connect the 4G/LTE dipole antenna prior to turning on the power supply.

⚠CAUTION

AFTER ELECTRICAL CONNECTION CHECK AGAIN:

- ***VISUAL INSPECTION FOR DAMAGES ON TRANSMITTER, CABLES, SENSORS AND CABLES GLANDS.***
- ***ENSURE THAT THE ENCLOSURE IS PROPERLY FITTED, CLEAN AND UNDAMAGED.***
- ***ALL CABLE GLANDS ARE INSTALLED, TIGHTENED AND SEALED.***
- ***USE BLIND PLUGS FOR UNUSED CABLE ENTRIES.***

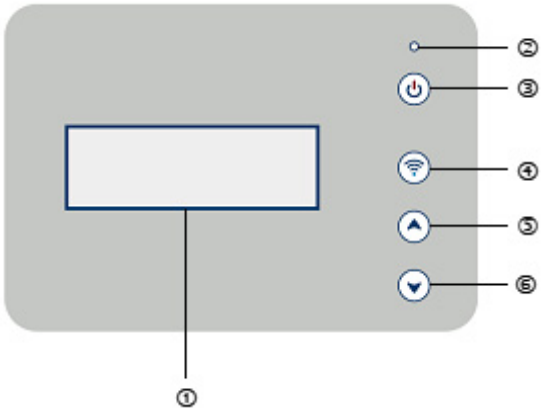
⚠CAUTION

- ***ADJUSTMENT OF CABLES MUST BE CARRIED OUT BY THE MANUFACTURER ONLY.***
- ***MOUNTED CABLES MUST BE STRAIN RELIEVED.***
- ***DO NOT BEND CABLES TO AVOID CABLE BREAKS.***
- ***DEFECT CABLES MUST BE REPLACED BY THE MANUFACTURER ONLY.***

6. COMMUNICATION WITH TRANSMITTER

6.1. Control Panel and LC-Display

The transmitter does not have an extra power switch. On connecting the transmitter to a power supply the LC-Display shows the programmed parameters and the control panel can be operated (*see Figure 11*).



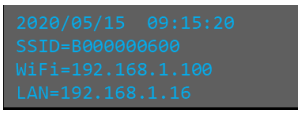
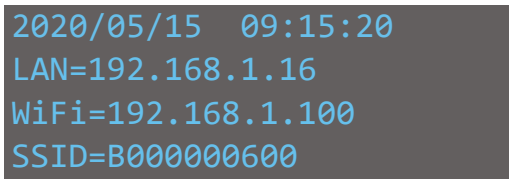
①	LC-Display 	Continuous display of flow meter status and current readings. Desired parameters and corresponding units to be displayed are user defined by programming every single lines of the display page via management user interface. Display / Scroll interval is also defined via user interface.
②	LED control light	● power on ● power off
③		Reset / Restart button Press button for 1 second > software controlled shut down. → Reset after 3 seconds Press button for more than 8 seconds > hardware controlled power off / switch off → Restart after 3 seconds ⓘ Only use if system is unresponsive!
④	WiFi	Press to start / stop WiFi.
⑤ ⑥	Navigation keys up / down	Press to navigate through single display pages.

Figure 11: Control panel and display functions

For programming and operation simply connect your PC, notebook, tablet, or smart phone to the flow computer of the transmitter via WiFi or LAN by calling up the graphic user interface (GUI) using a standard web browser.

6.2. Wireless Communication WiFi

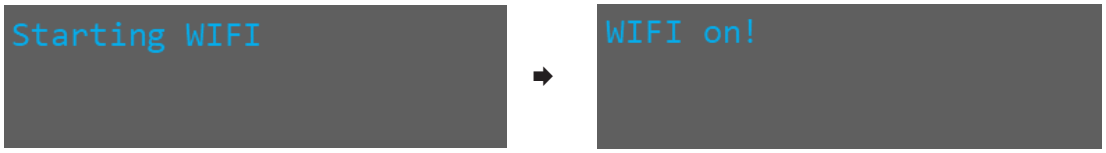
(1) Switch on power supply for transmitter.
The display will show the predefined specific SSID (access point name) of the device: for example B000000600 (corresponding to serial number of device).



(2) Start WiFi by pressing WiFi button of transmitter.

Press

Wait for status message "WIFI on!".

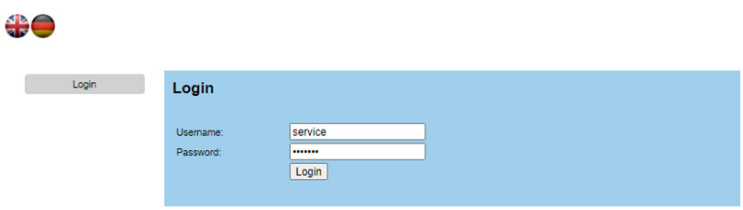


If WiFi IP address does not display, reboot the meter.

(3) Switch on your PC, notebook, tablet or smartphone and establish WiFi connection according to your operating system.

(4) Select predefined SSID to connect transmitter with your device.
Enter the **WiFi password** according to the network number printed below the manufactured date on the nameplate (see 9 on nameplate). Enter only numbers without characters or space!
Example:
number: B131104/1208 > **password: 1311041208**
Then open your web browser and type the following IP address in the address bar:
192.168.1.100
The IP address is also displayed on the transmitter display under WiFi.

(5) If your device is connected to the transmitter, the login page of the GUI (graphical user interface) opens.



(6) Log in by entering user name and password to start working with the user interface.

Username: service
Password: badger6000

NOTE: Cookies and JavaScript must be enabled in your browser settings to login.

If settings are not activated, the following error messages appear:

6.3. Communication to the Transmitter via Ethernet LAN

Use RJ45 cable to connect transmitter with your PC.

Then establish connection corresponding to individual network settings or ask your network administrator for assistance.

Default setting: Automatic assignment of the IP address via DHCP.

The corresponding IP address is displayed on the transmitter display under LAN.

Manual IP address assignment (without DHCP): If a static IP address, subnet mask and default gateway are required, the parameters can be assigned manually by deactivating DHCP and enter new IP address and network parameters.

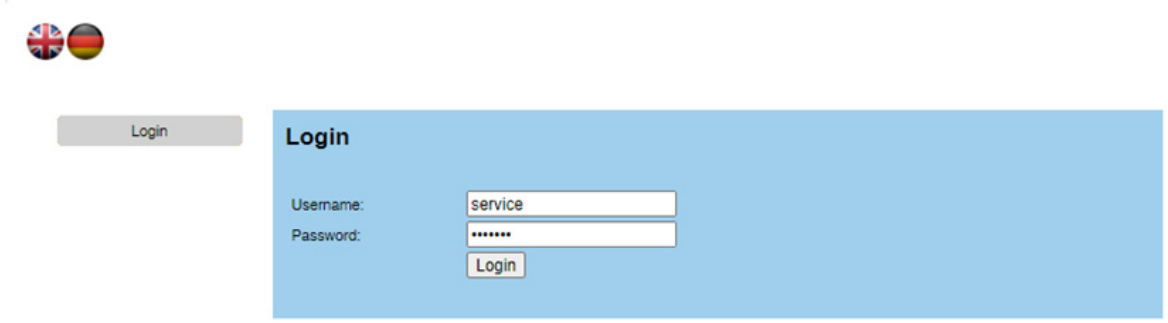
The settings are changed in GUI in the main menu ▶ **Communication** under ▷Network LAN.

7. PROGRAMMING

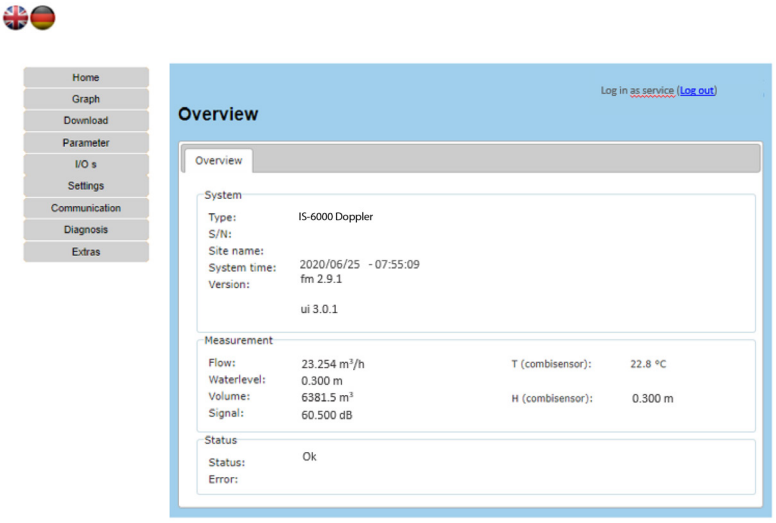
7.1. Login

After connecting to the transmitter, the login page of the GUI will be displayed.

▼ **Login**



▷ **Login**

Setting	**Description**
Username	> Enter username **> service**
Password	> Enter your password **> badger6000**
	☝ Click > **Login** to sign in.
A query window appears for saving the password for future logins (browser dependent).	
Save Password	☝ To save the password in the browser cache of the local computer click **Save password.**
The main page opens:	

7.1.1. User Groups and Access Rights

The following user groups with different individual user rights are preset by the manufacturer.

Username (name of user group)	**Rights**	**Password**
User	• Read data • Read parameters and settings • Download data files	1234
Service	In addition to the rights under the login *User*: • Set, change and save transmitter settings • Definition of units and user defined measurement parameters • Restart of volume calculation • Software update • Backup and restore settings	badger6000

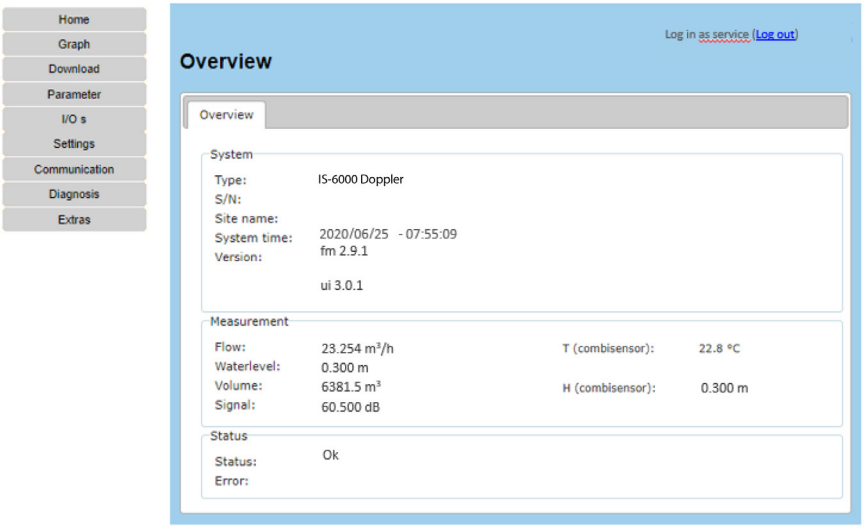
IMPORTANT

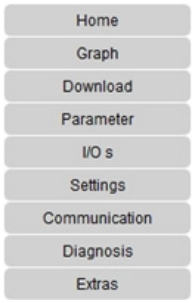
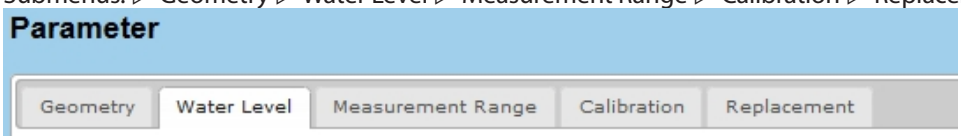
Passwords are predefined and can only be changed by the manufacturer. The manufacturer has full access to the unit and data for online analysis, troubleshooting and debugging.

7.2. Menu Structure

The user interface is clearly structured and shows four function areas:

① Main menu, ② Submenu, ③ Language selection, ④ Log in / Log out



①	Main menu:	The main menu consists of the following 9 main menu items:
		Select by clicking on desired submenu button. Selected item will be highlighted in blue.
②	Submenu:	Display of selected main menu item with submenus for editing further specific functions and settings.
		Example: Main menu item ▶ **Parameter** Submenus: ▷ Geometry ▷ Water Level ▷ Measurement Range ▷ Calibration ▷ Replacement 
③	Flag symbols	Language selection (further languages available under ▶ **Extras** ▷ Language Location)
④	Log in / Log out S/N:	Right side: • S/N: Display of serial number of connected flow meter • Display of name of site • Log-in information (display of username of current user) • **Log-out** function to end the session

7.2.1. Overview of Main Menu Items and Function of Corresponding Submenus

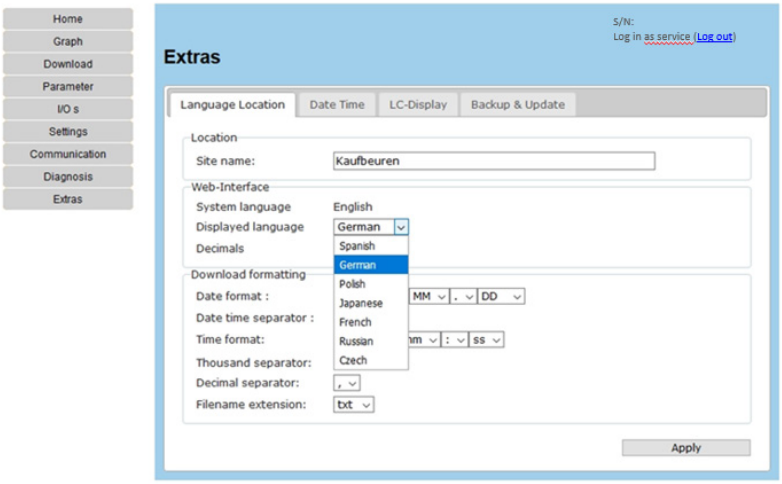
Home	▷ **Overview** Overview status of measuring system. (system specification, name measuring site, display current readings, status information, error messages, version no.)
Graph	▷ **3 Days** ▷ **Current** ▷ **History** ▷ **v-Profile** ▷ **Settings** Data visualization (real time data, customized time series, velocity profile)
Download	▷ **Download** ▷ **Setting** Data retrieval and customizing settings for data transfer
Parameter	▷ **Geometry** ▷ **Water level** ▷ **Measurement Range** ▷ **Calibration** ▷ **Replacement** Parameterization of measuring profile, settings for water level measurement, measurement range, calibration, discharge calculation replacement function
I/Os	▷ **Analog In** ▷ **Analog Out** ▷ **Digital In** ▷ **Digital Out** ▷ **User values** I/Os settings for digital, analog in- and outputs, pulse outputs, user defined outputs
Settings	▷ **Logging** ▷ **Units** ▷ **Displayed Units** ▷ **Totalizer** Customized settings for data logging, units, volume totalizer.
Communication	▷ **Network** ▷ **SMS** ▷ **FTP** ▷ **Modbus** ▷ **Serial** Selection of communication type (LAN, FTP, Modbus, Serial) / communication interface to sensor, settings for SMS alarm
Diagnosis	▷ **Log Files** ▷ **Data** Display of log file content for analysis, data summary sheet.
Extras	▷ **Language** ▷ **Date Time** ▷ **LC-Display** ▷**Power Management** ▷ **Backup & Update** Settings for language, data transfer, date and time, time synchronization, settings for power management (during battery operation) and options for backup and software update.
HW Configuration	▷ **DSP Configuration** Settings for DSP (Digital Signal Processing) configuration. ⓘ This menu is only visible and editable by the manufacturer or authorized users.

For the description of the user interface (GUI), the following symbols are used:	
▶	Main menu item
▷	Submenu
🖱	Mouse click, left mouse button
>	Type, enter, etc.
▼	Select from drop-down list
☐	Checkbox, disabled > function not active
☑	Checkbox, enabled > function active
Update	Commands are written in **bold**
Link	Link; click on **link** to activate function
ⓘ	Notice, information
[1]	Literature reference

7.3. Settings for Language and Location

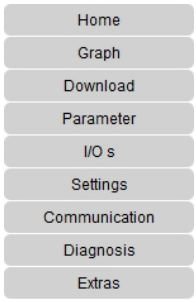
Default language at first start is English. To change the displayed language, click main menu item > **Extras.** The corresponding flag symbol of the selected language will be displayed. To change between languages, click the flag symbol.

▼ **Extras**

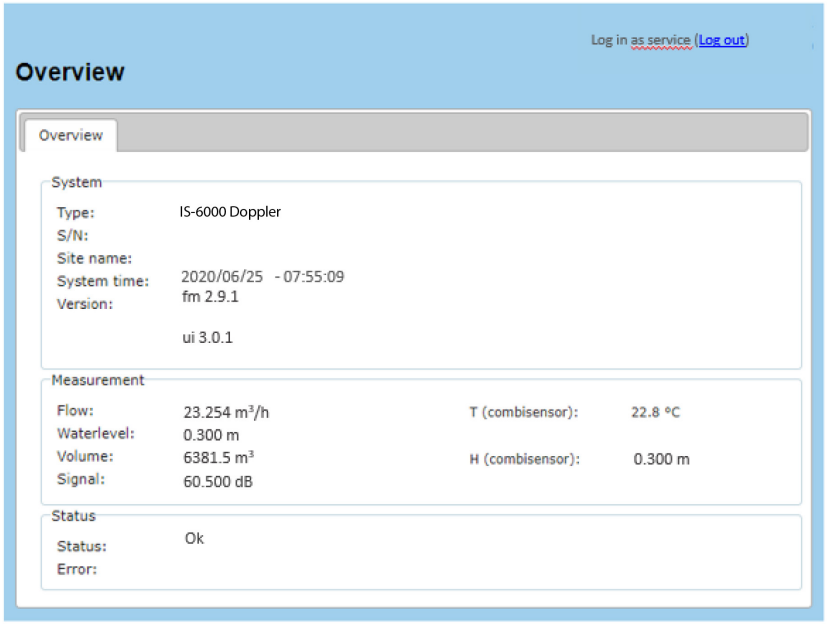


▷ **Language Location**	
Setting	**Description**
Location	
Site name	> Enter name of measuring site. Site name is displayed on start page ▼ Home – Overview.
Web-Interface	
System language	English
Displayed language ▼Spanish… Czech	> Select language from drop-down list.
	☝ Click **Apply** to save settings. The corresponding flag symbol of the selected language will be displayed. ☝ Click the flag symbol to change between languages.
	For more settings, see *"7.2.1. Overview of Main Menu Items and Function of Corresponding Submenus" on page 31*.

7.4. Home - Overview

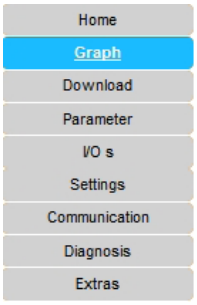


▶ **Home - Overview**
▷ Overview
General information on measuring system and status.



▷ **Overview**		
Parameter	**Setting**	**Description**
System	Type	Display name of connected measuring system.
	S/N	Display of serial number of measuring system; automatically assigned.
	Site name	Display name measuring site. Name entry field under ▼ **Extras** ▷ Language Location.
	System time	Display system time
	Version	Current version numbers of hard- and software fm: version flow meter ui: version GUI (user interface).
Measurement	Flow	Display of current value discharge.
	Water level	Display of current water level.
	Volume	Display of current value total volume.
	Signal	Display of current signal value.
	T (combisensor)	Display of current water temperature
	H (combisensor)	Display of current water level value
Status	Status	Display device status.
	Error	Display of date, time, error codes (binary code) and error description. ⓘ Note that on the transmitter LCD the specific error code will not be displayed. Error message displayed on transmitter: ERROR. Refer to user interface for error code.

7.5. Graph - Data Visualization



▶ Graph

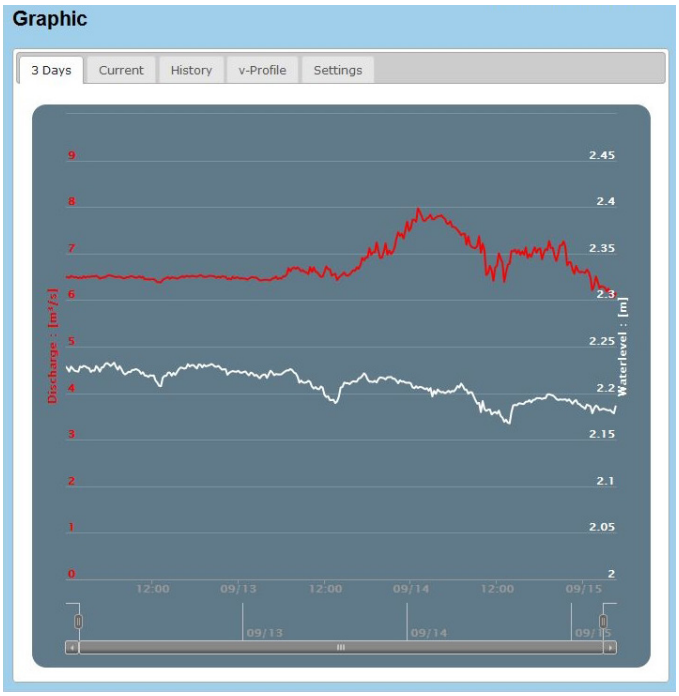
▷ 3 Days ▷ Current ▷ History ▷ v-Profile ▷ Settings

This menu consists of 5 functions and provides flexible options for graphical display of data, for example

- online data presentation (Current)
- data point information by clicking directly on data curve
- data display over a user defined time period, data history (3 Days, History)
- velocity profile (v-Profile)
- customized parameters, color selection and scaling (Settings)

7.5.1. Three-Day Display

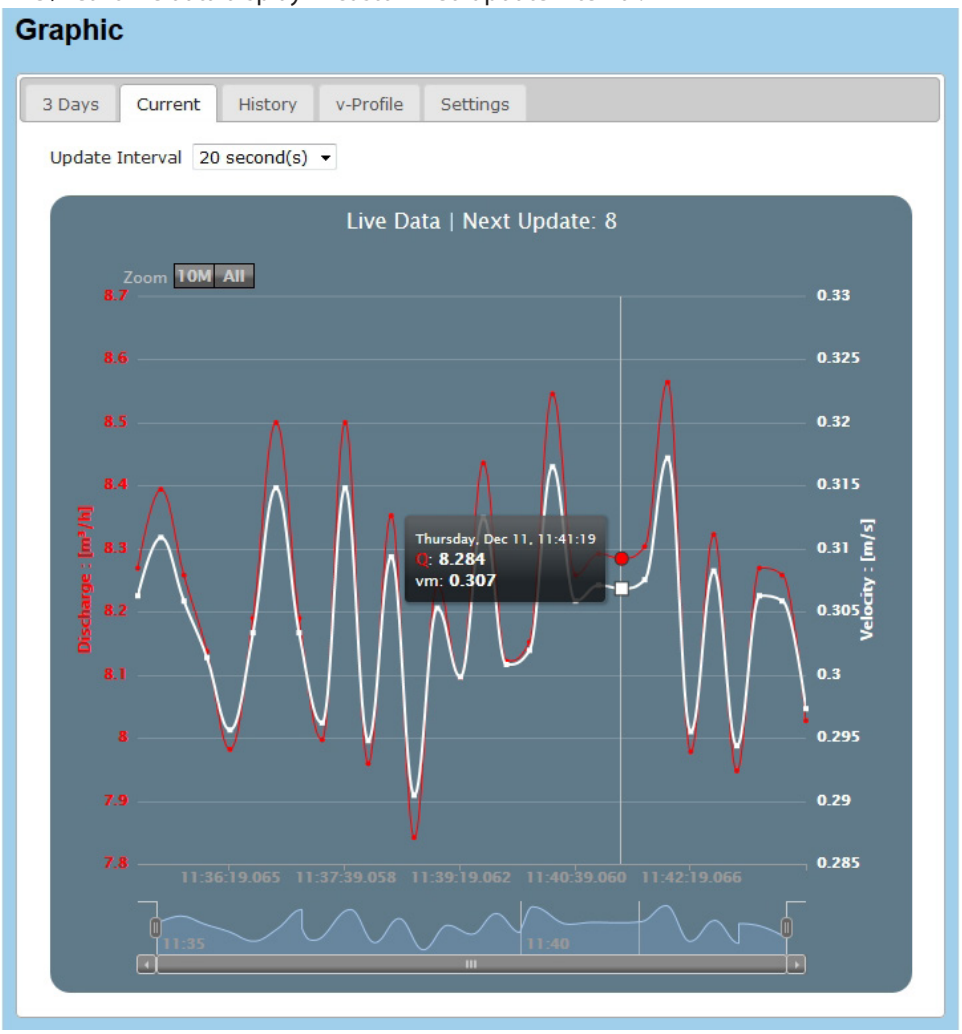
Display time series over max. 3 days.



▷ **3 Days**	
Setting	**Description**
3 Days	Data display of last 3 days. ☝ Click on single data point for display of measurement value.
Adjustable time bar	Select time span by adjusting the time bar; click with left mouse button on the end of the bar, hold down the left mouse button and drag bar in position for desired date

7.5.2. Current

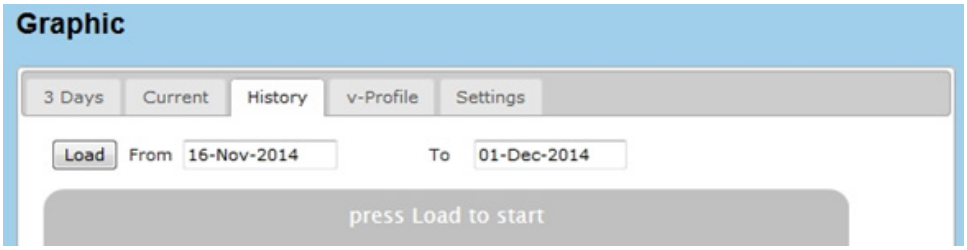
Live / real time data display in customized update interval.

