CTD 90 M Series II

Memory Probe

Sea & Sun Marine Tech

User's Manual

Operating Instructions

Rev. 07 , 2022-02-21

Sea & Sun Marine Tech
is member of
Sea & Sun Technology

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Notes and warnings:

Warning!

This reminder informs about safety rules and instructions, which have to be followed to avoid dangerous consequences.

Note!

This reminder contains important hints or recommendations to avoid troubles and problems for the user.

Preface

Standard warranty

Sea & Sun Technology GmbH (thereafter “SST”) guarantees that the materials and workmanship of this product are of high standard and free of defects. A warranty of 2 years as from the date of shipment is valid provided the appliance has not been abused and used properly in accordance with the SST operating instructions. This warranty is limited to repairs or replacements at the premises of SST in Trappenkamp (Germany) only and does not include costs for shipment, freight and packaging or may be incurring customs duty. Since this product is pressure tested to rated depth prior to shipment, SST does not assume responsibility for any damage due to leakage or implosion.

Limited liability statement

Care should be taken when operating or servicing this equipment. The instrument should be used and serviced only by personnel with knowledge and experience in the use of oceanographic electronic equipment. Sea & Sun Technology GmbH disclaims all product liability risks arising from the use, deployment and servicing of this system. SST has not the possibility to control the use of this equipment and to choose the personnel to operate it. Therefore SST cannot take steps to comply with laws pertaining to product liability and laws which impose a duty to warn the user of any dangers concatenated with the operation of this system. Therefore the acceptance of this system by the customer shall be deemed to include a covenant by the customer to defend, indemnify and hold Sea & Sun Technology GmbH harmless from all product liability claims resulting from using or servicing this instrument.

Changes and proprietary information

The information, description and illustration in this manual are the property of Sea & Sun Technology GmbH. Materials may not be reproduced or disseminated without a prior written consent from SST. SST reserves all rights to change specifications and to modify the product without any obligation to change previous installed units. This manual is provided for information and is subject to change without notice.

This user manual provides complete instructions for use and maintenance of the CTD90M memory probe. Please read it prior to deploying the equipment and follow the instructions during setup and installation.

Revisions

Rev	Date	Changed	Writer
01	2013-06-20	New CTD90 M Serie II	Christian Held
02	2015-02-02	New Turbidity ranges	Heino Beth
03	2015-03-10	Modified Seapoint Fluorometer ChlA	Heino Beth
04	2016-02-11	Update P-Sensor / Probe electronics	Heino Beth
05	2017-01-25	Update Appendix	Heino Beth
06	2020-07-03	Appendix Water Sampler	Heino Beth
07	2022-02-21	Appendix Probe configuration and data readout	Heino Beth

Table of Contents

About this manual

This manual is to be used with the CTD90M. It is intended as user guide for installing, operation and maintenance of the CTD90M and provides helpful information about calibration procedures, serial data format and other useful hints and warnings.

1 General description

The CTD90 memory probe is a medium sized microprocessor controlled multi-parameter probe for precise online measurements as well as for self-contained operation in shallow water up to 2000 m depth (consider sensor depth capability!). Data are stored in a standard flash memory card with a capacity limited to 128 megabytes by the internal firmware. This is sufficient for 3 million complete datasets including time and date stamps.

The memory probe has to be configured before deployment with our *Sea & Sun Technology – Standard Data Acquisition* software. The probe is completely made of titanium except the screws. The housing is inert against nearly all chemical compounds and absolutely corrosion free.

The CTD90M allows operation in different modes:

- time mode,
- increment mode,
- continuous mode,
- online mode (RS232C).

The CTD90M is equipped with a 16 channel data aquisition system with 16 bit resolution. A high long-term stability and automatic self-calibration of the analogue digital converter guarantees stable and precise CTD measurements for many years.

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Figure 1: CTD90 memory probe

2 Unpacking

As with any electronic equipment the CTD90M should be handled with a certain amount of care during transport, unpacking and storage.

When shipped from the factory the instrument is packed either in a plywood transport box (Figure 2) or in a plastic suitcase (Figure 3, page 12). All materials are carefully wrapped in the factory to avoid damage during shipment. Inspect each part whilst unpacking and report any damage to the freight carrier and to Sea & Sun Technology.

A **box of plywood** is used when the CTD90M is equipped with third party instruments that are assembled with the CTD in a common titanium frame. Documentation and accessories are packed separately in a card box. The probe is connected to the third party instruments and ready for operation when the external cable is connected to a power supply and PC.

THE BATTERIES ARE NEVER INSERTED DURING TRANSPORT.

Figure 2: The CTD90M in a box of plywood.

The CTD90M with the standard sensor protection cage will be packed in a plastic suitcase if there is no big frame as mounting device. All accessories which are necessary for operation and maintenance are packed in the two compartments beside the probe. Manuals, calibration documents and software CD are stored behind the hinged lid in the top lid of the suitcase (Figure 3, page 12).

Figure 3: If there is no big frame as mounting device, the CTD90M is packed in a plastic suitcase.

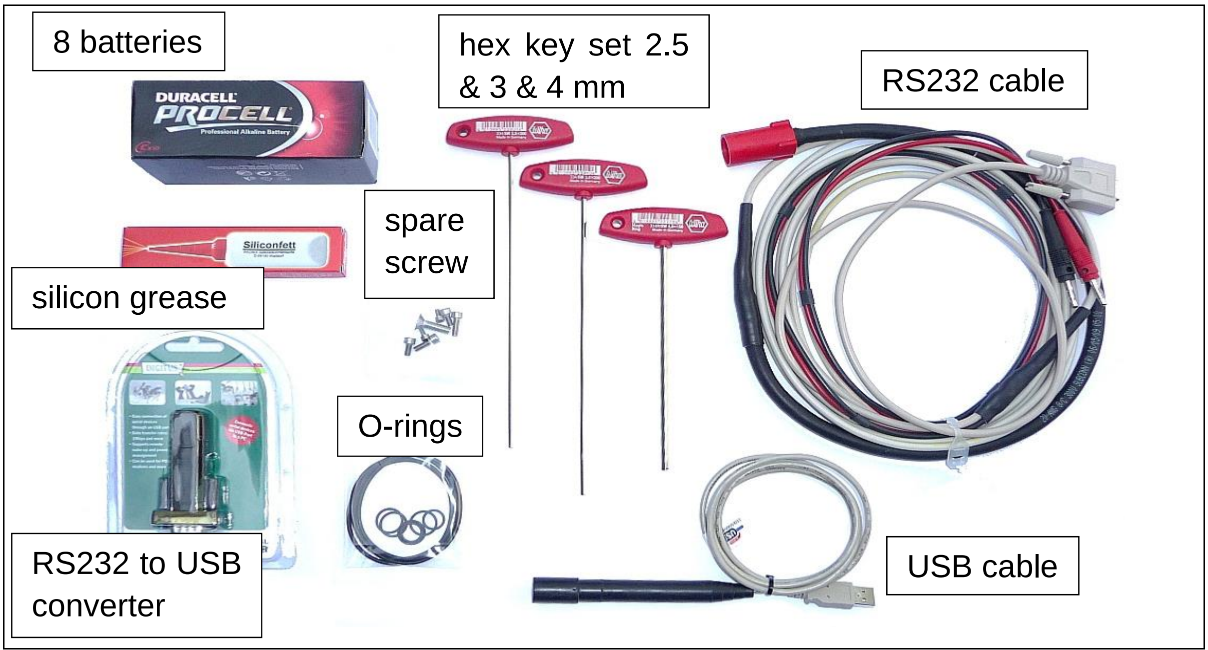
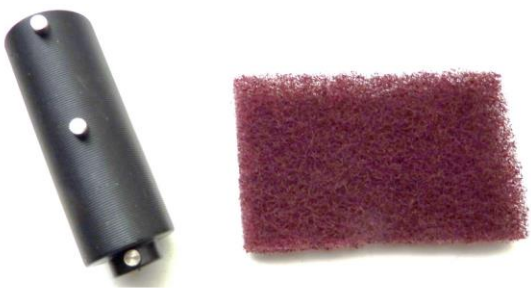


Figure 4: The standard accessories.

A magnetic rod for switching on/off the probe and a 5 mm shackle complete the accessory list (Figure 5).

Figure 5: magnetic rod and 5 mm shackle.

Depending on the kind of the additional sensor there may be some accessories and consumables added to the delivery. Figure 6 shows the Oxyguard DO spare kit, tools and the pH storage solution.



a membrane spanner and sponge, **a membrane Kit D05XMF and**

an Electrolyte D05XE 50 mL. **pH storage solution 50 mL.**

Figure 6: Oxyguard DO spare kit, tools and pH storage solution 50 mL.

3 Installation of the SDA software under Windows 7 and higher

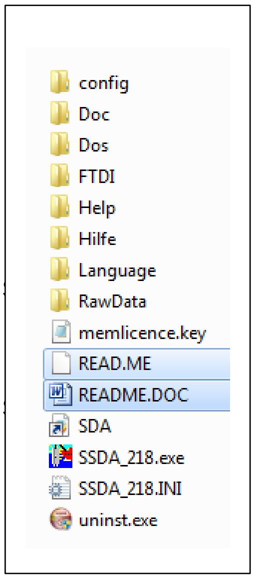
Users of Windows 7, 8 or 10 operating systems should make sure about their administrative rights before starting the installation procedure.

- Insert the CD / USB-stick in the CD/DVD drive or USB slot.
- Use Windows explorer to select the proper drive.
- Double click on the drive symbol opens the folder.
- Click on symbol **StartMenu.exe** to open the Installation menu.
- Select SDA software and click into the “**setup**” box.
- Follow the instructions of the **SDA Setup** wizard.
- Select the path to the destination folder, where the SDA should be installed (default is **C:\sst_sda**).

Administrators may use the default path but other users with limited rights and access restrictions should install the SDA software in their user area.

The wizard will create the SST_SDA directory with the following subdirectories and files:

- **Config** subdirectory
  Contains probe and project files and header (PRB-file, SPJ-file, HDR-file).



- **Doc** subdirectory
  Contains SDA and probe manuals and calibration certificates.
- **Dos** subdirectory
  Provides some DOS based tools for CTD data acquisition.
- **FTDI**
  Contains FTDI USB drivers and information.
- **Rawdata**
  Default location for all stored data files.
- Memlicence.key
  Is necessarily required for all memory probes.

SDA_xxx.exe starts the SDA software (xxx = actual version number).

When the installation is finished and the wizard menu is closed, the SDA software starts automatically (default setting).

Default installation routine uses COM port 1 as serial data input, which is available when using older desktop computers. Laptops have mostly no COM ports and the user has to connect the probe via a RS232 to USB adapter, which provide USB connectivity to RS232 peripherals, but needs a driver installation before use. The converter in our accessory uses the FTDI chip set with the proper driver located in the FTDI subdirectory.

More details to the USB installation procedure and the necessary SDA modifications will be given in the next chapter.

4 Installation of USB driver

4.1 Installation of USB driver

If the user has already a RS232 to USB converter with his laptop we recommend to use the existing adapter including driver.

If not please proceed the following way:

- Insert the converter into any USB slot, the operating system recognizes the new hardware and tries to find automatically the driver driver when the computer has internet connection. If the driver cannot be found, the system displays a message:

  "driver software has not been successfully installed".

