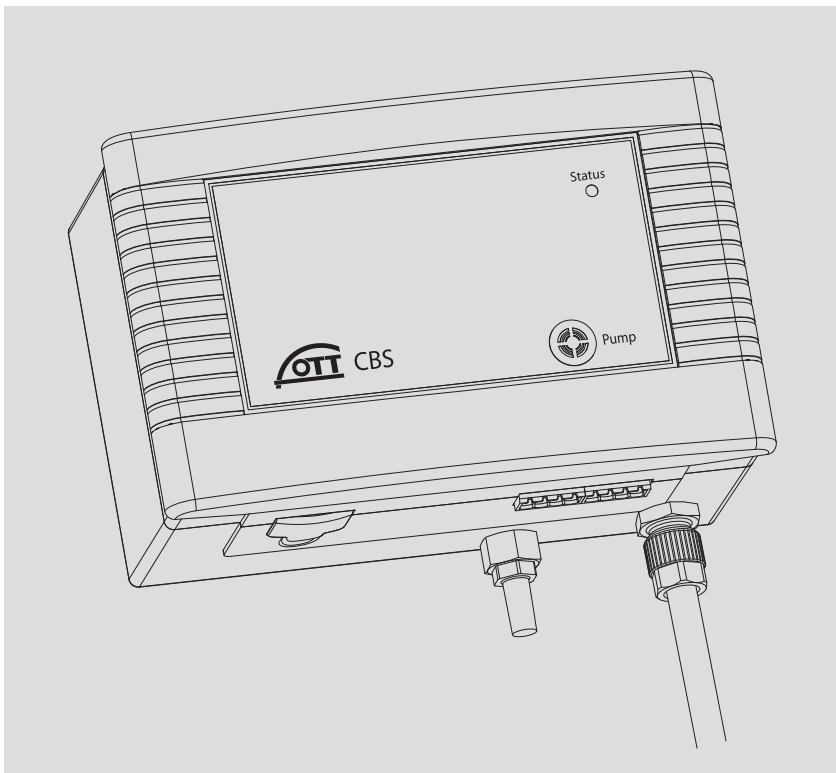


Operating instructions

Bubble Sensor **OTT CBS**



We reserve the right to make technical changes and improvements without notice.

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1 Scope of supply

- ▶ **OTT CBS**
 - 1 Bubble Sensor OTT CBS with possibility for connecting measuring tubes with 4 mm/2 mm external/internal diameter
 - 1 Installation kit (top hat rail with fastening parts; screw terminal blocks, pin jumpers)
 - 1 Operating Instructions

2 Order numbers

▶ OTT CBS	Bubble Sensor OTT CBS	63.200.001.9.2
▶ Accessories	Measuring tube 4 mm/2 mm external/internal diameter; transparent PE	
	- 50 m	99.420.050.9.5
	- 100 m	99.420.100.9.5
	Combined measuring tube/ bubble chamber suspension cable black, with kevlar core for length stabilization, measuring tube with 4 mm/2 mm external/internal diameter; transparent PE	
	- 50 m	99.420.009.9.5
	- 100 m	99.420.008.9.5
	Measuring tube 6 mm/4 mm with sheathing Length as requested	20.500.133.5.5
	Measuring tube 6 mm/4 mm without sheathing Length as requested	20.500.302.5.5
	Bubble chamber suspension cable black, with Kevlar core for length stabilization	
	- 50 m	99.000.050.9.5
	- 100 m	99.000.100.9.5
	Bubble chamber for ground water - for observation wells beginning at 2" diameter, 670 gram	55.510.051.4.2
	Bubble Pot EPS 50 for surface water	
	- hose connector 4 mm/2 mm	55.510.048.3.2
	- hose connector 6 mm/4 mm	55.510.049.3.2
	Straight pipe fitting - for connecting measuring tubes with 1/8" internal diameter and 3/8" external diameter	63.200.025.9.2

3 Introduction

The OTT CBS, working on the air bubble principle, can be used for measuring ground water or water levels depending on the bubble chamber used.

To meet the various demands of the station, three different versions of the OTT CBS bubble sensor are available:

Standard version:

- ▶ Measuring range 0 ... 15 m or 0 ... 1500 mbar
- ▶ Resolution 1 mm or 0.1 mbar
- ▶ Accuracy ± 5 mm

USGS specification version:

- ▶ Measuring range 0 ... 15 m or 0 ... 1500 mbar
- ▶ Resolution 1 mm or 0.1 mbar
- ▶ Accuracy measuring range 0 ... 15 ft: ± 0.01 ft
measuring range 15 ... 50 ft: ± 0.065 % of measured value or ± 0.02 ft, whichever is less

30 m measuring range version:

- ▶ Measuring range 0 ... 30 m or 0 ... 3000 mbar
- ▶ Resolution 1 mm or 0.1 mbar
- ▶ Accuracy ± 5 mm

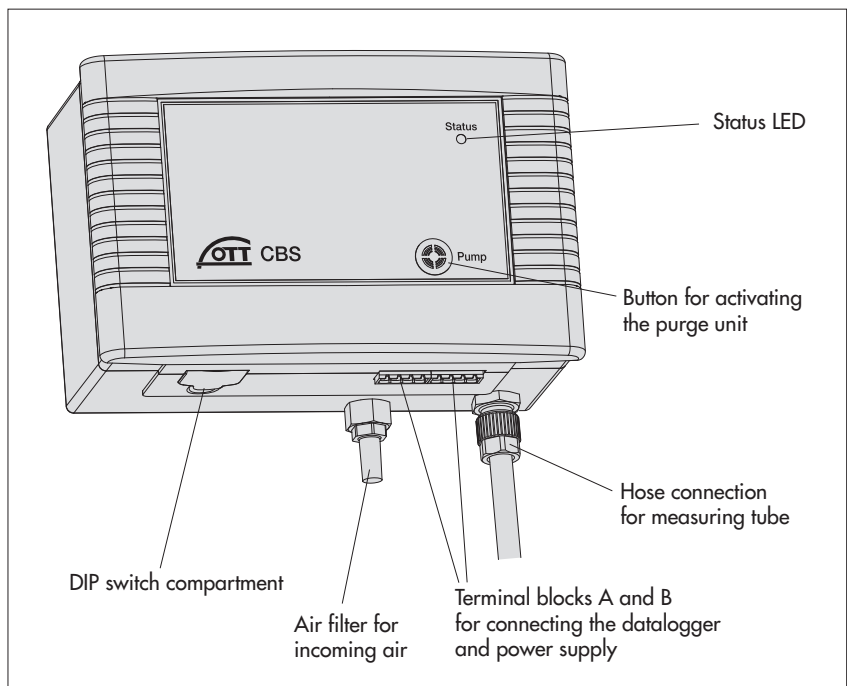
The compressed air produced by a piston pump flows via a measuring tube and the bubble chamber into the water to be measured. The pressure created in the measuring tube is directly proportional to the water column above the bubble chamber. The OTT CBS determines the barometric air and bubble pressure one after the other. By taking the difference between the two signals, the OTT CBS calculates the height of the water level above the bubble chamber.

The power supply can be provided from a mains adapter, battery or solar power.

The OTT CBS contains a purge function. This clears the measuring tube and the bubble chamber of any minor contamination by pumping a large volume of air into the measuring tube.

By using an intelligent pump strategy, no air drying unit is necessary for the measuring range of 0 ... 15 m.