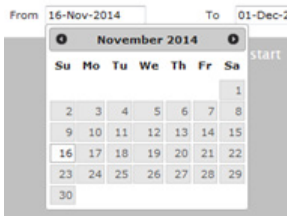


▷ **Current**	
Setting	**Description**
Update Interval ▼ 5…30 seconds	> Select time for data update interval from drop-down list.
Zoom 10M - All	Zoom options data display. Click **10M** to display data of last 10 minutes since opening page in selected update interval. Click **All** to display all data since opening page in selected update interval. Adjustable time bar: Zoom function for data display in user defined time span by adjusting the time bar. Click with left mouse button on the end of the bar, hold down the left mouse button and drag bar in position for desired time interval for data display. Click on single data point for display of measurement values.

7.5.3. History

Data display over user-defined time span.

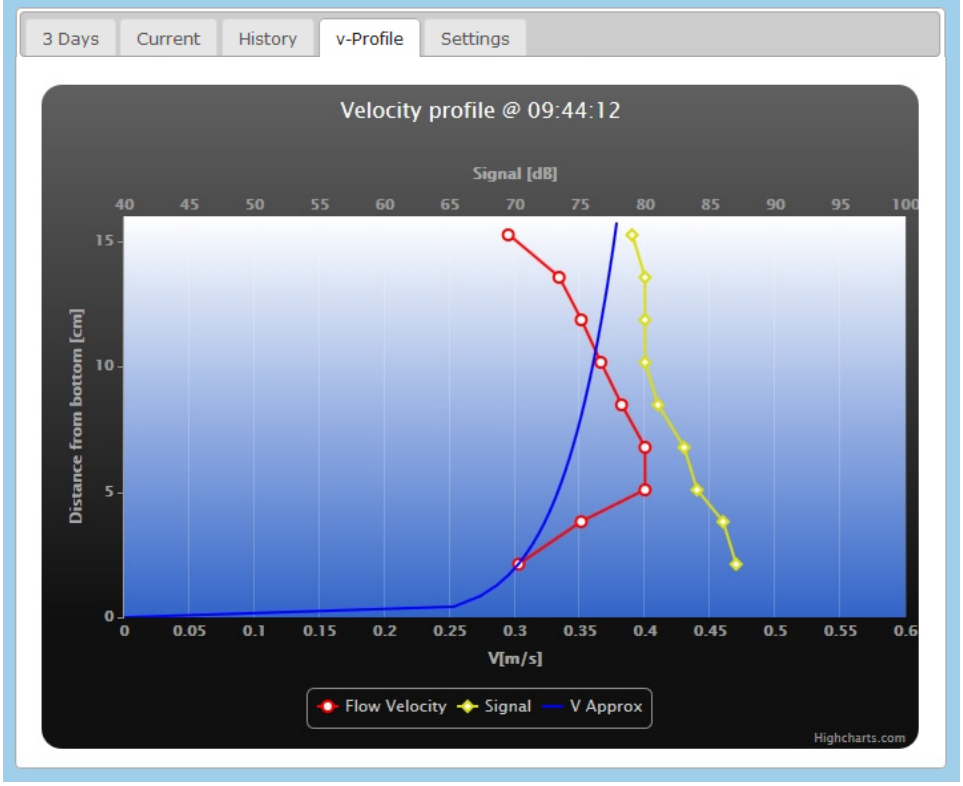


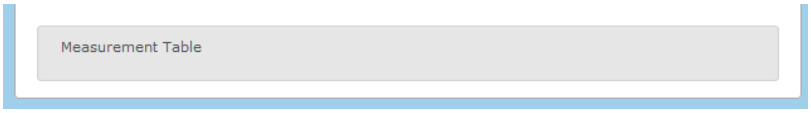
▷ **History**	
Setting	**Description**
From … To	> Enter start and end date for time series from drop-down calendar  ☟ Click **Load** to get data.

7.5.4. Velocity Profile

Display of velocity profile velocity (velocity lower X-axis) / distance from bottom (Y-axis), Signal (upper X-axis) and approximated velocity curve.

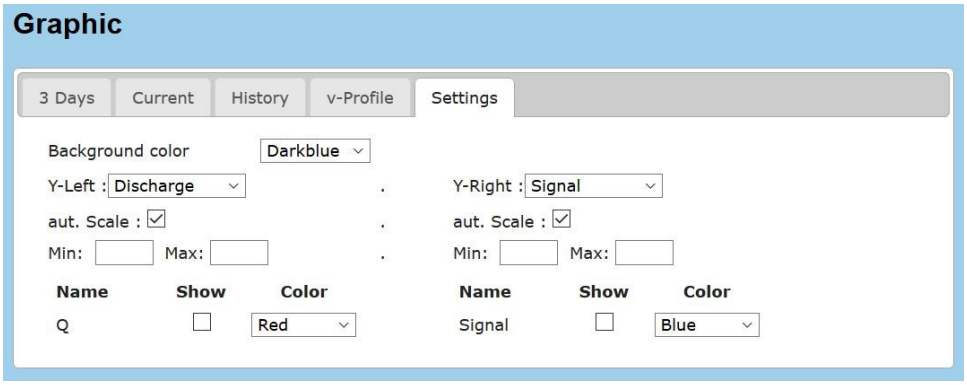
Graphic



▷ **v-Profile**	
Setting	**Description**
Measurement Table	☝ Click on single data point for display of measurement value.
	☝ Click **Measurement Table** to list data. 

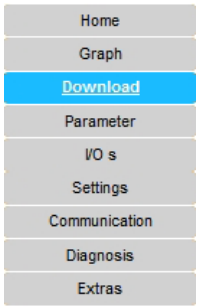
7.5.5. Settings

Parameter selection of the two Y-axes and display options.



▷ **Settings**	
Setting	**Description**
Background Color ▼ Dark blue HV Blue (…)	> Select color for background of graphic.
Y-Left ▼ Discharge Velocity Volume (…)	> Select parameter to be displayed on left Y-axis from drop-down list: Discharge Velocity Volume Waterlevel Area Temperature Signal Voltage Unitless
Y-Right ▼ Discharge Velocity Volume (…)	> Select parameter to be displayed on right Y-axis from drop-down list: Discharge Velocity Volume Waterlevel Area Temperature Signal Voltage Unitless
aut. Scale: ☐	> ☑ Tick checkbox to activate automatic scaling.
Min:	> Enter minimum value to be displayed. (entry only possible if automatic scaling is disabled)
Max:	> Enter maximum value to be displayed. (entry only possible if automatic scaling is disabled)
List Name	Display of selected parameter.
Show ☐	> ☑ Tick checkbox to show listed parameter.
Color ▼ Red Yellow (…)	> Select display color.

7.6. Download, Data Transfer



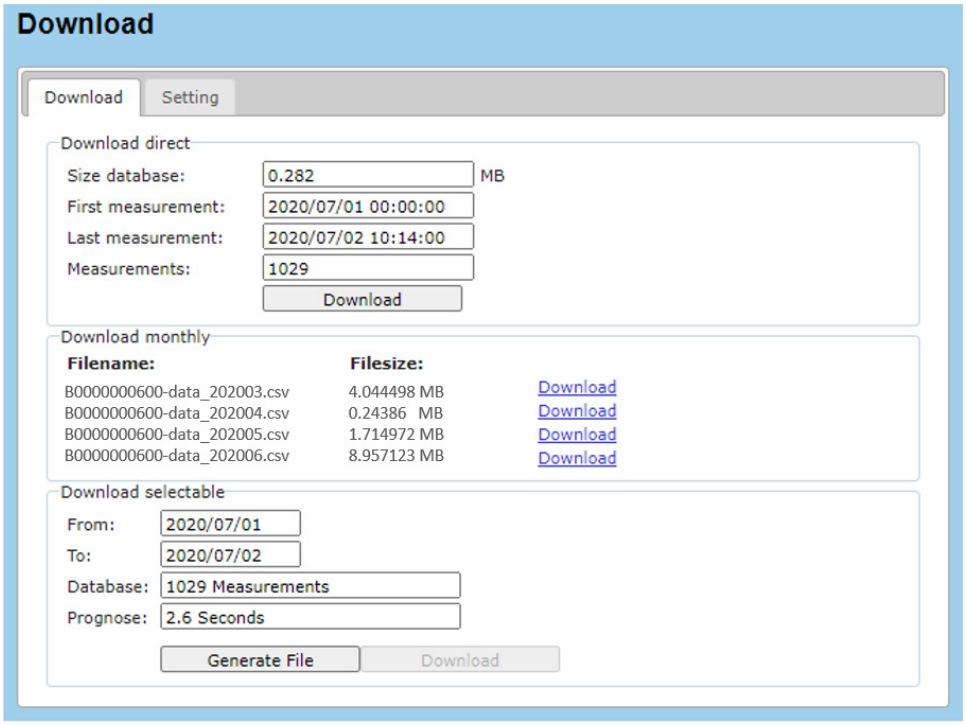
▶ **Download**
▷ Download ▷ Setting

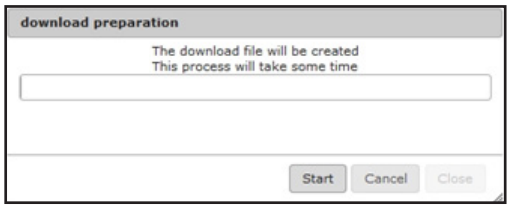
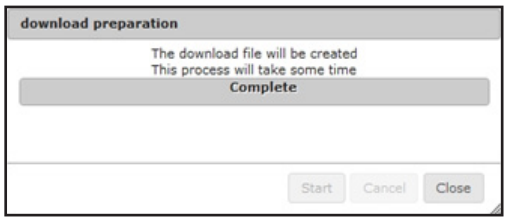
Options for data download.

7.6.1. Download

Settings for data download options.

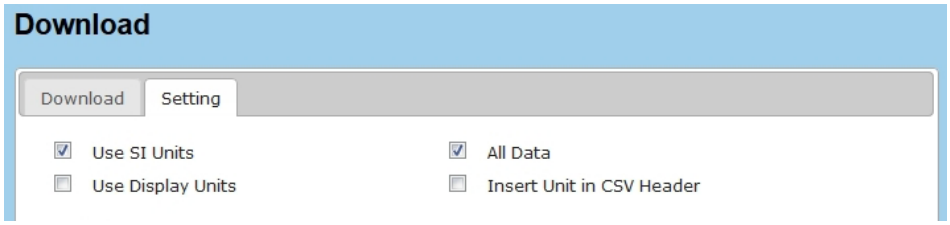
- Download of entire raw data.
- Download of monthly recorded data.
- Download of data over a user defined period.



▷ **Download**	
Download direct Download of raw data in SI units to a CSV-file. Units are not displayed in raw data file.	
Setting	**Description**
Size database	Display data base size.
First measurement	Display of date and time of first measurement.
First measurement	Display of date and time of last recorded measurement.
Measurements	Display of total numbers of measurements.
	☝ Click **Download** to save data file (data.csv). Depending on your browser settings a dialog box opens to open or save the data file. Confirm with > **OK** in the dialog box to start data download or press > **cancel** to abort data transfer.
Download monthly	Download of monthly recorded data. File name serial no-data_yyyymm.csv will be displayed and can be downloaded directly by clicking ☝ **Download.**
Download selectable Download of user-defined data sets and units for user defined period. ⓘ For selection of data sets and units go to ▶ **Download** ▷ Setting. For download formatting see under ▶ **Extras** ▷ Language Location.	
From	> Enter measurement start date from drop-down calendar.
To	> Enter measurement end date from drop-down calendar.
Database	Display of total numbers of measurements.
Prognosis	Display of estimated download time.
	☝ Click **Generate File** for download preparation. A dialog box opens to display download progress.  ☝ Click **Start** for download. While downloading data the remaining time is indicated. Or click ☝ **Cancel** to abort.  If download is complete ☝ click **Close** to return to main window. Then ☝ click highlighted button **Download**. Depending on your browser settings a dialog box opens to save or open the data file. Select the desired option in the dialog box (for example confirm with > OK or > cancel to abort data transfer) to complete data download. Default file name: System name_device serial number_start date yyyymmdd – last date yyyymmdd.csv

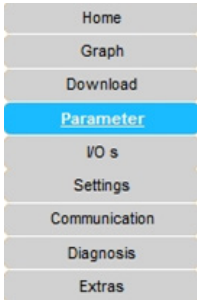
7.6.2. Setting

Settings for selection of parameters and corresponding units (SI units or displayed units) for download-file under Download selectable.



▷ **Setting**	
Setting	**Description**
Use SI units	☑ Tick checkbox to download data in SI units.
Use Display units	☑ Tick checkbox to download data in displayed units. ⓘ Before you start to choose the data, please check and define the displayed units in the main menu ▶ **Settings** under ▷ Displayed Units.
All Data	☑ Tick checkbox to select all data shown below. Do not tick if you want to select single parameters.
Insert Unit in CSV Header	☑ Tick checkbox to display unit in csv-file.
	In the following list you can also specify single parameters **(Length, Time, Time, Q, Velocity, Volume, Temperature, Unitless, Concentration, Signal, Voltage…)** for download by ticking the corresponding checkboxes. **NOTE:** The list comprises and shows all possible parameters that can be set for all measuring systems using the specified transmitter type and not only for the connected system.

7.7. Parameter - Parameterization



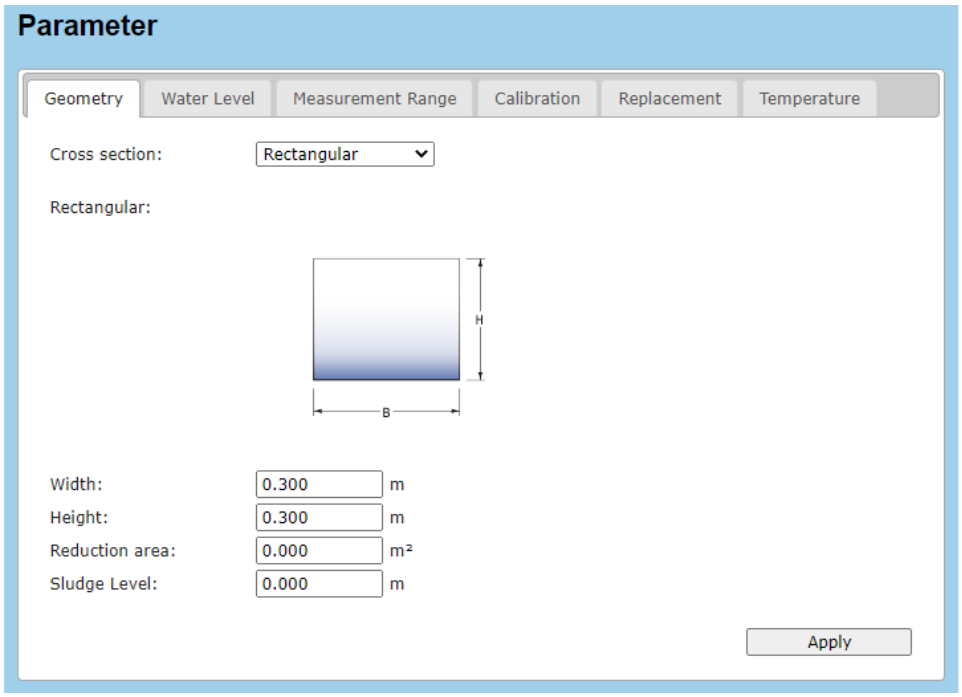
▶ **Parameter**
▷ Geometry ▷ Measurement Range ▷ Calibration
▷ Replacement ▷ Temperature
The menu provides further options for

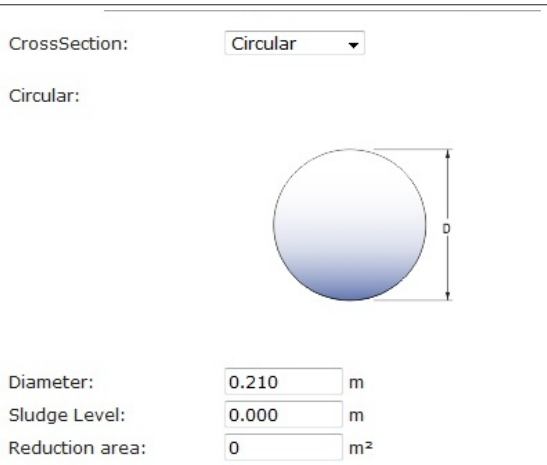
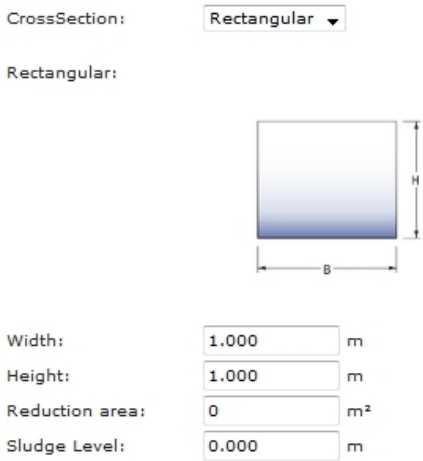
- Definition of cross-section parameters
- Settings for level measurement
- Parameter setting for discharge calculation
- Calibration
- Replacement function for discharge calculation
- Setting a temperature offset to a reference measurement

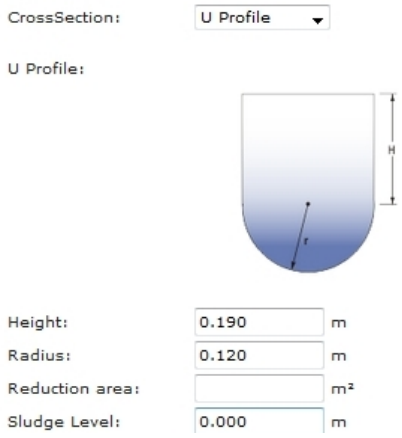
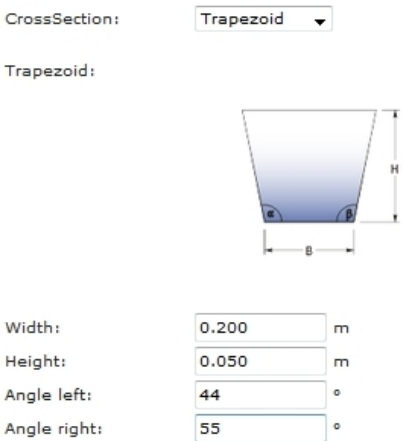
7.7.1. Geometry

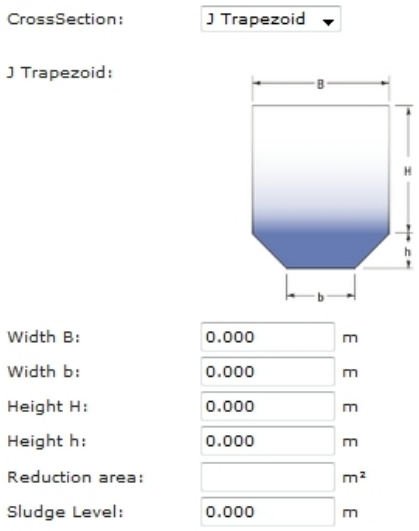
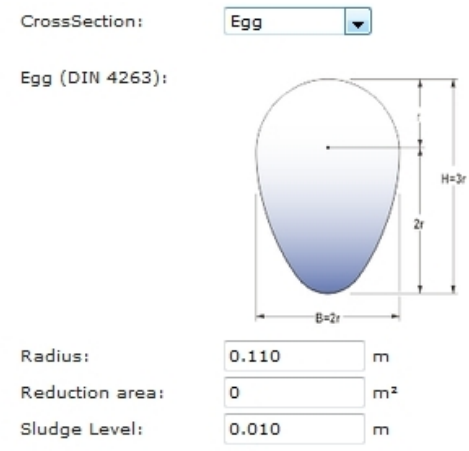
Definition of cross-section shapes and dimensions, geometrical values of sewers, drains and pipelines (according to DIN 4263 [1]).

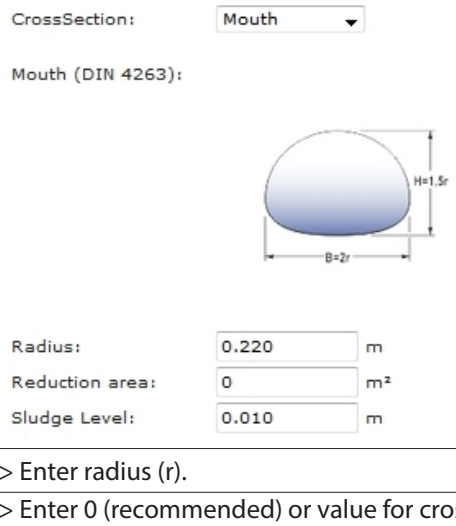
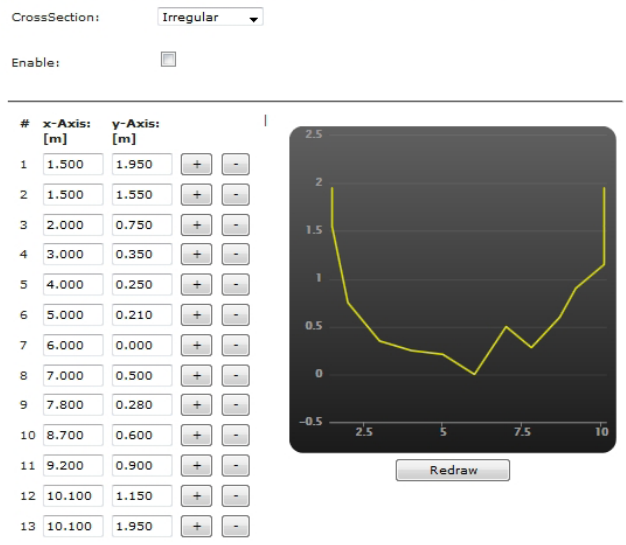
ⓘ Before you start the parameter input, please check and define the displayed units in the main menu ▶ **Settings** under ▷ Displayed Units.



▷ **Geometry**	
Setting	**Description**
CrossSection ▼ **Circular**	
Diameter	> Enter pipe diameter (D)
Sludge Level	> Enter thickness of sludge / sediment layer (*see Figure 12 on page 47*).
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
	☝ Click **Apply** to save settings for circular cross-section.
CrossSection ▼ **Rectangular**	
Width	> Enter width (B)
Height	> Enter height (H)
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
Sludge Level	> Enter thickness of sludge / sediment layer (*see Figure 12 on page 47*).
	☝ Click **Apply** to save settings for rectangular cross-section.

▷ **Geometry**	
CrossSection ▼ **U-Profile**	
Height	> Enter height (H) of cross-section as shown in drawing above.
Radius	> Enter radius of semi circle.
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
Sludge Level	> Enter thickness of sludge / sediment layer (*see Figure 12 on page 47*).
	☝ Click **Apply** to save settings for trapezoid cross-section.
CrossSection ▼ **Trapezoid**	
Width	> Enter width (B).
Height	> Enter height (H).
Angle_left	> Enter left angle (α).
Angle_right	> Enter right angle (β).
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
Sludge Level	> Enter thickness of sludge / sediment layer (*see Figure 12 on page 47*).
	☝ Click **Apply** to save settings for trapezoid cross-section.

▷ **Geometry**	
CrossSection ▼ **J Trapezoid**	
Width B	> Enter upper width (B).
Width b	> Enter lower width (b).
Height H	> Enter upper height H.
Height h	> Enter lower height h.
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
Sludge Level	> Enter thickness of sludge / sediment layer (see Fi. 22).
	☝ Click **Apply** to save settings for J trapezoid cross-section.
CrossSection ▼ **Egg**	
Radius	> Enter radius.
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
Sludge Level	> Enter thickness of sludge / sediment layer (*see Figure 12 on page 47*).
	☝ Click **Apply** to save settings for egg cross-section.

▷ **Geometry**	
CrossSection ▼ **Mouth**	
Radius	> Enter radius (r).
Reduction area	> Enter 0 (recommended) or value for cross section area reduction (for example due to installations in the pipe or channel).
Sludge Level	> Enter thickness of sludge / sediment layer (*see Figure 12 on page 47*).
	☝ Click **Apply** to save settings for mouth cross-section.
CrossSection ▼ **Irregular Polynom**	
x-Axis	> Enter values for width (x)
y-Axis	> Enter values for cross section height (y)
+ -	> Click + to add row for additional values or – to delete values.
	☝ Click **Apply** to save settings for irregular cross-section.