- Click with the left mouse button on the **windows start** symbol.
- Select control panel.
- The control panel menu opens. Click on the **device manager** symbol. If the symbol is not available enter in the search field **devmgmt.msc** and the device manager menu will appear and present a review of all devices.
- Look for COM ports: The new device must be listed there as a Serial USB port with an assigned COM port number (refer to next picture). **Please remember the COM port number.**
- Click with the right mouse button on the correspondend USB port symbol and select the option **update driver software.**

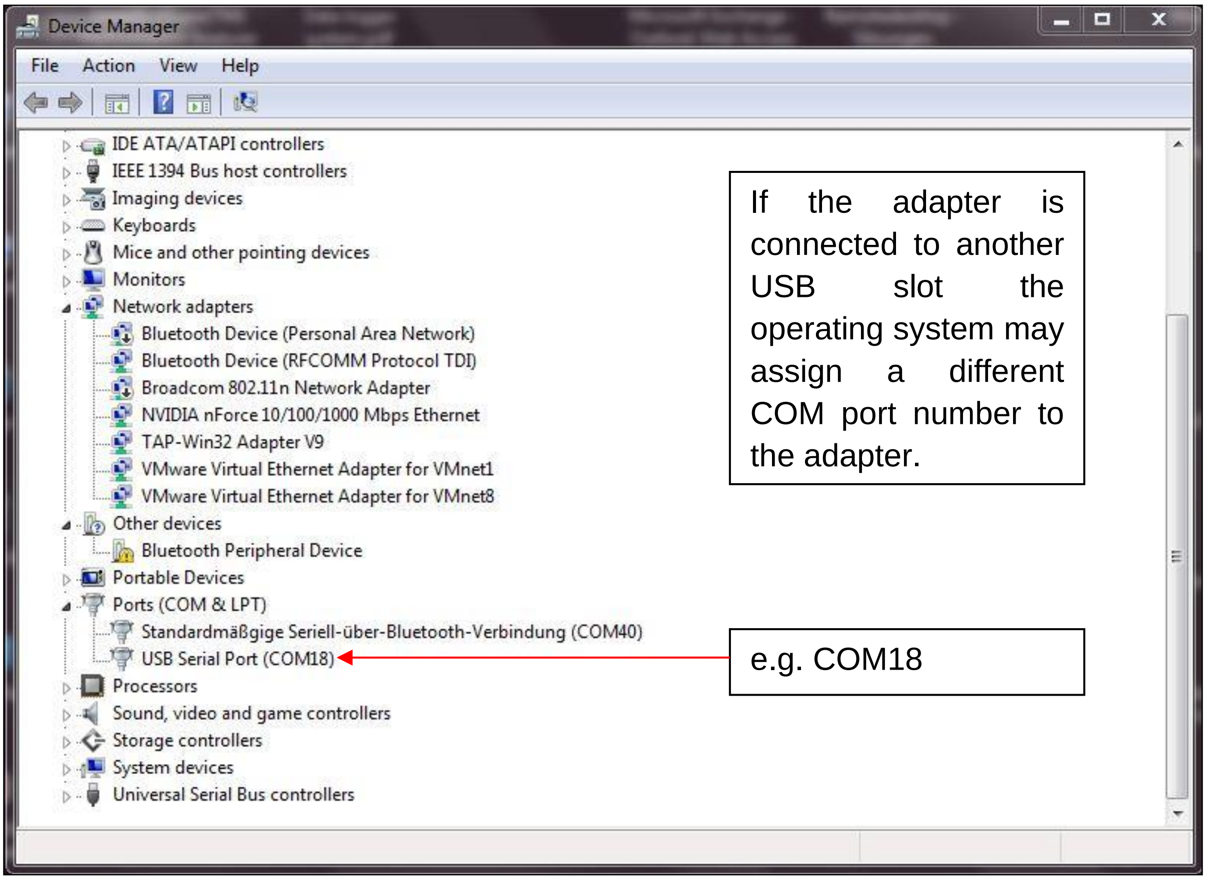


Figure 7: The device manager.

– The **driver update menu** offers two possibilities to continue:

(1) Browse for driver software on your computer.

If you have administrator rights enter the path to the driver: C:\sst_sda\FTDI (default) or otherwise to the location in the user area where the SDA software has been installed.

(2) Let me pick from a list of device drivers on my computer.

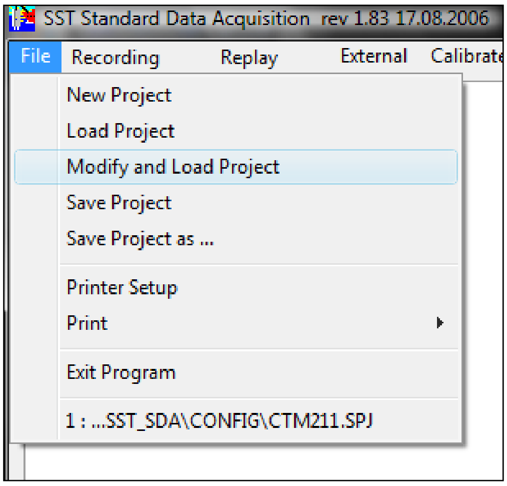
Select a driver from the driver list and close the window after installation.

Don´t worry if the installation procedure is failing at the first try, repeat this operation once more. The driver can also been loaded from the CD which is part of the RS232 to USB converter package. This driver is the same as in the SST_SDA\FTDI subdirectory.

4.2 SDA modifications

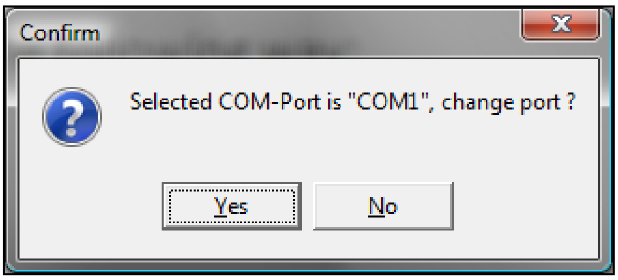
Default COM port setting of the SDA software is port 1.
To change the COM port number please use the SDA software:

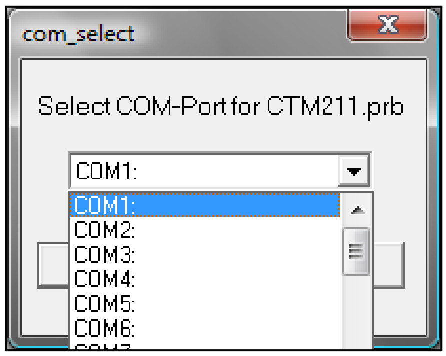
- Start the SDA-Software.
- Select **Modify and Load Project** in the SDA **File menu.**



Follow the instructions. Select a project file (SPJ), the probe file (PRB) will be assigned automatically.

- Select the COM port number you have noticed from the device manager menu (e.g.COM 18).





- When the modification has been finished successfully, data appears on the screen in scrolled mode.
- Save the settings with **Save Project.**
- The SDA COM port list ranges from COM1 to COM xxx.

4.3 Some hints for proper operation with the USB port

After installation and modification the selected COM port number will **not** be stored in the project file (SPJ-file) before either **Save Project** is executed or the SDA is closed via X button or **Exit Program**. When the user leaves the SDA program the last used settings are automatically saved in the SPJ-File and a new SDA start will have the same settings as before.

We recommend always to use the same USB slot for the serial communication between laptop and probe. Using other USB slots may lead to a different COM port number assignment.

Please take care that no serial probe data are present at the USB port during boot procedure of the operating system. Otherwise the operation system (OS) interprets the probe data as mouse cursor. The only way to get rid of this would be a system reset and reboot of Windows.

The SDA program may not be started before the USB device is recognized from the OS, the probe is powered and transmits serial data. Otherwise the SDA will not work.

To avoid these problems with the data communication keep the following sequence:

- Boot the laptop
- Plug the converter into the proper USB slot
- Power the probe
- Start the SDA software

4.4 CTD90M internal USB interface

The CTD90M has an internal FTDI chip set for USB; the above considerations are also valid for the probe´s USB port and the supplied special USB cable. The main difference between the probe´s USB port and RS232 port with USB converter is the data transfer speed during data retrieval:

– RS232 = 115 kBaud,
– USB is approximately 5 times faster.

The RS232 interface has to be used for online operation via multi-conductor cable, since the USB port is not able to drive more than some meters cable length. The USB interface should mainly be used to save time for data readout of large files.

Please note:

The 5 V supply of a laptop´s USB slot is limited in power. The supply of sensors with large current consumption or with input voltages exceeding +5 V is not possible. Hence these sensors are switched off if the probe is supplied via USB port. The data will be replaced by dummies on the SDA display. Standard sensors like P, T, C, DO (Oxyguard), fast DO (AMT), pH, ORP and PAR (LI-COR) will not be affected by this restriction.

If the battery set is inserted during USB cable connection, the probe is powered by the battery set and all sensors are powered up and data were transmitted and displayed.

5 Mechanical design of the CTD90M

All parts of the housing exposed to the sea water are absolutely made of corrosion resistant material:

- tube,
- bottom cap with sensors,
- top end cap with underwater connector,
- protection frame.

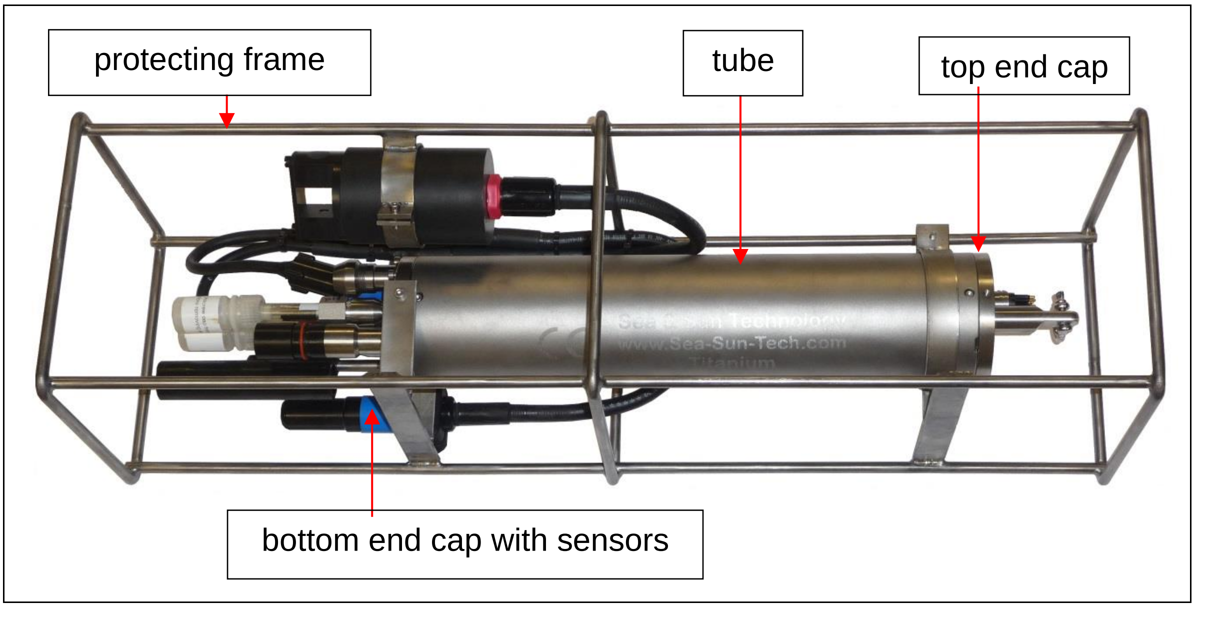


Figure 8: Parts of the CTD90M with a common titanium frame.

The sensors are described later in chapter 6 *Standard sensors*.

5.1 Tube

The tube is made of titanium grade 2 and has an external diameter of 88,9 mm and a wall thickness of 5,45 mm. On each tube-end there are 4 holes in 90° graduation necessary for fixing both end caps of the housing to the tube. Pipe and end caps are sealed by two O-ring 76 * 2,5 mm each and fixated by 4 screws M4*6 mm.

5.2 Bottom end cap

The bottom end cap made of titanium grade 2 is used to attach the sensors and serves as mounting platform for the electronic boards. Standard sensor configuration is CTD.

