PQ

Discharge measurement system

Manual

Setup version 3.20 (Firmware 2.04)

23.06.2022

Sommer Messtechnik

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Validity

This manual applies to the Discharge measurement system with the setup version 3.20, including all its subversions.

Created: 10.05.2021 Last update: 23.06.2022

EU conformity

CE

This product is in conformity with the following standards:

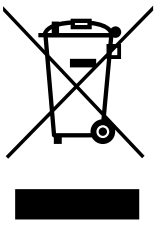
EMC	2014/30/EU	EN 301 489-1 V1.9.2
LVD	2014/35/EU	EN 62311:2008
		EN 62368-1:2014
RED	2014/53/EU	EN 300 440-2 V1.4.1
RoHS II	2011/65/EU	
RoHS III	2015/863/EU	

Safety information

Please read this manual carefully before installing or operating this equipment. Non-compliance with the instructions given in this manual can result in failure or damage of the equipment or may put people at risk by injuries through electrical or mechanic impact.

- Make sure that the personnel responsible for installation, configuration and maintenance is familiar with the applicable regulations and standards!
- Do not install the sensor in the immediate vicinity of motors, pumps, valves, sources of heat or other potential sources of interference.
- Excessive vibrations or pressure peaks can corrupt the measured values or even destroy the sensors.
- Maintenance and repair must be performed by trained personnel or an engineer of Sommer Messtechnik. Only replacement parts supplied by Sommer Messtechnik should be used for repairs.
- Make sure that NO power is connected to the equipment during installation and wiring!
- Only use a power supply that complies with the power rating specified for this equipment!
- Keep equipment dry during wiring and maintenance!
- If it becomes necessary to recalibrate the sensor, please send it back to Sommer Messtechnik.
- If applicable, it is recommended to use accessories of Sommer Messtechnik with this equipment.

Disposal



After this device has reached the end of its lifetime, it must not be disposed of with household waste! Instead, dispose of the device by returning it to a designated collection point for the recycling of waste electrical and electronic equipment.

Dispose of batteries separately!

Feedback

Should you come across any error in this manual, or if you miss information to handle and operate the PQ we are pleased to receive your feedback to office@sommer.at.

Content

1 What is the PQ?

The exact and real time knowledge of water discharge is of central importance for the operation of waste water treatment facilities, cost allocation in sewage networks and management of communal and industrial water resources.

The PQ continuously measures the water or effluent flow through ducts, pipes and open canals in sewer networks, water treatment plants and industrial facilities. It combines two sensors in one system. The first determines the water level by means of a pressure probe or radar sensor, the second simultaneously measures the mean flow velocity with an ultrasonic Doppler sensor.

2 Unpacking

When unpacking your PQ sensor box please make sure that the following items are present:

Qty	Name
1	PQ-Controller
1	SOMFLOW ultrasonic Doppler velocity sensor
1	PTM level sensor or SOMLEVEL-15 radar level sensor

In case of missing or damaged items please contact your Sommer Messtechnik sales partner.

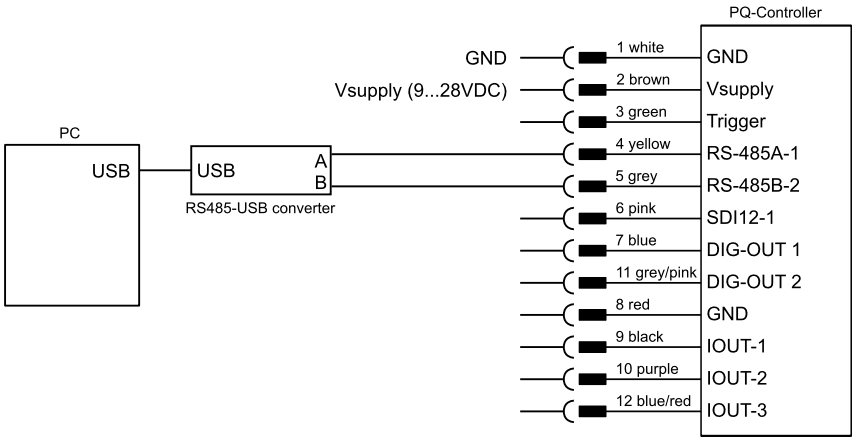
3 Get started

Follow the steps described below to set the basic configurations and to acquire the first measurement results.

> **NOTE** Perform the first start-up in your lab or office before installing the equipment in the field!

3.1 Connect the PQ to your PC

1. Install the SQ-Commander support software (see Installation of SQ-Commander)
2. Connect the yellow and gray wires of the sensor cable to the RS-485 to USB converter cable and plug it into your PC as illustrated in the figure below.
3. Connect the RS-232 to USB converter cable to the PQ and a USB port on your PC.
4. Connect a 9...28 VDC power supply to the PQ.
5. Establish a connection between the PQ and the SQ-Commander. See the video Connect a device in the online Service center.



3.2 Configure the PQ

1. Select measurement trigger, measurement interval, units and settings (see General settings)
2. Build and upload the cross-sectional profile (see video in the SQ Service Center)
3. Optional: Configure analog outputs (see Analog output).
4. Optional: Configure impulse output and limit monitor (see Digital output).
5. Send any modifications to the PQ by clicking Upload modified parameters to device.

3.3 Adjust the PQ to the current water level

This step needs to be performed as soon as the PQ has been installed at its final location. The respective procedure is described in Adjustment.

3.4 Acquire measurements

1. Establish a connection to your device. See the video Working with connections in the SQ-Commander section of the online Service center.
2. Record multiple measurements and verify their reliability. See the View live data of the in the SQ-Commander section of the online Service center.

4 How the PQ works

The PQ measures the water level and the mean flow velocity and calculates the water discharge based on a defined cross-sectional profile with a specified roughness.

The discharge Q is the volume of water V flowing through a cross section of a canal per time unit t. The default metric dimension is m^3/s.

$$Q = \frac{V}{t}$$

By applying the continuity equation the expression above can be transformed into the base equation of the discharge measurement:

$$Q = A \times v_m$$

where A is the wetted cross-sectional area deduced by the measured water level, and v_m the mean flow velocity.

4.1 Flow velocity

The mean flow velocity is measured with an ultrasonic Doppler radar mounted at the bottom of the canal.

4.2 Water level

The water level is either determined by a pressure probe fixed at the bottom of the canal, or a contact-free radar sensor mounted above the water (i.e. at the ceiling of the canal or a cross-arm or bridge).

5 Components

5.1 PTM pressure probe

The PTM pressure probe measures the water level between up to 1 bar and returns the results of its SDI-12 interface.

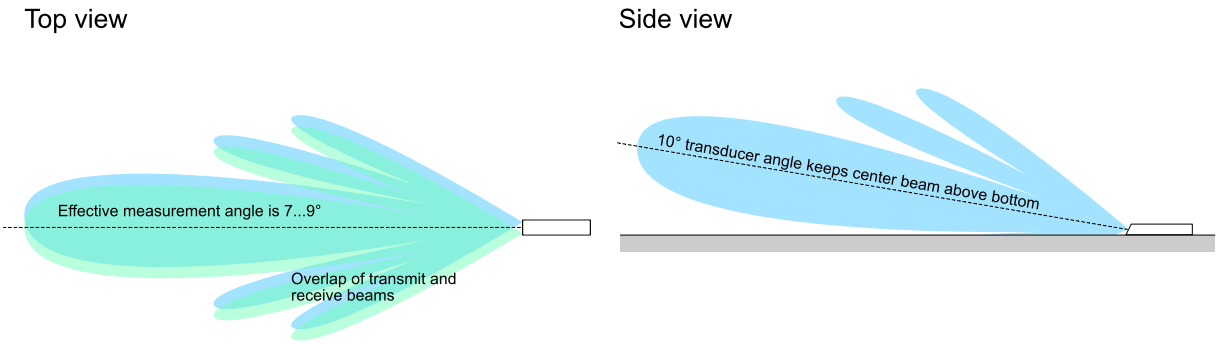
5.2 SOMLEVEL radar level sensor

The SOMLEVEL measures the water level from 0 m up to 15 m with a contact-free radar transceiver. Measurement values are returned by 4...20 mA signal.

5.3 SOMFLOW ultrasonic velocity sensor

The SOMFLOWdetermines the mean water flow velocity by means of a twin 1-MHz ultrasonic Doppler transceiver.

The following figure illustrates the shape and direction of the acoustic beam.



6 Specifications

PTM pressure probe	
Measurement range	0 ... 10m, 0 ... 1bar piezo membrane, absolute pressure, temperature compensated
Accuracy	±0.05 %
Long term stability	< 0.2% FS / < 4 mbar (1 year (typ. / max.), the long term stability can be improved by ageing (burn-in) the sensor)
Output	SID-12 V1.3
Operating temperature	-10° C ... +80° C
Storage temperature	-10° C ... +80° C
Size L x ∅	160 x 24 mm
Weight	200 g
Material	Stainless steel (316L / 1.4404)
Seals	Viton (Standard), EPDM, Kalrez

SOMLEVEL level sensor	
Measurement range	up to 15 m (49.21 ft)
Accuracy	≤ 2 mm
Beam angle	8°
Measurement frequency	W-band (80 GHz)
Mounting connection	Thread G1, 1NPT, R1
Process pressure	-1 ... +3 bar (-100 ... 200 kPa, -14.5 ... 43.51 psig)
Process temperature	-40 ... +80 °C (-40 ... +176 °F)
Ambient temperature	-40 ... +80 °C (-40 ... +176 °F)
Size Ø x H	Straight cable output: Ø76 x 109 mm (Ø2.99 x 4.28 in)

SOMLEVEL level sensor	
Weight	0.7 kg (1.543 lbs)
Material	Wetted parts: PVDF Process seal: FKM Connection cable: PVC insulated
Protection rating	IP68

SOMFLOW ultrasonic Doppler sensor	
Measurement range	Bi-directional 0.01 to 5 m/s (0.03 to 16.4 ft/s)
Accuracy	± 2 % of reading if V ≥0.5m/s (1.64 ft/s) ± 0.01 m/s (± 0.03 ft/s) if V<0.5m/s (1.64 ft/s)
Resolution	1 mm/s (0.003ft/s)
Minimum fluid level	5 mm (0.59 in) to 20mm (0.79in) above base of sensor, provided transducers fully wetted
Immersion	up to 1 bar
Principle	Doppler sensor using twin 1 MHz transducers
Operating temperature	-20 to +60 °C (fluid non-freezing)
Storage temperature	-20 to +70 °C
Size L x B x H	122 x 46 x 19 mm
Weight	1.1 kg (incl. 10-m cable)
Material	PVDF, polyurethane, 316 Stainless steel

PQ-Controller	
Power supply	9...28 VDC; Overvoltage and reverse voltage protection deep-discharge protected if used with optional battery
Outputs	- RS-485 (9600...115200 Baud), Modbus RTU - SDI-12 (version 1.3) - 3x 4 ... 20 mA output (level, velocity and flow) - Impulse output of flow volume - Switch for limit monitoring
Measurement interval	2 s … 12 h (default 60 s)

PQ-Controller	
Statistics interval	10 s … 12 h
Operating temperature	-40…60 °C (-40…140 °F)
Storage temperature	-40…60 °C (-40…140 °F)
Protection rating	IP67
Lightning protection	Integrated protection against indirect lightning with a discharge capacity of 6 kA Ppp
Housing material	Aluminium, powder coated
Power supply	9...28 VDC; Overvoltage and reverse voltage protection deep-discharge protected if used with optional battery

7 Installation

7.1 Site selection

When selecting the measurement site, the following needs to be considered:

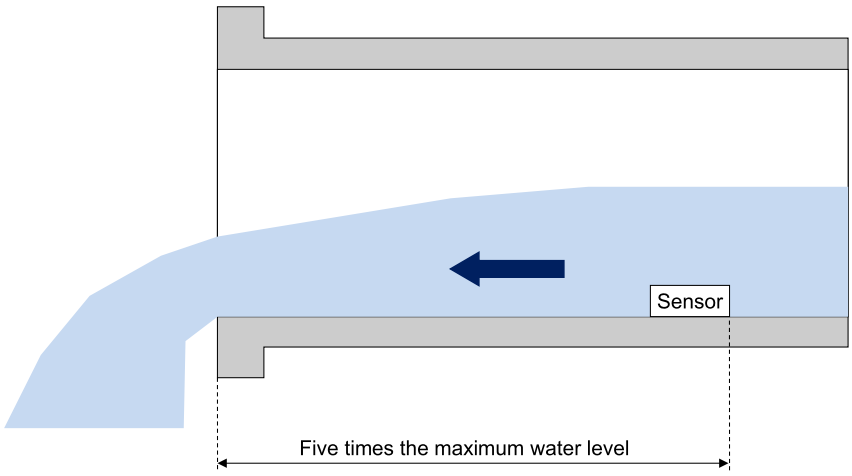
- The mounting spot of the sensor should be easily accessible (e.g. manhole directly above the flow).
- The distance between the sensors and the switch cabinet with the data acquisition system should be short.
- Interference from downstream processes and installations should be avoided (e.g. tide, weirs, ...).
- The site should not subject to the risk of vandalism, electrical interference or risk of lightning.