7.7.1.1. Sludge Level

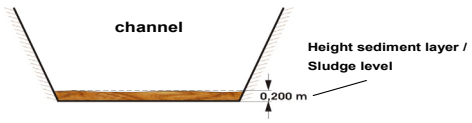
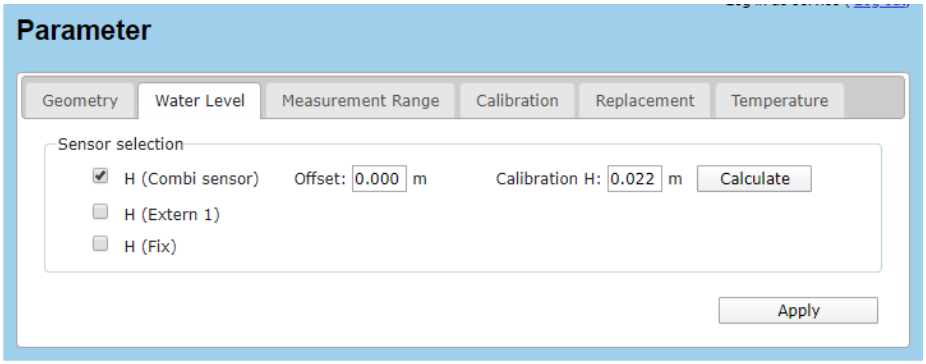
Sludge level	> Enter thickness of sediment / sludge layer (*"Height of sediment layer in a cross section (sludge level)"*) accumulated on the bottom of a pipe or channel or riverbed. The program will calculate the area covered with sediment or sludge; this value will be subtracted from the total wetted hydraulic area for accurate water level and cross-section measurements. 

Figure 12: Height of sediment layer in a cross section (sludge level)

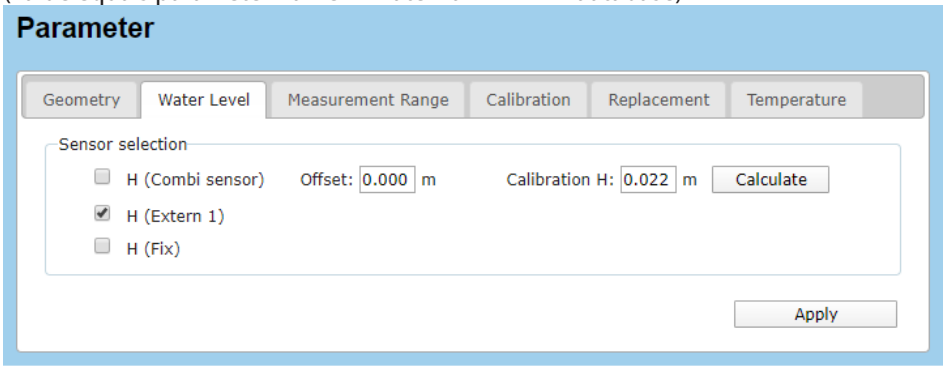
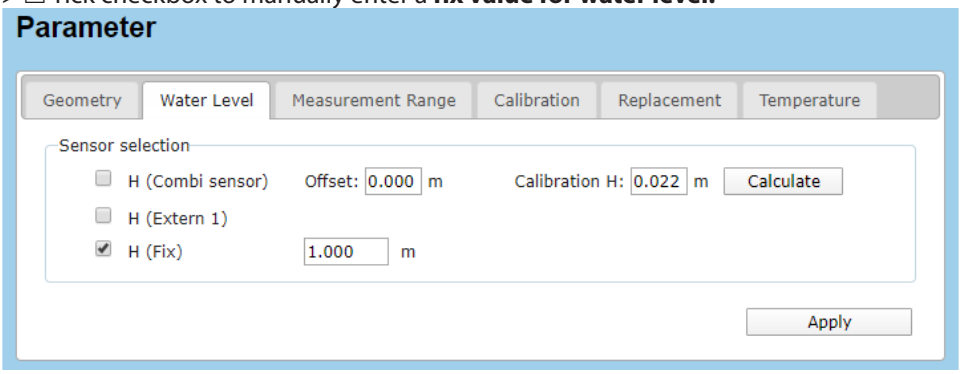
7.7.2. Water Level

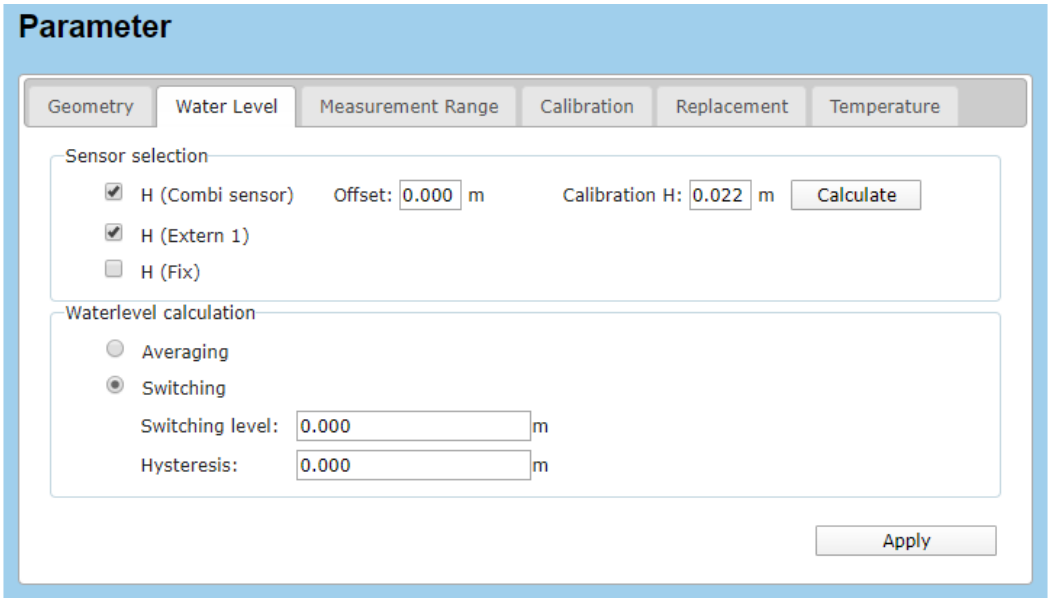
Select method for water level measurement depending on sensor type and sensor position in cross-section.

- H (Combi sensor): water level measurement with area velocity sensor.
- H (Extern 1): water level measurement with additional water level sensor (for example, hydrostatic pressure sensor or non-contact ultrasonic sensor).
- H (Fix): fix value for water level.



▷ **Water level**	
Setting	**Description**
Sensor selection	
H (Combi sensor)	Option for standard use. Measurement of water level from bottom to top of water surface. > ☑ Tick checkbox for integrated ultrasonic water level measurement with area velocity sensor installed on the bottom of cross-section. (value equals parameter name "HUS" in database) **NOTE:** Min. water level > 1.6 in. (4 cm).
	☝ Click **Apply** to save settings.
Offset	> Enter offset value for area velocity sensor (sensor specific) (sensor offset = height mounting plate + height sensor housing) = 0.9 in. (22 mm)
Calibration H	> Enter water level value from an external water level measurement (e.g. from water level gauge) if a deviation with the measured water level value from area velocity sensor occurs. ☝ Click Calculate for correction/adoption of measured value. ☝ Click Apply to save settings.

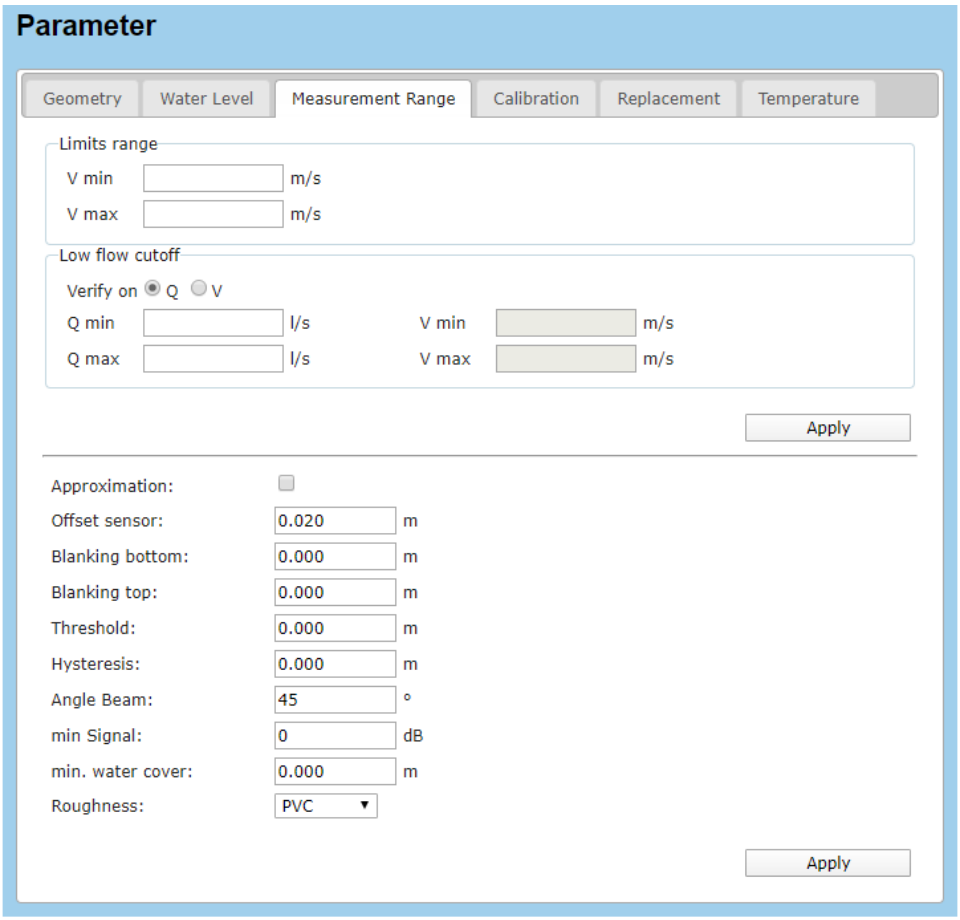
▷ **Water level**	
Setting	**Description**
H (Extern 1)	> ☑ Tick checkbox for water level measurement with an additional **external water level sensor (e. g. hydrostatic or ultrasonic water level sensor).** (value equals parameter name "HWater" or "HAir" in database)  Parameter Geometry / Water Level / Measurement Range / Calibration / Replacement / Temperature Sensor selection H (Combi sensor) Offset: 0.000 m Calibration H: 0.022 m Calculate H (Extern 1) H (Fix) Apply ☝ Click **Apply** to save settings.
H (Fix)	This option is used for measurements in full pipes where no level measurements are required or in case of sensor failure. > ☑ Tick checkbox to manually enter a **fix value for water level.**  Parameter Geometry / Water Level / Measurement Range / Calibration / Replacement / Temperature Sensor selection H (Combi sensor) Offset: 0.000 m Calibration H: 0.022 m Calculate H (Extern 1) H (Fix) 1.000 m Apply ☝ Click **Apply** to save settings.

▷ **Water level**	
Setting	**Description**
H (Combi sensor) **H (Extern 1)**	Option for combination of **2 level measurements with area velocity sensor and additional water level sensor.** This combination is used for discharge measurements for fluctuating water levels from very low levels to overflow conditions. > ☑ Tick checkboxes for combination of **Area velocity sensor (Combi sensor) and additional water level sensor (e. g. hydrostatic or ultrasonic down-looking level sensor).** 
Water level calculation **(in case of sensor combination)**	
Averaging	> ⊙ Activate function for averaging the 2 level values.
Switching	> ⊙Activate function for switching between the 2 sensors.
	Switching level > Enter water level value to activate switching between the 2 water level sensors. Each time the defined value is reached, the level measurement switches from area velocity sensor (H (Combi sensor)) to additional water level sensor and vice versa.
	Hysteresis The specification of a hysteresis increases the system stability. The hysteresis-value is required for situations with a water level that oscillates around the defined switching level causing to switch constantly between the 2 sensors. > Enter hysteresis value to define upper and lower limits which have to be exceeded to switch sensors.

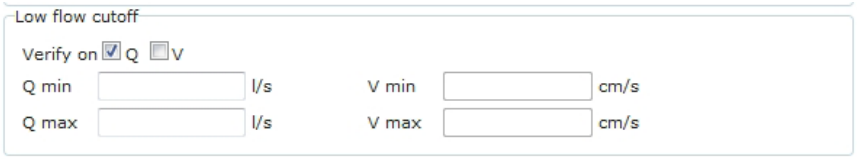
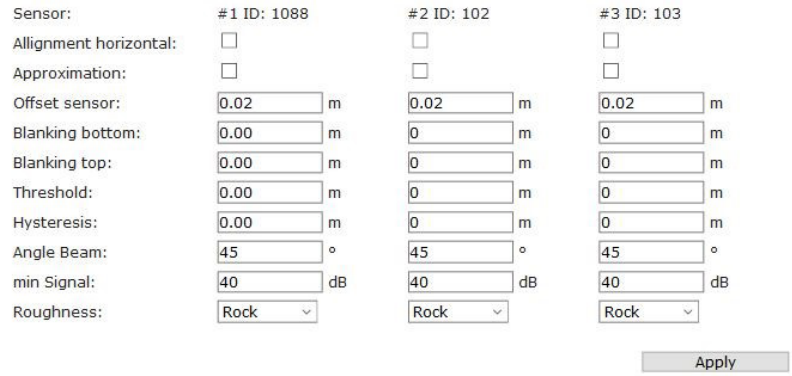
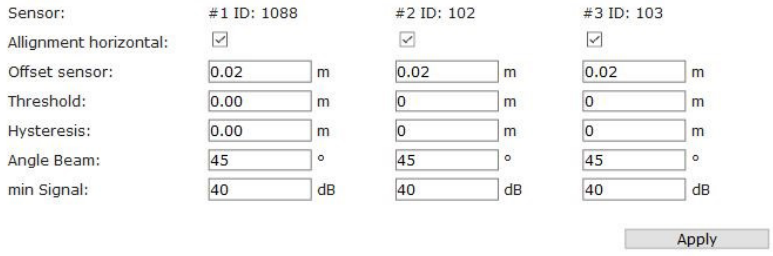
▷ **Water level**	
Setting	**Description**
Switching (continued)	There are two possible situations depending of the direction to which the water level changes. **<u>Situation A</u>** The water level is higher than value of Switching level + (0.5 × Hysteresis). Water level of additional water level sensor will be used. Not before the water level falls below the value Switching level – (0.5 × Hysteresis) software is switching automatically, and water level of area velocity sensor will be used. **<u>Situation B</u>** The water level is lower than value Switching level – (0.5 × Hysteresis)). Water level of area velocity sensor will be used. Not before the water level rises above the value of Switching value + (0.5 × Hysteresis) software is switching automatically, and water level of additional water level sensor will be used. ☝ Click **Apply** to save settings.

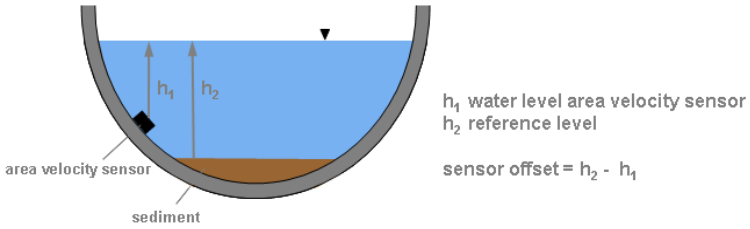
7.7.3. Measurement Range

Settings for discharge calculation.



▷ **Measurement Range / Discharge calculation**		
Setting	**Description**	
Limits Range V min V max	> Enter minimum and / or maximum for velocity value V for plausibility check.	
	Limits range V min cm/s V max cm/s	If no range is set, all V-values of the measurement are used for Q calculation.
	Limits range V min 30 cm/s V max cm/s	V- values from 30 cm/s are used for Q calculation. (V > 30 cm/s)
	Limits range V min cm/s V max 1000 cm/s	V-values lower than 1000 cm/s are used for Q calculation. (V < 1000 cm/s)
	Limits range V min 30 cm/s V max 1200 cm/s	V-values > 30 cm/s and < 1200 cm/ are used for Q calculation. (30 cm/s < V < 1200 cm/s)

▷ **Measurement Range / Discharge calculation**	
Setting	**Description**
Low flow cut off	ⓘ Values defined in the range of the low flow cut off are set to 0. > Enter range of very low and therefore often unsteady discharge (Q) or velocity (v) values. Measurement values below or within the adjustable range will be set to zero and will also be displayed as zero on the transmitter display.
Verify on Q / V	> ☑ Tick checkbox to choose option for Q- or V- values
Q min / Q max	> Enter minimum and / or maximum for discharge value.
V min / V max	> Enter minimum and / or maximum for velocity value. 
Sensor parametrization (option for connection of up to 3 area velocity sensors) ⓘ Note that sensor names (IDs #1, #2, #3) are preset by manufacturer.	
Alignment horizontal	> ☐ Checkbox not activated. Choose this option if **measurement direction** of area velocity sensor is **vertical** (default setting). 
Alignment horizontal	> ☑ Tick checkbox, if **measurement direction** of area velocity sensor is **not vertically.** For accurate water level measurement an external water level sensor is required (see 7.7.2). 
Approximation ☐	> ☑ Tick checkbox for approximation of velocity curve.
Offset Sensor	If the area velocity sensor must be installed laterally on the pipe or channel wall due to sediment layers on the bottom the measured water level has to be adjusted (see Figure below). > Enter difference of water level value measured by area velocity sensor and reference water level. This value will be added to the measurement value.

▷ **Measurement Range / Discharge calculation**	
Setting	**Description**
Offset Sensor (continued)	
Blanking bottom	> Enter value for adjustable distance above channel- or riverbed that will be excluded in measurement of velocity profile to eliminate measuring inaccuracies due to interference of irregular currents or turbulences around sensor housing.
Blanking top	> Enter distance value for adjustable zone below water surface that will not be considered for measuring depending on water level.
Threshold	Only applicable for horizontal orientation. Flow velocity measurement only starts if minimum water level + 0.5 × hysteresis value is exceeded. > Enter value for minimum water level value.
Hysteresis	The specification of a hysteresis increases the system stability. The hysteresis-value is required for situations with a water level that oscillates around the defined threshold causing the velocity measurement constantly being switched off and on. > Enter hysteresis value to define upper and lower limits which have to be exceeded to start/ stop velocity measurement.
	Threshold and hysteresis are values used by the software to determine if velocity measurement depending on the current water level is active or not. There are two possible situations depending of the direction to which the water level changes. **<u>Situation A</u>** The water level is higher than value of Threshold + (0.5 × Hysteresis). The velocity measurement will be activated. If the water level falls below the value Threshold – (0.5 × Hysteresis). The velocity measurement will be stopped. **<u>Situation B</u>** The water level is lower than value Threshold – (0.5 × Hysteresis). The velocity measurement will be stopped. If the water level is rising, the measurement will only start if the value of the water level is greater than Threshold + (0.5 × Hysteresis). If the water level rises above the value of Threshold + (0.5 × Hysteresis) the velocity measurement will be activated.
Angle Beam	Default setting: 45 ° (angle beam for vertical measurement direction of area velocity sensor) If angle beam deviates from 45° due to installation condition (measurement direction is not vertically), the deviation has to be measured manually and recalculated.
Min Signal	> Enter value for minimal signal strength from which measurement is activated. Example: 50 dB => measurement values with signal strengths > 50 dB are considered for discharge calculation. If no value is entered, signal strengths lower than 35 dB are considered to be no signal at all.

▷ **Measurement Range / Discharge calculation**	
Setting	**Description**
Min. water cover-	Enter height above the channel/pipe floor, above which flow measurement is activated. No measurement values will be recorded if the water level falls below this threshold. Default value: 0.000 m.
Roughness ▼ Rock, Stone, Sand, (…) PE	> Select the material of channel surface to define specific roughness values of channel-, riverbed or pipe: Rock Stone Sand Earth Concrete Cement PVC PE The empirical values for different materials are included in approximation formula for the velocity curve. Smoother surfaces have generally lower roughness coefficient values and rougher surfaces have higher values.
	☝ Click **Apply** to save settings.

7.7.4. Calibration

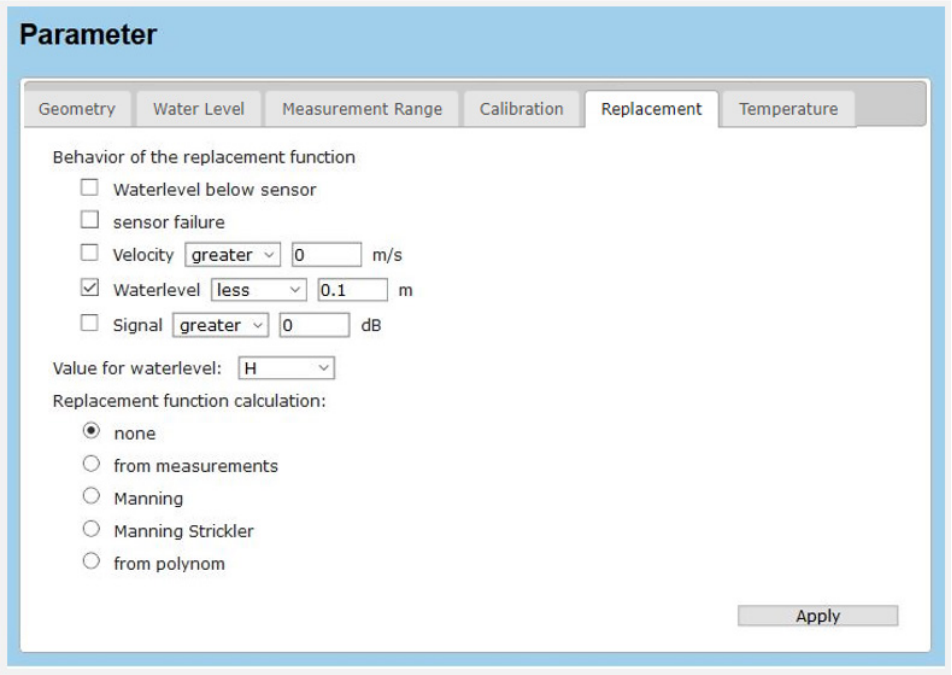
Settings for calibration through comparative measurement with reference device.

Example for 5 measurements:

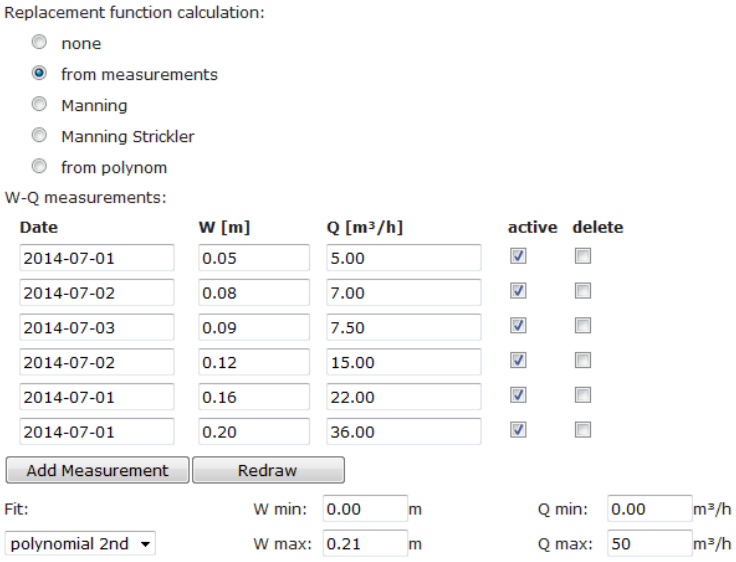
▷ **Calibration**	
ⓘ Before you start to enter values, please check and define the displayed units in the main menu ▶ **Settings** under ▷ Displayed Units. Enter values for Q meas (IS-6000 Doppler) and Q ref (reference device) in table of values:	
Setting	**Description**
Date	> Enter date.
W	> Enter water level.
Q meas	> Enter measured Q value.
Q ref	> Enter reference Q value (from reference device).
☐ active / ☐ delete	> Tick checkbox to activate or delete value pair for calibration curve.
	☝ Click **Apply** to save settings. Values are displayed in the list above.
	☝ Click **Add new measurement** to enter additional values.
Definition and graph of regression for calibration curve within discharge range (Q min / Q max):	
Active ☐ / ☑	> ☑ Tick checkbox to enable curve fitting.
Fit ▼ linear polynomial 2nd polynomial 3rd polynomial 4th	> Select curve fitting options from drop-down menu.
Q max	> Enter maximum for discharge value.
Q min	> Enter minimum for discharge value.
R-Coefficient	> Shows calculated regression coefficient.

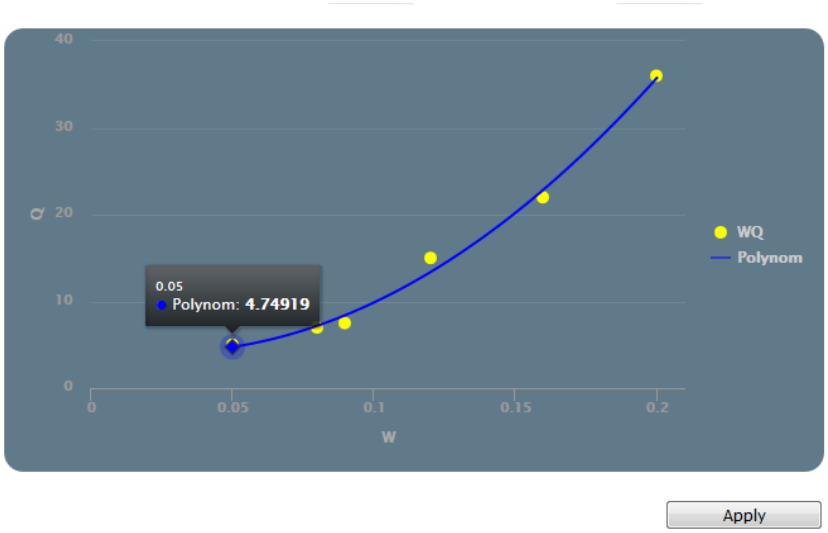
7.7.5. Replacement

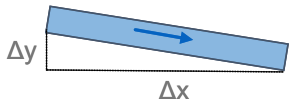
The replacement function provides different methods to calculate flow (Q). This option is applied in case of sensor failure or if calculation of Q is required below or above preset min. and max. limit values for velocity, water level or signal strength.