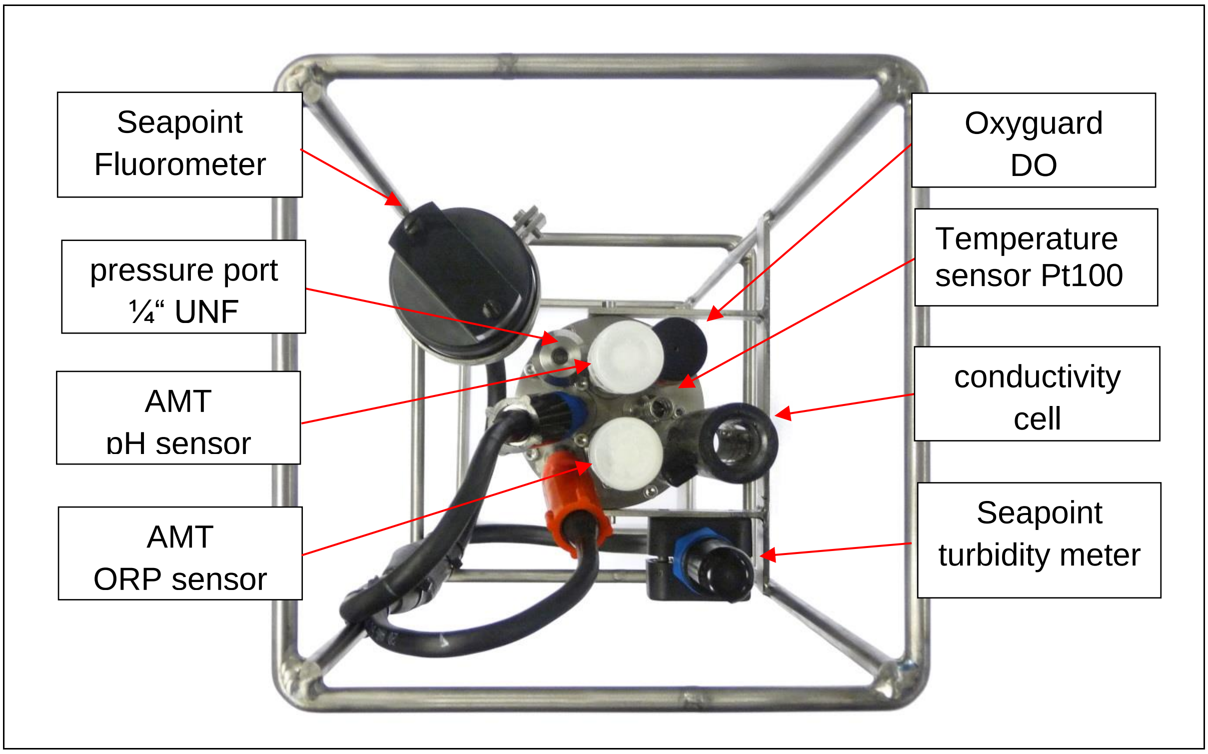


Figure 9: Bottom view of a CTD90M with sensors.

The CTD90M is modular designed and can be equipped with different sensor configurations. 8 Sensors with a standard 20 mm flange can be mounted, for example:

- conductivity sensor,
- AMT fast DO sensor, Oxyguard DO522M18,
- Seapoint turbidity meter,
- different models of pH and ORP sensors,
- the complete Cyclops-7 fluorometer family.

Third party instruments can be connected via underwater cable connection to the CTD90M when they have an analogue output e.g. PAR sensors (LI-COR, BI), transmissiometers, fluorometers, optical oxygen sensors like AADI 4175C and Rinko III.

Free positions will be closed by dummy caps.

Lid and pressure tube are sealed by two O-rings 76 * 2,5mm and are bolted onto the side with 4 screws M3*6.

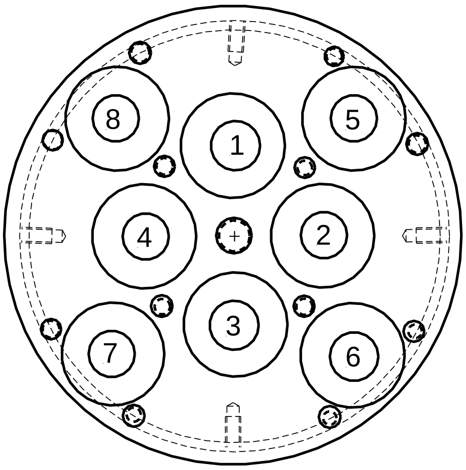


Figure 10: Bottom view

5.3 Top end cap

The top end cap has the same dimensions as the bottom end cap and is made of titanium grade 2. Fastening and sealing are identical to that of the bottom cap (2 O-rings 76 x 2,5 mm). A bolt with a 6 mm hole for a shackle is used as suspension to the sea cable.

An underwater bulkhead connector SUBCONN MCBH8M is used for communication (configuration and data retrieval) and external power supply. Additionally, there are some control elements (red LED and reed contact). The reed contact is used for turning on/off the power with the magnetic rod (like a toggle circuit). The red LED is necessary for power status display and as optical control of memory access (data write and read).

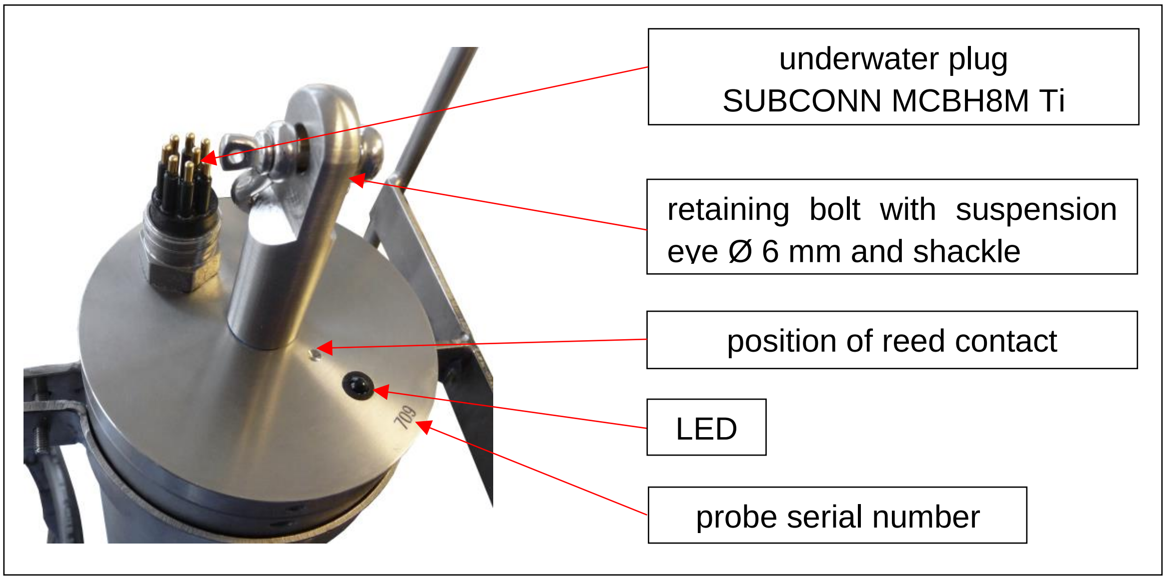


Figure 11: Top view on the top end cap.

Behind the protection ring (Figure 12, page 25) is either a coverboard, or if FSK is used a telemetrieboard, that works as signal distributor for power and signal lines coming from and going to the underwater plug and control elements (reed contact and LED). It contains the cabel-driver circuitry and FSK modulator and all the necessary wiring. The connection to the probe electronics is established by a separable 16 wire cable-connection.

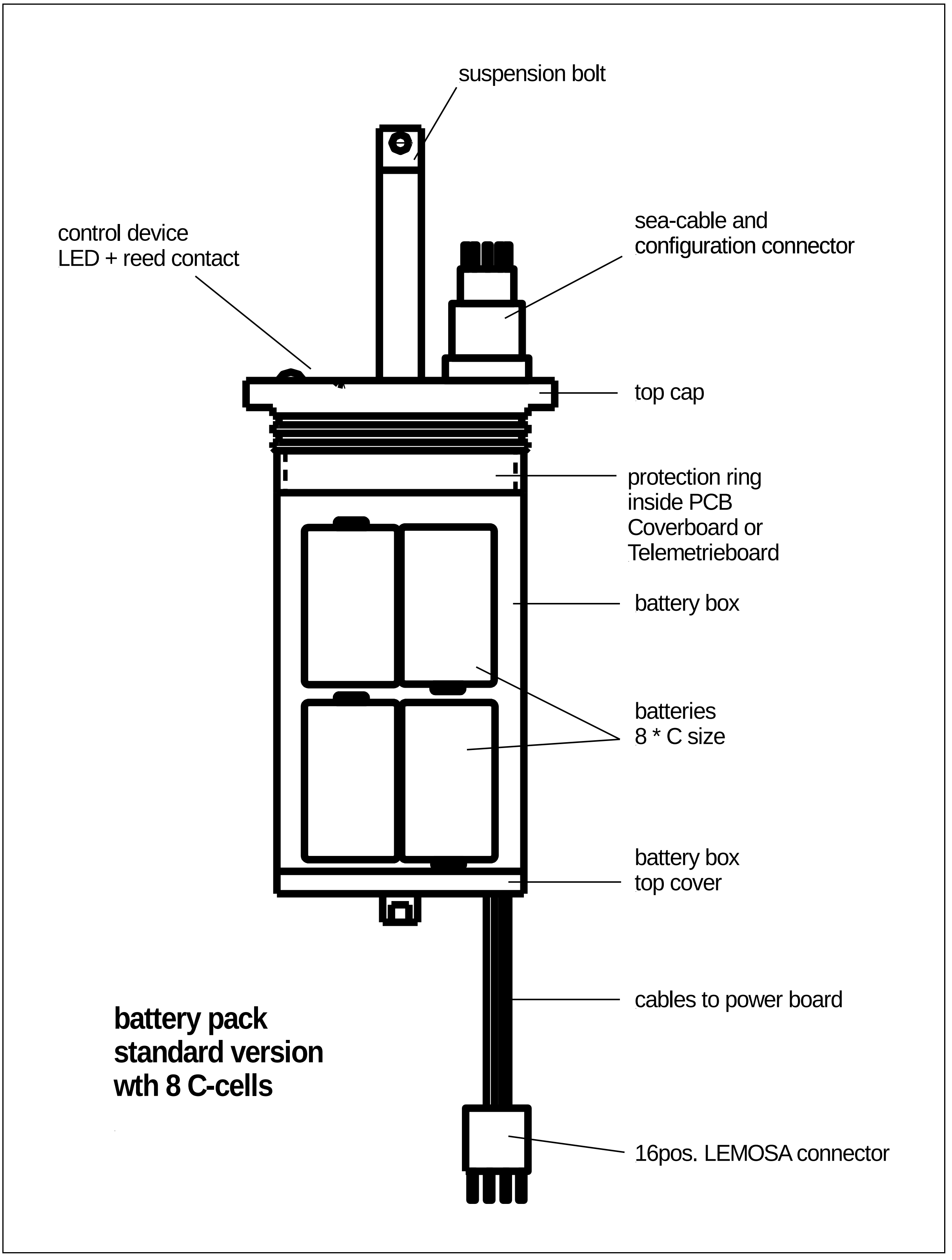


Figure 12: Top cap with battery box.

5.4 Sensor protection frame

The sensor protection frame is made of 6mm titanium rods and has a length of 220 mm. It protects the sensors against shocks on the sea floor and ground contact and prevents direct impact with the shipside. The protection cage is clamped on the tube and the bottom end cap.

Figure 13: The standard sensor protection frame.