7.2 Things to consider for installation

7.2.1 Hydraulic conditions

Installation near an outlet

If the velocity sensor needs to be installed close to an outlet, it should be positioned as illustrated below:

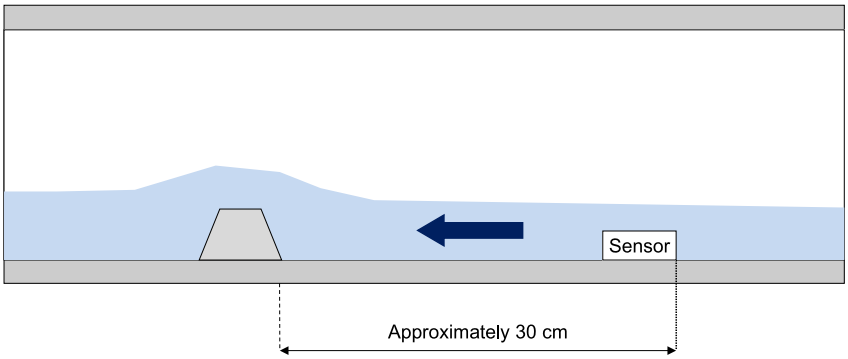


Installation near a sill

The presence of a sill requires some thought before installation in order to find a compromise between minimum velocity and minimum water level along the cross-section.

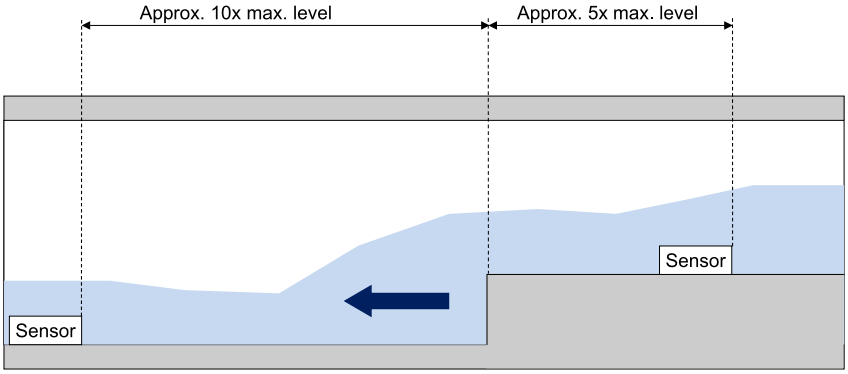
The water level must be at least 1.5 to 2 cm above the velocity sensor for reliable operation. Close to the sill the velocity drops, thus favoring deposition of solids. It is therefore necessary to know the contribution of deposits on the measurement spot before installing the velocity sensor. A certain amount of self-cleaning should be maintained in the system. Also, bear in mind that the minimum measurable velocity is 1 cm/s. This means that you have to keep a certain distance to the sill.

A sill can be installed downstream of the velocity sensor as a means to increase the water level artificially to enable velocity measurements. Drops in velocity and their consequences, as described above, must be taken into consideration.



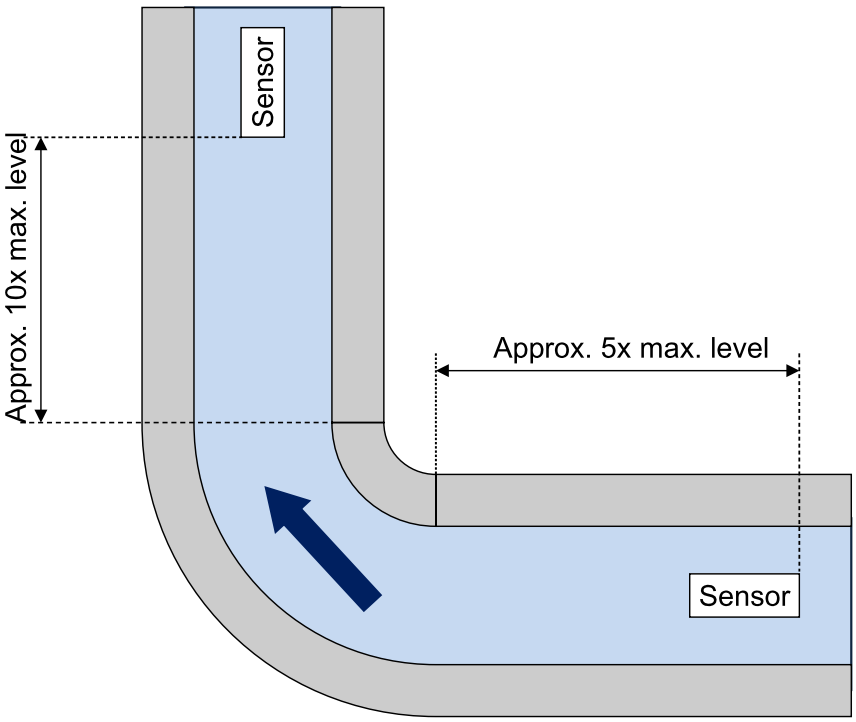
Installation near a drop

If the velocity sensor needs to be installed close to a drop, it should be positioned as illustrated below:



Installation near a bend

If the velocity sensor needs to be installed close to a bend, it should be positioned as illustrated below:



If it is impossible to meet these lengths, it may be desirable to install a deflector to correct the turbulence and smooth out the velocity profile.

7.2.2 Sensor position

The velocity and pressure sensors must be positioned so that they are constantly submerged. Thanks to the characteristics of the emission field of the velocity sensor, it can be secured to the bottom of the flow channel or slightly offset from the axis in the event of frequent deposition of material. The constraints related to measurement are therefore relatively small.

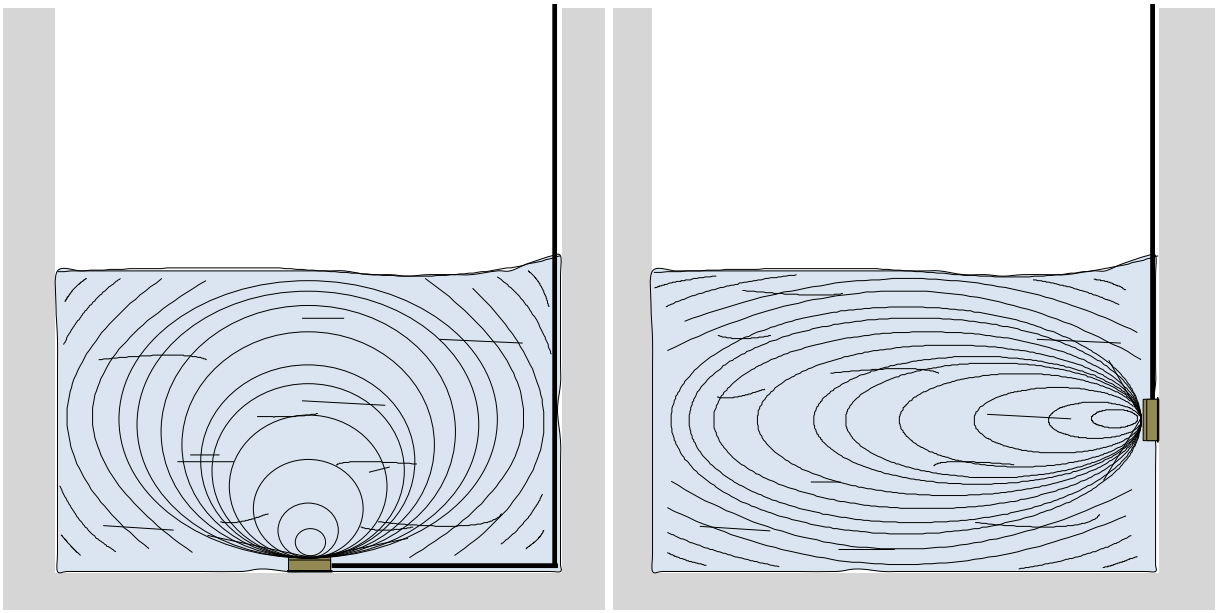


Figure 1 Positioning in a rectangular canal

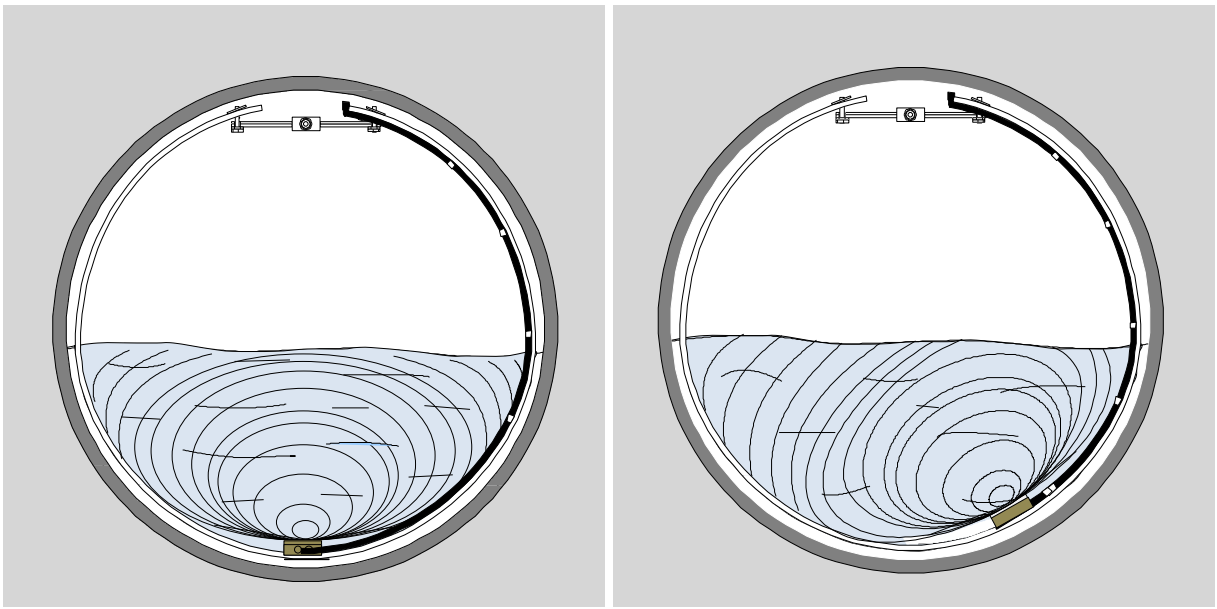


Figure 2 Positioning in a circular pipe

7.2.3 Power supply

The PQ can be powered by a 9...28 VDC power supply.