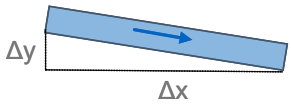


▷ **Replacement**	
Behavior of replacement function	
Setting	**Description**
☐ Waterlevel below sensor	> ☑ Tick checkbox if no measurement is possible due to too low water level for proper measurement.
☐ Sensor failure	> ☑ Tick checkbox in case of sensor failure.
☐ Velocity	> ☑ Tick checkbox to activate replacement function, if current measurement value exceeds or falls below the defined limit for flow velocity. > Enter velocity limit value. less ˅ = replacement function is activated if current measurement value falls below the defined limit value. greater ˅ = replacement function is activated if current measurement value exceeds the defined limit value.
☐ Waterlevel	> ☑ Tick checkbox to activate replacement function if current measurement value exceeds or falls below the defined limit for water level. > Enter water level limit value. less ˅ = replacement function is activated if current measurement value falls below the defined limit value. greater ˅ = replacement function is activated if current measurement value exceeds the defined limit value.

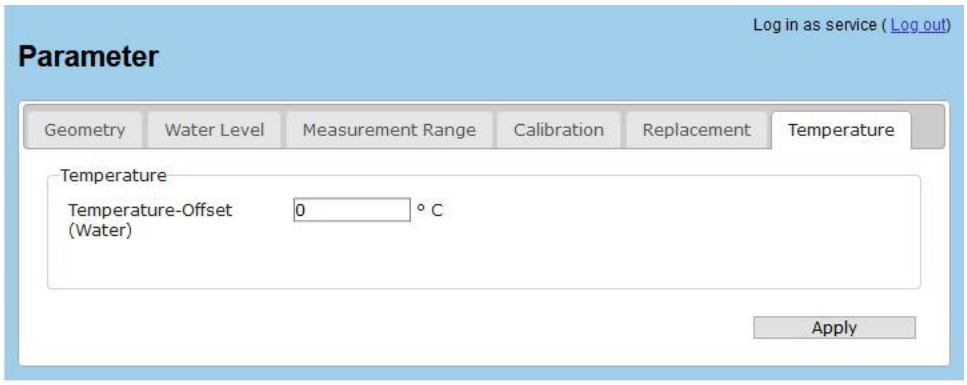
▷ **Replacement**	
Behavior of replacement function	
Setting	**Description**
☐ Signal	> ☑ Tick checkbox to activate replacement function if current measurement value exceeds or falls below the defined limit for signal strength. > Enter signal limit in dB less ˅ = replacement function is activated if current measurement value falls below the defined limit value. greater ˅ = replacement function is activated if current measurement value exceeds the defined limit value.
Value for waterlevel ▼ H HWater Hair	> Select which water level parameter will be used for checking if replacement function will be applied.
Replacement function calculation	
○ **none**	> ⊙ Tick checkbox if no replacement function shall be used for discharge calculation.
○ **from measurements**	> ⊙ Tick checkbox to calculate Q from W/Q (water level / discharge) relation. 

▷ **Replacement**	
Behavior of replacement function	
Setting	**Description**
○ **from measurements (continued)**	
	W-Q measurements Then enter values for date and measuring values for W and corresponding Q in table below
	☐ active / delete > ☑ Tick checkbox to activate or delete value pair for W/Q curve.
	☝ Click **Add new measurement** to add new line to enter additional values.
	☝ Click **Redraw** to save settings. Values are displayed in the list above.
	Curve fitting options The pairs of value are plotted in W/Q graph for rating curve according to approximation settings.
	Fit: ▼ linear polynomial 2nd (…) The values and the discharge rating curve are plotted in a W/Q diagram. For curve fitting choose linear or polynomials up to 6 degrees. > Select reasonable curve fitting options from drop-down list.
	W min / W max > Enter minimum / maximum value for water level.
	Q min / Q max > Enter minimum / maximum value for discharge.
	☝ Click **Apply** to redraw graph.

▷ **Replacement**	
Behavior of replacement function	
Setting	**Description**
○ **Manning**	> Tick checkbox for empirical discharge calculation according to **Manning** and enter corresponding parameters (see 11.1).
	Replacement function calculation: ○ none ○ from measurements ◉ Manning ○ Manning Strickler ○ from polynom Manning-Strickler coefficient MaxW: m MinW: m Slope: n-factor:
	MaxW / MinW >Enter minimum / maximum value for water level.
	Slope > Enter value for channel slope. (dimensionless: Δy / Δx; see below) 
	n-factor > Enter specific roughness coefficient n for channel material. (Manning Coefficient) (*"Roughness Coefficients" on page 109*)
	☝ Click **Apply** to save settings

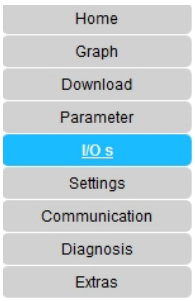
▷ **Replacement**	
Behavior of replacement function	
Setting	**Description**
○ **Manning Strickler**	> Tick checkbox for empirical discharge calculation according to **Manning Strickler** and enter corresponding parameters (*"Roughness Coefficients" on page 109*).
	Replacement function calculation: ○ none ○ from measurements ○ Manning ◉ Manning Strickler ○ from polynom Manning-Strickler coefficient MaxW: m MinW: m Slope: kst-factor:
	MaxW / MinW > Enter minimum / maximum value for water level.
○ **Manning Strickler (continued)**	Slope > Enter value for channel slope. (dimensionless: Δy / Δx; see below) 
	kst-factor > Enter specific roughness coefficient kst for channel material. (Strickler Coefficient) (*"Roughness Coefficients" on page 109*)
	🖐 Click **Apply** to save settings
○ **from polynom**	> Tick checkbox to calculate discharge from polynom coefficients.
	Replacement function calculation: ○ none ○ from measurements ○ Manning ○ Manning Strickler ◉ from polynom Polynomcoefficents c0: 0.00028 c1: 0 c2: 0 c3: 0 c4: 0 c5: 0 c6: 0
Polynom-coefficients c0…	> Enter coefficients of desired polynomial fitting / regression.
	🖐 Click **Apply** to save settings.

7.7.6. Temperature



▷ **Replacement**	
Setting	**Description**
Temperature-Offset (Water)	> Default setting: 0 °C. Enter the difference between a reference temperature measurement and the integrated temperature measurement of the area velocity sensor. Example: Tref = 20 °C and Tint = 19 °C; temperature offset = +1 °C

7.8. I/Os – Digital and analog inputs and outputs

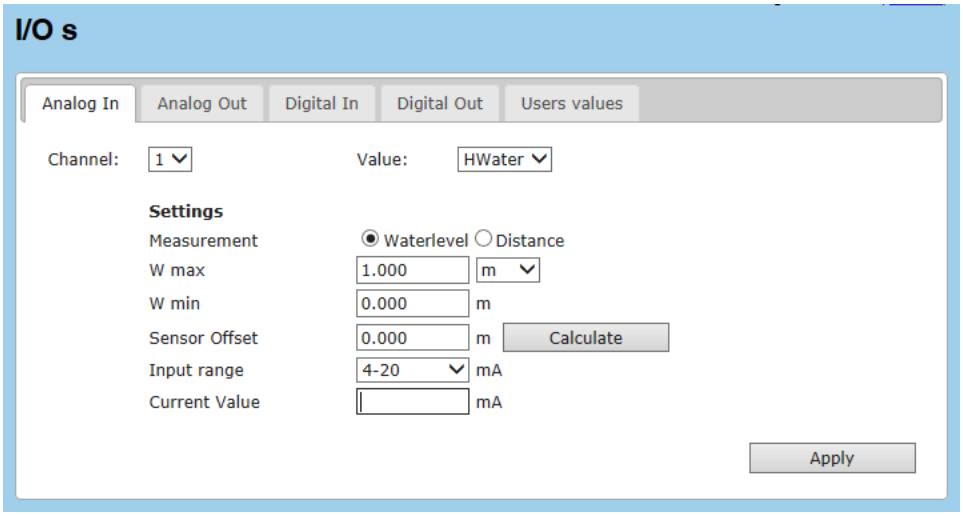


▶ I/Os
▷ Analog In ▷ Analog Out ▷ Digital In ▷ Digital Out
▷ Users values

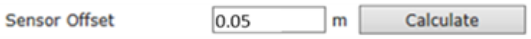
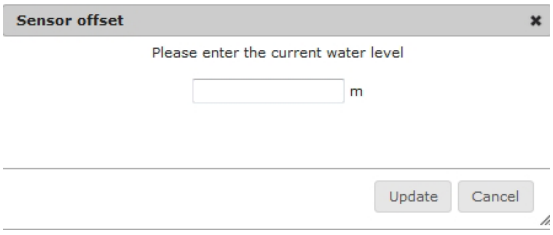
Parameterization for analog and digital in- and outputs, pulse output and user-defined outputs.

7.8.1. Analog Input

Parameterization and settings for analog connected sensors (water level sensors, sensors for user defined parameters).

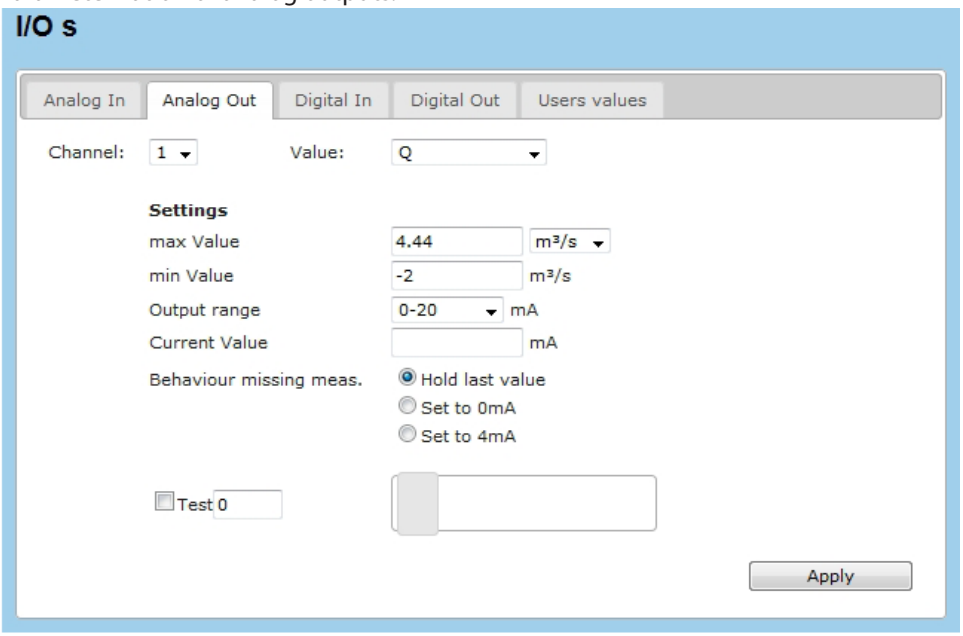


Setting	**Description**
Channel ▼ 1,2,3,4	Assignment of available channels for connected sensors. > Select desired channel (analog input) from drop-down list.
Value ▼ HWater, HAir, None	> Select the connected external water level sensor type for preselected channel from drop-down list. ⓘ Always connect the external water level sensor on channel 1. As value always choose HWater for channel 1. This water level sensor can be selected for discharge calculation in the main menu under ▶ Parameter ▷ Water Level as H (Extern 1). HWater: External water level sensor connected on channel 1. HAir: If a second water level sensor is connected on channel 2, 3 or 4, then choose HAir as value. None: No analog sensor is connected.
Settings	
Measurement	Select the method of water level measurement (water level / distance).
Measurement ⊙ Waterlevel	The sensor measures the water level from bottom to water surface (height of water column). The user defined water level range of the selected sensor is proportional to the input current range. Example: 0…10 m water level measuring range 0/4 mA corresponds to 0 m water level and 20 mA corresponds to 10 m water level **NOTE:** Choose this option for parameterization of all water level sensor types provided by the manufacturer. Even if non-contact sensors are used, the distance values are converted to water level values by the sensor.
W max	> Enter max. water level value for max. current input value: Example: water level measurement range 0…10 m: 20 mA corresponds to 10 m water level Select corresponding unit for water level (length).
W min	>Enter min. water level value for min. current input value: 0 mA corresponds to 0 m water level Select corresponding unit for water level (length).
Measurement ⊙ Distance	The water level sensor is mounted above water surface and measures the distance from sensor surface to the water surface. In this case, a high water level means a smaller distance to the sensor and vice versa. Example: distance measuring range 0…10 m: 0 mA corresponds to 0 m distance (= 10 m water level) 20 mA corresponds to 10 m distance (= 0 m water level)
max Distance	> Enter max. distance value for the min. current input value: Example for 0…10 m water level measuring range: 0 mA corresponds to 10 m distance (= 0 m water level) Select corresponding unit for distance (length).
min Distance	> Define min. distance for max. current input value: 20 mA corresponds to 0 m distance (=10 m water level) Select corresponding unit for distance (length).

Setting	Description
Sensor offset	Depending on the sensor position and orientation in the cross section, the measured water level value must be corrected by an off-set value to obtain correct readings. By entering the sensor offset, the measured water level value is automatically corrected by the offset value. **Example:** The water level sensor is installed 1.00 m below water surface and indicates W = 1.00 m. However, the water-level according to the gauge board = 1.05 m. Consequently, the offset value is 0.05 m and the water level value is corrected by 0.05 m. There are two options to obtain the offset value: Option 1: > Enter the offset value for the installed water level sensor (fix value). for example 0.05 m  Option 2: The offset value will be calculated by a reference measurement. The measured water level is compared internally with the reference water level (for example from reference device or staff gauge) and the corresponding is calculated and displayed. ☝ Click Calculate. Enter current water level value (measured by a reference device, staff gauge).  ☝ Click **Update** to apply calculated offset value for measurement values or **Cancel** to abort.
Input range ▼ 4…20 0…20	> Select current input range in mA from drop-down menu.
Current value	Display of actual input current.
	☝ Click **Apply** to save settings.

7.8.2. Analog Output

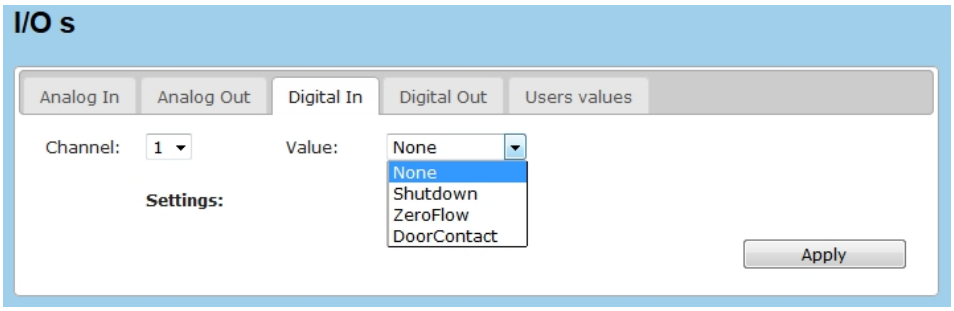
Parameterization of analog outputs.



▷ **Analog Out**	
Setting	**Description**
Channel ▼ 1,2,3,4	Assignment of available channels. > Select desired channel (analog output) from drop-down list.
Value ▼ Q, A …	> Select measured value / parameter from drop-down list corresponding to channel; the corresponding unit is displayed. (for example Q)
Settings	
Max Value	> Enter maximum for selected parameter. Select corresponding unit.
Min Value	> Enter minimum for selected parameter.
Output range ▼ 4…20 0…20	> Select current output range in mA from drop-down menu.
Current value	Display of actual output current.
Behavior missing meas.	Choose between the following options in case of missing measuring values. ⊙ Hold last value Tick if exported value is missing. The last current/ voltage is maintained. ⊙ Set to 0 mA Measurement output value is set to 0 mA. ⊙ Set to 4 mA Measurement output value is set to 4 mA.
☐ Test	> ☑ Tick checkbox to enable test. Adjust test bar to different values.
	☝ Click **Apply** to save settings.

7.8.3. Digital Input

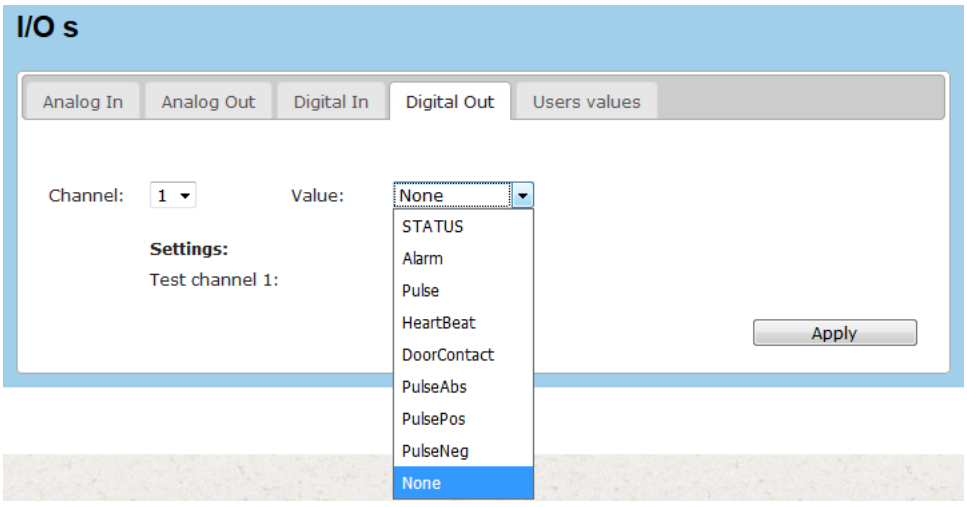
Settings for connection on digital input.

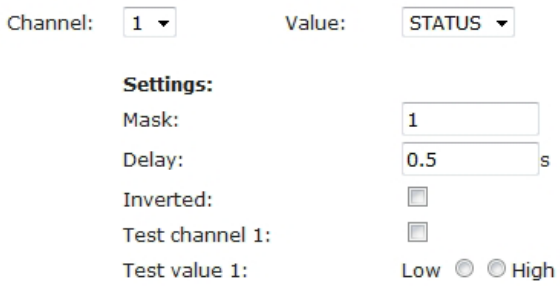


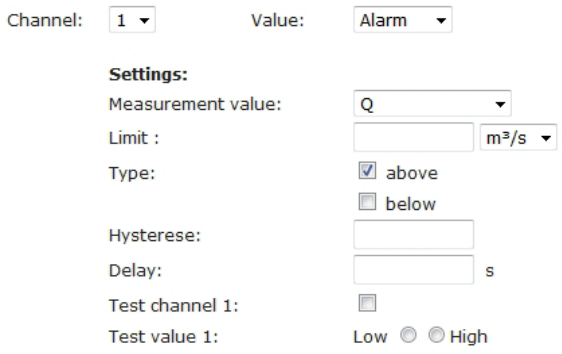
▷ **Digital In**	
Setting	**Description**
Channel ▼ 1,2	Assignment of available channels. > Select channel for corresponding value from drop-down list.
Value ▼ None Shutdown ZeroFlow DoorContact	> Select corresponding function for selected channel from drop-down list. None: default setting, no signal Shutdown: system shutdown (reboot) after predefined delay time. ZeroFlow: during signal input discharge is set to “zero” DoorContact: This feature is visible, but not functional.
Settings	
Delay (only applicable for “Shutdown”)	> Enter time (delay time) in s; after delay period the system reboots.
	🖒 Click **Apply** to save settings.

7.8.4. Digital Output

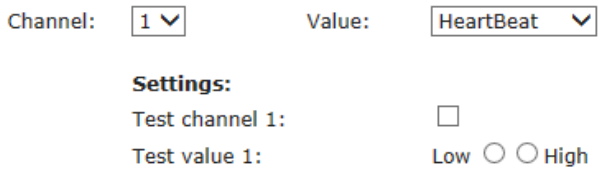
Different signal types can be exported as digital output signals.
Assignment of pulse output signals.



▷ **Digital Out**	
Setting	**Description**
Channel ▼ 1…8	Available channels for assignment of values. > Select channel for corresponding value from drop-down list.
Value ▼ **STATUS** Alarm Pulse HeartBeat DoorContact PulseAbs PulsePos PulseNeg None	> Select value from drop-down list to define alarm signal via relay for selected parameters.
Value ▼ **STATUS**	> Select **STATUS** for export of error message The STATUS value corresponds in the software to a binary bit field where each bit reflects an information. With the help of a bit mask this information can be filtered out and exported through the digital output. > **STATUS = Error codes** (= bit mask)
Settings	
Mask	> Enter bit mask no. (currently 1 for bit mask error codes)
Delay	> Enter time in s. Enter delay time in s between change of status and the setting of the digital channel.
Inverted	Option to invert digital output signal. ☑ Tick checkbox to invert signal. Example: Mask value is 1. If bit 0 is set in STATUS the output signal is not active (de-energized), if bit 0 in STATUS is not set the output signal is active (energized). ☐ Output signal is not inverted. Example: Mask value is 1. If bit 0 is set in STATUS field the output signal is active (energized), if bit 0 is not set in STATUS, the output signal is not active (de-energized).
Test Channel 1	☑ Tick checkbox to activate signal test.
Test value 1	Specify low or high signal. ⊙ low / ⊙ high
	🖐 Click **Apply** to save settings.

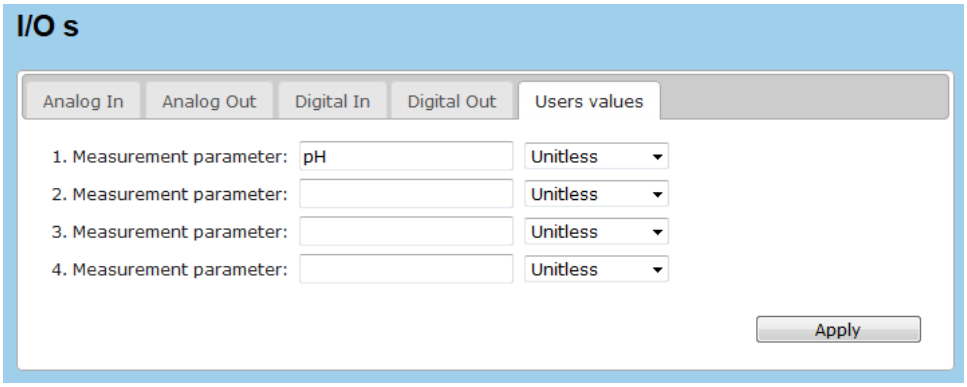
<table>
<tr><td colspan="3">▷ Digital Out</td></tr>
<tr><td>Setting</td><td colspan="2">Description</td></tr>
<tr><td>Value
▼ Alarm</td><td colspan="2">Assignment of available channels.
> Select Alarm from drop down list to define alarm signal via relay for selected parameters.
  </td></tr>
<tr><td>Measurement value</td><td colspan="2">> Select desired parameter for alarm signal from drop-down list.</td></tr>
<tr><td>Limit</td><td colspan="2">> Enter minimum value (lower limit) for alarm activation.</td></tr>
<tr><td>Type</td><td colspan="2">Specify alarm activation above or below set limit.
☑ above
Tick to trigger alarm above limit.
☑ below
Tick to trigger alarm below limit.</td></tr>
<tr><td>Hysteresis</td><td colspan="2">> Enter hysteresis value to define upper and lower limit which has to be exceeded to trigger an alarm (limit ± hysteresis).
A suitable hysteresis value prevents the alarm from being triggered unnecessarily by small measurement deviations.</td></tr>
<tr><td>Delay</td><td colspan="2">> Enter minimum time span for measuring values exceeding the upper or lower limit. Only after this time an alarm is activated.
This option avoids that an alarm is activated due to short term deviations.</td></tr>
<tr><td>Test Channel 1</td><td colspan="2">☑ Tick checkbox to activate signal test.</td></tr>
<tr><td>Test value 1</td><td colspan="2">Specify low or high signal-
⊙ low / ⊙ high</td></tr>
<tr><td></td><td colspan="2">☝ Click Apply to save settings.</td></tr>
<tr><td>Value
▼ Pulse
PulseAbs
PulsePos
PulseNeg</td><td colspan="2">Settings for pulse output signals for volume counter (totalizer).
4 types of counters (totalizer) can be parameterized taking into account the flow direction (positive +V in flow direction / negative -V against flow direction).