5.5 Dimensions and weights

probe

	tube	bottom cap	top cap
material:	titanium grade 2	titanium grade 2	titanium grade 2
length / thickness	390 mm	30 mm	30 mm
diameter	88,9 mm	89 mm	89 mm
wall thickness	5,45 mm	---	---

protection cage

	standard	large
material:	titanium grade 2	titanium grade 2
length	220 mm	700 mm
diameter	120 mm	200 mm / 200 mm

total dimensions:

gross length:	670 mm
total weight including battery	5,5 kg
buoyancy:	2,5 kg

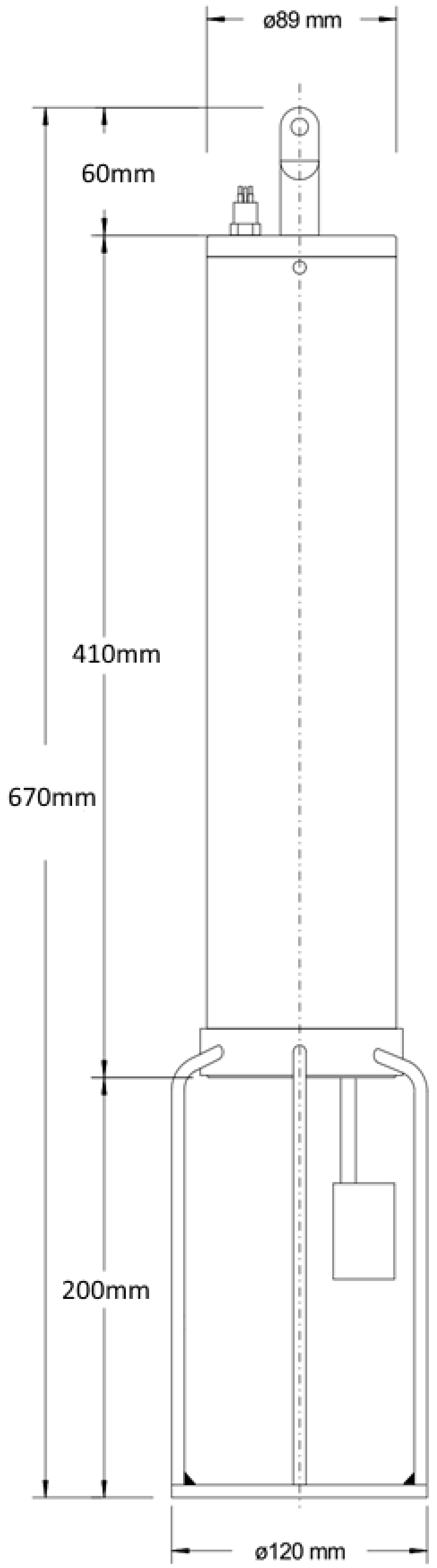


Figure 14: Mechanical drawing of the CTD90M.

6 Standard sensors

6.1 Ground runner

The function of the ground runner is to recognize the sea floor in time during profiling online. It helps avoiding damage to the sensors through ground contact. The ground runner mainly consists of a mobile magnet and a reed contact, which are held together by spring tension. During a profile the magnet is pressed against the spring tension by a control weight on a line and so kept away from the reed contact, the contact is open. If the control weight has floor contact the spring releases the tension and presses the magnet to the reed contact which is then closed by the magnetic field.

The reed contact produces a digital signal, which is interrogated by the micro-controller.

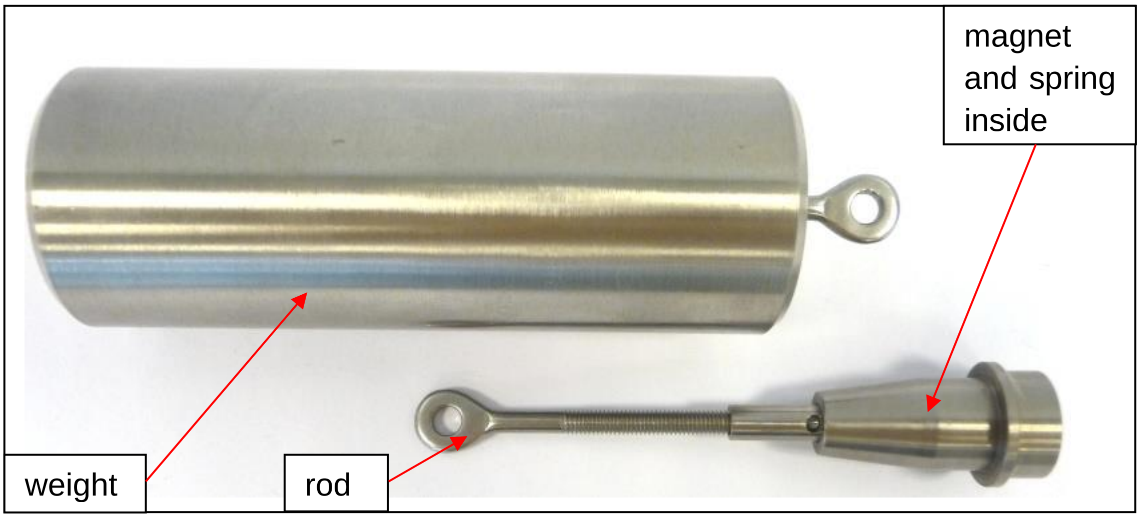


Figure 15: Bottom contact warnig device

The weight is available in two different sizes and made of stainless steel. The cord length may vary betwwen 1 and 5 m dependent on the sinking velocity of the probe.

6.2 Pressure sensor

6.2.1 PA-7LHE with progress print

The pressure transducer is a piezo-resistive full bridge with a diameter of 15 mm and a total height of 5 mm. It is available as OEM version (Figure 16). Casing and diaphragm are made of corrosion proved alloy C276. The transducer is delivered with a small SMD-PCB that includes a temperature compensation of the pressure measurement and a factory calibration with 0,5 % FS accuracy.

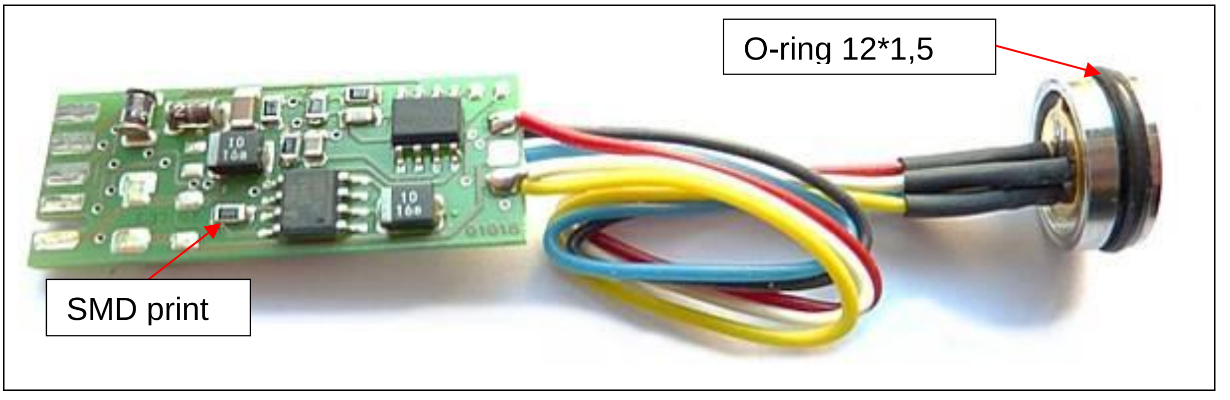


Figure 16: The figure shows the OEM transducer and SMD-print as delivered from KELLER AG, Switzerland.

6.2.1.1 Technical specifications

Manufacturer:	KELLER AG, Switzerland
Model:	PA7LHE/xxx bar/80933.4 (*)
Nominal range:	50dbar – 2000 dbar (*)
Burst pressure:	150 %FS (**)
Overall accuracy:	0,5 %FS
Sensor diameter:	15 mm
Sensor height:	5,2 mm
O-ring:	12*1,5 mm
Temp. compensation:	0 – 50°C

Please note:

(*) The OEM transducer is available in FS ranges of 50, 100, 200, 500, 1000 and 2000 dbar. (FS = full scale).

(**) Please be careful when exposing the sensor to overpressure. Exceeding the nominal pressure range of more than 50% lead to destruction of the transducer.

6.2.1.2 Wiring and pin assignment

The SMD-print will directly be hardwired to the analogue board. The cable connection between transducer and electronic board can be separated by small round connectors (see Figure 17).

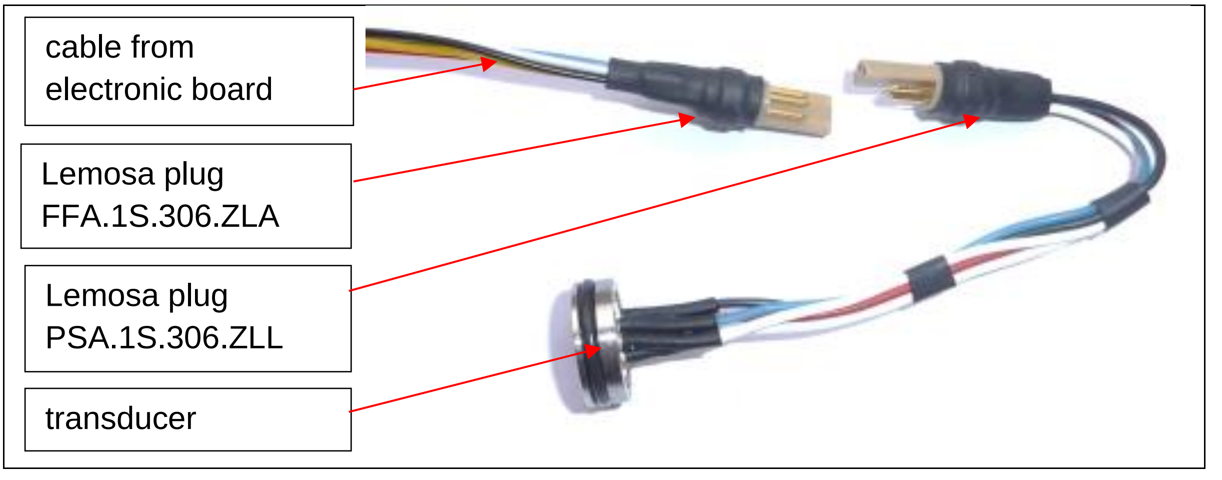


Figure 17: The wiring of the pressure sensor.

The separable connection between transducer and SMD print allows an easy service and check of electronic circuitry and sensor. The transducer is sometimes delivered with one yellow cable instead of a white.

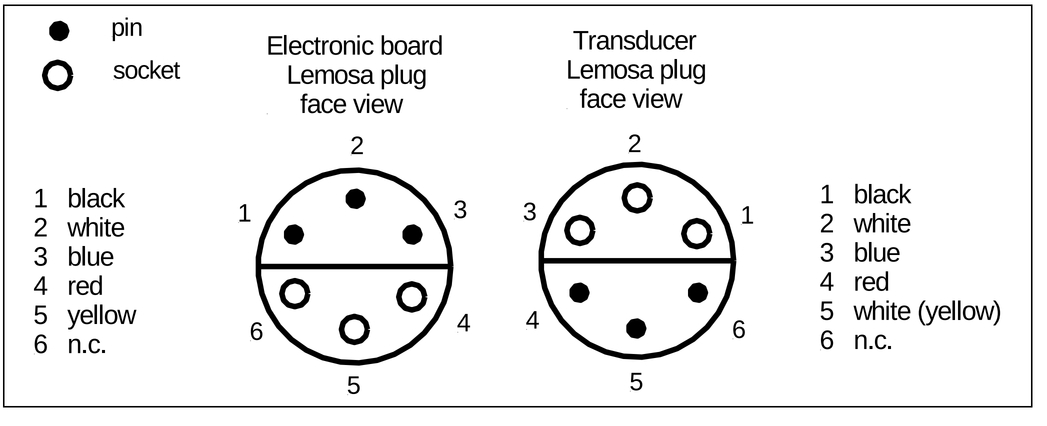


Figure 18: The figure describes the connector numbering and wiring.

The transducer is a full Wheatstone bridge with a bridge resistance of 3,5 kΩ at air pressure. It is supplied by constant current of typical 1 mA from the SMD print. The actual temperature of the bridge silicon chip is measured via the bridge voltage and used for compensation of thermal drifts of zero point and sensitivity. The temperature dependency is stored in a custom specific EEPROM chip on the print. This results in excellent temperature and long term stability.