7.2.4 Signal cables

Maximum cable length

Please consider the maximum cable lengths for the applied transmission protocol:

Protocol	Max. cable length
SDI-12	~60 m (depending on wire cross section and number of sensors)
RS-485	~300 m

Table 1 Maximum cable lengths

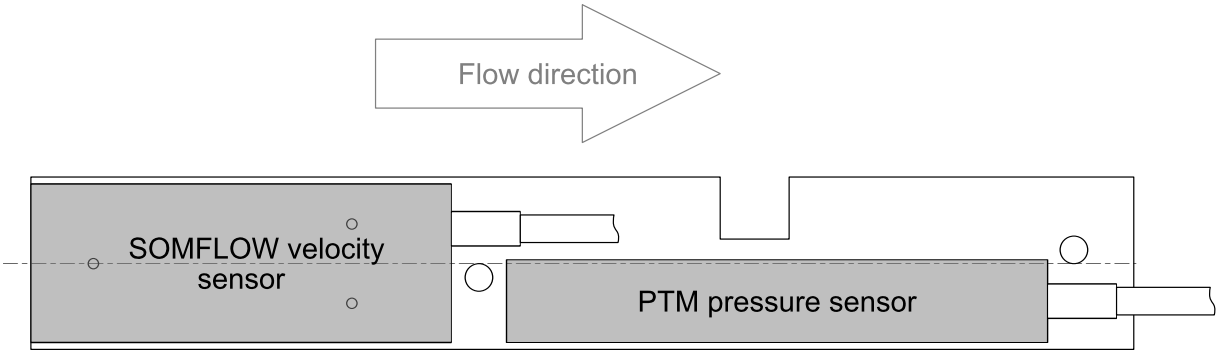
NOTE Cable lengths longer than 60 m require a heavier gauge wire if the power supply drops below 11 V.

7.3 Mounting

The velocity sensor can be installed facing up- or downstream. In the latter case, the velocity measurement is negative.

NOTE The position of the velocity sensor does not affect the acquisition of velocity measurements. However, the position does affect the quality of velocity measurements. This effect will be negligible if the velocity sensor remains close to the maximum velocity stream. In fact, the more the velocity measurement takes the maximum velocities into account, the higher the quality of measurement. Therefore, a greater offset from the surface creates a greater distance from the maximum velocity stream, and the measured values become less representative of the flow.

For easy pipe installation, mount the velocity and pressure sensors behind each other on a baseplate as illustrated below. Use proper fixation to attach the baseplate to the canal wall.



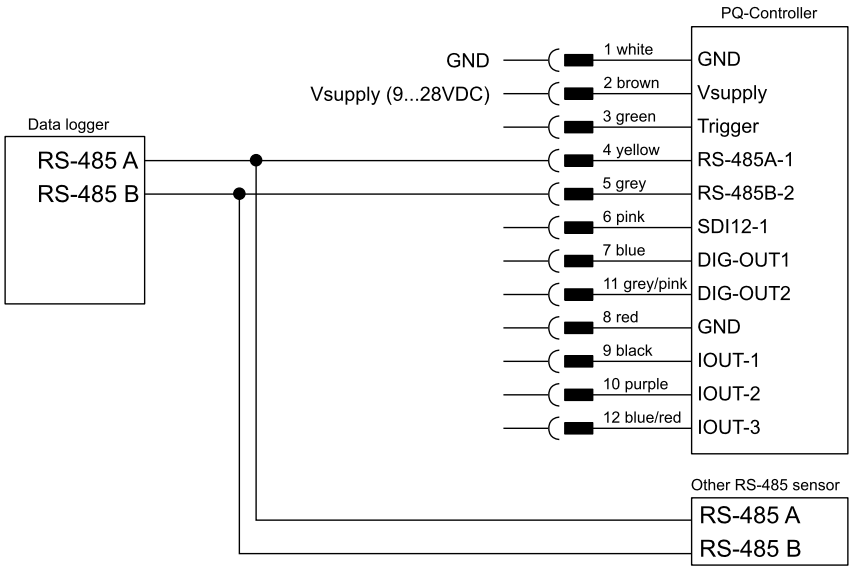
To prevent debris from catching on the sensor cables, it is important to attach the cable to the pipe so it offers as little resistance to the flow as possible. Attach the sensor cables downstream of the sensors, using suitable fixtures, e.g. self-locking cable ties.

ATTENTION When attaching the sensor cables to the pipe wall, do not over-tighten the fixtures! Overtightening may squeeze the pressure equalization capillary of the pressure sensor.

7.4 Wiring

7.4.1 RS-485 wiring

Connect the PQ to a data logger or RS-485 network according to the figure below.



7.4.2 SDI-12 wiring

Connect the PQ to a data logger by SDI-12 according to the figure below.

SDI-12 uses a shared bus with a ground wire, a data wire (indicated as SDI-12) and an optional +12 V wire.

NOTE The connection with the 12 V power supply is optional and depends on the connected SDI-12 master device (typically a data logger).

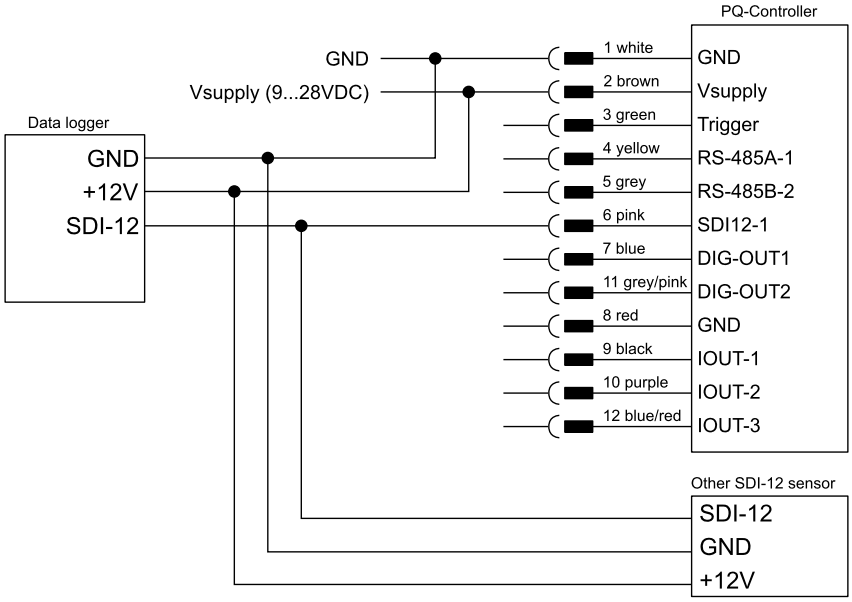
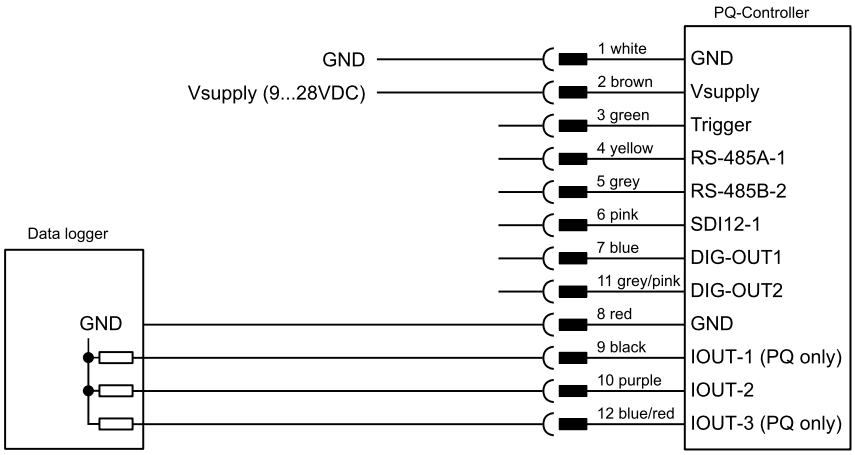


Figure 3 Wiring of the PQ with a data logger via SDI-12

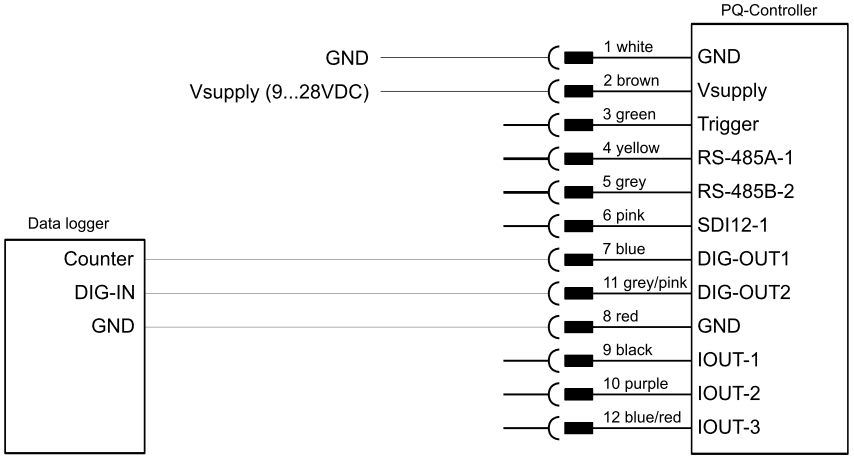
7.4.3 How to wire analog outputs

Connect the analog outputs of the PQ to a data acquisition device according to the figure below.



NOTE If a data logger is connected to the IOUT outputs, the resistance of the logger input(s) must not exceed 470 Ω.

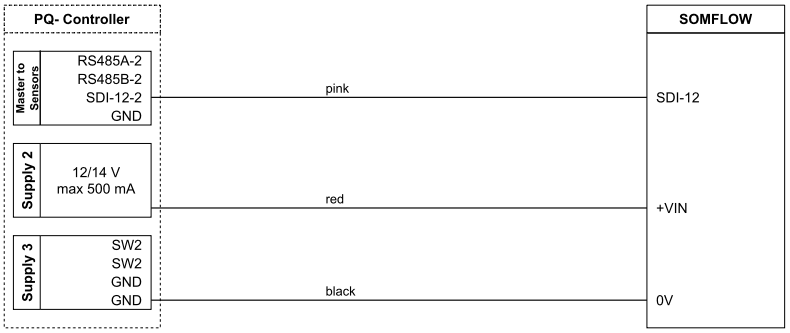
7.4.4 How to wire digital outputs



7.4.5 Internal sensor wiring

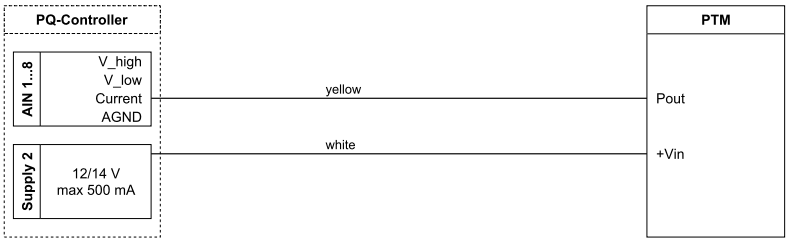
The velocity and level sensors of the PQ are connected to the controller as shown in the illustrations below:

SOMFLOW (SDI-12)

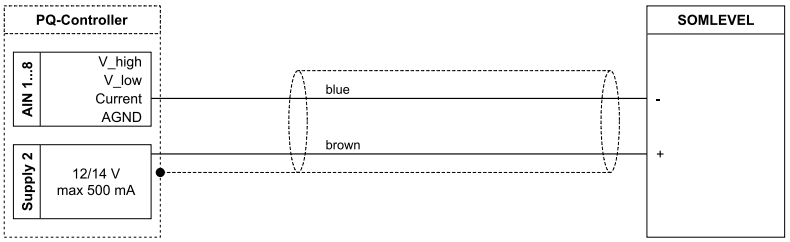


PTM (SDI-12)

PTM (analog)



SOMLEVEL (analog)



7.5 Testing

Perform the following steps to verify the correct data acquisition:

1. Install the SQ-Commander software on your PC.
2. Connect a 9...28 VDC power supply to the PQ-controller.
3. Connect USB to RS-485 converter to the signal cable of the PQ-controller and your PC.
4. Start the SQ-Commander on your PC.
5. Click on SQ-Commander.
6. Click CONNECT on the Connection tile.
7. If the window Found devices pops up, click NEXT to continue.
8. Click MEASUREMENT VALUES on the Measurement values tile.