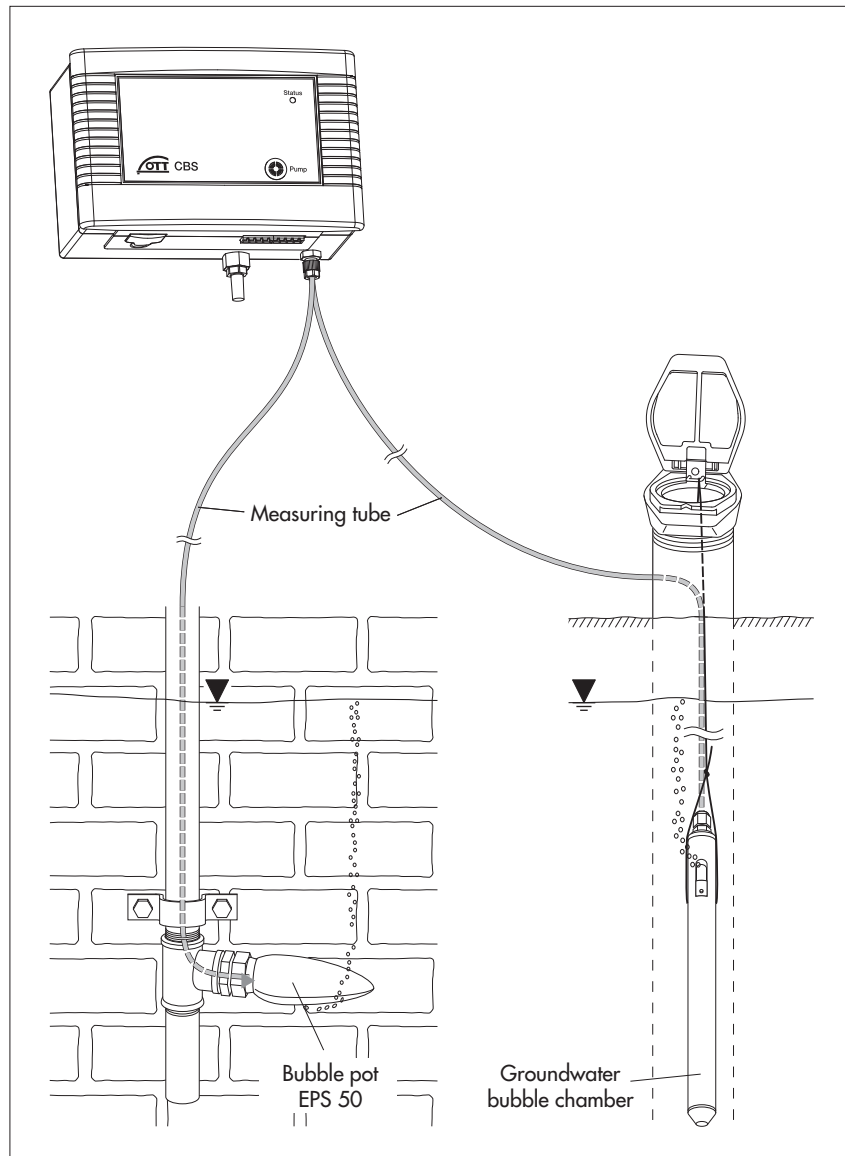
Fig. 1: Overview of OTT CBS.



For the display of any error states that may occur, the OTT CBS has a *Status* LED (see Fig. 1).

Various operating parameters can be set using the eight DIP switches.

Fig. 2: The main layout of a level station with OTT CBS bubble sensor.



4 Installing OTT CBS



4.1 Preparing the OTT CBS for installation

- If necessary and you have not already done so: set operating parameters with DIP switches (see Chapter 8).

4.2 Fastening OTT CBS

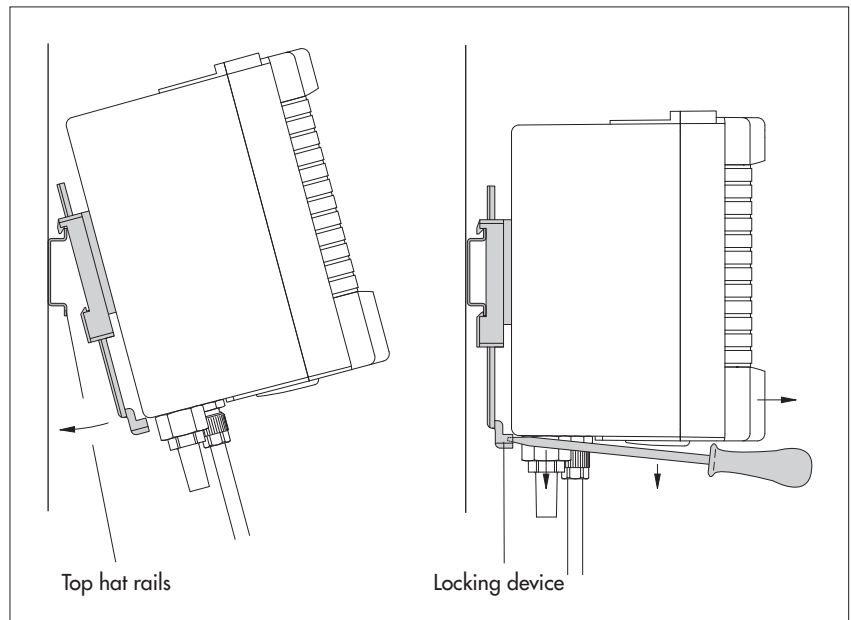
The OTT CBS is designed only to be installed on top hat rails (a section of top hat rail is supplied with the OTT CBS). Choose a dry and dust free location for the installation such as a gage station or control cabinet.

- First attach the OTT CBS on the upper edge of the top hat rail and then press the underside against the top hat rail until it clicks into place.

Demounting OTT CBS

- First press one locking device downwards and pull the OTT CBS slightly forwards at this point. Press the second locking device downwards and remove the OTT CBS upwards from the top hat rail.

Fig. 3: Fastening the CBS on the top hat rail (left)/demounting (right).



4.3 Connecting measuring tube to OTT CBS

To install the measuring tube on the OTT CBS, proceed as follows:

Measuring tube with 2 mm internal diameter

- Cut off the end of the measuring tube square with a sharp knife and push onto the factory fitted connection nipple.

Maximum length of the measuring tube: 100 m.

Measuring tube with 4 mm internal diameter

- Cut off the end of the measuring tube square with a sharp knife.
- Remove cap nut (width across flats: 10) and pull off the (short) factory mounted measuring tube from the connection nozzle.
- Push cap nut over the measuring tube (\varnothing 4 mm).
- Push measuring tube onto the connection nozzle.
- Push the cap nut back onto the connection nozzle and tighten by hand.

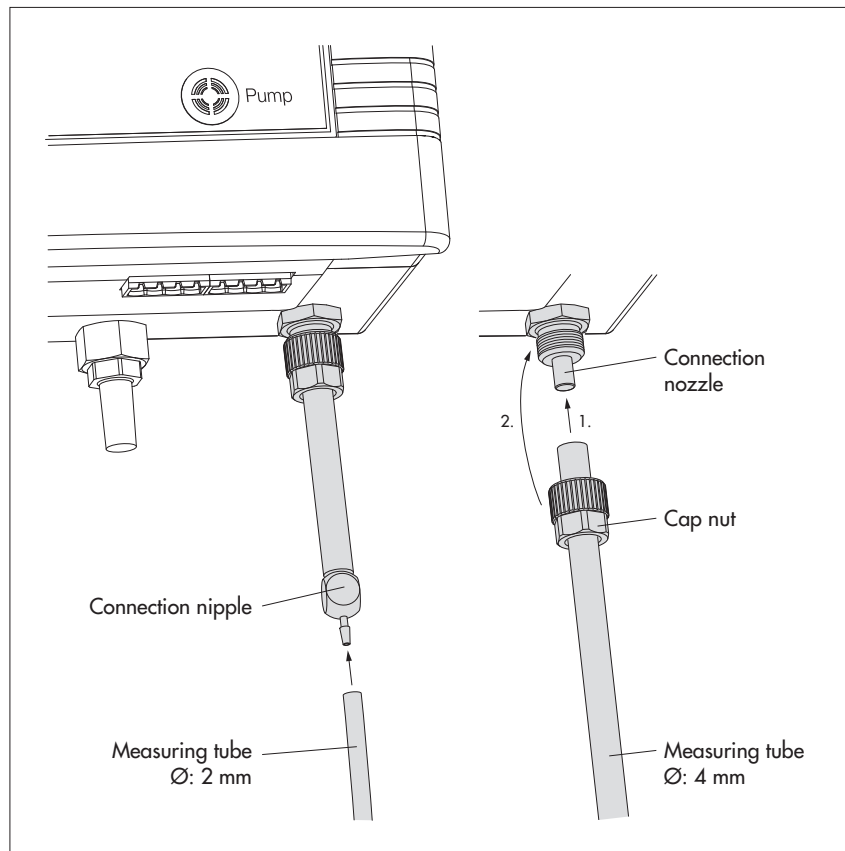
Maximum length of the measuring tube: 75 m.

Measuring tube with 1/8" internal diameter

A special pipe fitting for the 1/8" internal diameter measuring tube is available (accessory). Please follow the instructions delivered with the pipe fitting for installing the pipe.

Maximum length of the measuring tube: 100 m.

Fig. 4: Connecting measuring tube on OTT CBS.