See also under ▶ Settings ▷ Totalizer (7.9.4)</td></tr>
<tr><td></td><td>Pulse:</td><td>Volume value - difference
(+/- sign are taken into account in summation of V)
V = +V (volume positive) -V (volume negative)</td></tr>
<tr><td></td><td>PulseAbs:</td><td>Absolute volume
(- sign of negative volume is not taken into account in summation)
V abs (absolute volume) =
V (volume positive) + V (amount volume negative)</td></tr>
<tr><td></td><td>PulsePos:</td><td>Total positive volume (+V)
(V against flow direction)</td></tr>
<tr><td></td><td>PulseNeg:</td><td>Total negative volume (-V)
(V in flow direction or “reverse flow”)</td></tr>
<tr><td></td><td colspan="2">> Select pulse types from drop down list to define pulse output and export total volume values.</td></tr>
</table>

▷ **Digital Out**	
Setting	**Description**
Value ▼ **Pulse** **PulseAbs** **PulsePos** **PulseNeg** **(continued)**	
Sum:	> Select volume value to trigger pulse. (for example 50 m^3 : 1 pulse is triggered per 50 m^3)
Width:	> Enter value for pulse width. Default value: 500 ms
Test Channel 1	☑ Tick checkbox to activate signal test.
Test value 1	Specify low or high signal. ⊙ low / ⊙ high
	Click **Apply** to save settings.
Value ▼ **HeartBeat**	> Select **HeartBeat** to monitor that system is running. (Every 30 s the system sends a ping/signal).
	
Test Channel 1	☑ Tick checkbox to activate signal test.
Test value 1	Specify low or high signal. ⊙ low / ⊙ high
	Click **Apply** to save settings.
Value ▼ **DoorContact**	This feature is visible but not functional.
Test Channel 1	☑ Tick checkbox to activate signal test.
Test value 1	Specify low or high signal ⊙ low / ⊙ high
	Click **Apply** to save settings.
Value ▼ **None**	> Select None for no further settings.
	Click **Apply** to save settings.

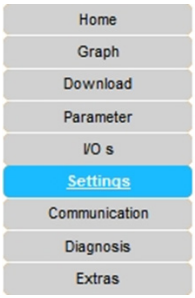
7.8.5. Users Values

Definition of user defined measurement parameters for the connection of max. 4 additional sensors.



▷ **Users values**	
Setting	**Description**
1. Measurement parameter	> Enter measurement parameter and corresponding unit of additional connected sensor.
2. Measurement parameter	> Enter measurement parameter and corresponding unit of additional connected sensor.
3. Measurement parameter	> Enter measurement parameter and corresponding unit of additional connected sensor.
4. Measurement parameter	> Enter measurement parameter and corresponding unit of additional connected sensor.
	Click **Apply** to save settings.

7.9. Settings – Data Logging and Display

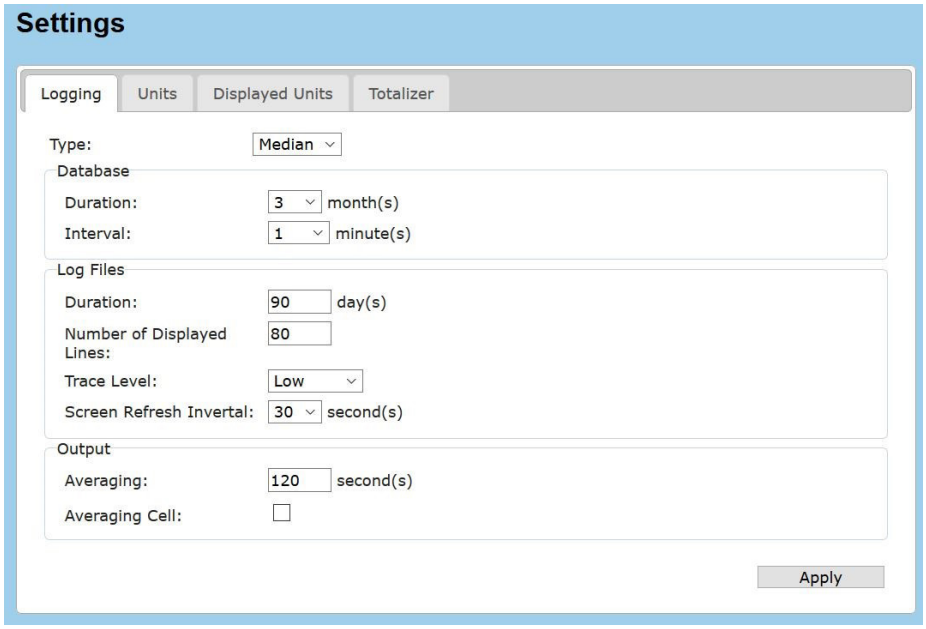


▶ Settings
▷ Logging ▷ Units ▷ Displayed Units ▷ Totalizer

Settings for data logging and log-file logging, settings for displayed units, user defined units, settings for totalizer.

7.9.1. Logging

Specifications for data and log file logging. Note that log files contain important information for troubleshooting and debugging in case of system failure.



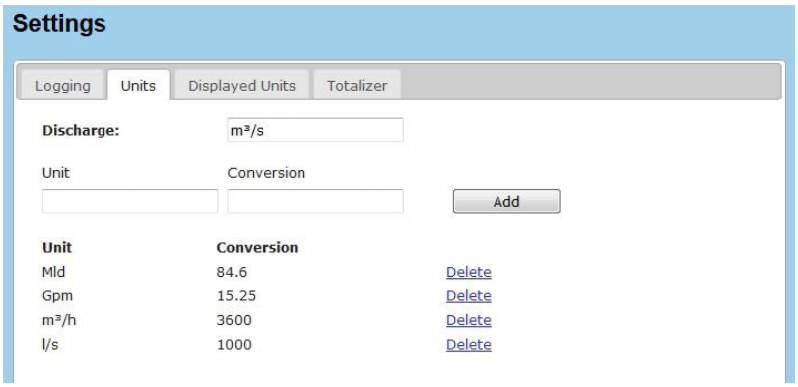
▷ **Logging**	
Setting	**Description**
Type ▼ Mean Median	>Select type of average calculation for measuring values from drop-down menu.
Database	
Duration ▼ 1, 2, …, 11, 12	> Select time span for database history from drop-down menu.
Interval	> Select time span for database interval from drop-down menu.
Log Files	
Duration	> Enter time span after log file is deleted.
Number of Displayed Lines	> Enter number lines of log file to be displayed.
Trace Level ▼ Less Medium High	> Select trace level for display of log file content. For example Trace Level Less: log file contains less detailed information than log file Trace level High (Default: Less)
Screen Refresh Interval ▼ 15, 30, 60	> Select time span for screen refresh from drop-down menu.
Output	
Averaging	> Enter time span which will be used for averaging (mean or median). ⓘ Time span should not be smaller than database interval.
Averaging Cell	☑ Tick checkbox to average cells for data in database.
	🖒 Click **Apply** to save your entries.

7.9.2. Units

Free user defined setting of units for the following parameters: discharge (Q)

- velocity (v)
- length (l)
- area (A)
- time (t)
- voltage (U)
- temperature (T)
- signal
- volume (V)
- concentration

Conversion factors of common measurement units are already specified. New units can be defined and added by the user.

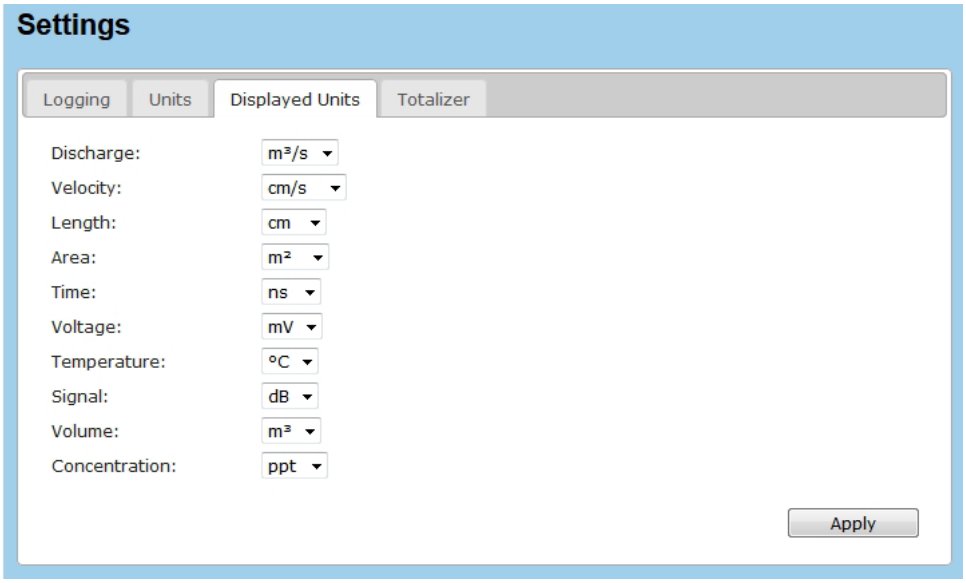


▷ **Units**			
Definition of displayed unit for listed parameter.			
Setting	**Description**		
Discharge	reference unit:	m^3/s	(cubic meters per second)
	available units:	l/s m^3/h Mld Gps Gpm Gph Gpd MGpd	(liter per second) (cubic meters per hour) (million liters per day) (US gallons per second) (US gallons per minute) (US gallons per hour) (US gallons per day) (million US gallons per day)
Velocity	reference unit:	m/s	(meter per second)
	available units:	km/h feet/s cm/s	(kilometer per hour) (feet per second) (centimeter per second)
Length	reference unit:	m	(meter)
	available units:	ft km mm cm	(feet) (kilometer) (millimeter) (centimeter)

▷ **Units**			
Definition of displayed unit for listed parameter.			
Setting	**Description**		
Area	reference unit:	m^2	(cubic meter)
	available units:	cm^2	(cubic centimeter)
Time	reference unit:	s	(seconds)
	available units:	m ms µs ns	(minutes) (milliseconds) (microseconds) (nanoseconds)
Voltage	reference unit:	V	(Volt)
	available units:	mV	(millivolt)
Temperature	reference unit:	°C	(degrees Celcius)
	available units:	°F	(degrees Fahrenheit)
Signal	reference unit:	dB	(decibels)
Volume	reference unit:	m^3	(cubic meters)
	available units:	l Ml	(liter) (million liter)
Concentration	reference unit:	ppt	(parts per trillion)
	available units:	psu	(practical salinity unit)
Unit	> Enter desired unit.		
Conversion	> Enter conversion factor related to reference unit.		
	☝ Click **Add** to save selected unit.		
	☝ Click **Delete** to delete entry.		

7.9.3. Displayed Units

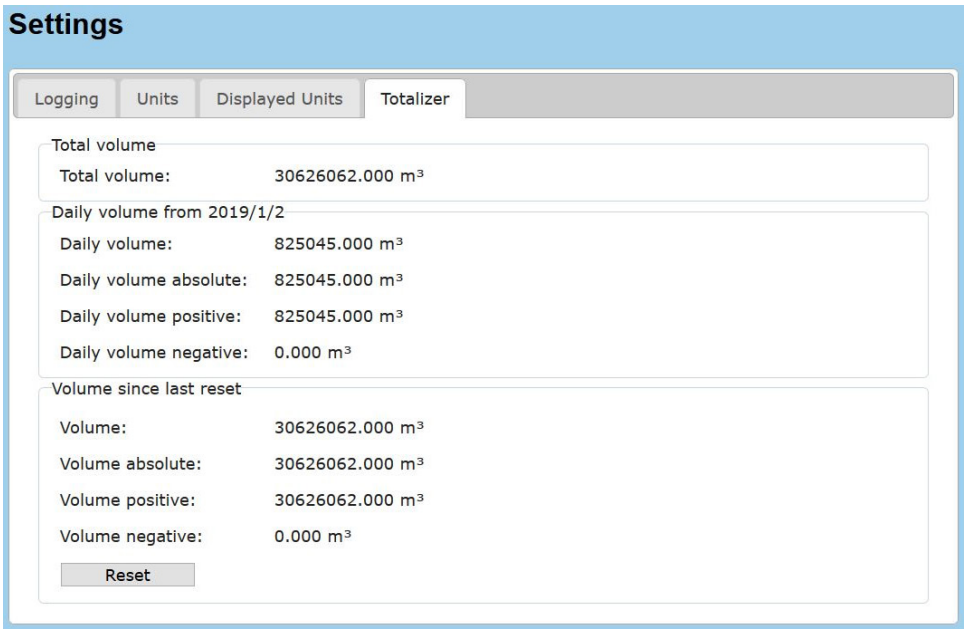
Choose specific measurement units for parameters to be displayed in graphs, input masks and data files (Download selectable).



▷ **Displayed Units**	
Setting	**Description**
Parameter Discharge Velocity Length Area Time Voltage Temperature Signal Volume Concentration	> Select desired unit from drop-down lists. Example: Drop-down list for units for discharge; Units to be defined under ▶ **Settings** ▷ Units ☝ Click **Apply** to save entries.

7.9.4. Totalizer

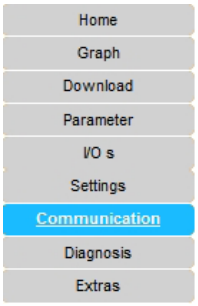
Totalizer function for measurement and display of total and daily volume values (V).
Flow is measured in either direction (bi-directional):
Volume positive +V (in flow direction), Volume negative -V (against flow direction)
Set, define or change required unit for Volume under ▶ **Settings** ▷ Units.



▷ **Totalizer**	
Setting	**Description**
Total volume	
Total Volume	Internal sum counter of total volume > Display of volume value measured since first system start / first commissioning. This value cannot be reset to zero.
Daily volume from YYYY/MM/DD	
Daily volume	Daily volume counter (V difference) > Display of daily volume value +/- sign are taken into account in summation of V V (daily volume) = +V (volume positive) -V (volume negative)
Daily volume absolute	> Display absolute volume per day (day total) (- sign of negative volume is not taken into account!) V (daily volume absolute) = V (volume positive) + V (amount volume negative)
Daily volume positive	Positive counter (+ V): > Display of daily volume against flow direction
Daily volume negative	Negative counter (-V): > Display of daily volume in flow direction
Volume since last reset	
Volume	Volume counter (V difference) > Display of volume value +/- sign are taken into account in summation of V V (daily volume) = +V (volume positive) -V (volume negative)

▷ **Totalizer**	
Setting	**Description**
Volume absolute	> Display absolute volume (- sign of negative volume is not taken into account!) V (volume absolute) = V (volume positive) + V (amount volume negative)
Volume positive	Positive counter: > Display of volume against flow direction
Volume negative	Negative counter: > Display of volume in flow direction
	☝ Click **Reset** to reset volume counters.

7.10. Communication – Network Settings

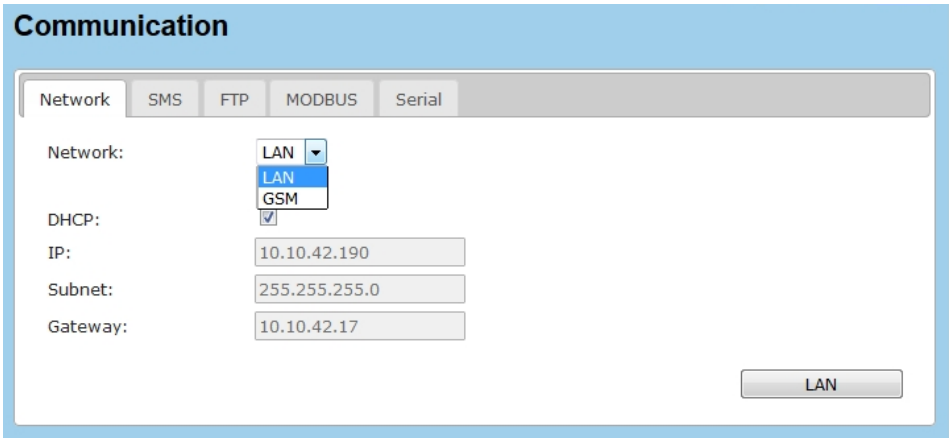


▶ **Communication**
▷ Network ▷ SMS ▷ FTP ▷ MODBUS ▷ Serial

Settings for communication with transmitter and data transfer; settings for SMS notification.

7.10.1. Network

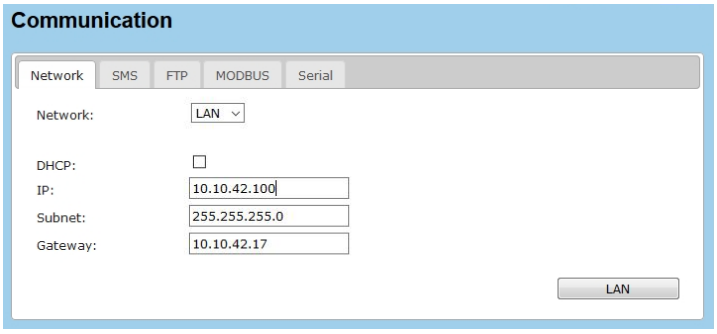
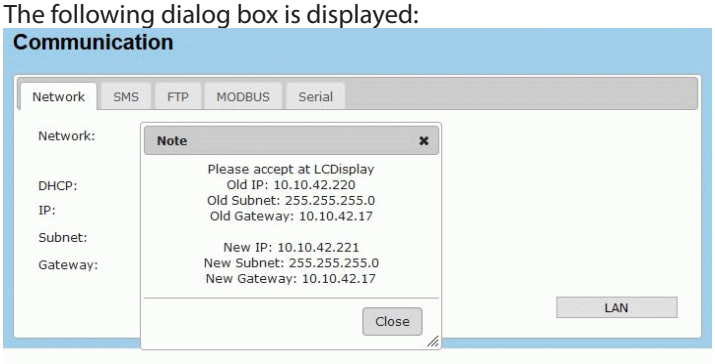
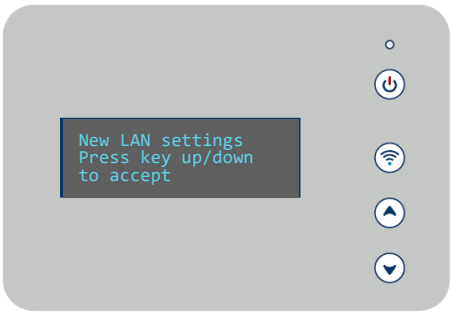
Specification of network type (LAN or GSM/WLAN) and basic network settings.



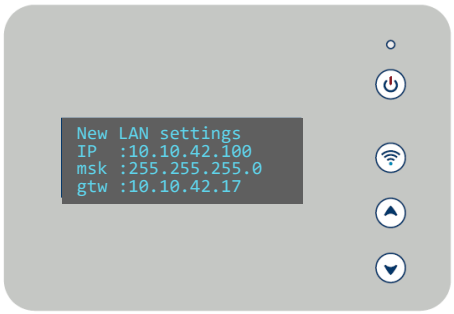
Network: ▼ **LAN** GSM	> Select network type from drop-down list. ▼ **LAN**
Setting	**Description**
DHCP ☑	☑ Enable / ☐ disable DHCP > ☑ DHCP (Dynamic Host Configuration Protocol) enabled. (factory setting) DHCP is activated and the IP address, Subnet and Gateway are automatically assigned by the server.
IP	Display IP address (automatically assigned).
Subnet	Display subnet mask (automatically assigned).
Gateway	Display gateway address (automatically assigned).
	Click **LAN** to confirm entry.

7.10.1.1. Manual Input and Changing the IP Address

If a static IP address is required (for example if no DCHP server is available) the network parameters can be assigned manually. Change the following settings:

DHCP ☐	☐ Enable DHCP. 
IP	> Enter new IP address.
Subnet	> Enter new subnet mask.
Gateway	> Enter new gateway.
	☝ Click **LAN** to save entries. The following dialog box is displayed: 
	Now check the transmitter LC display. The following message is shown:
	 > Confirm the new LAN settings by pressing one of the navigation keys. (up or down)

NOTE: If the new LAN settings are not accepted, the message will appear again after every restart of the system until the settings are confirmed by pressing a navigation key.

Gateway (continued)		After pressing a navigation key , the new LAN settings are displayed.

NOTE: Note that the existing network connection is disconnected automatically after the settings have been changed! Run your web browser again and enter the new IP address in the address bar to reconnect again.

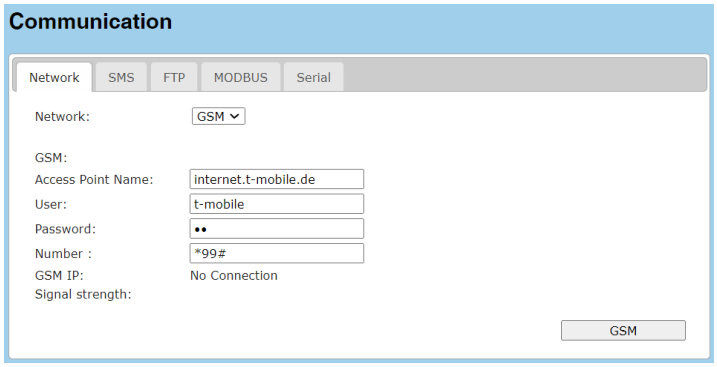
GSM network

Network: ▼ LAN **GSM**	> Select network type GSM from drop-down list for communication via GSM network. ▼ **GSM**

NOTE: Note that the settings for GSM network vary according to the device and communication type:

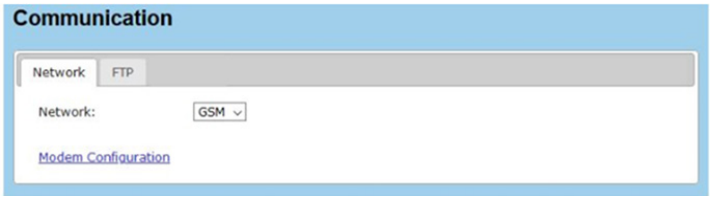
Device with external 3G/2G router:
When using an external 3G/2G router, no settings are required at this point. The router configuration is carried out via an integrated web interface. An additional router configuration manual will be provided to make sure correct connection and configuration.

Device with integrated 4G/3G/2G modem:
When using the integrated option, note that the modem is completely preconfigured by the manufacturer. Settings can be checked under the menu point Modem configuration via the modem user interface (see under "GSM network settings for IS-6000 Doppler with integrated 4G/3G/2G modem" on the following pages).

GSM network settings for IS-6000 Doppler-standard type (without 3G/2G router or 4G/3G/2G modem)	
	Access data for log-in are obtained form the service/network provider.
Access Point Name	> Enter Access Point Name APN of service/network provider.
User	> Enter user name.
Password	> Enter password.
Number	> Enter dial-up phone number of service/network provider.
GSM IP	> Enter GSM IP.
	Click **GSM** to save your entries. The IP address is displayed after successful login.

<table>
<tr><td>GSM network settings for IS-6000 Doppler with integrated 4G/3G/2G modem</td><td>> Select network type GSM from drop-down list for communication via GSM network.
▼ GSM
Integrated 4G/3G/2G modem:
For network settings only GSM type is needed (see below).

ⓘ Note that upon delivery, the integrated 4G/3G/2G modem is already pre-configured by the manufacturer. Just connect the dipole-antenna on the bottom of the enclosure and insert the SIM card to automatically connect to your provider.

ⓘ Note that APN, username and password are given by the network provider of the SIM Card (network profile).

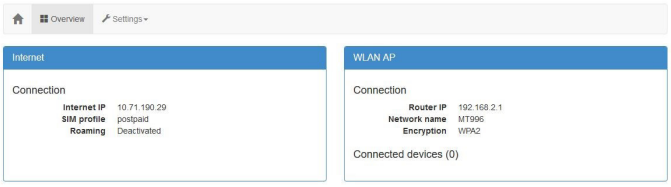
To avoid possible misconfigurations, do not change parameters. Change settings only if you have the appropriate experience.</td></tr>
<tr><td>Modem Configuration

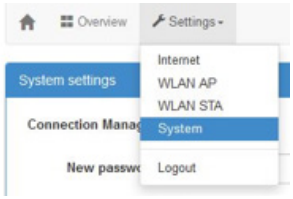
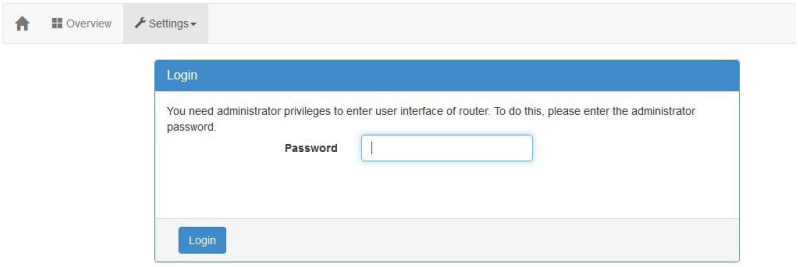
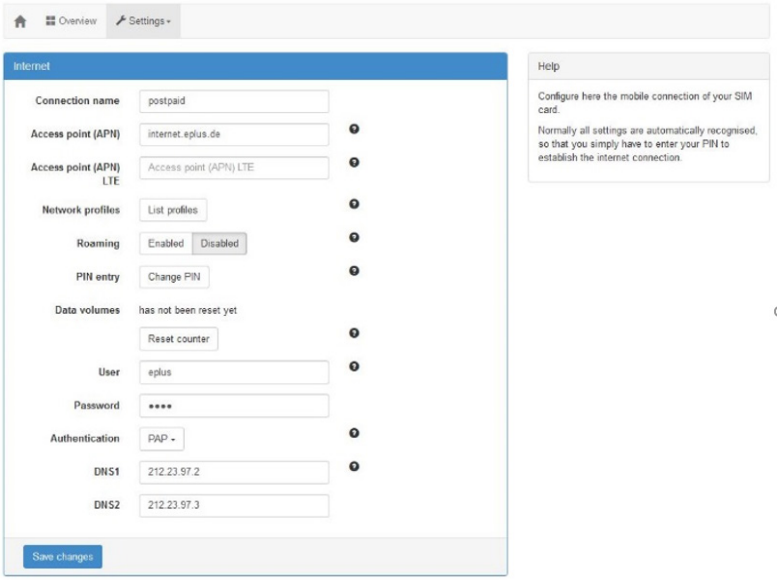
GSM Config</td><td>To check or change the settings of the configuration
☝ Click Modem Configuration

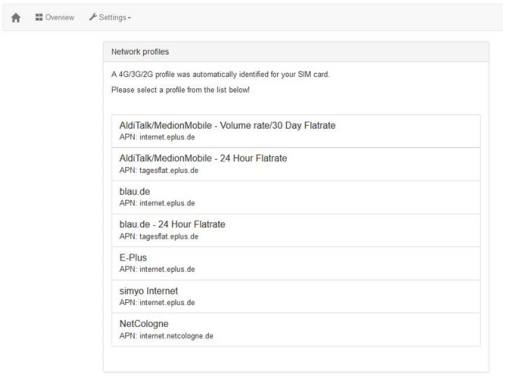
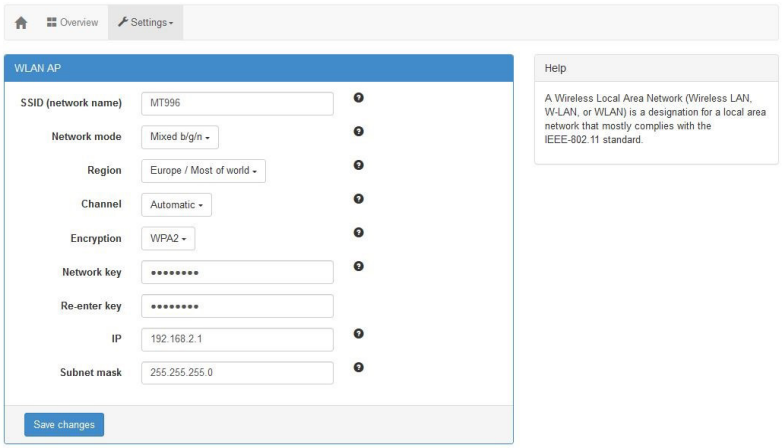
The WebUI interface of the original modem manufacturer opens.
The functions are described in the following.