Now the measurement values are displayed in the default one-minute interval.

To quit click the arrow in the top-left corner of the SQ-Commander.

7.6 Adjustment

In order to correct for the mounting position of the PTM pressure sensor or the SOMLEVEL radar sensor, the measured water level must be assigned to the PQ-Controller. Follow the steps below do perform this task:

1. Connect the PQ to your PC as done in Testing.
2. Click on PARAMETER MANAGER tile.
3. Click on SETUP ASSISTANT.
4. Select ADJUSTMENTS in the Steps tile.
5. Click on ADJUST of the Water level entry.
6. The SQ-Commander now performs a level measurement and displays its measured value. Enter the absolute water level measured from the bottom of the pipe or canal to the water surface. Click OK to adopt the value and wait for the PQ to finish a new measurement.
   With TEST you can verify the correct adjustment.

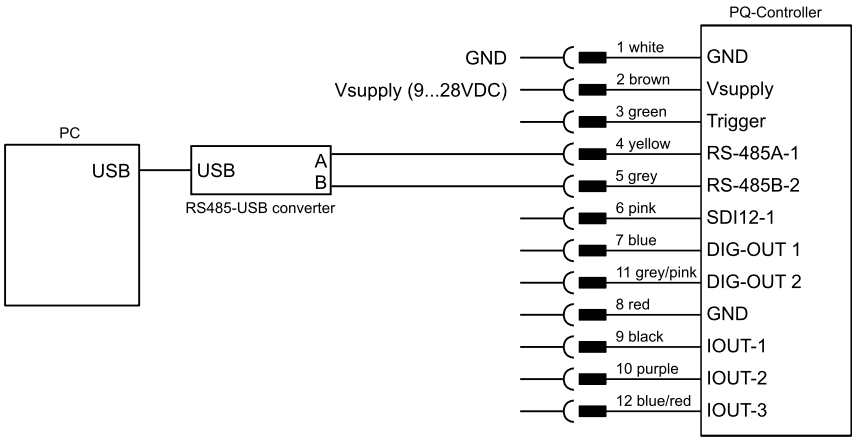
7.7 Start-up

After successful testing, connect the PQ to your data acquisition system, verify that the measurement data are recorded correctly and, if applicable, check the data transmission to the remote data server.

8 Operation

8.1 Connect device to PC

1. Install the SQ-Commander support software (see Installation of SQ-Commander)
2. Connect the yellow and gray wires of the sensor cable to the RS-485 to USB converter cable and plug it into your PC as illustrated in the figure below.
3. Connect the RS-232 to USB converter cable to the PQ and a USB port on your PC.
4. Connect a 9...28 VDC power supply to the PQ.
5. Establish a connection between the PQ and the SQ-Commander. See the video Connect a device in the online Service center.



9 Maintenance

Regularly clean the PQ from dirt, sediments and any caught debris, and check the sensors and cables for damage.

It is recommended to recalibrate the ultrasonic Doppler sensor and the PTM pressure probe annually. Please contact Sommer Messtechnik for details.

10 Support software SQ-Commander

10.1 Software features

The SQ-Commander is a multipurpose software tool to configure and operate any Sommer Messtechnik device. It offers the following functions:

FEATURES

- Create or import a cross-sectional profile
- Communicate with your PQ locally and remotely
- Configure and update the sensor settings
- View your measurement data
- Validate your data with the velocity diagnostics tool
- Transfer data files to HTTP and FTP servers
- Install the PQ with easy step-by-step guidance

10.2 System requirements

The SQ-Commander software supports 32- and 64-bit versions of Windows 7 SP1, Windows 8, Windows 8.1, Windows 10 and Windows 11.

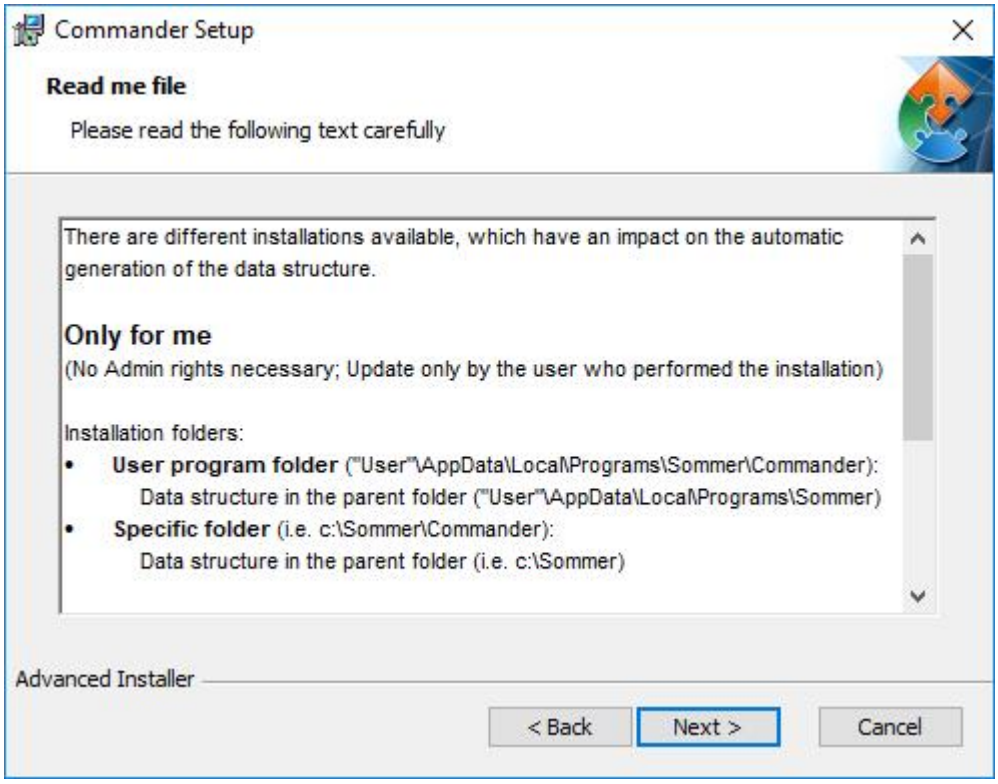
For correct operation Microsoft® .NET Framework 4.5 or later must be installed.

10.3 Installation of SQ-Commander

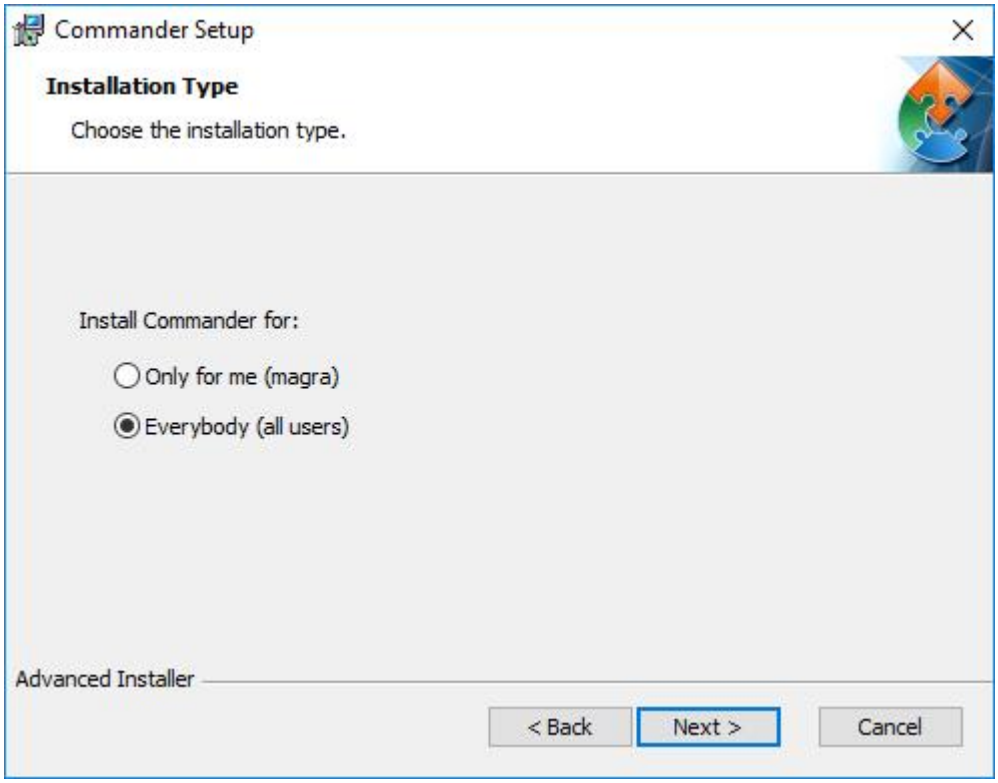
Follow the steps below to install the SQ-Commander software:

1. Plug the USB stick shipped with the device into your PC.
2. Double-click the commander.msi installer file on the USB drive.
3. Click Next on the pop-up window

4. Read the instructions and click Next



5. Select the installation type and click Next



NOTE

Two installation types are available. Depending on the selection, the access rights and the folder structure differ:

Only for me

No admin rights are required. Updates are only available to the user who installed the software.

Installation folders:

- User program folder:
  Users\User\AppData\Local\Programs\Sommer\Commander
  Data structure:
  Users\User\AppData\Local\Programs\Sommer
- Specific folder (default):
  C:\Sommer\Commander
  Data structure (default):
  C:\Sommer

Everybody

Admin rights are required. Updates may only be performed by system administrators.