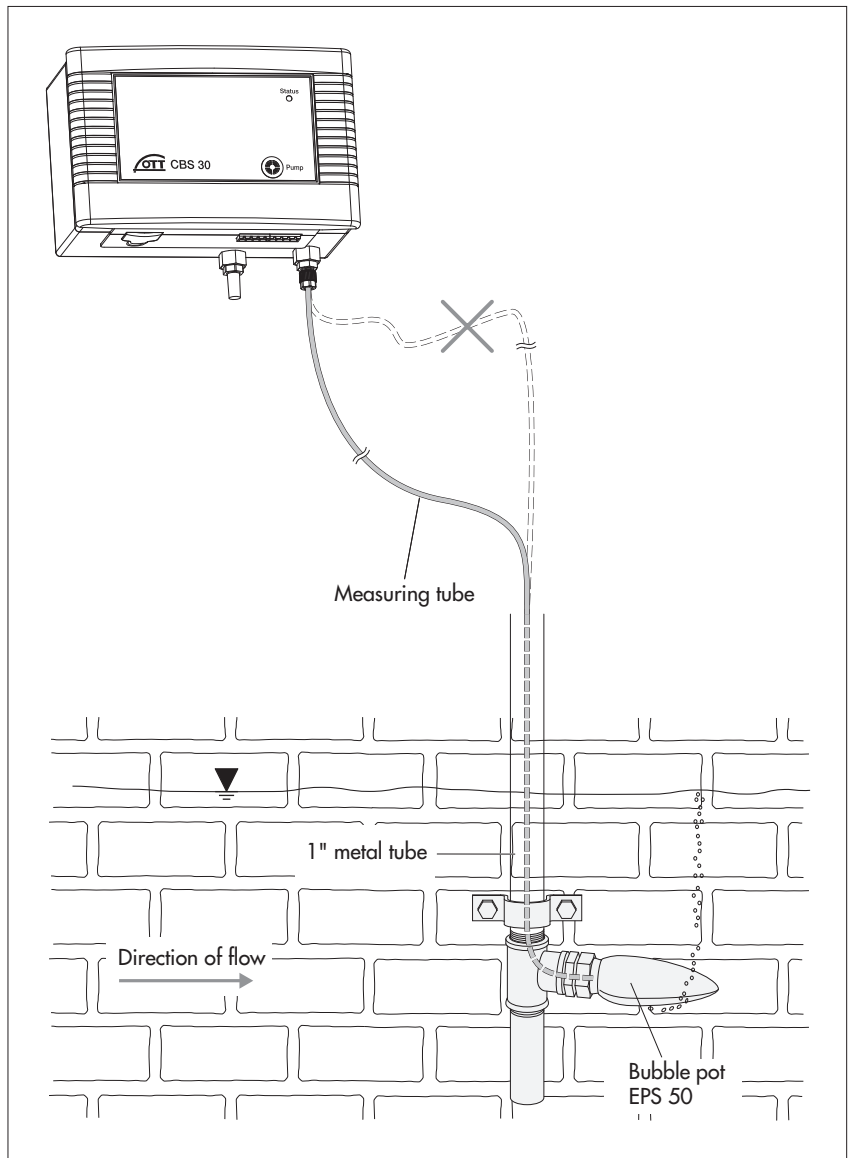


5 Installing bubble chamber

Please ensure the following points are noted during installation:

- ▶ No contamination or moisture may be allowed into the measuring tube.
- ▶ When immersing the bubble chamber (only EPS 50), the OTT CBS must be activated, so that the piston pump is operating during this process.
- ▶ Do not damage or kink the measuring tube during installation.
- ▶ Lay the measuring tube such that there is a continuous drop from the OTT CBS towards the bubble chamber. Otherwise moisture could collect in a *hollow* and potentially block the tube with the formation of drops (see Fig. 5)

Fig. 5: Routing requirements for measuring tube.



5.1 Installing bubble chamber for surface water

We recommend using the Bubble Pot EPS 50 for measurements in surface waters. See *Bubble Pot EPS 50* installation instructions for information on its installation.

5.2 Installing bubble chamber for ground water

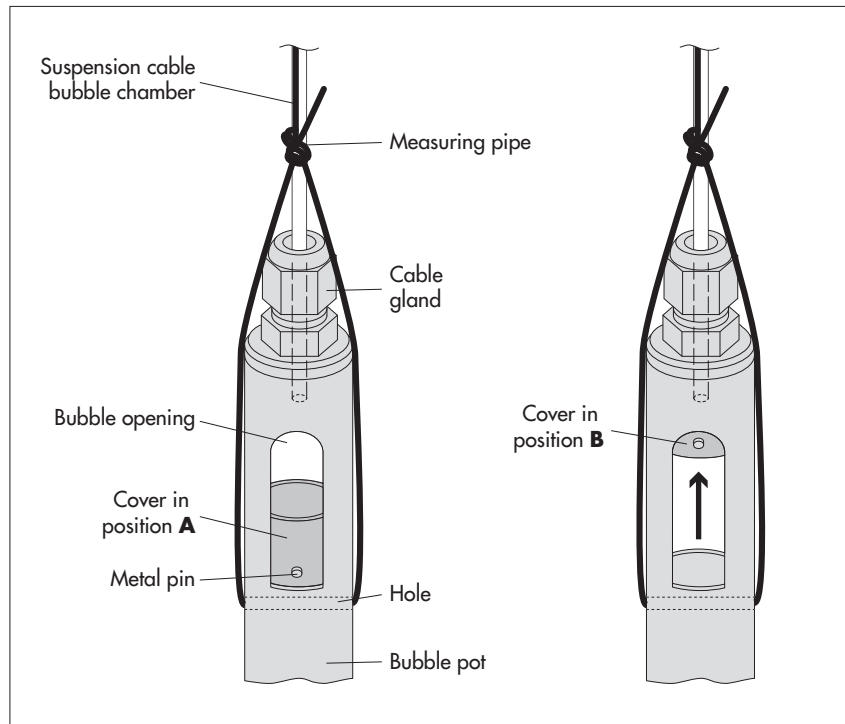
To install the bubble chamber for ground water, proceed as follows:

- Determine depth of the bubble chamber (e.g. using a contact gauge). The bubble chamber must be positioned under the lowest expected water level.
Depth = distance from bubble opening to upper edge of the top cap
- Push the measuring tube into the cable gland of the bubble chamber as far as it goes.
- Tighten the cable gland firmly by hand
- Cut suspension cable to length; **suspension cable length = depth + 125 cm** (to protect the suspension cable from being twisted off, it can be melted, with a cigarette lighter for example).
- Feed the suspension cable through the hole in the bubble chamber as shown in Figure 6 and tie firmly.
- Slide cover into position B (upwards), see Fig. 6.

Fig. 6: Installing bubble chamber for ground water.

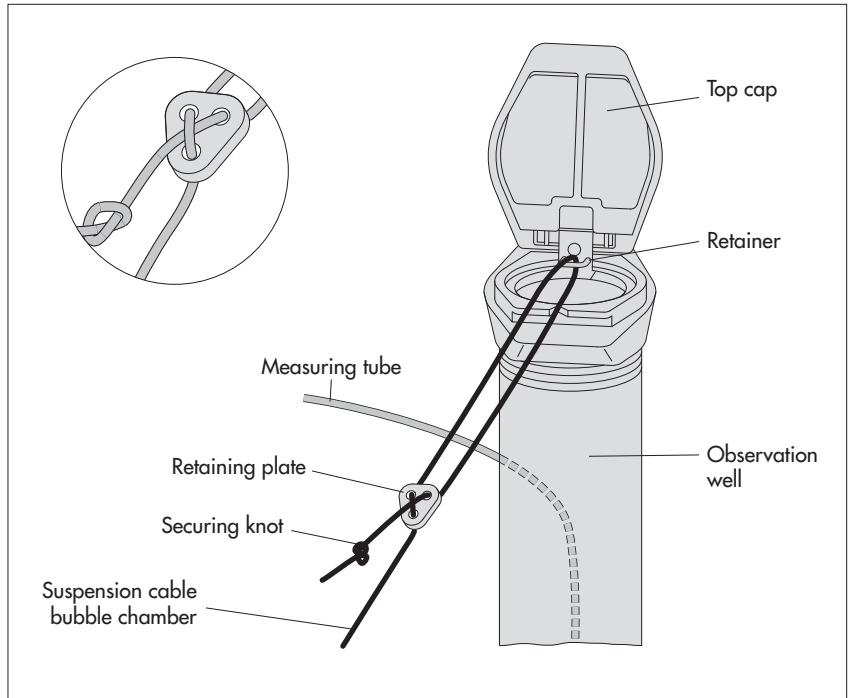
When lowering the bubble chamber, the cover must be in position B! The cover prevents water entering the measuring tube during installation.