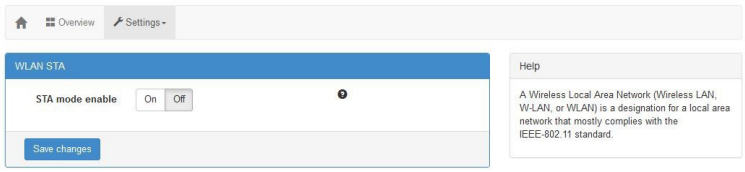
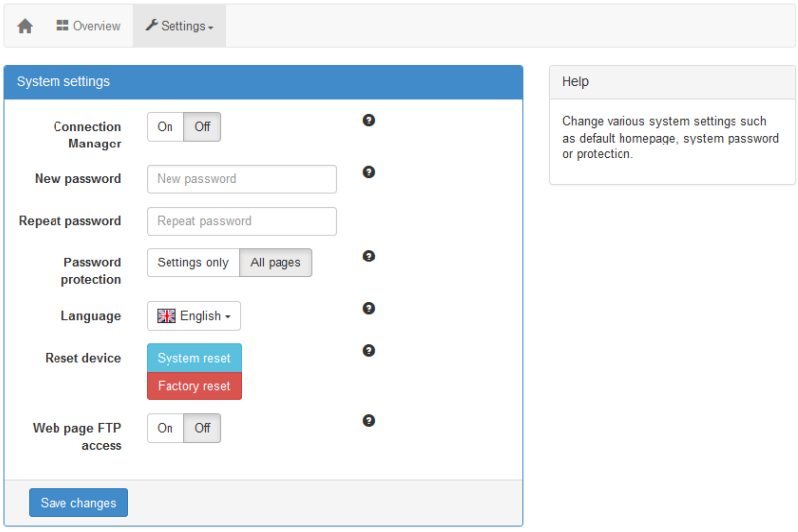
ⓘ Note that the configuration is saved when the "Save" button is clicked, and the configuration is applied at the next system boot.</td></tr>
<tr><td></td><td>Overview
Information regarding the cellular connectivity is displayed.

 bottom left: display of current GSM connectivity

 
</td></tr>
<tr><td></td><td>Internet</td></tr>
<tr><td></td><td>Connection
Internet IP
SIM profile
Roaming</td><td>
IP address assigned by provider
Profile name
deactivated (factory setting / default setting)</td></tr>
<tr><td></td><td>WLAN AP</td></tr>
<tr><td></td><td>Connection
Router IP
Network name
Encryption</td><td>
IP address network
SSID of the WiFI access point
Encryption WiFi access point</td></tr>
</table>

Modem Configuration GSM Config (continued)	Settings ▼ Internet WLAN AP WLAN STA System	
		
	Login	
	Password	Enter password: admin
	Internet	
		
	Connection name:	The settings for the SIM card are administered under a freely definable connection name. By default, this is usually the name of the cellular provider. The connection name can be changed manually.
	Access point (APN):	The Cellular subsystem tries to determine the access settings automatically based on the SIM card and stores them in the SIM card profile. It is possible to change the settings here manually.
	Access point (APN) LTE:	Since the Access Point for LTE network may be different from the Access point for 2G/3G network, it is possible to change the settings here manually.

Modem Configuration GSM Config (continued)	Network profiles:	By clicking this button it is possible to choose a cellular network profile from a preinstalled list. 
	Roaming:	This switch enables or disables the data roaming. With data roaming switched off, the router will not establish a connection when the cellular module is located outside of the home network. In the factory-programmed settings, the roaming is deactivated.
	PIN entry:	The PIN is requested when the SIM is inserted for the first time and generally must not be changed. If needed, change or set the PIN of the SIM card using the PIN dialog window.
	Data volumes:	The volume counter displayed in the status bar at the bottom indicates the amount of data transferred with the SIM card in mega-bytes (downloaded/uploaded) since the last reset. The counters can be reset clicking the "Reset counters" button.
	User:	This field sets the username to be used if authentication is required to establish a data connection to the cellular network.
	Password:	This field sets the password to be used if authentication is required to establish a data connection to the cellular network.
	Authentication:	This field sets the authentication procedure selection (PAP, CHAP, no authentication).
	DNS1:	This field specifies a static domain name server.
	DNS2:	This field specifies a second static domain name server.
	NOTE: The cellular network profile and configuration is tied to the individual SIM card.	
	WLAN AP "WLAN AP" configures the WiFi access point connectivity. 	

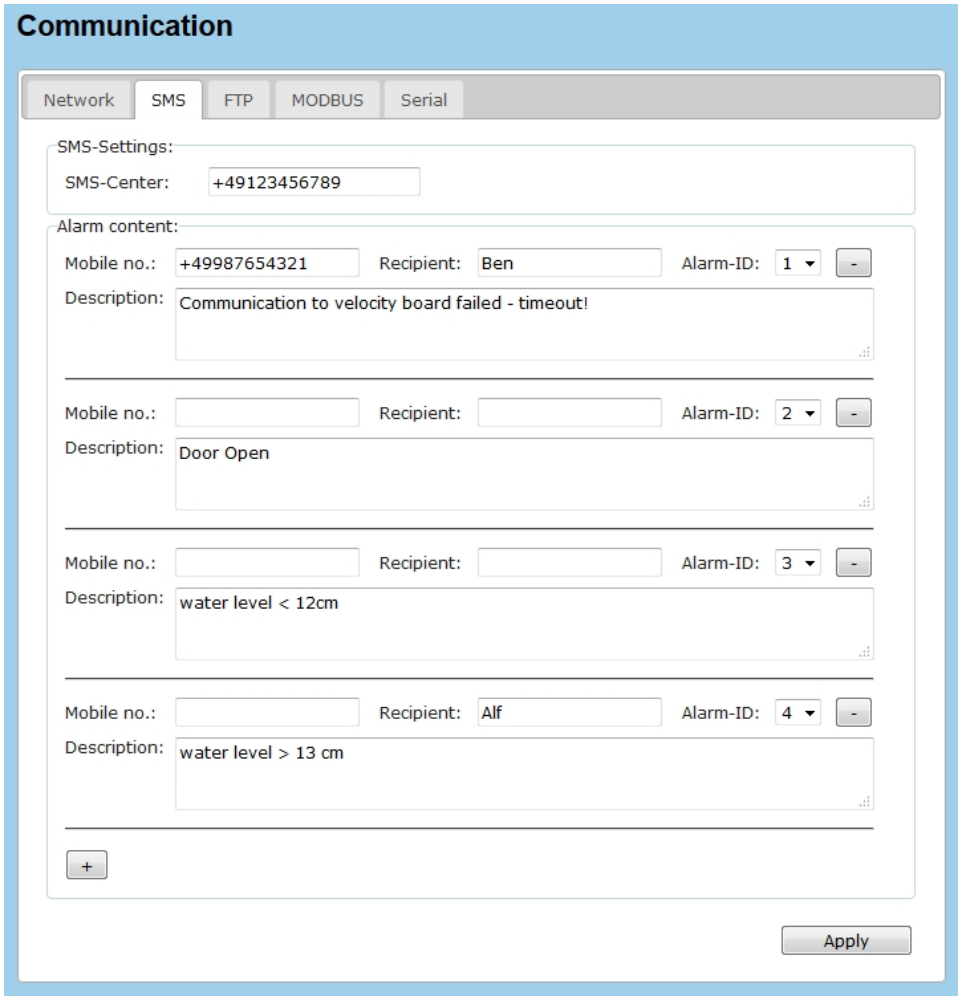
Modem Configuration GSM Config (continued)	SSID (Network name):	This field determines the SSID of the WiFi access point. The factory-programmed value is "UBXWifi".
	Network mode:	The network mode determines the IEEE 802.11 standard of the WiFi network. The factory-programmed value is "Mixed b/g/n".
	Region:	This field determines the regulatory domain. Depending on the region, specific channels are faded in or hidden. The factory-programmed value depends on the TOBY-L2 module version.
	Channel:	This field determines the channel of the WiFi access point. The factory-programmed value is "Automatic".
	Encryption:	This field determines the encryption of the WiFi access point. The factory-programmed value is "WPA2".
	Network key:	This field is used to define the WPA/WPA2 key. The factory-programmed value is "ubx-wifi". The key must be suitable for the encryption method.
	Re-enter key:	This field is used for confirming the network key to prevent incorrect entries.
	IP:	This field determines the IP address of the WiFi access point. The factory-programmed value is "192.168.2.1".
	Subnet mask:	**Subnet mask:** This field determines the subnet mask of the WiFi access point. The factory-programmed value is: "255.255.255.0".
	WLAN STA "WLAN STA" configures the connectivity to an external hotspot. Enable „WLAN STA“. (STA mode enable : on) The router/modem is not operated as access point but as client!  	
	System "System" is used for several system configurations.  	
	Connection Manager:	This switch enables or disables the Connection Configuration Manager.

Modem Configuration GSM Config (continued)	New password:	This field is used to change the system password.
	Repeat password:	This field is used for confirming the system password to prevent incorrect entries.
	Password protection:	This switch determines the protection level of web pages. If the "Settings page" option is set, then the WiFi / Cellular subsystem router will only ask for a password when entering the settings page. On the other hand, if the "All pages" option is selected, then all the tabs of the WiFi / Cellular subsystem web interface will be password protected.
	Language:	This multiple choice switch is used to select the output language of the WebUI.
	Reset device:	The "System reset" button reboots the WiFi / Cellular subsystem router, while the "Factory reset" button resets the WiFi / Cellular subsystem to the factory-programmed values.
	Web page FTP access:	The switch enables or disables the FTP access to the Web page files. The customer is allowed to personalize the aspect of the WebUI. The WebUI aspect may be reverted via AT command.

7.10.2. SMS

Settings for SMS alarm.

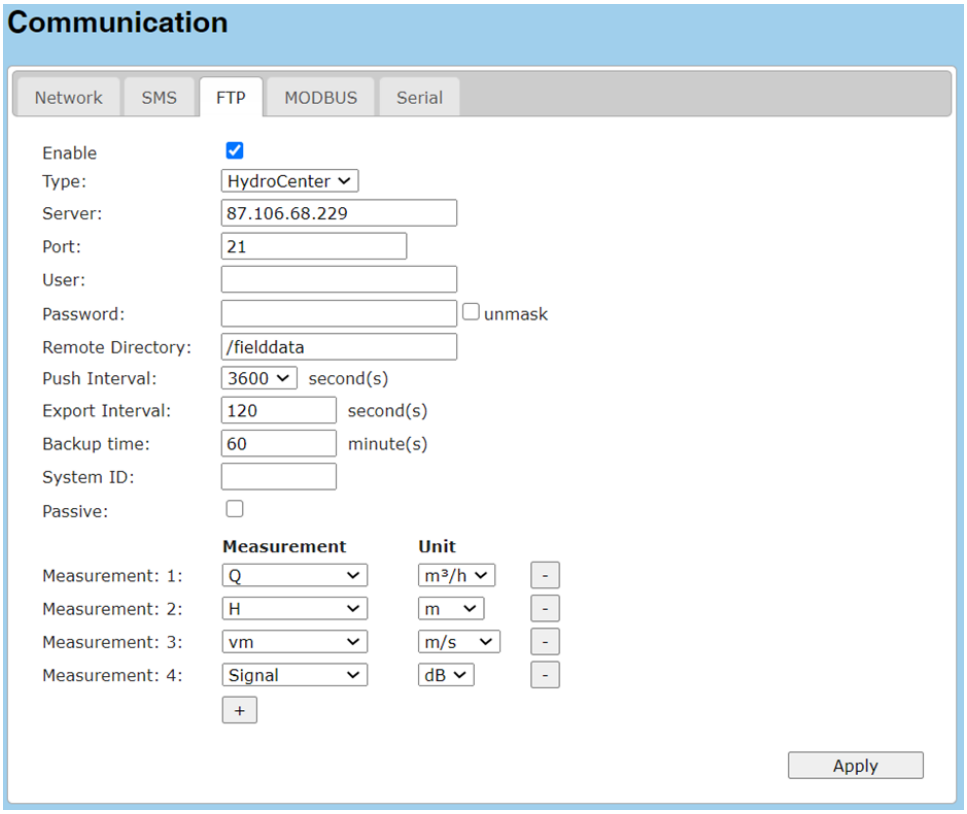
NOTE: The sending time of an SMS from the sender to a recipient depends solely on the service provider of the SMS Center.



▷ **SMS**	
Setting Description	
SMS Settings	
SMS-Center	> Enter service number of SMS center of the provider of your SIM card for forwarding SMS to your mobile phone. (format: +49123456789; +country code mobile no.)
Alarm content	
Mobile no.	> Enter mobile no. of recipient (+49128947662)
Recipient	> Enter name of SMS recipient.
Alarm ID	> Select alarm type (1…8) which is defined by the assignment of the respective digital output.
Description	> Description of SMS alarm type (for example door open)
+ -	> click + to insert new line (new alarm type) click - to delete line, alarm type.
	☝ Click **Apply** to save entries.

7.10.3. FTP

FTP (File Transfer Protocol) configuration.



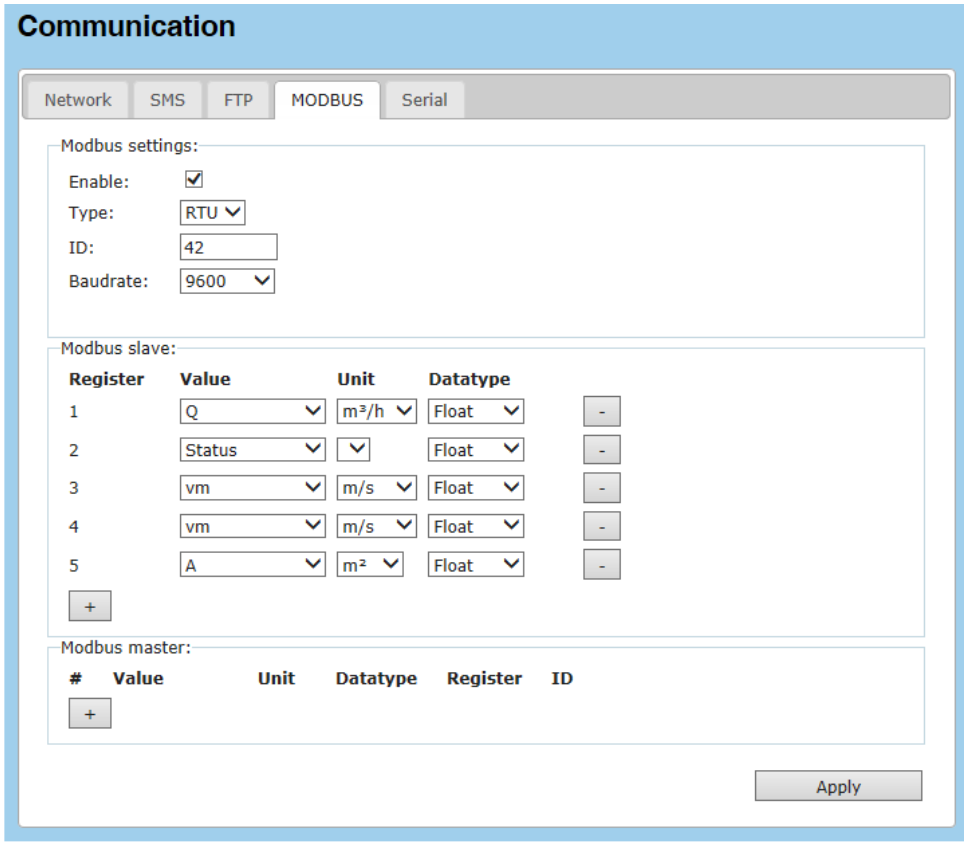
▷ **FTP**	
Setting	**Description**
Enable ☐	> ☑ Tick checkbox to enable / disable FTP.
Server	> Enter server IP address. Do not enter a name!
Port	> Enter port number.
User	> Enter username.
Password	> Enter password.
Remote Directory	> Enter directory name on server.
Push Interval ▼ 3600 (…) 300	> Select interval for file push. unit: s (seconds)
Export Interval	> Data interval in file.
Backup time	> Enter time span for the temporary data storage until the next data transmission.
Remote Directory	> Enter directory name on server.
System ID	> Enter system ID.
Suffix ⓘ only for type Ott binary and XRZP	> Enter file extension (for example .csv)
Passive	> ☑ Tick checkbox to enable FTP passive modus.

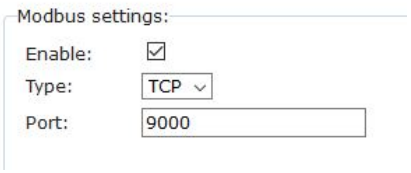
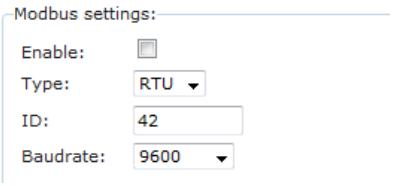
▷ **FTP**	
Setting	**Description**
Measurement 1: Measurement Value: ▼ None A H (…)	Specify measured values (Measurement 1) for data transfer. > Select measured values / parameters from drop-down list; corresponding units are displayed. (Explanation of abbreviations see 7.13)
▼ Unit	Display of corresponding units.
+ -	> Click + to add row for additional measurement value or – to delete values.
	☝ Click **Apply** to save entries.

7.10.4. Modbus

Modbus is a client-server communication protocol used for communication between electronic devices to exchange data mainly in the industrial environment.

A Modbus RTU interface (RS485/RS232) or an Ethernet interface with Modbus TCP protocol are available for communication.



▷ **MODBUS**	
Setting	**Description**
Modbus Settings	
Enable ☐	> ☑ Tick checkbox to enable / disable Modbus.
Type ▼ **TCP** **RTU**	> Select Modbus **TCP or RTU** protocol type from drop-down list.
Type ▼ **TCP**	> Select **TCP** 
Port	> 9000 (Default setting) TCP port number used for Modbus TCP server protocol.
Type ▼ **RTU**	> Select Modbus RTU protocol type for data transmission via internal interface RS485/RS232. 
ID	> Enter device / flow meter identification number (modbus address).
Baud rate ▼ 115200 (…) 1200	> Select desired baud rate from drop-down list.
Modbus slave	Definition of data transfer if system is used as slave.
Register 1, 2, ...	Number of register.
Value ▼ None A (…)	> Specify parameter for selected register.
Units ▼	Display of corresponding units. > Select desired unit from drop-down menu.
Datatype ▼ Float, LongInt	> Select data transmission format from drop-down list.
+ -	> Click + to add row for additional register or – to delete register.
Modbus master	Definition of data transfer if system is used as master.
#	Line number.
Value ▼ None A (…)	> Specify parameter for selected line.

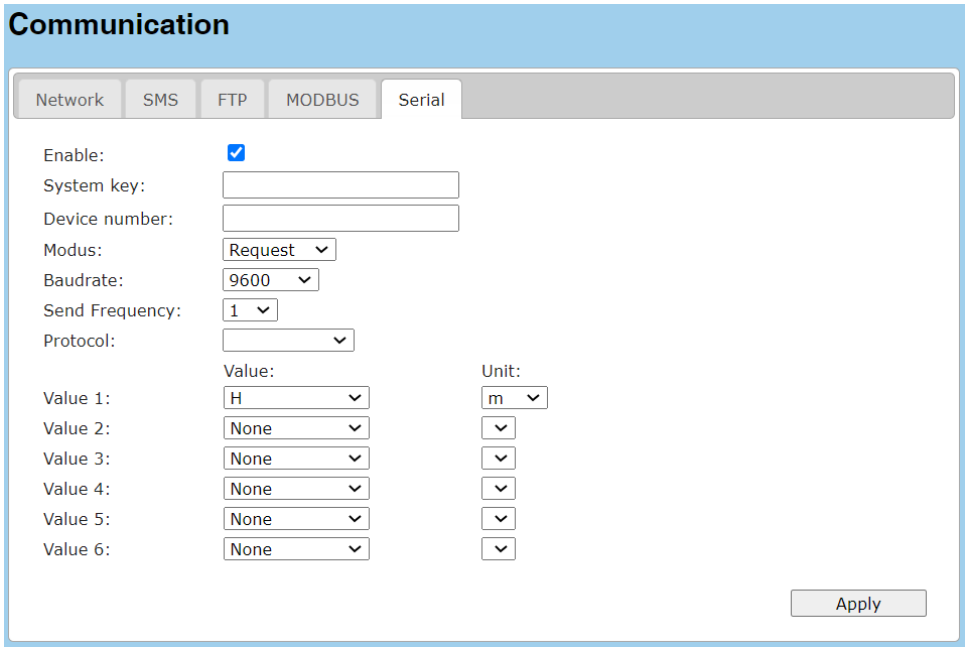
▷ **MODBUS**	
Setting	**Description**
Modbus Settings	
Unit ▼	Display of corresponding units. > Select desired unit from drop-down menu.
Datatype ▼ Float, LongInt	> Select data transmission format from drop-down list.
Register	> Enter register.
ID	> Enter device / flow meter identification number (modbus address).
+ -	> Click + to add row for additional parameter or – to delete parameter.
	Click **Apply** to save entries.
Further transmission parameters for Modbus RTU protocol:	
Data bits:	8
Stop bits:	1
Parity:	none
Realized functions:	Read holding register: Function 03

NOTE: If no measurement values are available (for example in case of missing values due to sensor failure), the following values are exported to Modbus interface:

- **Maximum value for "Float" data type - FLT_MAX = 3.4028234663852886e+38**
- **Maximum value for "LongInt" data type - LONG_MAX = 2147483647**

7.10.5. Serial

Settings for communication via serial interface.



▷ **Serial**	
Setting	**Description**
Enable ☐	> ☑ Tick checkbox to enable / disable serial communication.
System key	> Enter system key.
Device number	> Enter serial number of device.
Modus ▼ Request Autosend	> Select the transfer mode.
Baud rate ▼ 115200 (…) 1200	> Select desired baud rate from drop-down list.
Send Frequency ▼ 1, 5, (…), 60	> Select time span in seconds.
Protocol ▼ GWFSerial C Type SHWP	> Select serial communication protocol type. GWFSerial (Settings: baud rate 9600, parity: none; data bits: 8; stop bits 1) C Type Specific communication protocol corresponding to manufacturer specific data logger type. SHWP Specific communication protocol corresponding to manufacturer specific data logger type. Further specifications will be available on request.
Value ▼ A (…)	> Specify output parameter from dropdown list.
Unit ▼	> Select desired unit for the value.
	☝ Click **Apply** to save settings..