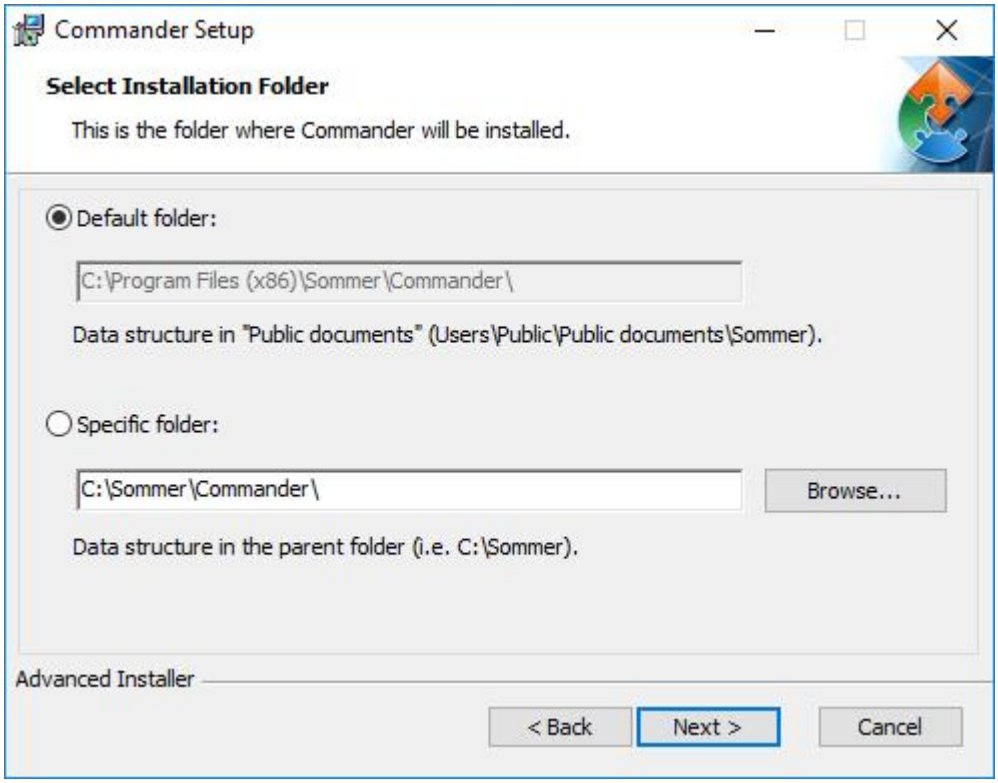
Installation folders:

- Standard program folder:
  Program Files (x86)\Sommer\Commander

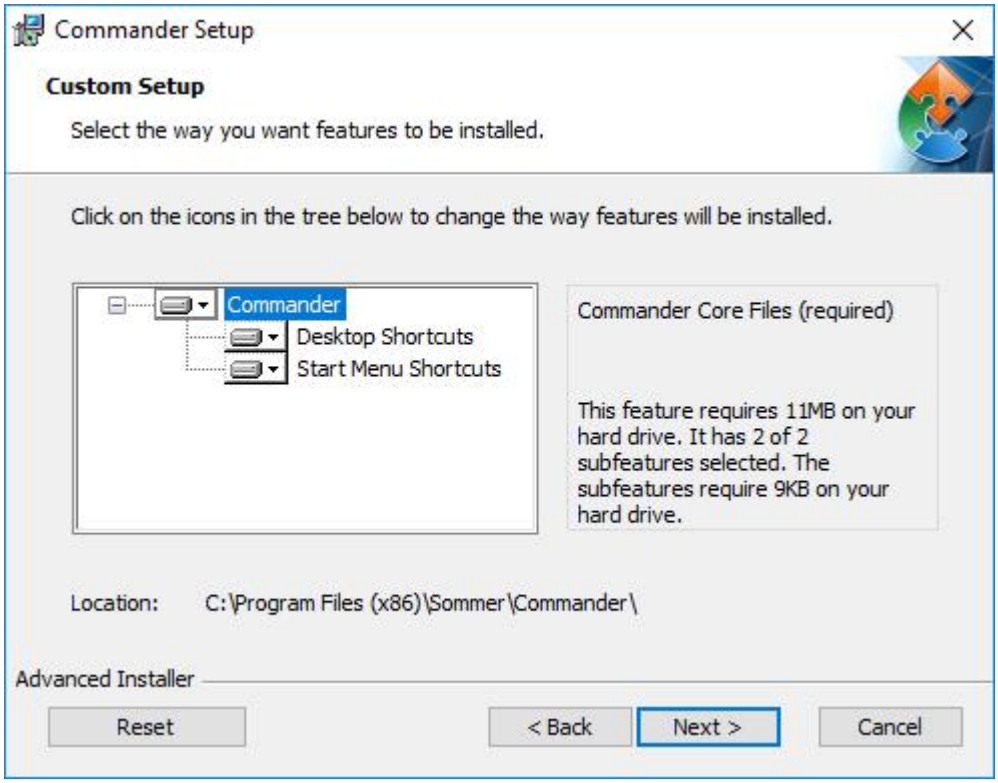
Data structure:
Users\Public\Public documents\Sommer

- Specific folder (default):
  C:\Sommer\Commander
  Data structure (default):
  C:\Sommer

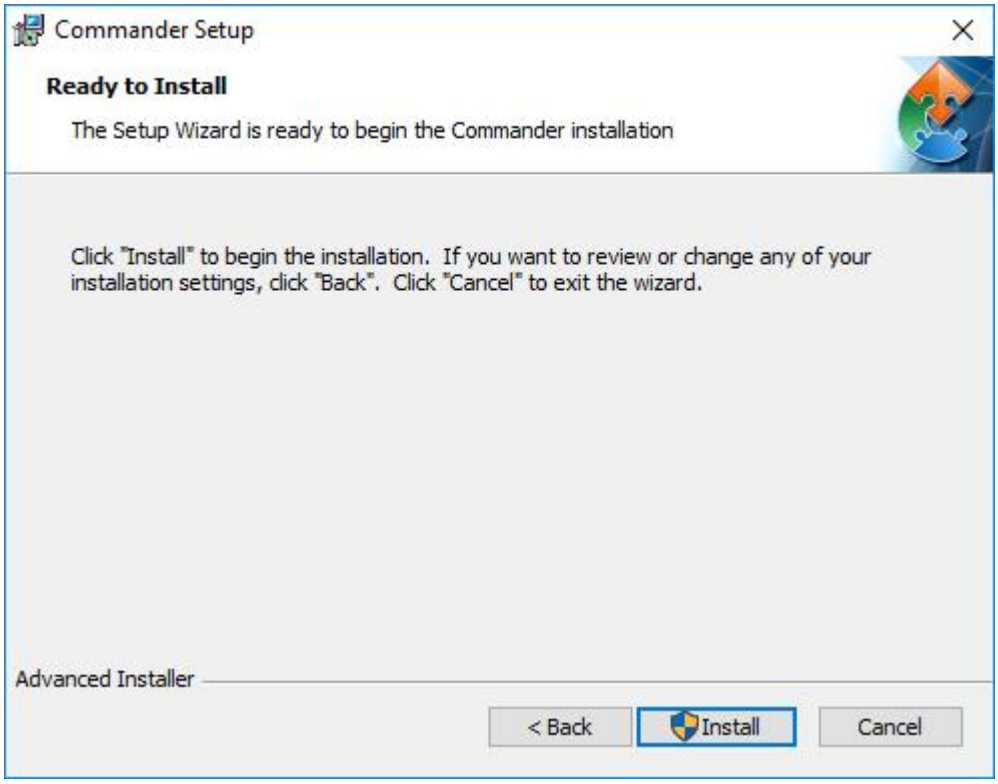
6. Select the installation directory and click Next.



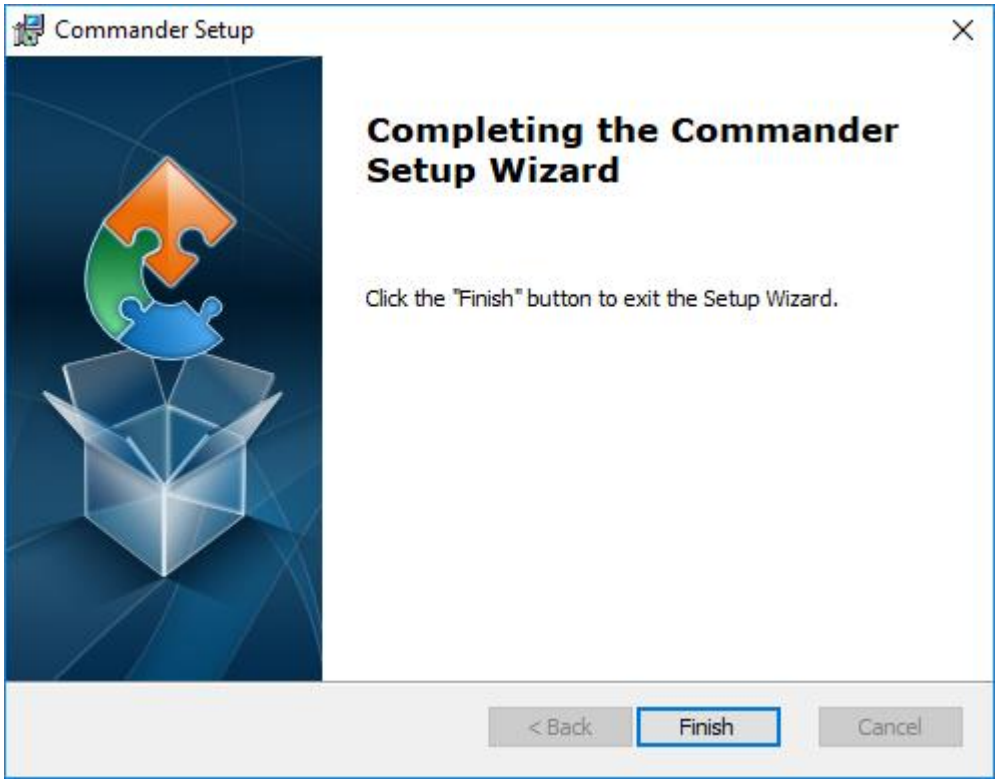
7. Select the features to be installed and click Next.



8. Click Install to start the installation.



9. Click Finish to complete the installation.



10.4 Sign-in to SQ-Commander

Please see the video on the online Service center for instructions.

10.5 Working with the SQ-Commander

Please see the videos on the online Service center for instructions on connections, setups and data management.

10.6 Working with data loggers

11 Configuration of the PQ

11.1 Software tools

The PQ can be configured with one of the following tools:

- Support software SQ-Commander

11.2 Conflict messages

During configuration with the SQ-Commander software, the PQ may return conflict messages after one or more parameters have been changed and uploaded to the device. An example is shown in Figure 4.

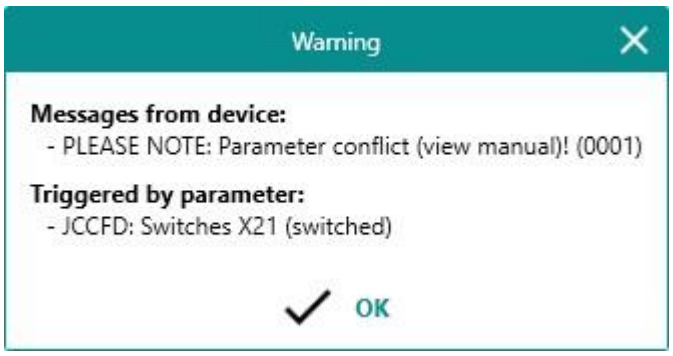


Figure 4 Example of a conflict message

The pop-up window lists the parameters and their indices which have triggered the warning. See Parameter conflicts for details.

ATTENTION If a conflict occurs, invalid settings are replaced automatically with valid values. Verify the values of the conflicting parameters and adapt them if needed!

11.3 General settings

When first setting-up a PQ at a measurement site, the parameters described below may need to be adapted.

11.3.1 Measurement trigger

Measurements are initiated by one of the options listed in the table below.

The commands to trigger measurements via RS-485 and SDI-12 are described in Communication.

Measured data are either returned directly after the measurement.