During initial startup, over pressure builds up in the measuring tube. As a result, the cover falls back to position A and opens the measuring tube in the process.



- As shown in Fig. 7, attach the suspension cable of the bubble chamber to the retainer on an OTT top cap already mounted. The retaining plate allows a fine height adjustment afterwards.
- Secure the suspension cable against slipping with a knot.
- If top caps without retainers are used, ensure the suspension cable is attached securely.
- Check all knots and attachments for correct position and firmness.
- Lower the bubble chamber slowly into the observation well with the suspension cable.
- Feed the measuring tube out of the observation well through a hole.

Fig. 7: Installing bubble chamber for ground water – attaching suspension cable.



6 Connecting OTT CBS

The OTT CBS has the following interfaces

- ▶ SDI-12
- ▶ 4 ... 20 mA (current loop)
- ▶ RS-485, 2-wire (SDI-12 protocol via a physical RS-485 interface)

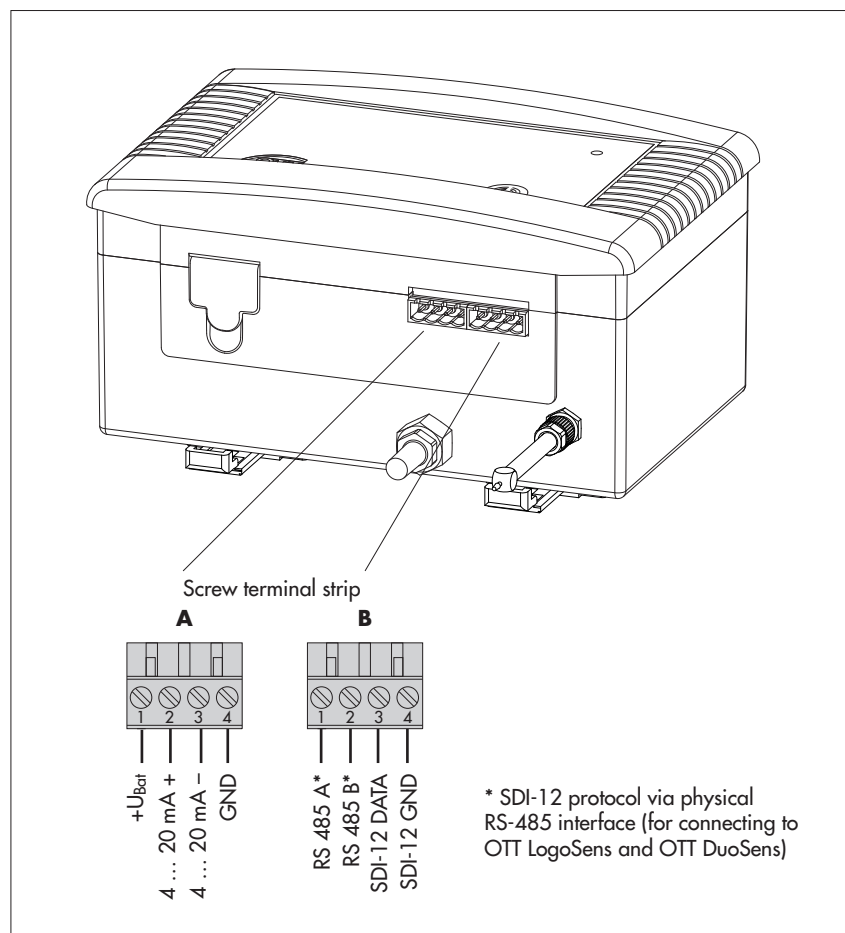
as well as a

- ▶ connection for the power supply ($U_{Bat} + GND$).

The three interfaces make it possible to connect the OTT CBS both to OTT data-loggers and to any datalogger by another manufacturer that has the correct interfaces. The SDI-12 interface meets SDI-12 Standard 1.3 (SDI-12 = Serial-Digital Interface with 1200 baud).

All electrical connections are made using two screw terminal strips (supplied) at terminal blocks A and B on the underside of the OTT CBS.

Fig. 8: Assignments for the screw terminal strips A and B of the OTT CBS.



6.1 Connect power supply

The OTT CBS requires a power supply of 10 ... 30 V DC, typ. 12/24 V DC (e.g. using batteries or mains connection with galvanically separated low safety voltage).

Please note the following points when dimensioning the power supply:

- ▶ Maximum power consumption per day: 3700 mAh (typ. 320 mAh/day) (with 1 min measurement interval and 100 m measuring tube using the 4 ... 20 mA interface)
- ▶ Peak current consumption: temporary max. 2 A
- ▶ Protect the supply voltage with a microfuse (e.g. 2.5 A, slow-blow)!
- ▶ When using solar panels, we recommend the use of an overvoltage protection device.

To supply the OTT CBS with power, proceed as follows:

- Connect the power supply to screw terminal strip A of the OTT CBS as shown in Fig. 8.

Notes

- ▶ The OTT CBS does not have a switch for switching the unit on and off. As soon as power is supplied, the OTT CBS is ready for operation.
- ▶ Each time the power supply is attached, the piston pump operates for approx. 400 strokes (approx. 5 minutes running time).

6.2 Connecting the OTT CBS to any datalogger using an SDI-12 interface

- Connect the OTT CBS to an SDI-12 input of the external datalogger. Follow the datalogger handbook as you do this. See Fig. 8 for the assignments.

6.3 Connecting the OTT CBS to any datalogger using 4 ... 20 mA interface

- Connect the OTT CBS to a 4 ... 20 mA input of the external datalogger. Follow the datalogger handbook as you do this as well as Chapter 10 of these instructions). See Fig. 8 for the assignments.
- With depth measurement: ensure that DIP switch 4 is set to ON.

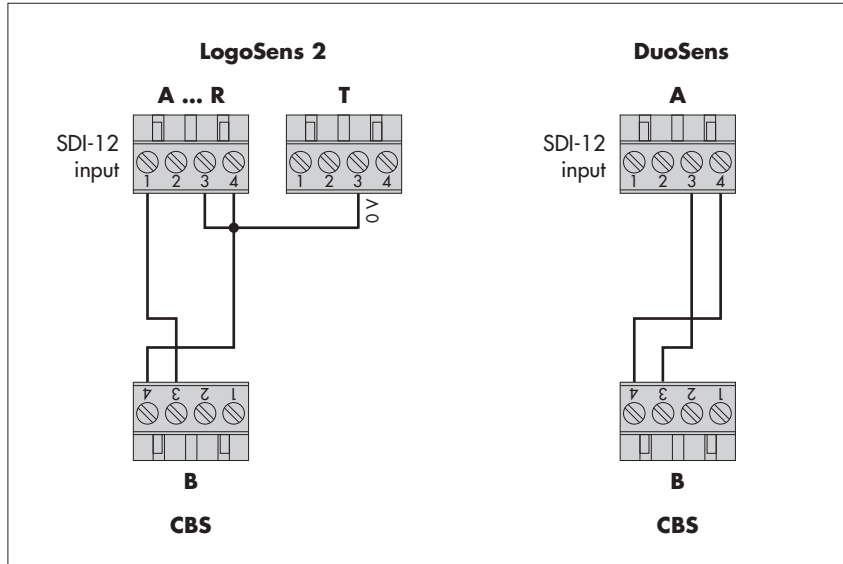
6.4 Connecting the OTT CBS to LogoSens 2 or DuoSens using an SDI-12 interface

Method A: Connect the OTT CBS via the SDI-12 interface (protocol and physical interface: SDI-12). The maximum length of the cable is 70 m. Recommended cable cross-section: 0.25 mm²:

- Connect the OTT CBS as shown in Figure 9 to the LogoSens 2 Station Manager or to the DuoSens Compact Data Logger. Take note of the operating instructions for the LogoSens 2/DuoSens.

Fig. 9: Connecting the OTT CBS to LogoSens 2 or DuoSens using an SDI-12 interface.

The letters above/below the screw terminal strip identify the possible connections on the LogoSens 2/DuoSens/CBS.