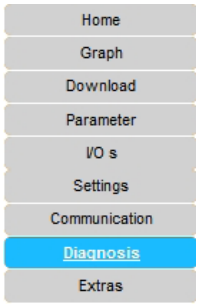
Example: Request of a floating point value
The flow meter device has the modbus address 42 (ID: 42).
In the user interface in register 1 the device is exporting the parameter water level (H),
with current value 0.8351314 m (Register: 1, Value: H, Unit: m).
Request (hexadecimal): 2A 03 00 00 00 02 C2 10

Description	**Hexadecimal byte**	**Remark**
Address	2A	User settings – 42
Function	03	Read Holding Register
Start address high	00	Start address 0 (user settings Register 1)
Start address low	00	—
Number of values high	00	2 registers needed to represent a float
Number of values low	02	—
Error check CRC	C2 10	—

Answer (hexadecimal): 2A 03 04 CB 2C 3F 55 4F 13

Description	Hexadecimal	Remark
Address	2A	User settings – 42
Function	03	Read Holding Register
Byte counter	04	—
Data	CB 2C 3F 55	Value decimal = 0.8351314 Value Hex (IEEE 754 single precision) = 3F55CB2C
Error check CRC	4F 13 10	—

7.11. Diagnosis

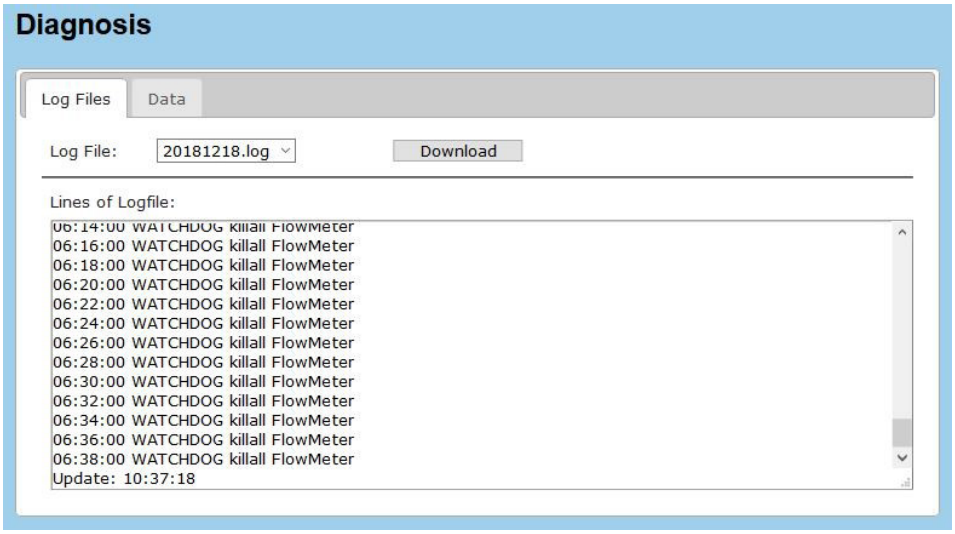


▶ **Diagnosis**
▷ Log Files ▷ Data

7.11.1. Log Files

Diagnosis tool with display of log files. The log file contains the protocol with information, warnings and error messages of all operations the system has executed. It provides valuable information about possible errors in hardware and also errors resulting from incorrect operation by the user.

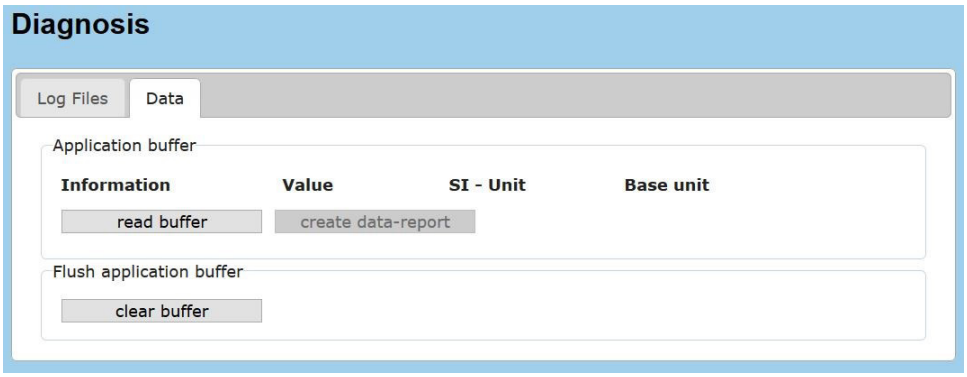
Settings for log-file history and display see in main menu ▶ Settings ▷ Logging.



▷ **Log Files**	
Setting	**Description**
Log File	> Select log-file from drop-down list. Filename: yyyymmdd.log
	☝ Click **Download** to display file content.

7.11.2. Data

Display of parameter list with measured and computed values, conversion factors and corresponding units.

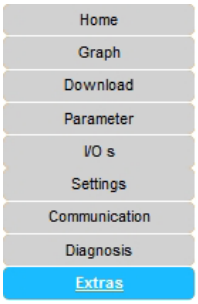


▷ **Data**	
Application buffer	Measured and calculated values data are loaded in an internal software buffer (application buffer) for averaging. ☝ Click **read buffer** to display parameter list with measured and computed values (average values).
	Log Files / Data Application buffer

Information	Value	SI - Unit	Base unit
A	0.022	m²	Area
CellSignal_01	88.000		Unitless
CellSignal_02	86.500		Unitless
CellSignal_03	84.500		Unitless
CellSignal_04	84.500		Unitless
CellSignal_05	86.000		Unitless
CellSignal_06	87.000		Unitless
CellSignal_07	87.500		Unitless
CellSignal_08	87.500		Unitless

	☝ Click **create data-report** to open data file in text editor.
Flush application buffer	☝ Click **clear buffer** to empty buffer and replace with most current data. After "flushing" the internal buffer, averaging calculation starts with most current data.

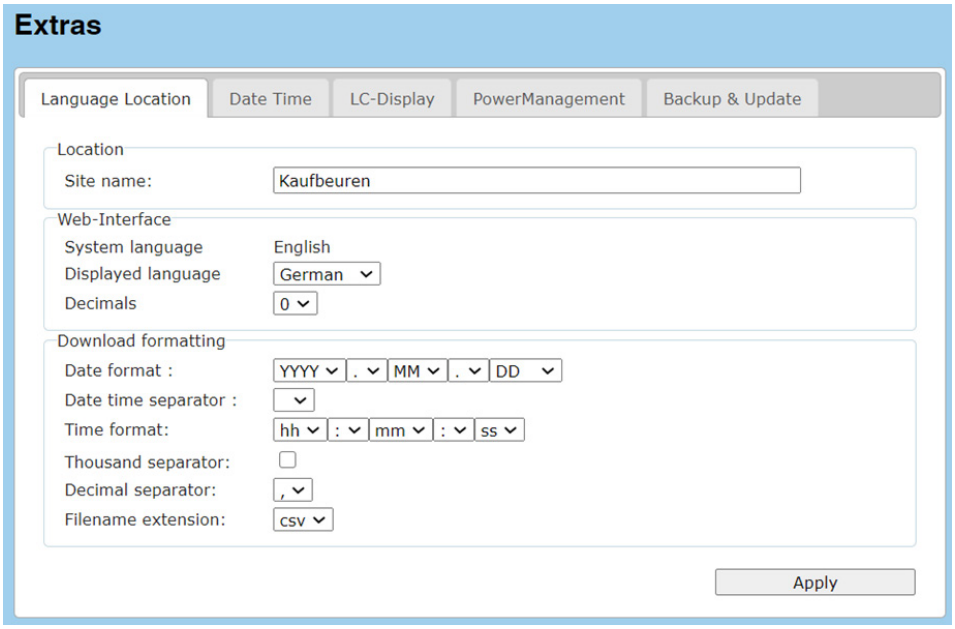
7.12. Extras



▶ **Extras**
▷ Language Location ▷ Date Time ▷ LC-Display
▷ Power Management ▷ Backup & Update

7.12.1. Language and Location

Language selection, site name entry field, settings for file, date, separator format.



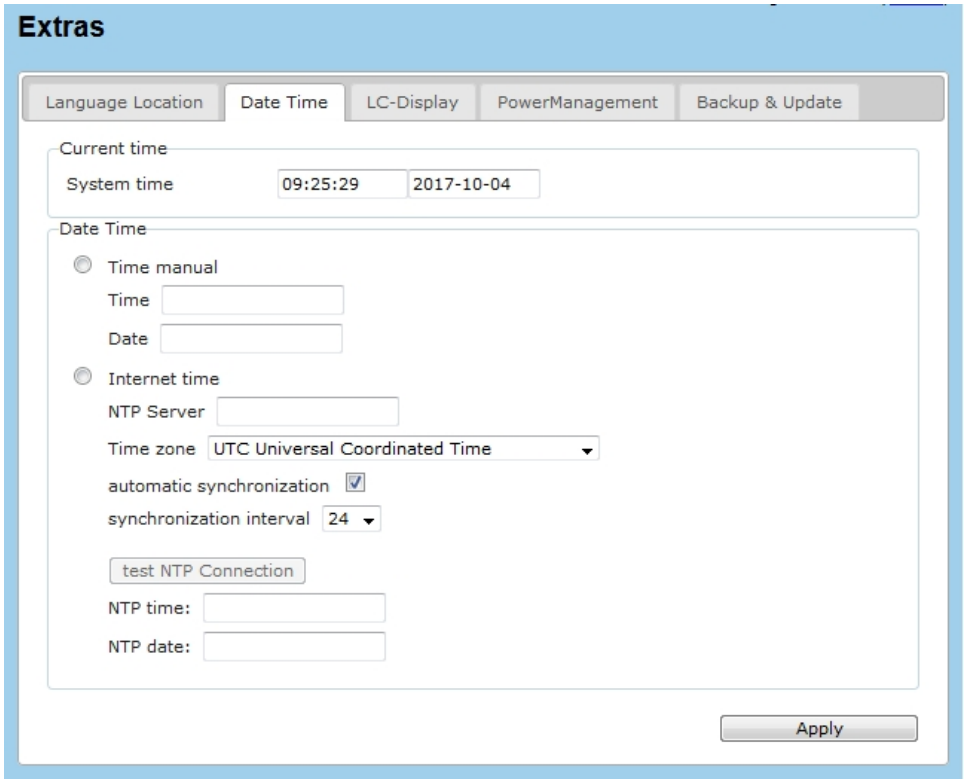
▷ **Language Location**	
Setting	**Description**
Location	
Site name:	Enter name of measuring site.
Web-Interface	
System Language	English
Displayed language ▼ Spanish German Polish Japanese French Russian Czech	> Choose GUI display language. ☝ Click **Apply** save data. The corresponding flag symbol of the selected language will be displayed. ☝ Click the flag symbol to change between languages.
Download formatting	ⓘ Download formatting is only possible for selectable download. Direct and monthly download cannot be formatted by user.
Date format:	> Choose date format from drop down list.
Date time separator	> Choose date and time separator from drop down list.
Time format	> Choose time format from drop down list.
Thousand separator	> ☑ Tick checkbox to insert decimal separator.
Decimal separator	> Choose type decimal separator from drop down list.

▷ **Language Location**	
Setting	**Description**
Filename extension	> Define file format (*.txt or *.csv) from drop down list. ⓘ Note that Excel might not open CSV files properly, for example all data are displayed in the first column due to different separators set in your Windows regional and language settings and the csv file. **For easy and correct import of measuring data in Excel, we recommend to save data as text file (*.txt). Opening a txt- file will start the text import wizard. The dialog box makes sure correct data import by defining the delimiters for example for date, time.**
	☝ Click **Apply** save data.

7.12.2. Date Time

Settings for time and date and option for time synchronization via internet.

Time synchronization via NTP server can be activated to synchronize the system time of the measuring system or PC with other data bases or networks to enable identical time stamps.



IMPORTANT

Save all measurement data (see chapter 7.6.1) and log files (see chapter 7.11.1) before changing system time or date. Otherwise, data could be deleted or overwritten. Measurement data and log files will be deleted if the last change to a file is too long in the past. The accepted time limit is 12 months for measurement data and 90 days for log files.

▷ **Date Time**	
Setting	**Description**
Current time	
System time	> Display of current system time and date.
Date Time	
⊙ Time manual	⊙ Check radio button to set time and date manually. After checking the button, the current time and date are displayed. 🖱 Click on the respective input field to change the time and date Time > Set desired time Date > Enter desired date
	🖱 Click **Apply** to save entries.
⊙ Internet time	⊙ Check radio button to activate time and date setting via NTP server (Network Time Protocol) Server.
	ⓘ NTP uses UTC (Coordinated Universal Time) for synchronization. In Germany MEZ (= CET) and MESZ (= CEST) is applied; CET = UTC + 1h respectively CEST = UTC + 2h

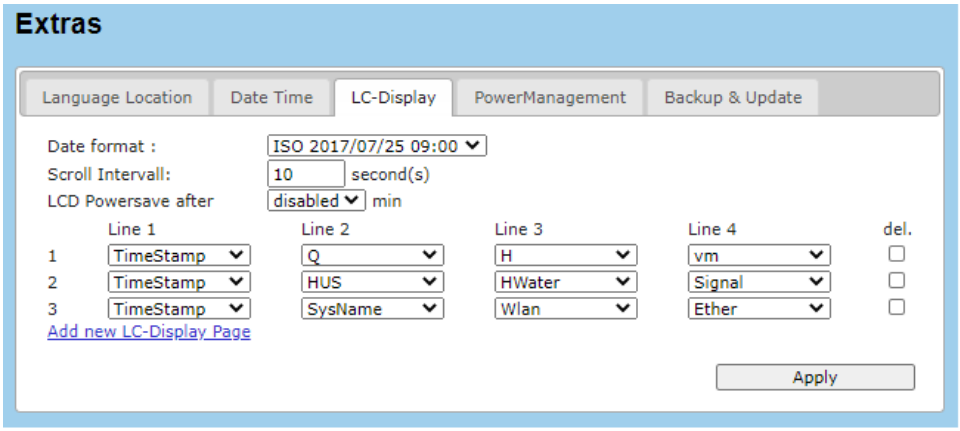
▷ **Date Time**	
Setting	**Description**
NTP Server	> Enter IP address of desired NTP Server. ⓘMany lists of IP addresses of NTV servers are available online.
Time zone	> Select local time zone from drop-down list.
automatic Synchronization	> ☑ Tick check-box for automatic synchronization.
Synchronization interval	> Select desired interval for time synchronization from drop-down-list
Test NTP connection	☝ Click **test NTP connection** to check settings. NTP time & date are displayed.
	☝ Click **Apply** to save entries.

7.12.3. LC Display

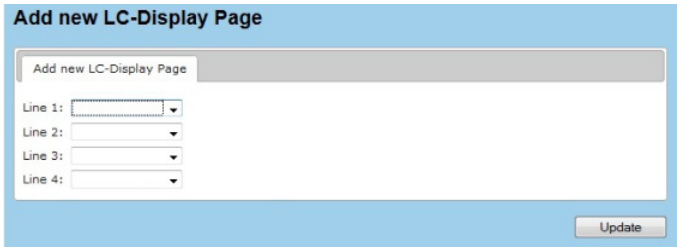
Settings for LC- transmitter display.

Definition for displayed parameters for 4-line display of transmitter (Line 1…Line 4). 4 parameters per LC screen can be displayed at once. Parameters can be selected individually from parameter list (*see "7.13. Abbreviations" on page 100*).

By adding additional LC screens, further parameters can be displayed in intervals.



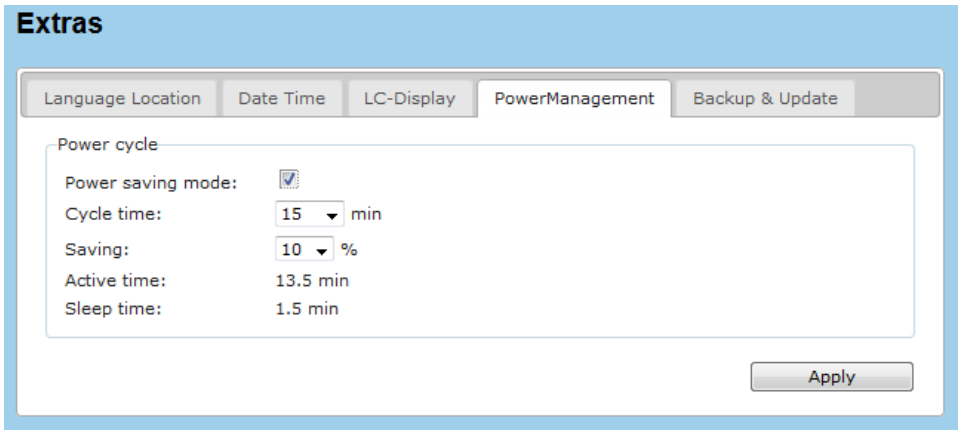
▷ **LC-Display**	
Setting	**Description**
Date format:	> Select data format. ISO: yyyy/mm/dd hh:ss US: mm/dd/yyyy hh:ss AM/PM
Scroll Interval	> Set time for scroll / display interval.
LCD Powersave after	> Set time for activation of power save modus for LC display. Or choose disabled to deactivate power save modus.
Line 1 Line 2 Line 3 Line 4	> Select parameter to be displayed from drop-down list. (abbreviation of parameter names as listed in database) ▼ TimeStamp Wlan (…) vm

▷ **LC-Display**	
Setting	**Description**
del. ☐	> ☑ Tick checkbox to delete entries.
	☝ Click **Apply** to save settings.
Add new LC-Display Page	☝ Click on **Add new LC Display Page** to add new display page.
	
	☝ Click **Apply** to save settings.

7.12.4. Power Management

Settings for power saving options during battery operation to save energy and to extend battery life.

NOTE: During specified sleep time NO measurements and NO data processing are carried out.



▷ **Power Management**	
Power cycle	
Setting	**Description**
Power saving mode	> ☑ Tick checkbox to activate the power saving mode.
Cycle time ▼ 15 30 (…) 360	> Select cycle time from drop-down list (max. 360 minutes). (Cycle time = Active Time + Sleep time)
Saving ▼ 10 25 50 75 90	> Select requested percentage energy saving during set cycle time.
Active time	Display of calculated active time during set cycle duration.

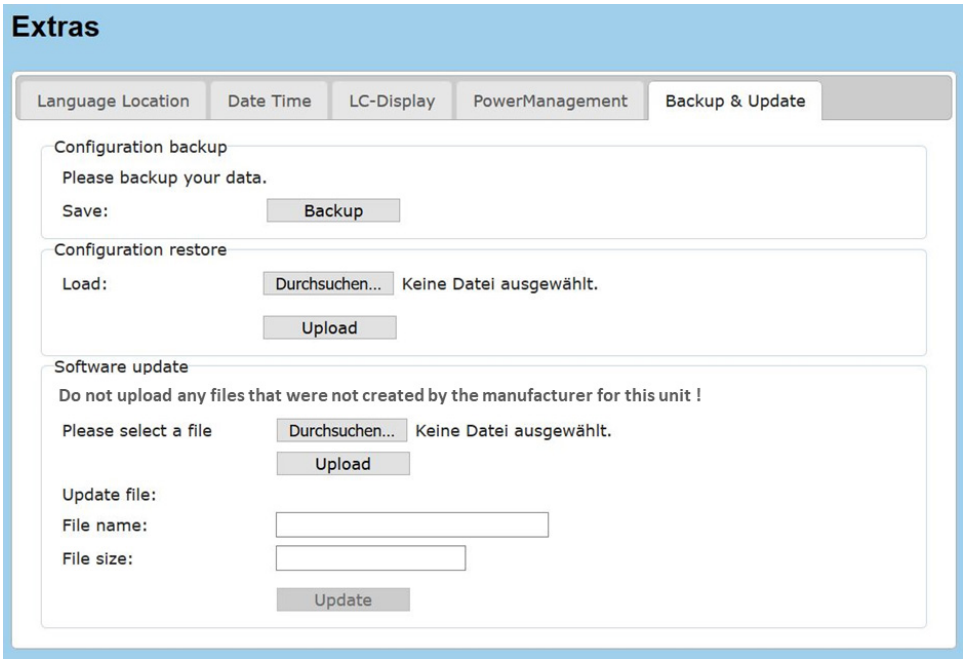
▷ **Power Management**	
Power cycle	
Setting	**Description**
Sleep time	Display of calculated sleep time during set cycle duration. ⓘ Always check sleep time settings with settings for FTP configuration under ▶ **Communication** ▷ FTP.
	☝ Click **Apply** to save settings.

7.12.5. Backup & Update

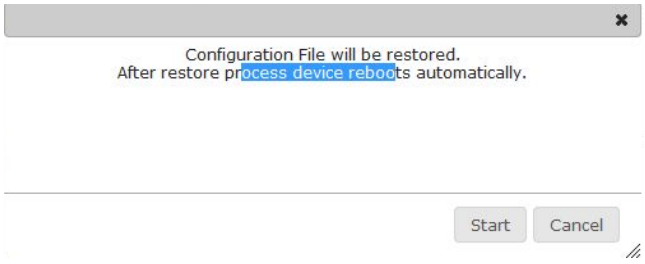
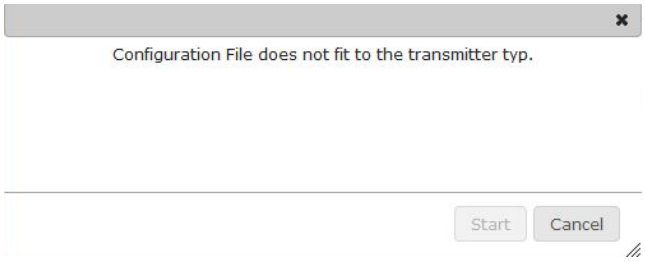
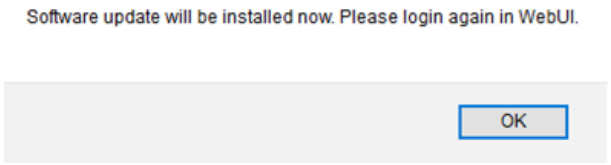
Function to save and upload data of hardware configuration and measurement parameters and software update option.

For a software update the manufacturer will provide you with the specific update file (updatemt.tgz).

ⓘ **Always make sure to save your configuration and settings after initial commissioning of the device!**



▷ **Backup & Update**	
Setting	**Description**
Configuration backup	
Save	☝ Click **Backup** to save configuration file in txt format.
Configuration restore	
Load	☝ Click **Search / Durchsuchen** and select configuration file from your directory.
	☝ Click **Upload** to load file.

▷ **Backup & Update**	
Setting	**Description**
Load (continued)	 ☝ Click **Start** to load file. ⓘ If the selected file does not correspond to the measuring system the following error message is displayed. 
	If the upload was successful, the system reboots.  ☝ Click **OK** to restart the system again.
Software update	
The manufacturer will provide you with the update file **updatemt.tgz.** Copy the file to your PC, Tablet etc.	
ⓘ **Always make sure to backup your data before starting an update. Only upload update files that are exclusively provided for your device by the manufacturer.**	
Please select a file	☝ Click **Search / Durchsuchen** and select update file from your directory.
	☝ Click **Upload** to load the file to transmitter.
File name	Display of update file name.
File size	Display of update file size.
	☝ Click **Update** for software update. ⓘ **Restart transmitter after successful software update.** **> press Reset / Restart key of transmitter.**

7.13. Abbreviations

NOTE: Display of parameters may vary according to the connected flow meter type.

(**Parameter list under ▶ Diagnosis ▷ Data)**

Abbreviation	Explanation
A	cross section area of flow
CellSignal_01 … CellSignal_18	signal strength of single measuring cells (for example CellSignal_01: signal strength in cell 01)
DVol	daily volume
DVolAbs	daily volume absolute
DVolNeg	daily volume negative (negative flow direction)
DVolPos	daily volume positive (positive flow direction)
H	water level, total
HAir	water level (external ultrasonic down-looking level sensor
HUS	water level (area velocity sensor)
HWater	water level (external hydrostatic level sensor)
OpHCount	operation time in hours
Q	discharge, flow
Status	status message of measuring system (only for internal use)
Salinity	salinity
Signal	signal strength
TAir	air temperature measured with additional external temperature sensor
TS	Timestamp
TWater	water temperature measured with additional external temperature sensor
TotalVolume	total volume
Volume	volume – since last volume reset
VolumeAbs	volume absolute – since last volume reset
VolumeNeg	volume negative (negative flow direction) – since last volume reset
VolumePos	volume positive (positive flow direction) – since last volume reset
v	velocity
vCell_01 … vCell_19	mean velocity in single cell (for example vCell_01: velocity in cell 01)
vm	mean velocity
Parameter list for transmitter LCD display	
TimeStamp	current time
Wlan	active connection via WLAN
Ether	active connection via Ethernet / LAN
SysName	display of system name
Location	display of name of measuring site
CPUF	processor frequency
Text>	display text

8. SERVICE

8.1. Cleaning, Maintenance and Care

⚠WARNING

RISK OF ELECTRIC SHOCK!

ALWAYS DISCONNECT POWER BEFORE DISMOUNTING OR CLEANING THE TRANSMITTER AND THE SENSORS.

DO NOT USE ANY SHARP OR POINTED OBJECTS TO CLEAN THE SENSORS.

IF THE FLOW METER IS USED PROPERLY, NO SPECIAL MAINTENANCE IS REQUIRED IN NORMAL OPERATION. NEVERTHELESS, CHECK TRANSMITTER, SENSORS, CABLES AND CONNECTIONS ON VISIBLE DIRT OR DEPOSITS AND DAMAGES. REMOVE POSSIBLE COATINGS AND DEPOSITS VERY CAREFULLY WITH A DAMP CLOTH AND MILD DETERGENT.

⚠WARNING

BIOLOGICAL HAZARD!