ID	Option	Description
1	Interval (default)	Measurements are initiated in a specified interval.
2	TRIG input	Measurements are triggered by the positive edge of a DC-voltage signal applied to the TRIG input (low: 0 ... 0.6 V, high: 2.2 ... 28 V, pulse duration must be ≥500 ms, delay between pulses must be ≥500 ms)
3	SDI-12/RS-485	Measurements are externally triggered by commands via RS-485 or SDI-12 from ,e.g. a data logger.
4	all allowed	Measurement is triggered by all options mentioned above.

11.3.2 Measurement interval

If Measurement trigger is set to interval, a measurement interval between 00:00:01 … 12:00:00 can be set.

11.3.3 Units and decimals

The units and number of decimal digits.

ATTENTION If any units or decimal places are changed, Total sum and Daily sum need to be reset!

NOTE

If units or decimals are changed, related parameters may need to be adjusted, e.g. Total sum.

Also, carefully select the number of decimal places! As the display of numbers is restricted to 8 digits, additional decimal places significantly reduce the maximum values of summed variables. For example, if Total sum has 3 decimal

places, the maximum sum is *9999.999*; if it has only 1 decimal place, the maximum sum is *99999.9*.

Keep in mind to use reasonable numbers of decimal places when selecting units. For example, use no decimal places when setting Flow to l/s, or use max. 3 decimal places when setting Flow to m^3/s.

11.3.4 Decimal character

The character used as decimal separator in the values of the settings, in serial data strings and in .csv files.

11.4 Water level adjustment

The water level reading of the PQ has to be corrected for its mounting position. This is usually done by measuring the water level by hand and assigning it to the PQ. See Adjustment on how to perform a water level adjustment.

12 Communication

12.1 Communication protocols

The PQ provides the following communication protocols:

- RS-485 (Sommer bus protocol)
- Modbus
- SDI-12

12.2 Data output

12.2.1 Output values

Index	Measurement value	Unit	Description
1	Water level	*	-
2	Mean velocity	*	-
3	Flow	*	Water flow rate
4	Total sum	*	Total water volume that has passed the sensor.
5	Daily flow	*	Water volume that has passed the sensor within one day.
6	Supply voltage	V	Voltage supplied to the PQ

* as defined in Units and decimals

NOTE

The Total sum is reset as soon as its value runs into overflow. This value depends on the number of decimals places, e.g. *999999.9* or *9999.999*.

The Total sum can be reset any time in the Setup assistant of the SQ-Commander.

NOTE The Daily sum is automatically reset at the time set in Reset time for sums in the TIME SETTINGS menu of the Setup assistant.

12.2.2 Exception values

Measurement data may be returned with the following exception values:

Value	Description
99999998	Initial value: No measurement has been performed yet.
99999997	Conversion error: Caused by a technical problem.
99999999	Positive overflow
-9999999	Negative overflow

Table 2 Exception values

12.3 RS-485

12.3.1 What is RS-485?

RS-485 is a serial communication method for computers and devices. It is currently a widely used communication interface in data acquisition and control applications where multiple nodes communicate with each other.[1]

12.3.2 What can I do with it?

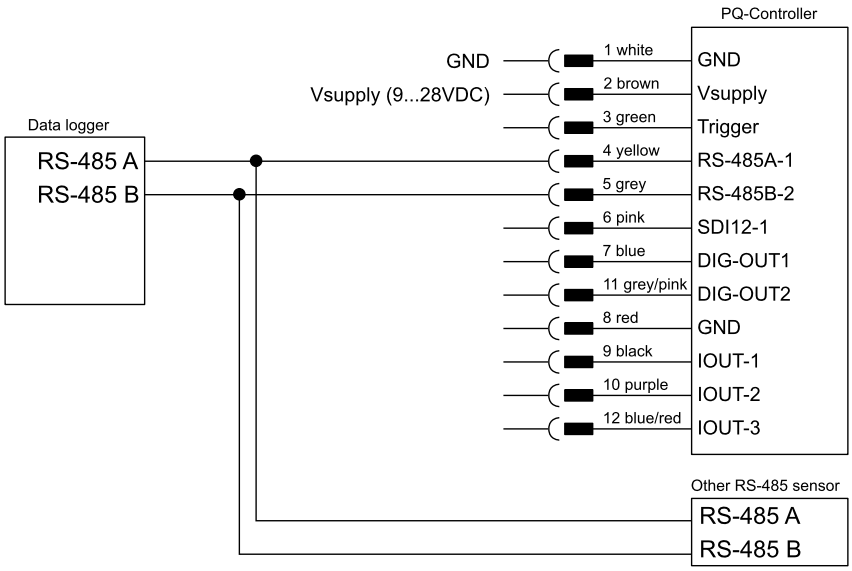
RS-485 communication is primarily used to trigger measurements and read their results. It also permits to change parameters of the PQ. The RS-485 interface of the PQ uses the Sommer Bus Protocol (SBP), which enables communication with Sommer Messtechnik data loggers such as the MRL-6 or MRL-7.

For advanced use like reading/writing parameter settings please contact Sommer Messtechnik.

[1]https://www.lammertbies.nl/comm/info/RS-485.html

12.3.3 RS-485 wiring

Connect the PQ to a data logger or RS-485 network according to the figure below.



12.4 SDI-12

12.4.1 What is SDI-12?

SDI-12 (Serial Data Interface at 1200 Baud) is a serial data communication standard for interfacing multiple sensors with a single data recorder. For a detailed description on SDI-12 communication please refer to www.sdi-12.org.

12.4.2 What can I do with it?

The PQ listens to standard SDI-12 commands as listed in the SDI-12 specifications of version 1.3, e.g., to trigger a measurement or retrieve measurement results. Additionally, a set of extended SDI-12 commands is implemented in all SOMMER sensors for instrument configuration.

12.4.3 Configuration

The PQ has SDI-12 communication enabled by default. When setting up a SDI-12 network take the following considerations into account:

- Each device in the SDI-12 network must have a unique address, e.g. data logger address *0*, PQ address *1*.
- If the PQ operates in polling mode (Measurement trigger set to *SDI-12/RS-485*), measurements are triggered by `M!` commands and data are retrieved by `D!` commands.
- If the PQ operates in pushing mode (Measurement trigger set to *interval*), data are retrieved by the `R!` commands.
- When multiple sensors are connected to the same network, data acquisition should be done in sequence, i.e., data should have been received from the first sensor before triggering the measurement of the second sensor.
- Most data loggers control the timing of messages (marking and spacing) automatically. If this is not the case, please refer to www.sdi-12.org.

12.4.4 SDI-12 wiring

Connect the PQ to a data logger by SDI-12 according to the figure below.

SDI-12 uses a shared bus with a ground wire, a data wire (indicated as SDI-12) and an optional +12 V wire.

NOTE The connection with the 12 V power supply is optional and depends on the connected SDI-12 master device (typically a data logger).

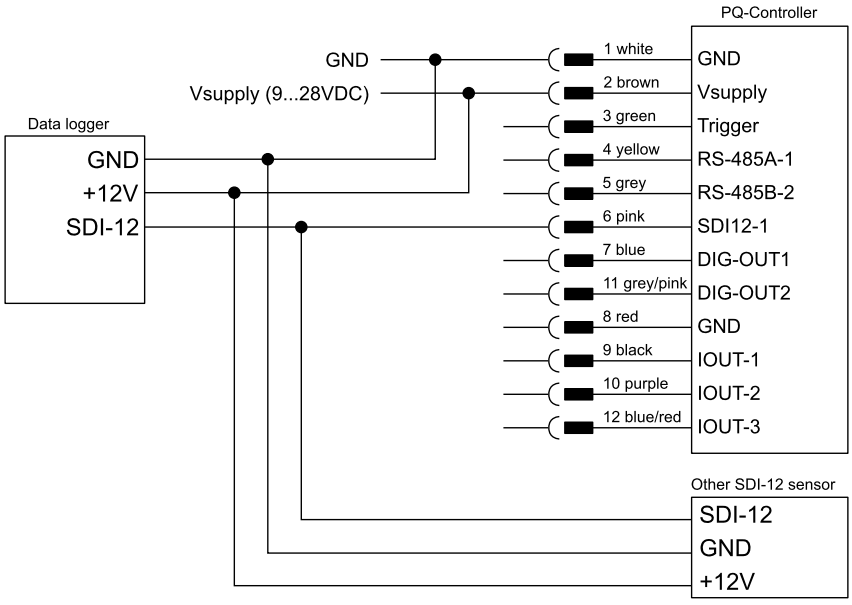


Figure 5 Wiring of the PQ with a data logger via SDI-12

12.4.5 Data structure

The answer from the SDI-12 device is a string containing the sensor address, the requested data and a terminating carriage return/line feed.

In a string containing measurement data, the measurements are returned in the same order as listed by the index in Data output.

EXAMPLE

`0+193+1.25+0.169+62+37.2+10.92<CR><LF>`

Value	Content
0	Sensor address
193	Water level
1.25	Mean velocity
0.169	Flow
62	Total flow
37.2	Daily flow
10.92	Supply voltage

12.4.6 SDI-12 commands

The following tasks can be performed with standard and extended SDI-12 commands.

Extended SDI-12 commands are non-standard commands implemented by SOMMER to enable device configuration via SDI-12.

NOTE After any changes, the settings have to be adopted with the command `aXW_ts|!`, with `a` the sensor address.

Command structure

A standard SDI-12 command starts with the sensor address and ends with an exclamation mark, e.g., `0M!` to trigger a measurement.

Configuration commands contain additional information; see the sections below for details.

Identify device

The identification of a SDI-12 device is requested with the command `aI!`, with `a` the sensor address.

EXAMPLE

`0I!` Answer `013Sommer USH 140r90 USH-9 <CR><LF>`

The answer contains the following information:

`0`	SDI-12 address
`1`	SDI-12 version prior to the point
`3`	SDI-12 version after the point
`Sommer`	Description of the company (6 characters and 2 blanks)
`USH`	Description of the firmware (5 characters and 2 blanks)
`140r90`	Firmware version (6 characters and 2 blanks)
`PQ`	Device designation (max. 13 characters)

Acquire measurements

To acquire a measurement from a sensor, two individual SDI-12 commands – trigger a measurement and request measurement values – need to be sent.

EXAMPLE

`0M!` Answer: `00084<CR><LF> and 0<CR><LF>` after 8 seconds

`0D0!` Answer: `0+2591+706+25.53+0<CR><LF>`

The first values in the response to the `aDn!` command is the sensor address.

Trigger measurement

The command `aM!` with sensor address `a` triggers a measurement as in the example below.

The response states the measurement duration and the number of measurement values (see example below). After completion of the measurement, the device will return an additional `a<CR><LF>`, with `a` the sensor address.

EXAMPLE

`0M!` Answer: `00084<CR><LF>` and `0<CR><LF>` after 8 seconds

The answer contains the following information:

`0`	SDI-12 address
`008`	Duration of the measurement in seconds
`4`	Number of measurement values

Request results

After each measurement, results are requested with the command `aDn!`, with `a` the sensor address and `n` the index of the returned data string.

EXAMPLE `0D0!` Answer: `0+2591+706+25.53+0<CR><LF>`

The leading `0` of the response is the sensor address.

Generally, the command `aD0!` is sufficient to request up to 9 measurement values. If more than 9 values need to be read, or if the values are returned in groups, the commands `aD1!`, `aD2!`,… may need to be issued after `aD0!`. For example, if a measurement returns 8 values in two groups of 4, the commands `aD0!` and `aD1!` need to be issued to receive all values.