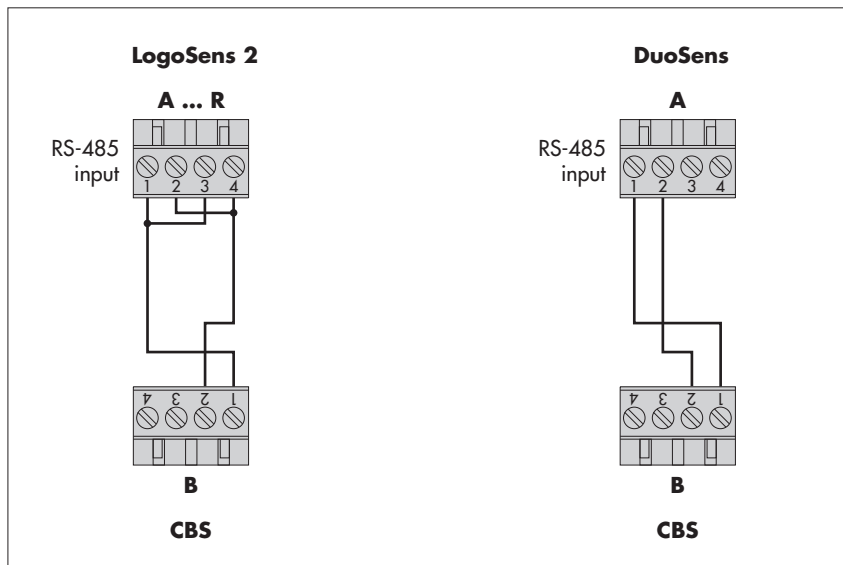


Method B: Connect OTT CBS using the physical RS-485 interface (SDI-12 protocol via physical RS-485 interface). The maximum length of the cable is 1,500 m. Recommended cable type: Unshielded twisted-pair cable; recommended cable cross-section: 0.25 mm²:

- Connect the OTT CBS as shown in Figure 10 to the LogoSens 2 Station Manager or to the DuoSens Compact Data Logger. Take note of the operating instructions for the LogoSens 2/DuoSens.

Fig. 10: Connecting the OTT CBS to LogoSens 2 or DuoSens using an RS-485 interface (SDI-12 protocol).

The letters above/below the screw terminal strip identify the possible connections on the LogoSens 2/DuoSens/CBS.



Configuring the LogoSens 2/DuoSens for the OTT CBS with SDI-12 interface

- Create a LogoSens 2/DuoSens channel with *SDI-12 Master* or *OTT SDI RS485* function block (*serial sensors* tab).
- Apply the following settings:

Fig. 11: Adjusting the operating parameters of the LogoSens 2/DuoSens *SDI-12 Master* function block.

The function block *OTT SDI RS485* is set in the same way.

SDI-12 Master			
Terminal block	A	Measurement mode	M!
Slave address	0		
Value no.	1		
Value no.	Virtual Terminal ID	Value no.	Virtual Terminal ID
2	V02	6	...
3	V03	7	...
4	V04	8	...
5	V06	9	...

- ▶ Terminal block
LogoSens 2: A ... R
DuoSens *SDI-12 Master*: A 3-4 (specified)
DuoSens *OTT SDI RS485*: A 1-2 (specified)
terminal block used (screw terminal strip) of the LogoSens 2/DuoSens.
 - ▶ Slave address
SDI-12 bus address. Each slave address may only be allocated once to an SDI-12 bus line. (checking/setting: see operating instructions LogoSens 2/DuoSens, Chapter *SDI-12 transparent mode*.) Typical setting: 0 (only one OTT CBS is connected to the terminal block; no bus operation).
 - ▶ Value no.
Identifies which value (the xth of n values) of the OTT CBS is recorded in this channel. Typical setting: 1 (first of seven values: level in [m])
 - ▶ Measurement mode
M! (For the maximum 7 values of the OTT CBS).
 - ▶ Value no./Virtual Terminal ID
Allocation of the further six values of the OTT CBS to virtual terminals (level in [cm]; level in [ft]; pressure in [mbar]; pressure in [psi]; temperature in [°C]; status; see Chapter 9, commands *aM!* and *aV!* for further information).
- In the relevant *Channel* function blocks, adjust to the required units and number of digits after the decimal place (m: 3; cm: 0; ft: 2; mbar: 1; psi: 3; °C: 1; status: 0).

Note: To record all seven values of an OTT CBS, seven channels in the LogoSens 2/DuoSens are necessary. The first channel contains the function block *SDI-12 Master* or *OTT SDI RS485* as the input signal. The other channels each contain a function block *Virtual Sensor* (V02 to V07) as the input signal. Naturally, just individual channels can be recorded. In this case, there are fewer entries required in the *Value no./Virtual Terminal ID* field.



Caution: The measuring time is at least 1 minute.

6.5 Connecting the OTT CBS to LogoSens 2 or DuoSens using a 4 ... 20 mA interface

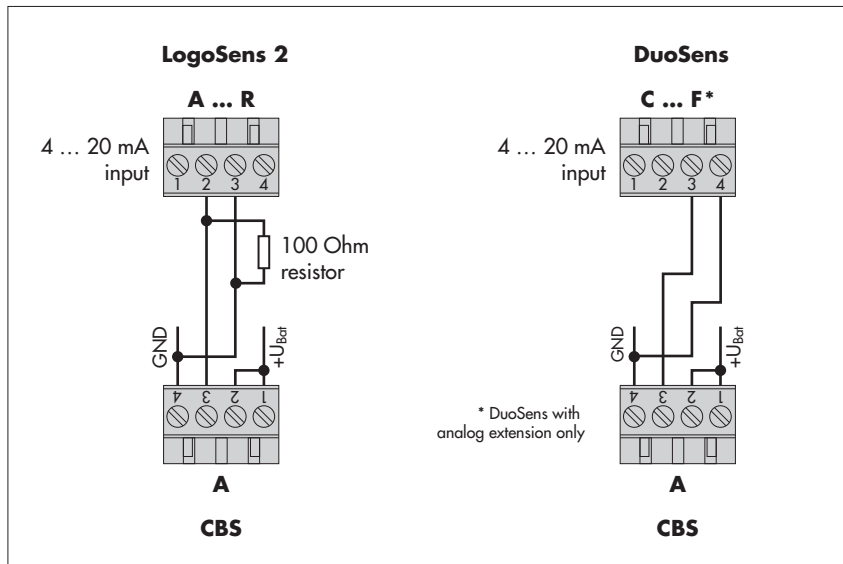
- Connect the OTT CBS to the LogoSens 2 Station Manager or to the DuoSens Compact Data Logger as shown in Figure 12. Take note of the operating instructions for the LogoSens 2/DuoSens. Maximum cable length/recommended cable cross-section: Ensure that the ohm cable resistance together with any resistor present does not exceed the maximum permitted load resistance (see Chapter 10)!

Fig. 12: Connecting the OTT CBS to LogoSens 2 or DuoSens using a 4 ... 20 mA interface.

Use the 100 Ohm OTT resistor (order number: 55.550.126.4.2)!

The letters above/below the screw terminal strip identify the possible connections on the LogoSens 2/DuoSens/CBS.

In the shown application the supply of the current loop will occur via the OTT CBS.

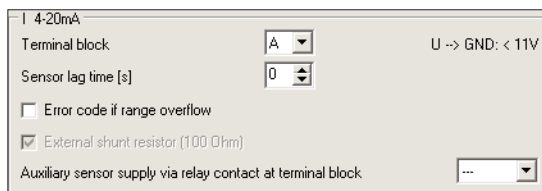


Configuring the LogoSens 2/DuoSens for OTT CBS with 4 ... 20 mA interface

- Create a LogoSens 2/DuoSens channel with function block *I 4-20 mA* (LogoSens 2) or *U/I/Pt100/...* (DuoSens) (*Analog sensors* tab).
- Apply the following settings:

Fig. 13: Setting operating parameters of the LogoSens 2 *I 4-20 mA* function block.

The DuoSens function block *U/I/Pt100/...* is set in the same way.



► Terminal block

LogoSens 2: A ... R
DuoSens: C ... F
terminal block used (screw terminal strip) of the LogoSens 2/DuoSens.
Set to *I 4-20 mA ext.*

► Measuring mode (only with DuoSens)
► Sensor lag time (s)

switches on the LogoSens 2/DuoSens input x seconds before the actual measurement process; set to *1*

- ▶ Error code if range overflow if required: record error codes if range overflow
- ▶ Auxiliary sensor supply via relay contact at terminal block (only for LogoSens 2) not required with an OTT CBS
- Insert a function block *2-Point scaling* into this channel and set the appropriate water levels for the electrical values measured (e.g. for an OTT CBS with 15 m measuring range and level measurement (DIP switches 5 + 6 = ON): Point 1: 4 → 0; Point 2: 20 → 15). Ensure you note here the settings of DIP switches 5 + 6!
- With depth measurement: ensure that DIP switch 4 is set to ON or carry out the inversion of the value via function *2-point scaling* (e.g. for an OTT CBS with 15 m measuring range and depth measurement (DIP switches 5 + 6 = ON): Point 1: 4 → 15; Point 2: 20 → 0).
- In the relevant *Channel* function block, set the unit and number of digits after the decimal place (m: 3; ft: 3; mbar: 1; psi: 3).