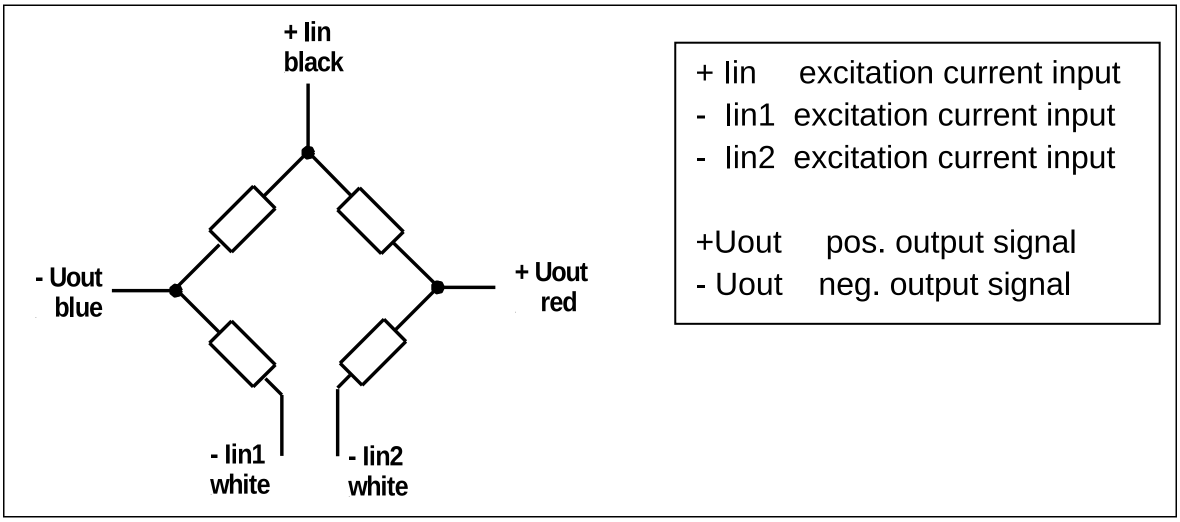


Figure 19: Block diagram of the transducer.

Both white wires are connected on the SMD print, so during operation the Wheatstone bridge is closed.

Each single resistor of the Wheatstone bridge has 3,5 kΩ resistance, therefore an open bridge shows 14 kΩ between the white cables. For electronic tests we use dummy Wheatstone bridges mounted on a plug simulating zero and FS pressure.

6.2.1.3 SMD print

The SMD print has to amplify the small ΔU_{out} difference signal into a large scale single ended voltage. Except to perform the temperature compensation the print has to scale the signal output voltage with a factory calibration accuracy of 0,5 %FS with respect to – 5 V:

U = 0,1 V p = 0 dbar (1000 mbar air pressure)
U = 2V p = FS dbar (1000 mbar air pressure)

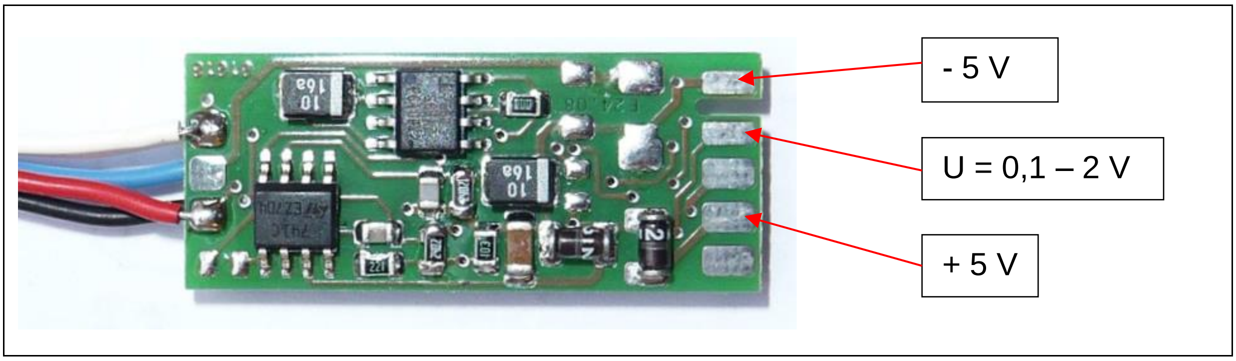


Figure 20: Top side of the SMD print.

6.2.2 PA-7LY

The pressure transducer is a piezo-resistive full bridge with a diameter of 15 mm and a total height of 5 mm. It is available as OEM version (Figure 21). Casing and diaphragm are made of corrosion proved alloy C276. The transducer is delivered with a small SMD-PCB on top of the transducer that includes a temperature compensation of the pressure measurement and a factory calibration with 0,5 % FS accuracy.

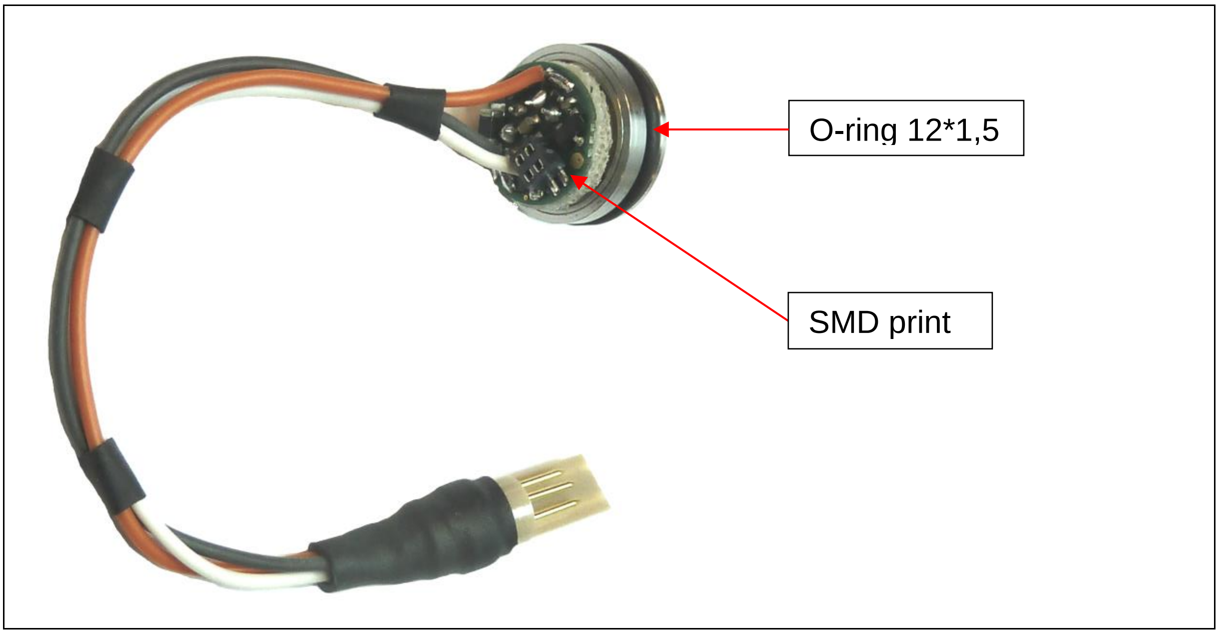


Figure 21: The figure shows the OEM transducer PA-7LY with SMD-print as delivered from KELLER AG, Switzerland.

6.2.1.4 Technical spezifications

Manufacturer:	KELLER AG, Switzerland
Model:	PA7LHE/xxx bar/80933.4 (*)
Nominal range:	50dbar – 2000 dbar (*)
Burst pressure:	150 %FS (**)
Overall accuracy:	0,5 %FS
Sensor diameter:	15 mm
Sensor height:	5,2 mm
O-ring:	12*1,5 mm
Temp. compensation:	0 – 50°C

Please note:

(*) The OEM transducer is available in FS ranges of 50, 100, 200, 500, 1000 and 2000 dbar. (FS = full scale).

(**) Please be careful when exposing the sensor to overpressure. Exceeding the nominal pressure range of more than 50% lead to destruction of the transducer.

6.2.1.5 Wiring and pin assignment

The SMD-print will directly be hardwired to the analogue board. The cable connection between transducer and electronic board can be separated by small round connectors (see Figure 22).

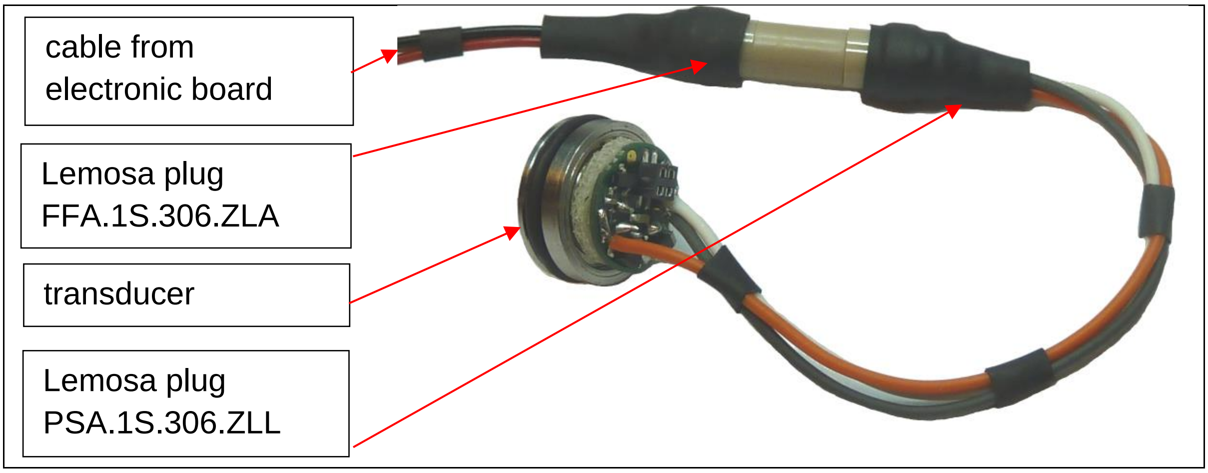


Figure 22: The wiring of the PA-7LY pressure sensor.

The separable connection between transducer and SMD print allows an easy service and check of electronic circuitry and sensor. The transducer is sometimes delivered with one yellow cable instead of a white.

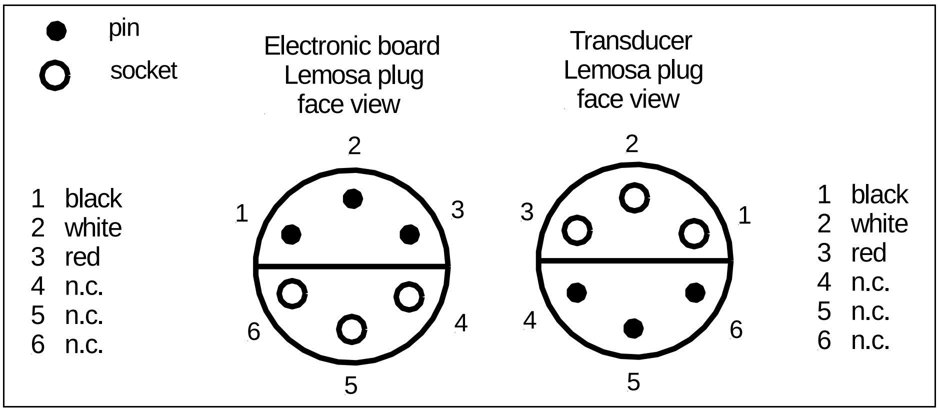


Figure 23: The figure describes the connector numbering and wiring.

The transducer is a full Wheatstone bridge with a bridge resistance of 3,5 kΩ at air pressure. It is supplied by constant current of typical 1 mA from the SMD print. The actual temperature of the bridge silicon chip is measured via the bridge voltage and used for compensation of thermal drifts of zero point and sensitivity. The temperature dependency is stored in a custom specific EEPROM chip on the print. This results in excellent temperature and long term stability.

6.3 Temperature sensor Pt100

The temperature sensor is a platinum resistor Pt100 in a tiny ceramic carrier of 15 mm length and 0,9 mm diameter. It is a platinum resistor with nominal 100 Ω resistance at 0°C. Manufacturer is the well-known company Thermal Developments International (TDI). The elements are wire wound platinum resistors mounted in a cylindrically shaped ceramic carrier. The carrier is placed in the fine sensor tips in thermal conductive fluid paste to avoid thermal resistance between titanium tube and Pt100 element.

It is fitted in a slender titanium tube 1,2 * 0,1 mm, about 30 mm long. This delicate tip is resistant to a pressure of 600 bar but it is extremely sensitive to knocks and inflection. Therefore the tip is surrounded by a titanium perforated shield tube, which is mounted onto the standard flange. The platinum resistor is connected in 4-wire technique.