Acquire continuous measurements

If the SDI-12 device is operating in continuous measurement mode (not polled by SDI-12), the command `aR0!` will request and return the current reading of the sensor. The values within the data string follow the order listed in the measurement table. The first values in the response to the `aRn!` command is the sensor address.

EXAMPLE

`0R0!` Answer: `0+2591+706+25.53+0<CR><LF>`

If more than 9 values need to be read, or if the values are returned in groups, the commands `aR1!`, `aR2!`,… may need to be issued after `aR0!`. For example, if a measurement returns 8 values in two groups of 4, the commands `aR0!` and `aR1!` need to be issued to receive all values.

12.5 Modbus

12.5.1 What is Modbus?

Modbus is a serial communication protocol used for transmitting information over serial lines between electronic devices. The device requesting the information is called the Modbus Master and the devices supplying information are Modbus Slaves. In a standard Modbus network, there is one Master and up to 247 Slaves, each with a unique Slave Address from 1 to 247. The Master can also write information to Slaves.

Modbus has become a standard communication protocol in industry, and is now the most commonly available means of connecting industrial electronic devices. It is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. Versions of the Modbus protocol exist for serial lines (Modbus RTU and Modbus ASCII) and for Ethernet (Modbus TCP).[1]

12.5.2 What can I do with it?

Modbus-communication with PQ allows reading of measurement values and device information by a Modbus master. Additionally, the basic RS-485 port settings can be written to the PQ.

12.5.3 Wiring

For Modbus communication the PQ is wired according to the table below.

Modbus	Connection wire	Description
Common	White	GND
Vsupply	Brown	9...28 VDC
D1 - B/B	Yellow	RS-485 A
D0 - A/A	Grey	RS-485 B

Table 3 Modbus wiring

[1] http://www.simplymodbus.ca/FAQ.htm

NOTE

Please note that different signal notations are in use for RS-485 connections:

TX+/RX+ or D+ or D1 as alternative for B

TX−/RX− or D− or D0 as alternative for A

NOTE If the PQ is operated with multiple Modbus devices within the same network, termination resistors may be required. Please contact Sommer Messtechnik for details.

12.5.4 How to switch the PQ to Modbus mode

Please see the video on the online Service center for instructions.

12.5.5 Modbus commands and registers

Read input registers

Input registers contain measurement values. The content of these registers is updated after each measurement.

	Index	Register address	Variable	Unit / value	Bytes	Format
Test value		0	Hardcoded test value	2.7519…	4	float
Output values	01	2	Water level	a	4	float
	02	4	Mean velocity	a		
	03	6	Flow	a		
	04	8	Total sum	a		
	05	10	Daily sum	a		
	06	12	Supply voltage	V		

	Index	Register address	Variable	Unit / value	Bytes	Format
Device info	-	65533	Device type and configuration	3701	2	unsigned int
	-	65534	Software version	XYYZZ	2	
	-	65535	Modbus version	10100	2	

[a]According to Units and decimals

Table 4 Input registers

NOTE The 4-byte float values have the format *ABCD*, big-endian (*A* is the most significant byte).

Read and write holding registers

Holding resisters are mainly used to configure the Modbus adapter communication. Configuration settings are read with function 03 (read holding registers) and written with function 06 (write single registers).

NOTE Restart the Modbus adapter after changing the configuration!

	Register address	Variable	Range	Bytes	Format
Config values	0	Modbus default[1]	0 - 1…read 1…write	2	unsigned int
	1	Modbus device address	1 to 247		
	2	RS-485 baud rate	1…1200 baud 2…2400 baud 3…4800 baud 4…9600 baud 5…19200 baud 6…38400 baud 7…57600 baud 8…115200 baud		
	3	RS-485 parity/ stop bits	1…no parity, 1 stop bit 2…no parity, 2 stop bits 3…even parity, 1 stop bit 4…odd parity, 1 stop bit		

Table 5 Holding registers

Report slave ID

The Modbus function 17 (report slave ID, read only) can be used to read basic information of the PQ. The following example shows the response of function 17 of a RG-30 sensor, which is received in hex-format:

EXAMPLE 23 11 26 53 FF 27 74 20 53 6F 6D 6D 65 72 20
20 52 47 2D 33 30 20 20 20 32 5F 37 31 72 30 31 20 34
35 31 35 31 38 32 31 00 BB D4

[1]Writing "1" sets the Modbus default settings.

			Example	
	Content	**Length (Bytes)**	**HEX-value**	**Decimal, ASCII**
PDU* response	Slave address	1	23	35
	Function code	1	11	17
	Number of bytes (excl. slave-address, function code, NUL and CRC)	1	26	38
	Slave ID	1	53	"S"
	Run status (0=inactive; FF=active)	1	FF	255
	Modbus implementation version	2	27 74	10100
	Separator	1	20	" "
	Vendor string	7	53 6F 6D 6D 65 72 20	"Sommer "
	Separator	1	20	" "
	Device configuration	7	52 47 2D 33 30 20 20	“RG-30 “
	Separator	1	20	" "
	Software version	7	32 5F 37 31 72 30 31	2_71r01
	Separator	1	20	" "
	Serial number	8	34 35 31 35 31 38 32 31	45151821
	NUL	1	00	
	CRC	2	BB D4	

*Protocol Data Unit

Table 6 Slave ID

12.5.6 How to switch the PQ to Sommer bus protocol

Please see the video on the online Service center for instructions.

12.5.7 PLC integration

The PQ can be integrated into a PLC system as a slave device. It supports the PROFIBUS, PROFINET, EtherCAT and CANopen protocols. This requires an additional serial converter, e.g. Anybus Communicator.

13 Analog output

13.1 What can I do with it?

Measured values of water level, mean flow velocity and flow rate can be returned by three 4...20 mA outputs which can be connected to any data acquisition system that has current input terminals available.

13.2 Activation

The state of the analog outputs can be set in the ANALOG OUTPUTS menu of the SQ-Commander to one of the following options:

ID	Option	Description
1	off (default)	Analog outputs are inactive.
2	just during TRIG	Analog outputs are only active, if an external signal is present at the TRIG input. The outputs are high as long as the signal at the TRIG input is high.
3	always on	Analog outputs are permanently active.

NOTE The PQ delays analog data acquisition by 200 ms. If the output is set to *just during TRIG* , the analog output must be read with a delay of min. 200 ms after the trigger has been sent. This ensures that the analog measurement has sufficiently stabilized. As the analog measurement itself requires some time, the result should be read with a delay of *min. 1 second*.

13.3 Scaling

The variables and their analog output range are configured as described below.

NOTE
The analog outputs may return currents between 0 and 21 mA. However, the accuracies stated in the specifications are only valid for signals within 4 to 20

mA!

If the measured value falls below or exceeds the 3.9…21 mA range, 3.9 mA and 21 mA, respectively, are returned. An exception are the measurement values `99999998` and `99999997`, which return a 3.8-mA and 3.7-mA signal, respectively.

ATTENTION The 4-mA output should correspond to a measurement value at or below the expected minimum! With low current output the accuracy tends to decrease and cross-talk with other analog channels may occur.

13.4 IOUT 1 - water level

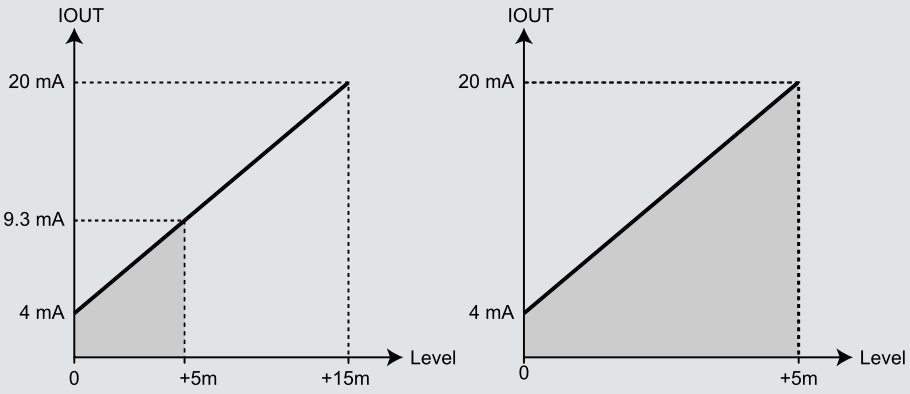
The analog output IOUT 1 returns the water level. The output corresponds to a linear equation defined by the span between 4 and 20 mA and the offset at 4 mA.

By default, the 4-mA value is set to zero and the 4...20-mA range to the measurement range of the level sensor, e.g. 10 m for a PTM pressure probe. However, the entire range is often not required and is a waste of resolution.

EXAMPLE

The SOMLEVEL-15 is a water level sensor with a measurement range from *0* to *15 m*. In a fictional monitoring setup the water level ranges only between *0* and *5 m*.

Setting the 4...20-mA span to *15 m* would waste 2/3 of the analog output range (left graph). It is more appropriate to set the span to *5 m*, taking advantage of the entire analog output range (right graph).



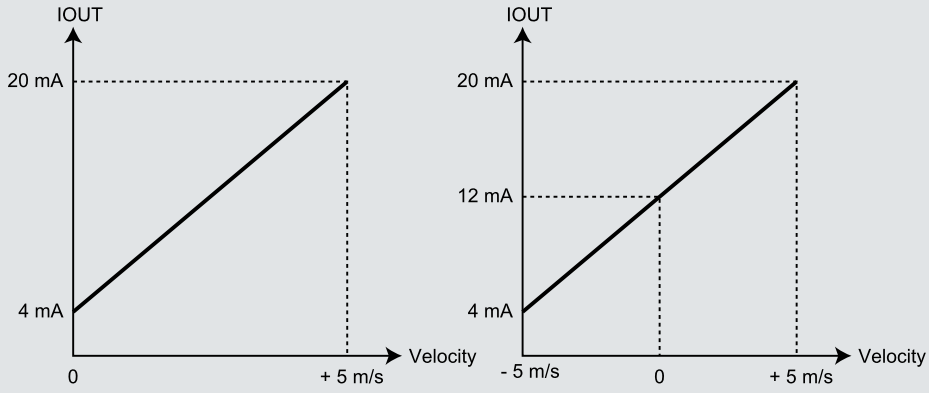
13.5 IOUT 2 - mean velocity

The analog output IOUT 2 returns the mean flow velocity. The output corresponds to a linear equation defined by the span between 4 and 20 mA and the offset at 4 mA.

By default, the 4-mA value is set to zero and the 4...20-mA range to the measurement range of the velocity sensor, i.e. 5 m/s for the SOMFLOW ultrasonic Doppler sensor.

NOTE

The SOMFLOWultrasonic Doppler sensor can detect bi-directional flow, where water flow in the opposite direction is negative. If bi-directional velocities need to be returned on the analog output, the 4-mA value is set to -5 m/s and the 4...20-mA range to 10 m/s. This setting reflects the measurement range of -5 to +5 m/s. This situation is illustrated in the figure below.



13.6 IOUT 3 - flow

The analog output IOUT 3 returns the water flow rate. The output corresponds to a linear equation defined by the span between 4 and 20 mA and the offset at 4 mA.

By default, the 4-mA value is set to zero and the 4...20-mA range to the maximum expected flow rate, e.g. 10 m^3/s.

13.7 Simulate current output

With this function the analog outputs can be simulated. A user-defined current value between 4 and 20 mA is applied to the analog output pins, which can be read by a connected data acquisition device or multimeter. By pressing Return/Enter again the simulation stops.

14 Pulse output

14.1 What can I do with it?

The PQ sensor provides an impulse output for the water flow, i.e. an impulse with a high level of the supply voltage is applied to the DIG-OUT 1 port for a specified water volume.