Note on points 6.2 to 6.5

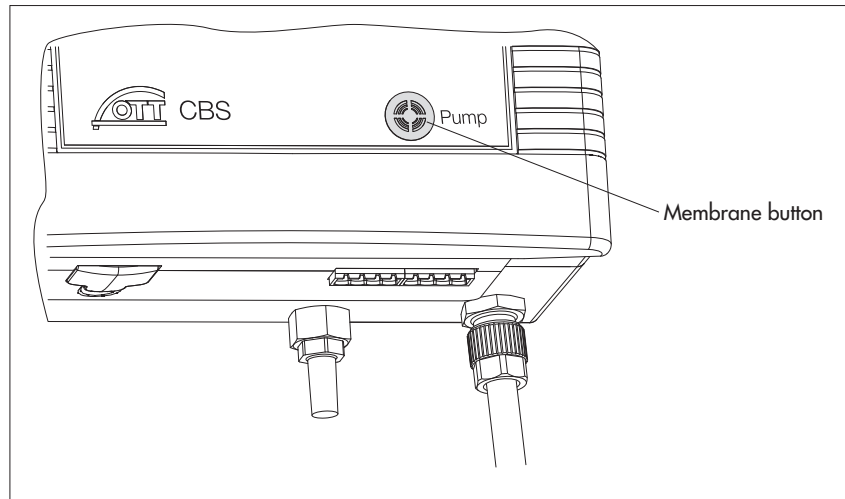
- ▶ To reference OTT CBS level/depth values to a level zero: Input the contact gauge/staff gauge measurement, for example using the scaling function of the datalogger connected to the OTT CBS (e.g. LogoSens/DuoSens).

7 Activating the purge function

On the front of the OTT CBS there is a *Pump* membrane button (see Fig. 14). Pressing the button activates the purge function for as long as it is pressed. The *Status* LED lights for approx. 2 seconds. With an activated purge function, the CBS pumps a large amount of air through the measuring tube for the required time period (see also Chapter 11). The purge function can also be activated via an SDI-12 command.

Note: Press the membrane button for at least one second as otherwise the error memory is called and displayed at the *Status* LED.

Fig. 14: Activating purge function manually on the OTT CBS with membrane button.



8 Setting operating parameters using DIP switches

The eight DIP switches are behind a cover on the underside of the OTT CBS (see Figure 1). The following operating parameters can be set with them:

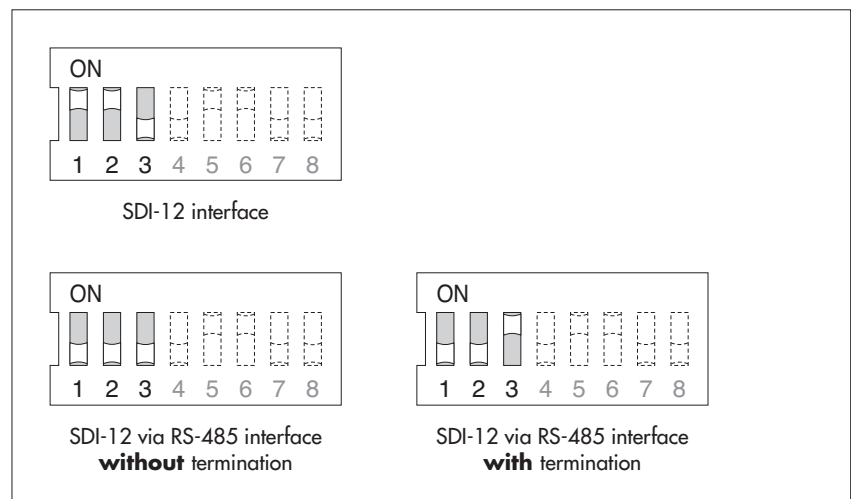
- ▶ DIP 1, 2, 3 Setting the type of SDI-12 interface
- ▶ DIP 4 Setting measurement type as level or depth measurement*
- ▶ DIP 5 + 6 Scaling measuring range*
- ▶ DIP 7 Setting metric or imperial system (m/mbar or feet/psi)*
- ▶ DIP 8 Setting measurement type as water level or pressure measurement*

* these settings only affect the 4 ... 20 mA interface.

8.1 Setting the type of SDI-12 interface

With DIP 1 ... 3 select the type of SDI-12 interface of the OTT CBS (screw terminal strip B; contacts 1 to 4). Please also take note that only one of the interfaces can be used in each case: 4 ... 20 mA or SDI-12 (no parallel operation of the interfaces).

Fig. 15: Setting the type of SDI-12 interface of the OTT CBS.

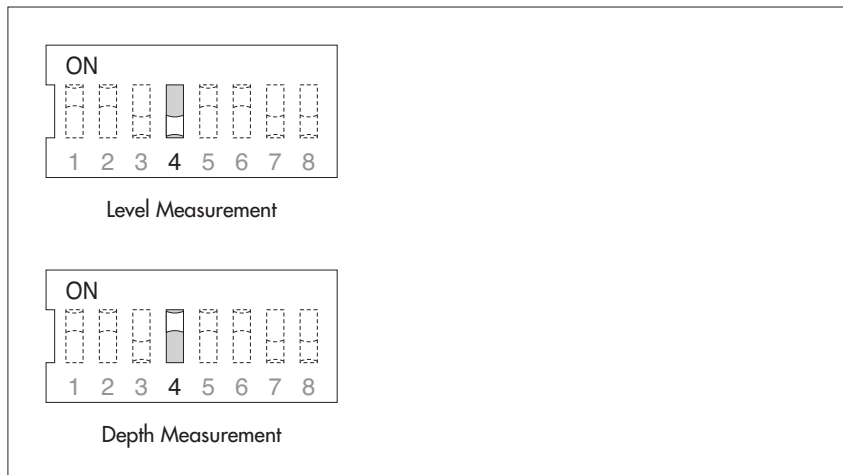


Possible types for the SDI-12 interface

- ▶ Standard SDI-12 interface (protocol and physical interface: SDI-12)
- ▶ SDI-12 via RS-485 interface **without** termination (SDI-12 protocol via physical RS-485 interface).
Use this setting if multiple OTT CBS are connected in parallel to one RS-485 cable (bus operation) for all OTT CBS except the last device at the end of the bus.
- ▶ SDI-12 via RS-485 interface **with** termination (SDI-12 protocol via physical RS-485 interface).
Use this setting if
 - multiple OTT CBS are connected in parallel to the RS-485 cable (bus operation) for the last device at the end of the bus, or if
 - only one OTT CBS is connected to the RS-485 cable.

8.2 Setting measurement type of the 4 ... 20 mA interface to level or depth measurement

Fig. 16: Setting measurement type level or depth measurement of the OTT CBS (4 ... 20 mA interface).



8.3 Scaling the measuring range for the 4 ... 20 mA interface

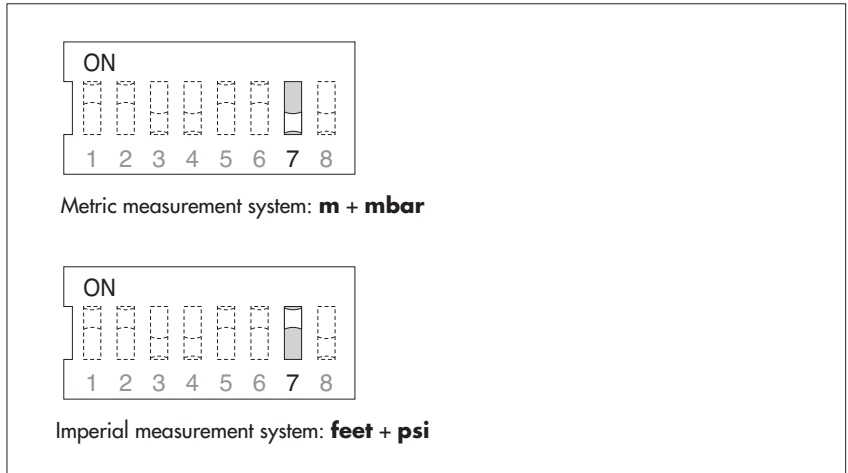
With DIPs 5 and 6 you can scale the available measuring range (15 or 30 m) of an OTT CBS to a smaller range. Where the whole measuring range is not required, this has the advantage that a higher resolution for the 4 ... 20 mA interface can be achieved. Example: For 2 m water level change 16 mA measuring range is available (DIP switches 5 + 6 = OFF).