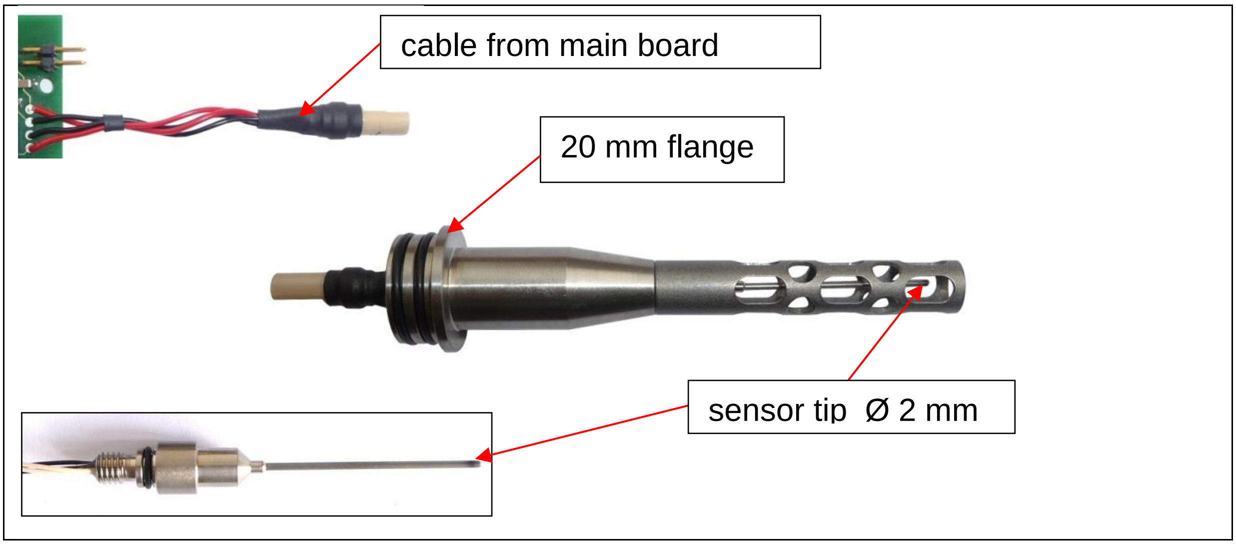


Figure 24: Temperature sensor Pt100.

Technical specifications

Pt100 model:	1509
manufacturer:	TDI
TDI order number:	P100/1509
response time(*):	30 ms
diameter:	0,9 mm
length without leads:	15 mm
mounted in tube:	1,2*0,1 mm
overall response time (**):	0,2 sec

(*) Response time of the pure Pt100 element in water of 1 m/sec flow

according to manufacturers data sheet.
(**) Response time determined in laboratory with the complete sensor.

Wiring and pin assignment

The platinum resistors are connected in 4-pole technique to eliminate the influence of connector contact resistances. All sensor models have the same connector and pin assignment; wiring and pin assignment is depicted in Figure 25.

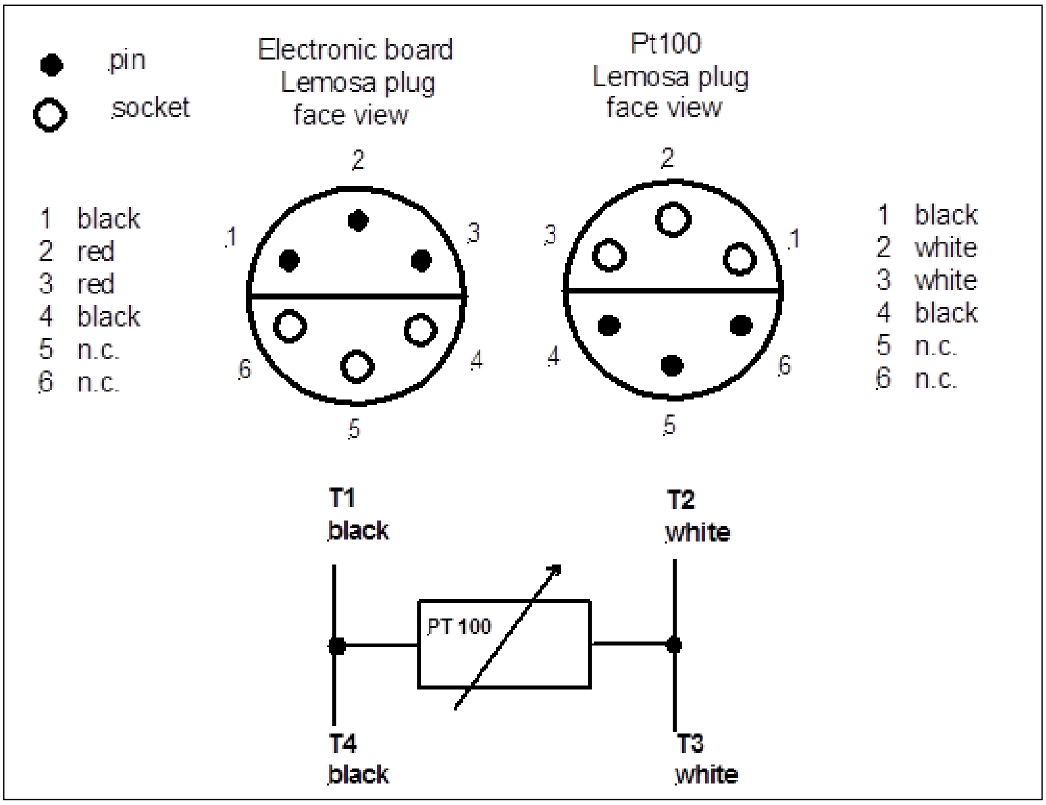


Figure 25: Wiring of the PT100 temperature sensor.

Mechanical specifications

sensor:	Ø 20 mm flange
O-rings:	16*1,5 mm (2)
sensor tip O-ring:	4*1 mm
sensor tip thread:	M5
sensor tip dimensions (*):	53*8 mm
overall length:	122 mm
glass feed through:	Keller size 4L
connector:	LEMOSA

(*) thread not included

6.4 Conductivity sensor

The conductivity cell consists of a quartz glass cylinder with 7 platinum coated ring electrodes. The cleaning procedure must be carried out very careful, because the glass cylinder is very sensitive against shock and impact.

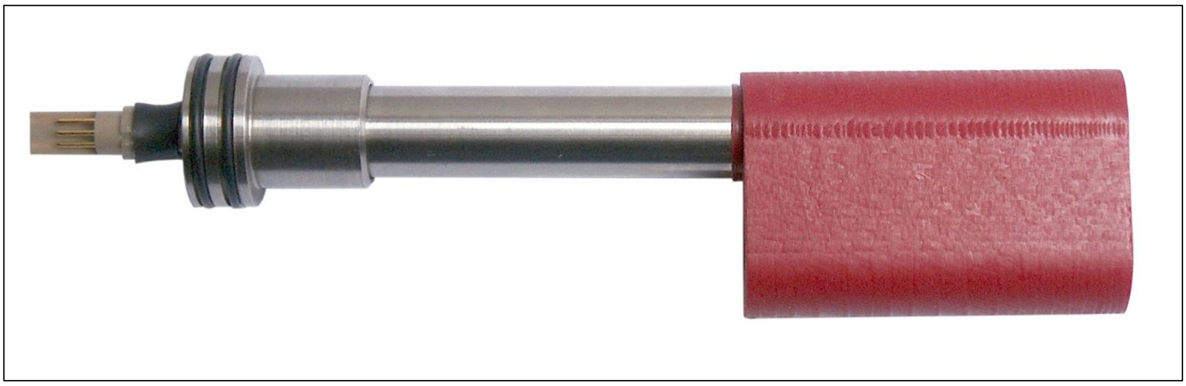


Figure 26: The smal conductivity sensor.

The central electrode D is used to impress alternating current of 500 Hz to 1 kHz frequency (square wave) into the water volume while both outside electrodes A and G are the current return leads, which are held on a constant potential. There exist two pairs of sensing electrodes (B, C and E, F), which measure the voltage drop across them. The electrical field in a homogeneous medium is symmetrically divided on both half-cells. The constant potential on the outer electrodes limits the electrical field to the inside of the cylinder and prevents any influence from boundary conditions outside the cell. The conductivity electronic is mainly an automatic closed AC control loop which holds the voltage drop across the sensing electrodes on a constant level, while the current is proportional to the actual conductivity value.

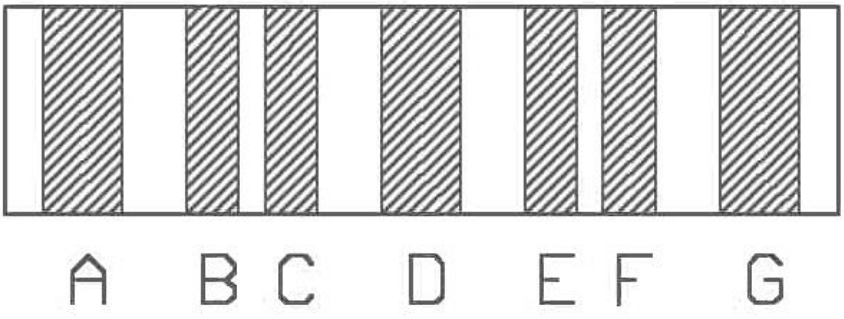


Figure 27: Conductivity Cell

Technical specifications

Model:	7-pole electrode cell
Material:	quartz glass
Electrodes:	coated with platinum
Cell factor:	K= 1,09 +/- 0,05
Length:	L = 110 mm
Inner diameter:	D = 20 mm
Range:	0 – 70 mS/cm
Response time:	100 ms at 0,5 m/sec flow
Reproducibility:	< 5µS/cm
Initial accuracy:	10 µS/cm
Resolution:	1 µS/cm
Maximum depth:	6000 m

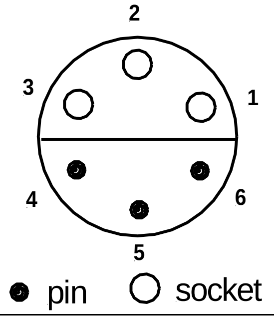
Mechanical specifications

Sensor:	Ø 20 mm flange
O-rings:	16 x 1,5 mm (2)
overall length:	200 mm
moulding size:	120 x 27 x 38 mm
glass feed through:	Keller size 4L
connector:	LEMOSA PSA.1S.306.ZLL

Figure 28: large conductivity sensor

The following diagram shows the face view of the sensor connector and the colours of the connection cable to the PCB:

Figure 29: Conductivity cell pin assignment



pin	signal	colour
1	B	grey
2	C	blue
3	D	red
4	E	yellow
5	F	violet
6	G,A	green

Lemosa PSA.1S.306.ZLL face view

6.5 SST DO sensor

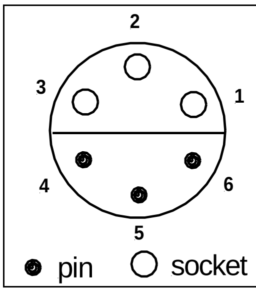
The SST optical DO Sensor is an oxygen meter for the underwater operation down to 2000 meters. The optical DO Sensor measures the partial pressure of the dissolved oxygen in liquids and gases. It utilizes a measuring principle based on red light excitation and lifetime detection in the near infrared using luminescent oxygen indicators. The oxygen measurement is generally temperature dependent. Therefore, the optical DO Sensor is equipped with a temperature sensor for the measured medium and a built-in temperature compensation.