14.2 Configuration

The impulse output port DIG-OUT 1 is configured in the DIGITAL OUTPUT menu of the SQ-Commander. Its settings must be carefully selected to provide accurate results over a large flow range.

The following examples illustrate the selection of the required settings for the impulse output.

EXAMPLE

Industrial discharge channel

Assumption:

- Discharge rate: 100 l/s
- Measurement Interval: 60s

Unit and impulse configuration:

- Impulse quantity: 1 m^3/impulse
- Impulse width: 500 ms
- Flow pulses unit: m^3, 1 decimals

This results in a water volume of 6.0 m^3 for each measurement interval, expressed in the unit of Flow pulses.

The PQ returns 6 impulses after each measurement interval.

EXAMPLE

Industrial discharge channel

Assumption:

- Discharge rate: 500 l/s
- Measurement Interval: 300s

Unit and impulse configuration:

- Impulse quantity: 10 m^3/impulse
- Impulse width: 500 ms
- Flow pulses unit: m^3, 0 decimals

This results in a water volume of 150 m^3 for each measurement interval, expressed in the unit of Flow pulses.

As one impulse corresponds to 10 m^3, the PQ returns 15 impulses after each measurement interval.

NOTE Fractional volumes are added to the next measurement interval. For example, if 6.5 m^3 need to be returned by the impulse output, 6 impulses are triggered after the measurement interval and 0.5 m^3 are added to the next interval.

15 Digital output

15.1 Configuration

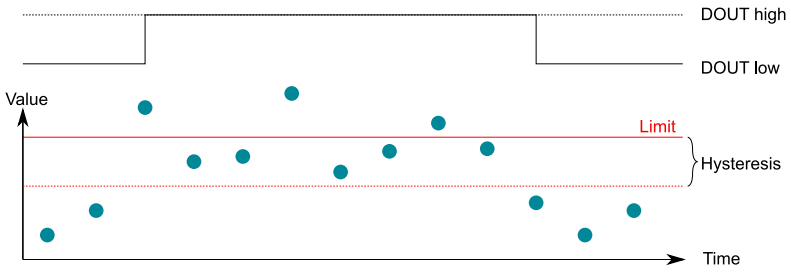
The limit monitor DIG-OUT 2 is configured in the DIGITAL OUTPUT menu of the SQ-Commander.

By clicking on the DIG-OUT 2 entry, the monitored variable (Measurement) and its threshold (Limit value) can be selected.

With Limit type the output can be set high if the measured value exceeds or falls below the specified threshold.

The following examples illustrate the selection of the required settings for the impulse output.

Setting a hysteresis value suppresses multiple violations if the measurement value closely fluctuates around the threshold. After a violation the output state is preserved until the measured value exceeds or falls below the specified hysteresis value. The hysteresis is an absolute value and is added with the correct sign to the threshold. The figure below illustrates an example.



Appendix A Troubleshooting

A.1 Devices

A.1.1 The PQ is not responding or returns unreadable characters

Reason	Solution
The power supply is not connected or turned off.	Check if the power supply is connected and on.
The polarity of connected power supply wires is wrong.	Check the polarity of connected wires.
Wrong sensor cable.	Use the original sensor cable configured by Sommer Messtechnik (only applicable to Sommer Messtechnik cables).
Power supply is insufficient. The PQ requires a certain inrush-current that the power supply is not able to provide.	1. Use a power supply providing >0.5 A at 12 VDC or a fully charged battery. 2. In case of long sensor cables (>50 m) use a 24-VDC power supply. Please note that power supplied by the USB-port is insufficient to power the PQ!
The power supply voltage is out of range.	Adjust the power supply to match the specified voltage range.
The polarity of the connected RS-485-A and RS-485-B wires is wrong.	Reverse the polarity of the connected RS-485-A and RS-485-B wires.

Reason	Solution
The port settings of the PQ and the data acquisition system do not match.	Use the SQ-CommanderCommunication assistant or adapt port settings on your device. **NOTE** Sommer Messtechnik devices require the following Baud rates: ● Sensor: 9600 ● Data logger: 115200 ● Modbus: 19200 In case of doubt use the function Check port in the Communication assistant.
The PQ is set to Modbus.	Connect to the sensor using the Communication assistant of the SQ-Commander and select the *Modbus* option in the *Serial connection*.
A sensor wire is not connected firmly to the terminal of the data acquisition device.	Check the firm connection of the sensor wires.
A pin of the connector plug is bent or broken.	Verify that all connector pins are straight.
The sensor cable is damaged.	Replace the sensor cable.
The COM-port has not been assigned correctly to the USB converter.	1. Make sure to use a Sommer Messtechnik USB converter. Third party converters are not supported. 2. Check the COM-port number using Windows Device Manager. 3. Plug in the USB converter first, then start SQ-Commander.
The USB converter is faulty.	Replace the USB converter.
The USB port on your PC is not working.	Use another USB port.
The driver of the USB converter was incorrectly installed	Reinstall the driver of the USB converter.

A.1.2 The PQ reboots repeatedly

Reason	Solution
The power supply has not enough current to start the PQ.	Verify that the power supply provides enough current. A PQ consumes up to 140 mA @ 12 V. If required, power the PQ by an additional or alternative supply.

A.2 Measurement data

A.2.1 Measurement data are not updated

The device is connected to the SQ-Commander, but the data are not updated.

Cause	Solution
Data traffic conflict	Reboot the device by interrupting the power supply.

A.3 Firmware & software

A.3.1 Commander loads wrong setup

If the setup is reloaded from the device the SQ-Commander seems to display an old version.

Cause	Solution
The device has been connected to the same PC before and several different setup files have been loaded.	● In the Communication section of the SQ-Commander, select Mode *Connection* and click on the trash can icon on the right edge. Then, reload the setup from the device. ● Delete the setup files of the device that have been downloaded by SQ-Commander to the folder *C:\Users\Public\Documents\Sommer\Setup*. The respective files can be identified by the serial number in the file name and the file date.

A.3.2 Firmware update via RS-485 is aborted

Reason	Solution
USB to RS-485 converter cable is damaged or can only operate on 9600 baud.	Replace USB to RS-485 converter cable. The programmer requires 57600 baud.

A.4 SDI-12

A.4.1 The PQ is not detected by a SDI-12 master device

Reason	Solution
The PQ and the SDI-12 master have different grounds.	Verify that the PQ and the SDI-12 master are connected by a ground (GND) wire.

A.5 Analog output

A.5.1 The 4-20 mA output is wrong

Reason	Solution
Analog output settings incorrect.	1. Check analog output settings. 2. Run Simulate current output and verify the correct output.
Sensor and data acquisition system have different grounds.	Verify that sensor and data acquisition system have the same ground.
The analog output is read by a data acquisition system and the scaling in wrong.	Verify scale and offset on your data acquisition system.

Reason	Solution
Two or more analog outputs of the PQ are read by a data acquisition system and the wiring is wrong, e.g. IOUT1 is read as IOUT2.	Verify the wiring on your data acquisition system and swap the wires if required.
The 4-20 mA output is delayed by approx. 150 ms. If the output is read before, a wrong value is acquired.	Sample the 4-20 mA output with a delay of more than 150 ms.

Appendix A Tips & tricks

A.1 Terminal commands for Type 810

Use

Commands to configure the SOMFLOW with a terminal program.

Commands

Command	Read	Write	Description
Get higher access	-	#000;RETAW	Enable access to advanced functions.
Communication mode	#097	#096;0 #096;1	Hash mode Modbus mode
SDI mode	#616	#615;0 #615;1	SDI disabled SDI enabled
Restore default settings	-	#999;0 #999;1 #999;2	All settings Measurement settings Communication settings
Water level	#522	#521;xxx	xxx = level in 0.1mm
Start measurement	-	#098;1	
Read results	#815	-	
Read area	#512	-	(only with water level measurement and discharge table)
Read flow	#519	-	(only with water level measurement and discharge table)

A.2 Record diagnostic data of SOMFLOW

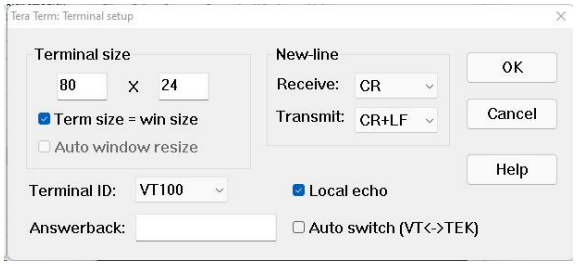
Use

The diagnostic data of the SOMFLOW are used to assess the quality of the velocity measurement.

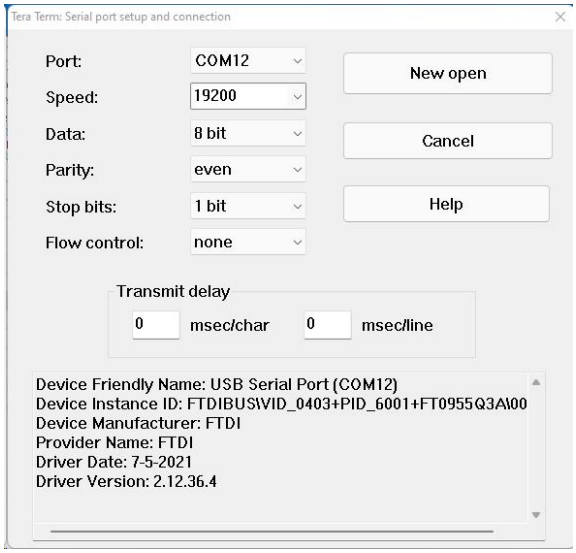
Procedure

Connect to the SOMFLOW with a terminal program (here Teraterm is used)

1. Connect the SOMFLOW to a Sommer Messtechnik USB to RS-485 converter and a 12-V power supply:
   - White to RS-485 A
   - Brown to RS-485 B
   - Red to 12 VDC
   - Black to power GND
2. Open Teraterm and select Setup > Terminal....
3. Change Transmit to *CR+LF* and tick Local echo.



4. Select Setup > Serial port....
5. Select the Port, set Speed to *19200* and Parity to *even*. Then click New open.



6. Select File > Log....
7. Enter a File name and select the options Binary and Append.

Setup of SOMFLOW for Diagnostics Mode

1. Enter into configuration mode by sending # continuously until they are echoed back and then send *<CR><LF>*. The device will return *ERROR<CR><LF>* followed by a new command prompt >.
2. Send the password for higher level access *#000;RETAW CR><LF>*.
3. Set the device into continuous mode *#051;2<CR><LF>*.
4. Set the measurement interval to 120 seconds *#055;120<CR><LF>*.
5. Enable diagnostics mode *#885;9<CR><LF>*.
6. Put the device back into run mode *#028<CR><LF>*.
7. Wait 120 seconds to capture all data from the device. To add an additional measurement send *#028<CR><LF>* again.
8. Once a diagnostic measurement has been taken, stop logging by selecting File > Stop Logging (Q).
9. Setup the device back to normal operation again.

Setup of SOMFLOW for Single Measurement Operation Mode

1. Enter into configuration mode by sending # continuously until they are echoed back and then send *<CR><LF>*. The device will return *ERROR<CR><LF>* followed by a new command prompt >.
2. Send the password for higher level access *#000;RETAW CR><LF>*.
3. Disable diagnostics mode *#885;0<CR><LF>*.
4. Set the device into single measurement mode *#051;0<CR><LF>*.
5. Set the measurement interval to 5 seconds *#055;5<CR><LF>*.

6. Put the device back into run mode *#028<CR><LF>*.
7. Re-power the device.