Fig. 17: Scaling the measuring range of the OTT CBS (4 ... 20 mA interface).

	CBS version	
	Standard + USGS specification	30 m measuring range
<p>ON 1 2 3 4 5 6 7 8</p>	15 m / 50 ft 1.5 bar / 25 psi (not scaled)	30 m / 100 ft 3 bar / 50 psi (not scaled)
<p>ON 1 2 3 4 5 6 7 8</p>	8 m / 25 ft 0.8 bar / 12 psi	15 m / 50 ft 1.5 bar / 25 psi
<p>ON 1 2 3 4 5 6 7 8</p>	4 m / 12 ft 0.4 bar / 6 psi	8 m / 25 ft 0.8 bar / 12 psi
<p>ON 1 2 3 4 5 6 7 8</p>	2 m / 6 ft 0.2 bar / 3 psi	4 m / 12 ft 1.5 bar / 6 psi

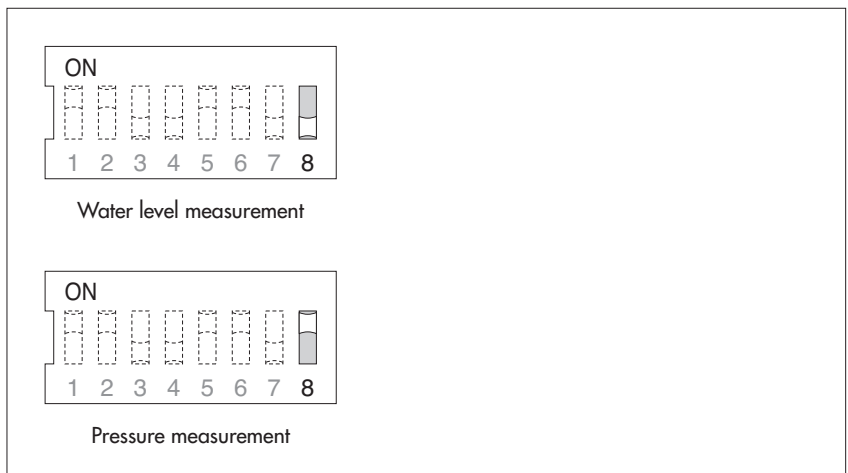
8.4 Setting the measuring system for the 4 ... 20 mA interface

Fig. 18: Setting the measuring system of the OTT CBS (4 ... 20 mA interface).



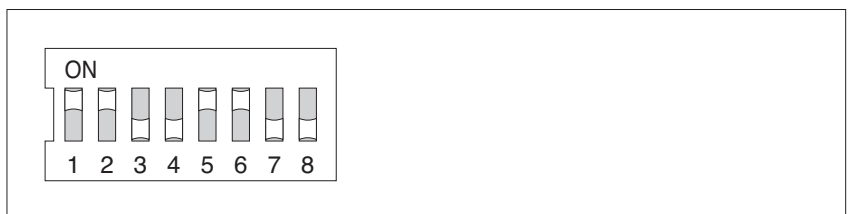
8.5 Setting measurement type of the 4 ... 20 mA interface to water level or pressure measurement

Fig. 19: Setting measurement type to water level or pressure measurement (4 ... 20 mA interface).



8.6 Factory setting of the operating parameters

Fig. 20: Factory setting of the operating parameters.



- Standard SDI-12 interface; level measurement; measuring range not scaled; metric system; water level measurement.

9 SDI-12 Commands and Response

9.1 Standard commands

The following SDI-12 standard commands are implemented in the OTT CBS:

Command	Response	Description
a!	a<CR><LF>	Acknowledge active
aI!	allccccccccmmmmmm... ...vvvxxxx<CR><LF>	Send Identification OTT CBS Response = 13OTT HACH CBS107
aAb!	b<CR><LF>	Change Address
?!	a<CR><LF>	Adress Query
aM!	atttn<CR><LF>*	Start measurement in normal mode. The measured values are output as follows: D0: Level [m]; resolution: 0,001 m D1: Level [cm]; resolution: 1 cm D2: Level [ft]; resolution: 0,01 ft D3: Pressure [mbar]; resolution: 0,1 mbar D4: Pressure [psi]; resolution: 0,001 psi D5: Temperature [°C]; resolution: 0,1 °C D6: Status (see command aV!)
aD0!	a<wert><CR><LF>	Send data. The answer looks as follows: a = device address <values> = pd.d = +1,000 (level value – maximum of 9 characters per value and 35 characters per query). If several measured values are queried, it may be necessary to continue with further queries, e.g. aD1!.
aV!	atttn<CR><LF>*	Start verification. The verification lasts 1 second and provides a value representing the test result: D0: a+0<CR><LF>: no error D0: a+1<CR><LF>: level too low (< 5 cm) D0: a+2<CR><LF>: overload (measuring range exceeded) D0: a+4<CR><LF>: power supply voltage too low D0: a+8<CR><LF>: pump motor overloaded D0: a+16<CR><LF>: watchdog error D0: a+256<CR><LF>: data memory defective D0: a+512<CR><LF>: data bus defective D0: a+1024<CR><LF>: analog converter defective D0: a+2048<CR><LF>: measuring cell defective more than one error: sum of errors

Note:

Messages 256 to 2048 signify hardware problems that can only be rectified by the OTT Repaircenter (see chapter 11). In this case, send your OTT CBS to us. Message 16 means that your unit has been restarted. No intervention is necessary.

* The answers consist of the following:

a = device address

ttt = 001 = time in seconds until the sensor is ready again at the latest

n = 5 = number of measured values

More information on the SDI-12 standard commands can be found in the document *SDI-12; A Serial-Digital Interface Standard for Microprocessor-Based Sensors; Version 1.3* (see Internet page www.sdi-12.org).

9.2 Advanced SDI-12 commands

All advanced SDI-12 commands begin with an O for OTT. With these commands, it is possible to configure the OTT CBS through the transparent mode of a datalogger.

Command	Response	Description
aOXP<value>!	aOXP<value><CR><LF>	Activate purge function. The parameter <value> represents the setting defined as follows: 0 = purge function deactivated 1 = purge function activated
aOXG<value>! or aOXG!	a<value><CR><LF>	Set/query value for local gravitational constant. Format: cbb.aaa c: Polarity (+ or -) bb: Number before the decimal point aaa: Number after the decimal point
aOXT<value>! or aOXT!	a<value><CR><LF>	Set/query value for local water temperature. Format: cbb.aaa c: Polarity (+ or -) bb: Number before the decimal point aaa: Number after the decimal point

Notes on commands aOXG<value>! and aOXT<value>!

The probe either produces a value proportional to the pressure, or an actual water level compensated for the relative density of the water.

The corrected water level measurement is calculated according to the following formula

$$\text{Water level} = \text{mH}_2\text{O pressure at } 4 \text{ }^\circ\text{C} * \frac{1}{\text{Water density}} * \frac{9.80665}{\text{Local gravitational constant}}$$

With: water density = $-6.017777e^{-6} t^2 + 0.0000408 t + 0.999841$ and with t = temperature in $^\circ\text{C}$

The OTT CBS can calculate the water density at any time using the value for the local water temperature. You can enter the value for the local gravitational constant using the command aOXG<value>!.

Calculation of the correct value for the local gravitational constant

The gravitational acceleration at the earth's surface varies between 9.78036 m/s² at the equator and 9.83208 m/s² at the poles. Also, it decreases by 0.003086 m/s² for each kilometer above sea level. With the following formula the local gravitational constant g in m/s² can be calculated:

$$g = 9.780356 * (1 + 0.0052885 \sin^2\alpha - 0.0000059 \sin^2 2\alpha) - 0.003086 h$$

where α is the degrees of latitude and h the height above sea level in km. (Jursa, A.S., Ed., Handbook of Geophysics and the Space Environment, 4th ed., Air Force Geophysics Laboratory, 1985, pp. 14-17).

Example: Kempten (OTT)

At a height above mean sea level of 669 m (0.669 km) and a latitude of 47.71°, a local gravitational constant of 9.80659 m/s² results.

Note: The OTT CBS is preset to an average value for Germany (Kassel). The measurement deviation caused by gravitation is ± 3 mm in Germany (Flensburg – Oberstdorf). This measurement error can be compensated by inputting the local gravitational constant.