Technical specifications

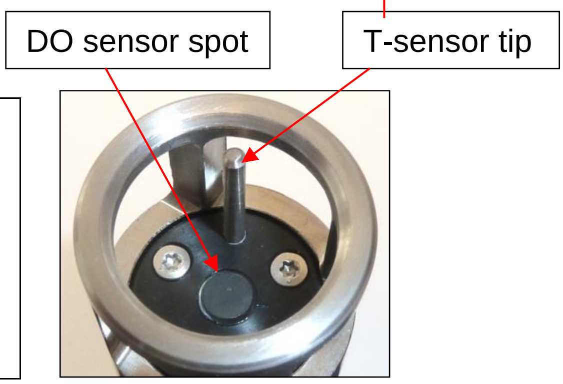
- manufacturer	SST
- measuring principle	lifetime detection of indicator luminescence
- excitation wavelength	620 nm (orange-red)
- detection wavelength	760 nm (near infrared)
- max. sample rate	4 samples per second
- measur. range O2 partial pressure	0 – 500 mbar
- measur. range O2 saturation	0 – 240 %
- Oxygen response time (t90)	<3 sec.
- measuring range Ti	-5°C – 60°C
- Temperature response time	<6 sec.
- accuracy	+/- 2%
- maximum depth	2000 m

Figure 30: SST Do sensor

Figure 31: Connector pin assignment



pin	signal	colour
1	GND	black
2	TxD	green
3	RxD	yellow
4	+5V	red
5	n.c.	
6	n.c.	



Lemosa PSA.1S.306.ZLL face view

6.6 Oxyguard DO sensor

The oxygen sensor measures the dissolved oxygen in the water using polarographic methods. The cathode has a diameter of 4mm and is encased with a Teflon membrane. The oxygen current consumption ranges from 0 to 12 µA due to the big diameter of the centre electrode. The relative high current consumption requires a minimum current flow in order to avoid oxygen depletion in front of the membrane.

Technical specifications

Manufacturer/model:	Oxyguard DO522M18
Principle:	Clark electrode, self galvanizing
Polarisation voltage:	-0,7 VDC
Range	0 – 250 %
Oxygen current	0 – 12 µA
Temperature range	-2°C – 30°C
Response time	3 sec (63 %),. 10 sec (98 %)
Accuracy	+ /-3 %
Maximum depth	2000 m

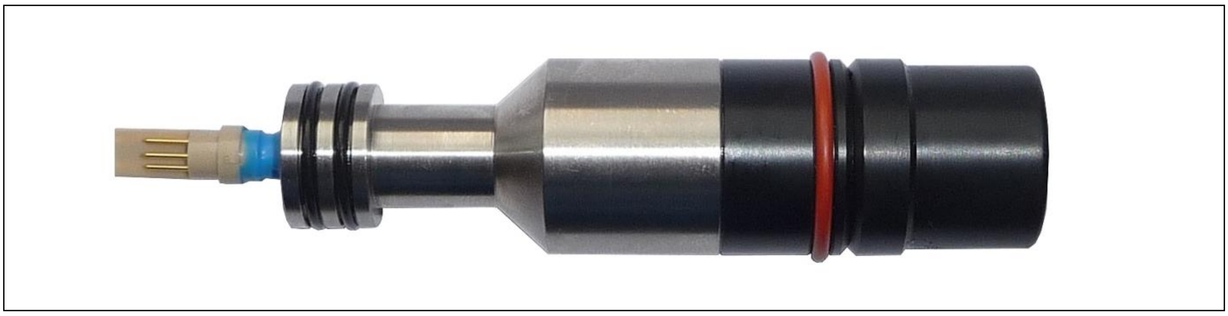


Figure 32: Oxygen sensor without protection cap.

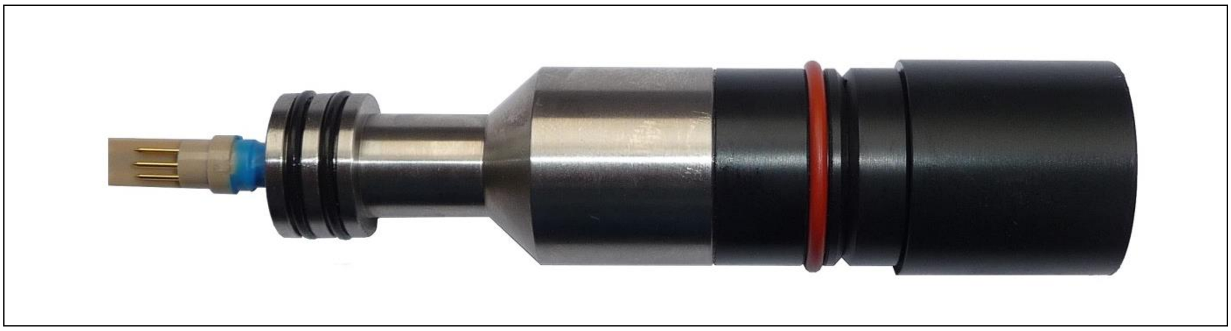
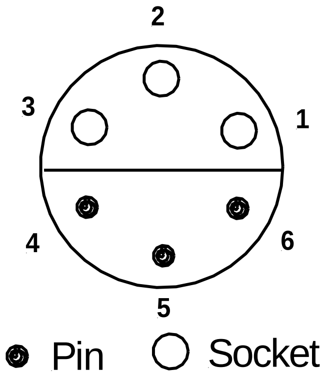


Figure 33: Oxygen sensor with protection cap.

The Oxyguard sensor is internally temperature compensated with a resistor and thermistor in the full ocean temperature range and thus provides a quite linear signal output. The sensor has a low output signal of approximately **30…40 mV** for 100% saturation. Since the DO sensor is self-galvanizing, the output voltage is always available and can be checked with a standard voltmeter between pin2 and pin3 of the sensor connector.



Pin	Signal	colour
1	n.c.	
2	+Uout	brown
3	- Uout	Blue
4	n.c.	
5	n.c.	
6	n.c.	

Lemosa PSA.1S.306.ZLL face view

Figure 34: Connector pin assignment.

6.7 AMT fast DO-sensor

The AMT fast DO shallow water sensor is a galvanic micro-sensor, which has been developed for very fast in-situ profiling of dissolved oxygen with CTD probe systems for depths of up to 100 m.

The sensor has a very short response time. A streaming of the membrane (as it is well known from nearly all kind of Clark-type oxygen sensors) is not necessary. Therefore, profiling and stationary measurements without stirring the analyte becomes possible with a very high signal and local resolution. The sensor is self-polarising. This avoids long adjustment times after switching on. The adjustment time depends only on the membrane swelling in water, if the sensor has dried out during storage and on the exchange of oxygen concentration at the very small sensor membrane.

Figure 35: AMT fast DO-sensor

The sensor has a limited lifetime of typical 12 – 16 month. Since the membrane and electrolyte cannot be exchanged, it has to be replaced.

Technical specifications

manufacturer:	AMT
model:	galvanic Clark-type micro-sensor
polarisation:	approx. -0,7VDC, self-polarising
range:	0 – 200 % saturation
oxygen input current:	0 – 5 nA
temperature range:	0°C – 30°C
response time:	typ. < 1sec
accuracy:	± 2%
maximum depth:	**100 m**

To achieve the highest possible accuracy, the sensor has to be re-calibrated from time to time. This is especially recommended during the first weeks of the sensor´s life.

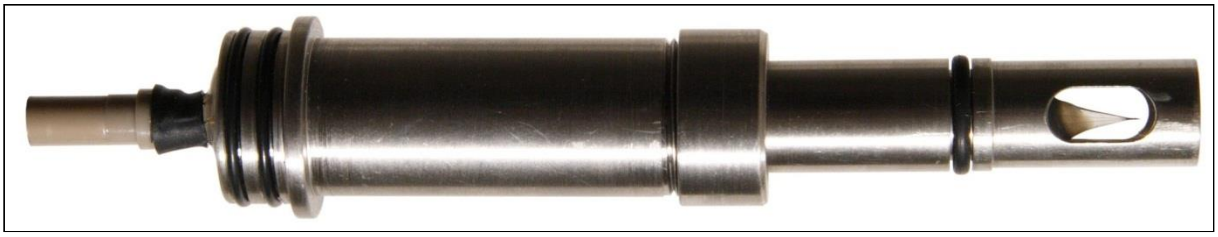
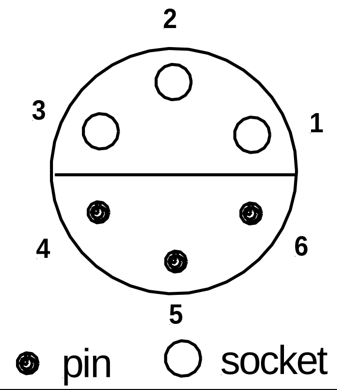


Figure 36: AMT fast DO-sensor

Due to the very small tip diameter of less than 100µ the user should handle the instrument with care and do not expose the sensor to shock and impact.

Figure 37: Connector pin assignment



pin	signal	colour
1	n.c.	black
2	GND	blue
3	0..5nA	red
4	n.c.	
5	n.c.	
6	n.c.	

Lemosa PSA.1S.306.ZLL face view

6.8 AMT H2S sensor

The amperometric H_2S micro-sensor measures the dissolved H_2S partial pressure in the water. Its micro sized glass tip is membrane covered and only permeable for H_2S gas. If it is combined with a pH and temperature sensor, the following parameters can be calculated: total dissolved sulphide amount in the sample and the hydrogen sulphide ion/sulphide ion concentration.

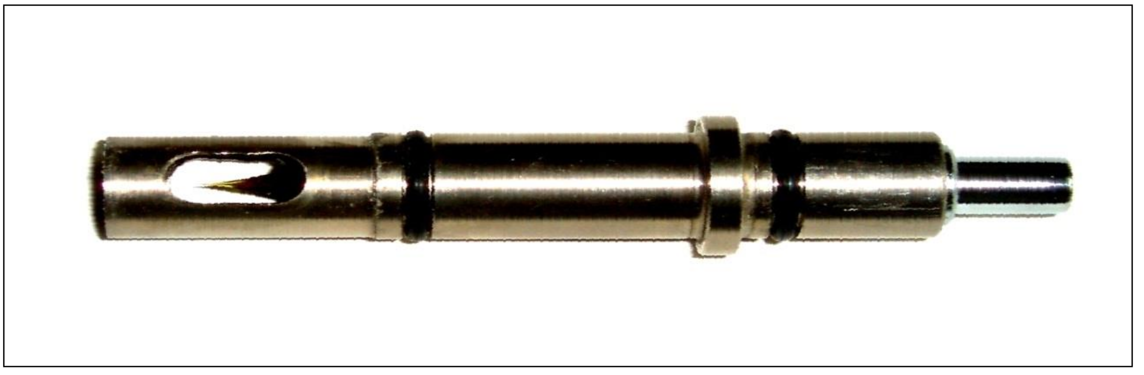


Figure 38: AMT H2S-sensor

Technical specifications

manufacturer	AMT GmbH
model SW-UF-SA	
measuring ranges	Type III (0,01…3 mg/l H_2S) Type II (0,5…50 mg/l H_2S) Type I (0,05…10 mg/l H_2S)
maximum depth	**100 m**
shaft material	titanium
sensitive tip	glass
response time	< 1 sec
accuracy	2% of measuring value
measuring principle:	amperometry, membrane covered sensor
polarization:	necessary, realized by means of integrated electronic board (-85mV)
temperature range:	0°C ... 30°C for storage and measurement
pH-range:	0 ... 8,5
average life time:	9 months (depends on the H_2S stress and on the sample)
- ready formeasurements switching on	after 5...15 minutes

A detailed description of H2S measuring is added in the Appendix.

H2S sensor and flange have the same mechanical dimensions as the fast DO sensor. Be aware that both sensor tips will not be mixed.

Like the AMT fast DO, this sensor has to be re-calibrated from time to time. This is especially necessary during the first weeks of the sensor´s life. For information on H2S calibration and H2S generators contact AMT-GmbH.com.