OBEY SAFETY REGULATIONS AND WEAR PERSONAL PROTECTIVE EQUIPMENT WHEN HANDLING A DEVICE THAT MAY HAVE COME IN CONTACT WITH BIOLOGICAL HAZARDOUS MATERIAL (FOR EXAMPLE, WASTEWATER). WASH AND DECONTAMINATE THE INSTRUMENTS (TRANSMITTER CASE, SENSORS, CABLES) WITH DISINFECTANT SOAP AND RINSE WITH WARM WATER BEFORE MAINTENANCE OR SHIPPING.

If the flow meter is used properly, no special maintenance is required in normal operation. The transmitter is designed to be practically maintenance and wear-free. Nevertheless, check transmitter, sensors, cables and connections on visible dirt or deposits and damages.

If necessary, the transmitter housing can be cleaned with a dry, dust- and lint-free cloth. In case of severe soiling, it can be wiped with a damp cloth.

Possible coatings and deposits on the sensors can be removed very carefully with a damp cloth and mild detergent.

8.2. Troubleshooting

8.2.1. Error Codes

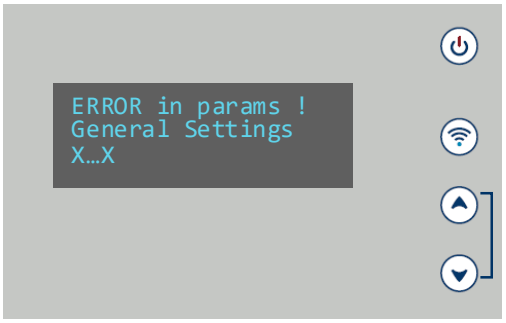
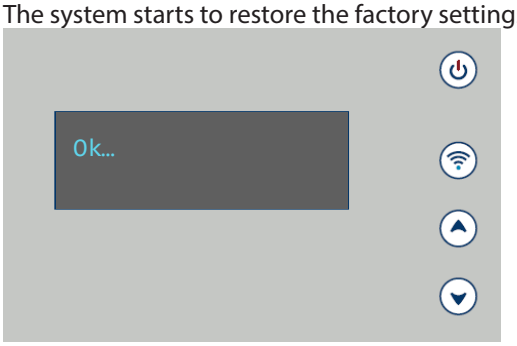
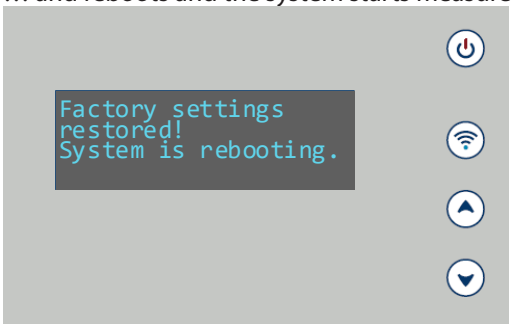
Error code	Error message	Description	Error Handling
1	failure	General system failure	Contact manufacturer
2	velocity	Failure velocity measurement	Check sensor and wiring
4	w water	Failure water level measurement with hydrostatic level sensor	Check sensor and wiring
8	w air	Failure water level measurement with ultrasonic down-looking level sensor	Check sensor and wiring
16	t water	Failure water temperature measurement (external T sensor)	Check sensor and wiring
32	t air	Failure air temperature measurement (external T sensor)	Check sensor and wiring
64	water level	Failure water level measurement	Check sensor and wiring
128	v sensor communication timeout	Failure communication / connection to velocity sensor	Check sensor and wiring

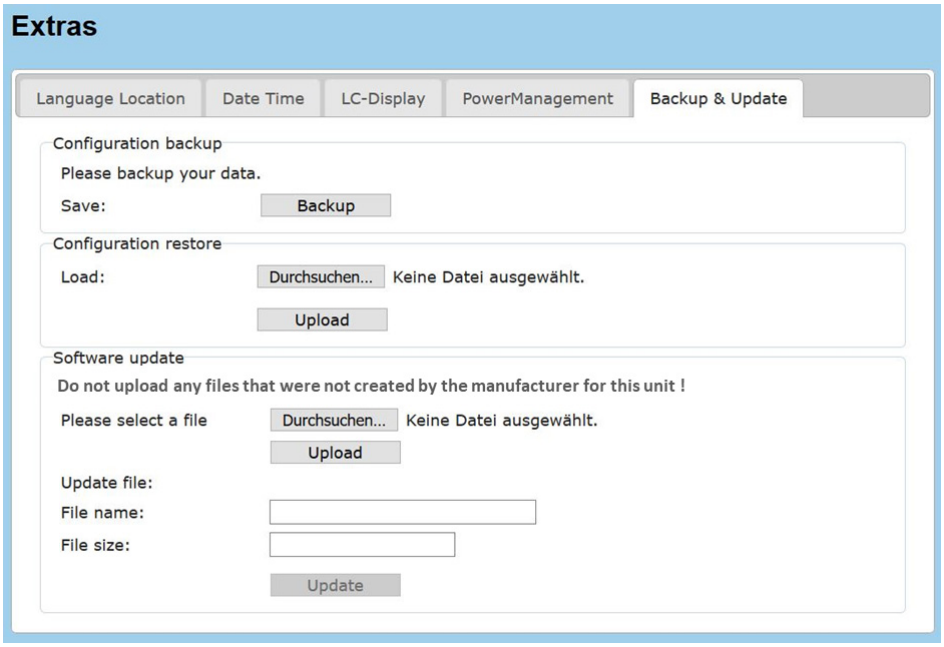
Table 1: Error codes (depending on the configuration of the measuring system)

8.2.2. Reset to Factory Settings

A total system failure might be caused by loss of the params.txt-file.

To resolve the failure reset the transmitter to default parameters (factory settings) by the following steps:

①	Error message transmitter display:  Press both navigation keys and hold for at least 5 sec.
②	Hold until the following message is displayed. Release buttons. Then press "up" button within the next 5 seconds.
③	The system starts to restore the factory settings… 
④	… and reboots and the system starts measurements again. 

⑤	After successful rebooting, it is now possible to upload the user-defined params.txt-file. Therefore Change to GUI and go to ▼ Extras ▷ Backup & Update:  **Configuration restore** ☝ Click **Search / Durchsuchen** and select configuration file from your directory. ☝ Click **Upload** to load file to transmitter. ☝ Click **Start** to restore configuration file.
⑥	Now press Reset / Restart button of transmitter to restart again and to activate changed settings.

8.3. Return / Repair

Please follow the following instructions in case the device has to be returned to the manufacturer for repair or inspection.

For returning the device proceed as follows:

- Request "Flow Meter Instrument Return Form" (IRF) by email from the manufacturer.
- Fill in one sheet per returned instrument. This will help us to get the information needed to carry out the repair as soon as possible.
- Include the completed and signed IFR with your return shipment.
- Clean and decontaminate the device properly.
- Pack it safely by ideally using the original packing.
- Send the parcel to the manufacturer for repair

IMPORTANT

Keep original packaging for safe storage and safe transport.

⚠CAUTION

DECONTAMINATION NOTE
BECAUSE OF LEGAL REGULATIONS ON ENVIRONMENTAL PROTECTION AND FOR THE SAFETY AND HEALTH OF OUR EMPLOYEES, ONLY SEND BACK CLEAN AND DECONTAMINATED DEVICES. IF THE DEVICE HAS BEEN OPERATED WITH TOXIC, FLAMMABLE OR WATER-ENDANGERING PRODUCTS CHECK AND MAKE SURE, IF NECESSARY, BY RINSING OR NEUTRALIZING, THAT ALL CAVITIES ARE FREE FROM SUCH DANGEROUS SUBSTANCES. THE MANUFACTURER RESERVES THE RIGHT TO REFUSE THE DELIVERY OF DIRTY OR CONTAMINATED DEVICES OR, IF NECESSARY, CHARGE EXTRA CLEANING COSTS. SIGN THE IRF (INSTRUMENT RETURN FORM) TO CONFIRM THAT THE DEVICE IS SAFE TO HANDLE.

8.4. Disposal

⚠WARNING

DISCONNECT POWER BEFORE DISMOUNTING THE DEVICE.

RISK OF POTENTIAL HAZARD TO HUMANS AND ENVIRONMENT DUE TO HARMFUL SUBSTANCES. MAKE SURE, THAT THE DEVICE AND SENSORS ARE FREE FROM HARMFUL SUBSTANCES.

IMPORTANT

Dispose the device in compliance with your country's legal and valid regulations for the disposal of electronic and electrical appliances. Correct disposal avoids negative effects on public health and the environment and makes sure recycling of useful raw materials.

This symbol indicates that the directive 2009/96 EG on waste and electronic equipment requirements shall be observed on the disposal of the device.

9. OPERATING PRINCIPLE

9.1. Doppler Flow Meter

An ultrasonic beam is transmitted into the flowing fluid at an oblique angle to the flow. The receiver collects scattered ultrasound from a core group of flowing particles travelling down the central axis of the open channel or pipe. This received ultrasound is shifted in frequency from the transmitted ultrasound in accordance with the general Doppler equation:

$$f_D = 2 * f_0 * \cos(\alpha_0) * \frac{V}{c_0}$$

f_D is the Doppler shifted frequency

f_0 is the transmit frequency

V is the average velocity of the scatterers

c_0 is the speed of sound of the fluid

α_0 is the beam angle relative to the scatterer velocity

The figure below depicts a simplified, two-dimensional diagram of the ultrasound beam injected into the flow stream with the center of the beam at angle. To simplify this explanation, the velocities along the centerline of flow are only considered. If all of the particles along the center flow line travel at the same velocity, there is a distribution of Doppler frequencies corresponding to the change in cos(*a*), due to the divergence of the ultrasound beam. The received Doppler shifted frequencies mix with the transmit frequency, resulting in a group of beat frequencies. The time domain, sinusoidal beat signals are digitized and converted to the frequency domain via a fast Fourier transform (FFT). The frequency spectrum generated by the FFT is scanned to find the dominant peak frequency. The point of highest intensity, the frequency spectrum peak, indicates the center flow velocity.

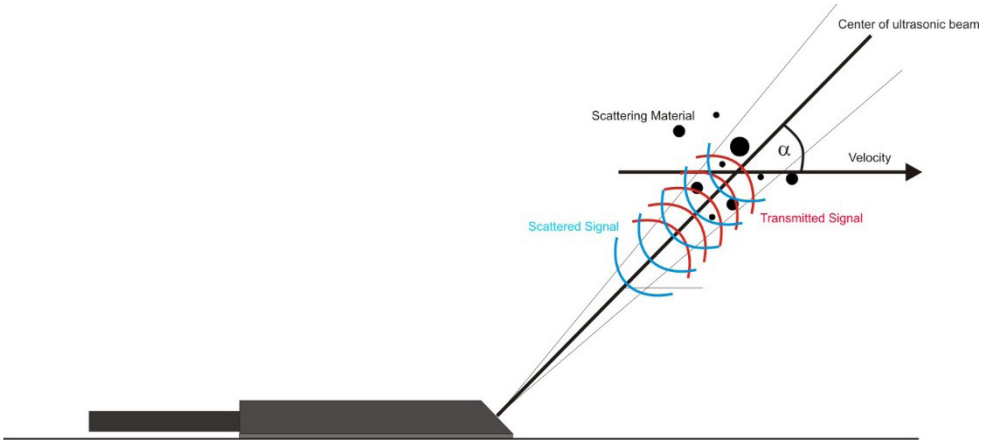


Figure 13: Doppler Principle

Doppler flow meters are not generally promoted for use in clean fluids. In real applications, strong Doppler shifted signals are required for reliable flow measurements.

The amplitude of the Doppler shifted signals from any application is largely related to the suitability of the sonic scatterers in the flow for producing detectable Doppler signals.

Identifying suitable sonic scatterers for Doppler flow meters is a complex combination of four basic criteria. How well the criteria are met determines the reliability and accuracy of a Doppler flow application.

The criteria are:

- The scattering material must have a sonic impedance different from the fluid
- There must be some particles large enough to cause longitudinal scattering
- For a given channel size, the longitudinal scattering must have sufficient energy to overcome the Rayleigh (energy wasting) scattering caused by smaller particles
- The scattering material must travel at the same velocity as the fluid for good accuracy

There are two main types of Doppler flow meter systems in common use today, Continuous Wave and Pulsed Wave. They differ in transducer design and operating features, signal processing procedures and in the types of information provided.

Continuous wave (CW) Doppler is the older and electronically more simple of the two kinds. As the name implies, CW Doppler involves continuous generation of ultrasound waves coupled with continuous ultrasound reception. A two crystal transducer accomplishes this dual function. The main disadvantage of CW Doppler is its lack of selectivity or depth discrimination. CW Doppler measurements are a spot velocity measurement. The sensor is not able to determinate at which level the velocity has been detected. Due to this reason the flow profile cannot be represented. To correct this deficiency, the average flow velocity is computed using a calibration factor. This factor must be determined previously such as by implementing a grid measurement which is time consuming and expensive.

9.2. Pulse Wave Doppler (PW)

Pulsed wave (PW) Doppler systems use a transducer that alternates transmission and reception of ultrasound. One main advantage of pulsed Doppler is its ability to provide Doppler shift data selectively from a small segment along the ultrasound beam, referred to as the "SCAN Window" or cell. The location of the SCAN Window is operator controlled. The ultrasonic pulsed wave Doppler is a new development that supersedes all the older Doppler principles. In contrast to CW Doppler principle, with the Pulse Doppler a shorter ultrasonic frequency bundle of defined length is transmitted. This makes it possible to assign a defined measurement window for received signals, step by step over the entire flow profile. The frequency shift of the transmitted ultrasonic signal into a defined measurement window is the measurement of the flow velocity in that measurement window. Reflections of particles in other areas do not have any influence on the velocity measurement.

9.3. Ultrasonic Signal Diagnostics

The flow information is derived from ultrasonic signals travelling through a moving fluid. One of the most critical aspects of the ultrasonic flow meter diagnostic software is to evaluate the individual ultrasonic signals to determine if the signal is acceptable for an accurate velocity measurement. If there is a problem with the ultrasonic signals themselves, the flow measurement will be incorrect. It is impossible to state what an ultrasonic signal should look like in general, but essentially the signal needs to appear as expected by the receiver and processing software.

The amplitude or strength of the ultrasonic signal (dB) depends on just about every aspect of the measurement system. Depending on the distance of the SCAN Window from the sensor, the lower is the received signal because of spreading and signal scattering within the fluid. High suspended loads weaken the signal as well.

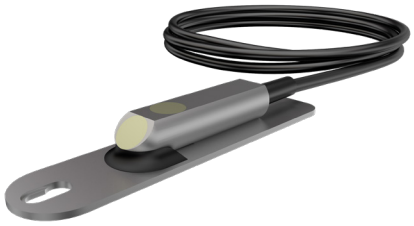
In general, signal strength readings between 50 dB and 80 dB are expected with a properly mounted sensor. Signal strength readings higher than 90 dB may indicate that the sensor need to be cleaned, as dirt may weaken the signal or sediment covers the sensor. Signal strengths lower than 35 dB are considered to be no signal at all.

10. TECHNICAL DATA

10.1. Transmitter

Display	LC-Display, 4 lines, 20 characters
Keyboard	4 keys
Enclosure	IP 66; Aluminum; wall mounted indoor use only or environmental enclosure
Operating Temperature	-4…140° F (-20…60° C)
Storage Temperature	-4…158° F (-20…70° C)
Maximum Humidity	90% (non-condensing)
Maximum Operating Altitude	AC device: 2000 m above sea level
Power Supply	100…240V AC, ±10% 47…63Hz or 10…36V DC, ±15%, 5% residual ripple
Power Consumption	AC: max. 40 VA, typically: 30VA DC: max. 30 W, typically: 8 W
Operating Conditions	Protection class I Overvoltage category I Pollution degree 2
Outputs Analog	Four 4…20 mA active channels, load <550 Ohms
Outputs Digital	Four relays 60V DC 1A or 30V AC 1A 200 Hz max.; normally open or normally closed Two pulse/frequency outputs; 24V DC
Inputs Analog	Four 4…20 mA input channels; 1 channel reserved for level
Inputs Digital	Two inputs 30V DC max.
Communication	Modbus RTU 485; Modbus TCP Ethernet 10/100 Mbps RJ45
Programming Port	Webserver using standard web browser via WiFi or Ethernet; English, French, German, Spanish, Polish, Czech, Russian or Japanese languages
Data Logging	16 GB Micro SD card; 12 months of storage; file transfer through web browser
Channel/Pipe Shapes	Round radius, U-shape, rectangular, trapezoid, egg-shape, custom channel
CE Compliance	Low Voltage Directive, 2014/35/EU, EMC 2014/30/EU, Radio Equipment Directive 2014/53/EU, RoHS 2 2011/65/EU, 2015/863/EU
Certification Option	cCSAus general area indoor use: CAN/CSA-C22.2 No. 61010-1-12, UPD1:2015, UPD2:2016, AMD1:2018; UL 61010-1 Third Edition (2012), AMD1:2018

10.2. Area Velocity Sensor



Sensor	Integrated Doppler ultrasonic velocity and water level with temperature measurement
Measuring Principle	Velocity: pulse coherent
Water level	Ultrasonic travel time Medium Wastewater ≥ 50 ppm
Frequency	1 MHz
Beam Angle	45°
Number of Cells	Max. 32 cells
Operating Temperature	5…122° F (-15…50° C)
Velocity Range	Velocity: ± 16.5 ft/s (± 5.0 m/s) Min. detectable flow velocity ± 0.13 ft/s (± 0.04 m/s) depending on size and amount of particles
Velocity Accuracy	± 1% full scale in the range 5.0…16.5 ft/s and -5.0…-16.5 ft/s (1.5…5.0 m/s and -5.0…-1.5 m/s) ±0.1 ft/s in the range -5.0…5.0 ft/s (± 0.03 m/s in the range -1.5…1.5 m/s)
Water Level Range	1.6…51 in. (0.04…1.3 m) Expandable via external 4…20 mA sensor
Water Level Accuracy	± 2.6 in. (± 0.065 m)
Temperature Accuracy	± 0.5 K for 4…57°C; Linearized range: 0…60° C Overall range: -60…150° C
Flow Accuracy	Typically ± 2% of reading
Material	Stainless steel (main unit, base plate) PEEK (Piezo Oscillator cover lid)
Protection Class	IP 68
Dimensions	7.1 x 1.6 x 0.9 in. (LxWxH) 180 x 40 x 22 mm (LxWxH) (incl. base / mounting plate)
Cable Length	32…262 ft (10…80 m)
Cable Outer Jacket	Polyethylene; Diameter Ø 0.4 ± 0.012 inn (10.00 ± 0.3 mm)
Cable Operating Temperature Range	-4…158° F (-20…70° C)

11. ANNEX

11.1. Roughness Coefficients

Manning´s equation roughness coefficients for various channel materials

The Manning´s equation is an empirical formula for open channel flow.

Function of velocity, flow area, channel slope and roughness

$Q = vA$ with $V = k_{St}\ Rh^{2/3}\ Ic^{½}$

Q: Discharge

v: Flow velocity

k_{St} : Roughness coefficient (Strickler)

$R_h^{2/3}$: Hydraulic radius (cross sectional A / wetted perimeter P)

$I_c^{½}$: Channel downward slope

Empirical roughness coefficients are listed in sets of tables (see below). The following symbols are used:

k_{St} = Strickler coefficient (more known in Europe)

n = Manning Coefficient

$k_{st}\ [m^{1/3}/s] = 1/n$

NOTE: Information in the following tables was taken from Isco Open Channel Flow Measurement Handbook & *CeCalc.com - Civil Engineering Calculations [2]

11.1.1. Closed conduit, Partly Full Metal Pipes

Material		Manning Coeff.			Strickler Coeff.
		n min	n Norm	n max	kst
1. Steel	a. Lockbar and welded	0.010	0.012	0.014	83
	b. Riveted and spiral	0.013	0.016	0.017	63
2. Cast Iron	a. Coated	0.010	0.013	0.014	77
	b. Uncoated	0.011	0.014	0.016	71
3. Wrought Iron	a. Black	0.012	0.014	0.015	71
	b. Galvanized	—	—	—	—
4. Corrugated	a. Subdrain	0.017	0.019	0.021	53
	b. Storm Drain	0.021	0.024	0.030	42

Table 2: Specific roughness coefficients (Manning & Strickler coefficients) for closed conduit, partly full metal pipesl

11.1.2. Closed Conduit, Partly Full Non-Metal Pipes

Material		Manning Coeff.			Strickler Coeff.
		n min	n Norm	n max	kst
1. Synthetics/ plastics	a. Acrylic	0.008	0.009	0.010	111
	b. Polyethylene (PE)	0.008	0.009	0.011	111
	c. Corrugated Polyethylene Culvert Pipe (smooth)	0.009	0.013	0.015	77
	d. Corrugated Polyethylene Culvert Pipe (corrugated)	0.018	0.023	0.025	43
	e. Polyvinyl chloride (PVC)	0.009	0.010	0.011	100
2. Glass	—	0.009	0.010	0.013	100
3. Wood	a. Stave	0.010	0.012	0.014	83
	b. Laminated, treated	0.015	0.017	0.020	59
4. Clay	a. Common drainage tile	0.011	0.013	0.017	77
	b. Vitrified sewer	0.011	0.014	0.017	71
	c. Vitrified sewer with manholes, inlets, etc.	0.013	0.015	0.017	67
5. Brick	a. Glazed	0.011	0.013	0.015	77
	b. Lined with cement	0.012	0.015	0.017	67
6. Concrete	a. Culvert, straight and free of debris	0.010	0.011	0.013	100
	b. Culvert with bends, connections and some debris	0.011	0.013	0.017	77
	c. Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017	67
	d. Unfinished, steel form	0.012	0.013	0.014	83
	e. Unfinished, smooth wood form	0.012	0.014	0.016	83
	f. Unfinished, rough wood form	0.015	0.017	0.020	59
7. Sanitary sewers coated with sewage slimes		0.012	0.013	0.016	77
8. Paved invert, sewer, smooth bottom		0.016	0.019	0.020	53
9. Rubble masonry, cemented		0.018	0.025	0.030	40

Table 3: Specific roughness coefficients (Manning & Strickler coefficients) for closed conduit, partly full non-metal pipesl

11.1.3. Lined or Built-Up Metal Channels

Material		Manning Coeff.			Strickler Coeff.
		n min	n Norm	n max	kst
1. Smooth steel surface	a. Painted	0.011	0.012	0.014	83
	b. Unpainted	0.012	0.013	0.017	77
2. Corrugated	—	0.021	0.025	0.030	40

Table 4: Specific roughness coefficients (Manning & Strickler coefficients) for lined or built-up metal channels

11.1.4. Lined or Built-Up Non-Metal Channels

Material		Manning Coeff.			Strickler Coeff.
		n min	n Norm	n max	kst
1. Cement	a. Neat surface	0.010	0.011	0.013	91
	b. Mortar	0.011	0.013	0.015	77
2. Concrete	a. Trowel finish	0.011	0.013	0.015	77
	b. Float finish	0.013	0.015	0.016	67
	c. Finished, with gravel on bottom	0.013	0.017	0.020	59
	d. Unfinished	0.014	0.017	0.020	59
3. Wood	a. Planed, untreated	0.0.1	0.012	0.014	83
	b. Planed, creosoted	0.011	0.012	0.015	83
	c. Unplaned	0.011	0.013	0.015	77
	d. Plank with battens	0.012	0.015	0.018	67
	a. Glazed	0.011	0.013	0.015	77
	b. In cement mortar	0.012	0.015	0.018	67
5. Masonry	a. Cemented rubble	0.017	0.025	0.030	40
	b. Dry rubble	0.023	0.032	0.035	31
6. Asphalt	a. Smooth	0.013	0.013	—	77
	b. Rough	0.016	0.016	—	63
7. Vegetal lining		0.030	—	0.500	—

Table 5: Specific roughness coefficients (Manning & Strickler coefficients) for lined or built-up non-metal channels

11.1.5. Excavated or Dredged Channels

Material	Manning Coeff.			Strickler Coeff.
	n min	n Norm	n max	kst
A. Earth, straight and uniform	0.016	0.022	0.035	29
B. Earth, winding and sluggish	0.023	0.030	0.040	25
C. Rock cuts	0.030	0.040	0.040	25
D. Unmaintained channels	0.040	0.070	0.140	7

Table 6: Specific roughness coefficients (Manning & Strickler coefficients) for excavated or dredged channels

11.1.6. Natural Channels

Material	Manning Coeff.			Strickler Coeff.
	n min	n Norm	n max	kst
A. Fairly regular section	0.030	0.050	0.070	20
B. Irregular section with pools	0.040	0.070	0.100	14

Table 7: Specific roughness coefficients (Manning & Strickler coefficients) for regular/irregular sections

11.2. Bibliography

[1] DIN 4263 (2011): Kennzahlen von Abwasserkanälen und -leitungen für die hydraulische Berechnung im Wasserwesen, Beuth Verlag GmbH, Berlin, 9 S.

[2] ISO 748:2007: Hydrometry - Measurement of liquid flow in open channels using current-meters or floats (ISO 748:2007); German version EN ISO 748:2007.

[3] Grant, Douglas M., Dawson, Brian D. (2001): Isco Open Channel Flow Measurement Handbook, 5 th edition; Isco Inc. Lincoln, Nebraska, USA.

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