10 Determining the maximum load resistance at the 4 ... 20 mA interface

The load resistance connected to the OTT CBS must not exceed a specific maximum value. This value depends on the level of the supply voltage of the OTT CBS. If the load resistance is greater, the output current can no longer be evaluated. Smaller load resistances are allowed.

- Read off the maximum load resistance for your power supply from the following diagram.

Example: Power supply 18 Volt → max. load resistance 450 Ohm.

The OTT CBS delivers an output current corresponding to the measured value for a load resistance of up to 450 Ohm.

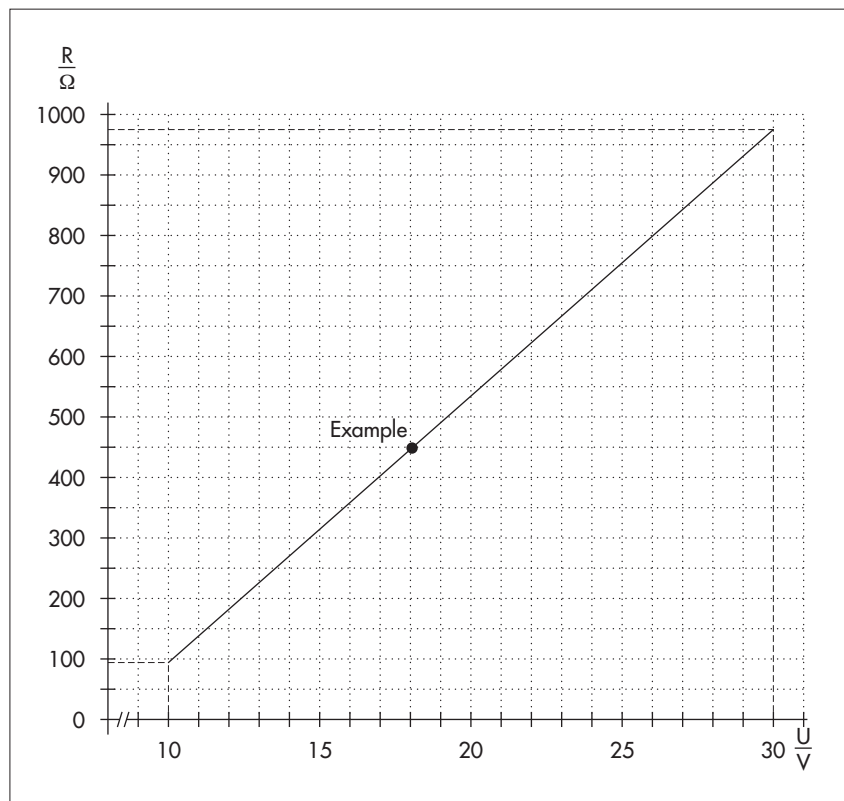
- Dimension the connected electrical circuit accordingly. Check the input resistance of the connected peripheral device for this purpose.

Fig. 21: Diagram to determine the maximum load resistance as a function of the power supply.

Minimum power supply: 10 V

Maximum power supply: 30 V

Resistor tolerance: 0.1 %/15 ppm.



11 Carrying out maintenance work

The OTT CBS bubble sensor itself is maintenance free. We recommend that the measuring tube and bubble chamber are checked at regular intervals as described below and cleaned as required:

11.1 Activating purge function

Activate the purge function of the OTT CBS quarterly by pressing the membrane button *Pump* (see also Fig. 14) and checking whether air bubbles rise out of the bubble chamber. If not, check whether the bubble chamber is blocked, and/or whether the measuring tube is leaking or blocked.

11.2 Cleaning bubble chamber

Check the bubble chamber quarterly for sand buildup and weed infiltration. For light sand buildup, clean the bubble chamber using the purge function, and for heavier buildup or weed infiltration clean the bubble chamber carefully manually (do not change the position of the bubble chamber).

11.3 Testing the measuring tube

After 15 years' operation, test the measuring tube for tightness/pressure resistance roughly every 2 years.



Never open the housing of the OTT CBS! There are no adjustment or control elements inside the housing!

In the case of device defects, contact the OTT Repaircenter:

OTT Hydromet GmbH
Repaircenter
Ludwigstrasse 16
87437 Kempten · Germany
Phone +49 831 5617-433
Fax +49 831 5617-439
repair@ott.com

12 Status LED

For the display of any error states that may occur, the OTT CBS has a *Status LED* on the front of the device (see Fig. 1).

The following error states can arise:

▶ level too low (< 5 cm)	1 x flash
▶ overload (measuring range exceeded)	2 x flash
▶ power supply voltage too low	3 x flash
▶ pump motor overloaded	4 x flash
▶ watchdog error	5 x flash
▶ data memory defective	6 x flash
▶ data bus defective	7 x flash
▶ analog converter defective	8 x flash
▶ measuring cell defective	9 x flash

The OTT CBS shows an error state when it arises and for approximately 2 minutes after pressing the *Pump* membrane button.

The ... defective error states signify hardware problems that can only be rectified by the OTT Repaircenter (see chapter 11). The *watchdog error* error state means that the OTT CBS has been restarted. No intervention is necessary.

Any error states arising can be displayed as follows:

- Press *Pump* membrane button briefly (< 1 second; otherwise the purge function is called) → the LED lights once for a longer period as confirmation → Pause → 1st error state arising (e.g. flashing once) → Pause → 2nd error state arising (e.g. flashing three times) → Pause → The OTT CBS repeats all error states arising for approx. two minutes.

Notes

- ▶ Interrupt displaying error states: press membrane button briefly.
- ▶ If no error state has arisen: the LED lights once for a longer period as confirmation.

13 Note about the disposal of old devices



In accordance with the European Union guideline 2002/96/EC, OTT takes back old devices within the member countries of the European Union and disposes of them in an appropriate way. The devices concerned by this are marked with the symbol shown aside. For further information about the return procedure, please contact your local sales contact. You will find the addresses of all sales partners in the internet on www.ott-hydrometry.com. Please take into consideration also the national implementation of the EU guideline 2002/96/EC of your country.

14 Technical Data

Measuring ranges	
<i>Standard + USGS specification version</i>	0 ... 15 m or 0 ... 1500 mbar 0 ... 50 ft or 0 ... 25 psi
<i>30 m measuring range version</i>	0 ... 30 m or 0 ... 3000 mbar 0 ... 100 ft or 0 ... 50 psi
Resolution	1 mm or 0.1 mbar 0.01 ft or 0.001 psi
Accuracy SDI-12 interface	
<i>Standard + 30 m measuring range version</i>	±5 mm ±0.02 ft
<i>USGS specification version</i>	measuring range 0 ... 15 ft: ±0.01 ft measuring range 15 ... 50 ft: ±0.065 % of measured value or ±0.02 ft, whichever is less
Accuracy 4 ... 20 mA interface	±0.1 % FS; TC 10 ppm/°C (at 20 °C)
Measuring dynamics (max. level change)	1 m/min
Units	m or ft; bar or PSI
Interfaces	4 ... 20 mA, SDI-12, SDI-12 via RS-485
Power supply	10 ... 30 V DC, typ. 12/24 V DC
Current consumption	
Query interval 1 min	typ. 320 mAh / day (max. 3 700 mAh / day)
Query interval 15 min	typ. 25 mAh / day (max. 300 mAh / day)
Dimensions L x W x H	165 mm x 205 mm x 115 mm
operating/display elements	
DIP switches	setting operating parameters (eight)
<i>Pump</i> membrane button	Call purge function; display error status using LED
<i>Status</i> LED	Display operating state/error status
Weight	approx. 1,500 g
Housing material	ABS
Type of protection	IP 43
Temperature range	
Operation	-20 ... +60 °C
Storage	-40 ... +85 °C
Relative humidity	10 ... 95 % not condensing
Measuring tube	
internal diameter	Connection possibilities for 2 mm, 4 mm, 1/8"
Length	2 mm, 1/8": max. 100 m 4 mm: max. 75 m
EMC limits	
Resistance to electrostatic discharge (ESD)	complies with EN 61000-4-2 degree of severity 2 (4 kV contact discharge)
Resistance to electromagnetic fields	complies with EN 61000-4-3 degree of severity 3 (3 V/m)
Resistance to transient fields (burst)	complies with EN 61000-4-4 degree of severity 5 (4 kV)
Resistance to surge	complies with EN 61000-4-5 degree of severity 5 (4 kV)
Line-borne and radiated interference	complies with EN 55022 Class B (30 ... 1000 MHz)



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