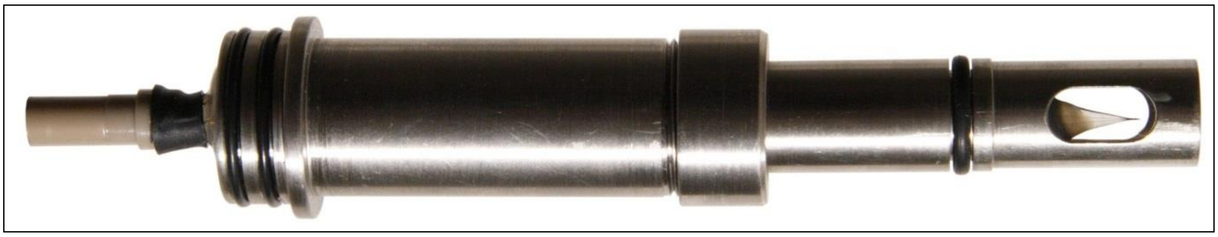
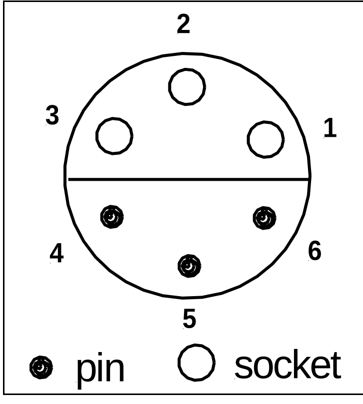


Figure 39: AMT H2S-sensor

Due to the very small tip diameter of less than 100µ the user should handle the instrument with care and do not expose the sensor to shock and impact.

Figure 40: Connector pin assignment



pin	signal	colour
1	n.c.	black
2	GND	blue
3	0..5nA	red
4	n.c.	
5	n.c.	
6	n.c.	

Lemosa PSA.1S.306.ZLL face view

6.9 pH or ORP sensor (H_2S resistant)

This pH/ORP Sensor uses a pressure-balanced glass electrode with a built-in reference to provide in-situ measurements up to 1200mm depth. It is pressure resistant up to several thousand meters depth with a slight decrease of performance. The sensor is equipped with a reference system using a solid gel (stiff polymer mass containing Ag+-free KCl) and a ceramic pore diaphragm. The pH/ORP probe is permanently sealed and supplied with a soaker bottle attachment. The bottle contents must always contain a storage solution when the probe is out of use. The storage solution should be a 3m KCl solution with a buffered pH value of approximately 3,5...4, that prevents the reference electrode from drying out during storage.

This sensor is absolutely **H_2S resistant** due to the silver-free reference electrolyte.

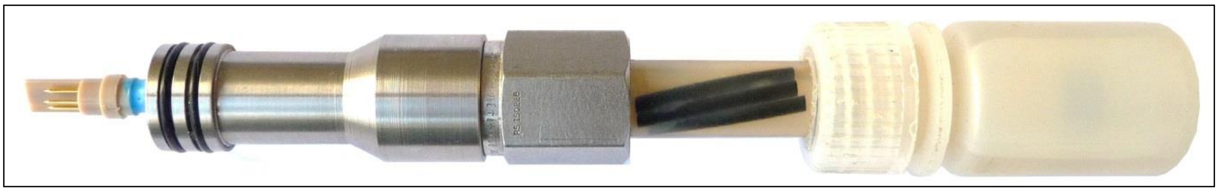


Figure 41: A pH or ORP sensor.

Technical specifications

	pH	ORP
Measuring range:(**)	4-10	-2000mV – 2000 mV
Maximum depth:(*)	1200 m (4000 m)	1200 m (4000 m)
Shaft diameter:	12 mm	12 mm
Shaft material:	transparent plastic	transparent plastic
Bulkhead material:	stainless steel	stainless steel
Thread:	G1/4 (ISO228)	G1/4 (ISO228)
Shaft length:	84 mm	84 mm
Length with flange:	150 mm	150 mm
Response time:	approx. 1 sec	approx. 1 s.

(*) 1200m is the nominal depth rate for the specified accuracy. This sensor is pressure resistant up to several thousand meters depth with a slight decrease of performance.

(**) pH range of 0 – 14 is recommended for measuring in H2S containing solutions.

6.10 Industrial pH and ORP sensors with S7/S8 head

For shallow water applications industrial sensors are best choice. pH and ORP combined electrodes are industrial sensors using a solid reference system (stiff polymer mass containing KCl) and an aperture diaphragm which allows direct contact between reference electrolyte and sample medium. Regeneration of the glass membrane or filling up electrolyte is not possible. When the lifetime of the sensor is over, it has to be replaced by a new one. The sensors have a standard S7/S8 head and are screwed into a flange with a fitting socket. A coaxial contact makes the electrical connection in the flange. Sealing between sensor and flange is achieved by an O-ring, which is part of the sensor.

Figure 42: Flange with double O-rings 16*1,5 mm, S7/S8 socket and coaxial contact.

Technical specifications

	pH	ORP
Manufacturer:	METTLER-TOLEDO	METTLER-TOLEDO
Model:	405-DXK-S8/120	Pt 4805-DXK-S8/120
Measuring range : 4…10		-2000 mV – 2000 mV
Maximum depth:	**160 m**	**160 m**
Shaft diameter:	12 mm	12 mm
Length with flange:	167 mm	167 mm
Response time:	approx. 1 sec	approx. 1 sec.
Sensor head:	S8	S8
O-ring: 1	6*1,5 mm	16*1,5 mm

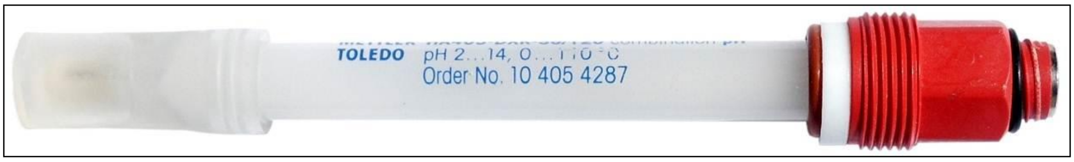


Figure 43: A METTLER-TOLEDO pH sensor.

	pH
Manufacturer:	Hamilton
Model:	Polylite Plus 120 XP
Maximum depth:	**500 m**
Range	4 - 10
Shaft diameter	12 mm
Length with flange	167 mm
Response time	approx. 1 sec
Sensor head	S8
O-ring	12*1,5mm

Figure 44: A Hamilton pH sensor.

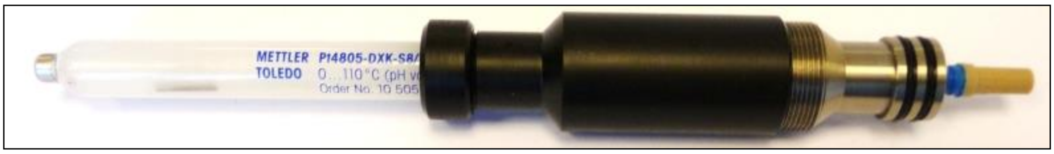


Figure 45: A complete flange with screw cap.

H2S resistant industrial versions for 100m depth are available!

6.11 Seapoint Turbidity meter

The bottom mounted turbidity sensor is based on the SEAPOINT turbidity meter in the bulkhead version, which is screwed onto a standard flange. Electrical connection is achieved by a separable 6 pin round connector. For further details please refer to SEAPOINT user's manual.

The Turbidity sensor measures the concentration of suspended matter. It is equipped with a pulsed infra-red light transmitter and detects the scattered light from the particles suspended in water. Transmitter and detector arrangement uses 90° scattering at a wavelength of 880 nm. The output signal is proportional to the particle concentration in a very wide range. For detailed description of Seapoint turbidity meter refer to the special user manual.

The turbidity sensor is available in two different versions:

The **Standard** version has an underwater plug, is connected to the probe via a 6-wire cable and has to be fixed to the probes protection cage with a clamp.

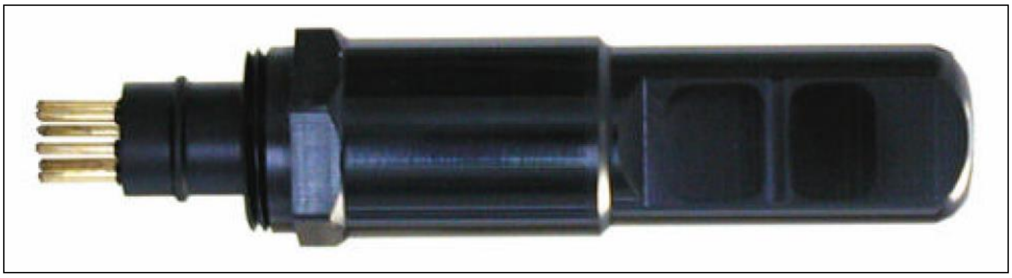


Figure 46: The seapoint standard turbidity meter.

The **Bulkhead** version is plugged into a fit of the bottom cap of the probe and needs no underwater connection cable.

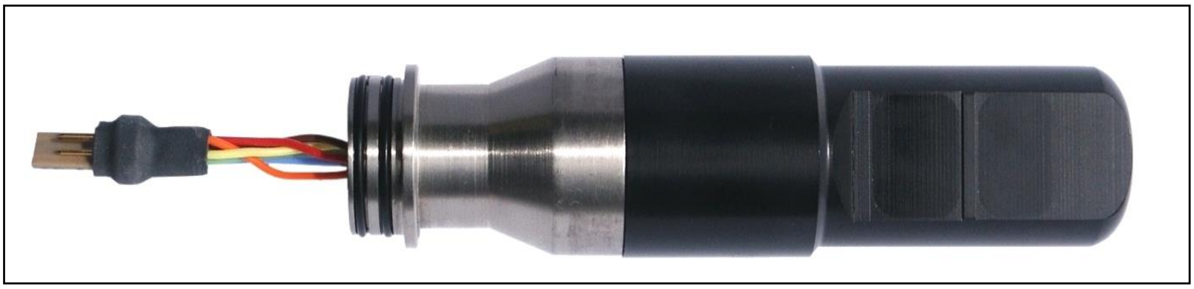


Figure 47: The bulkhead version with flange

Both versions (Standard and Bulkhead) have 4 ranges, which are controlled by two independent gain control lines A and B:

range	B	A	gain	calibration range
0	0	0	*1	0...4000 FTU (linear up to 1250 FTU)
1	1	0	*5	0.....500 FTU
2	0	1	*20	0 125 FTU
3	1	1	*100	0 25 FTU

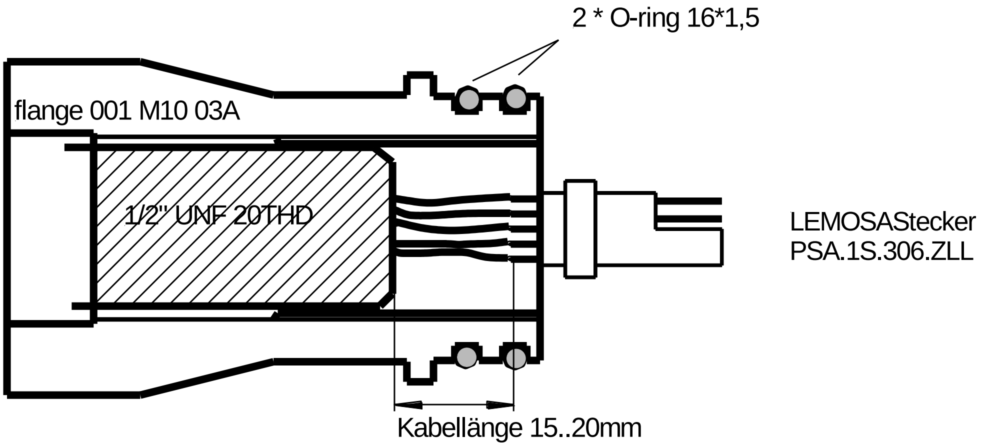
0:= line tied to GND
1:= line left open

The range can be selected by customer via SDA program.
The high range is nonlinear above 1250 FTU.

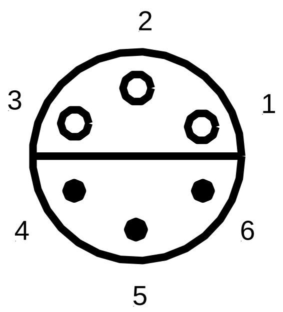
For more information please refer to the calibration documents of this sensor.

Technical and mechanical specifications

Power:	7 – 20 VDC, 3,5 mA average
Signal:	0...5 VDC (each range)
Scatterance angle:	90° average (15...150°)
Light source wavelength:	880 nm
Linearity:	2%
Depth capability:	6000 m
Size:	2,5 cm diameter, 11 cm length
Ranges:	0-25, 0-125, 0-500, 0-4000 FTU



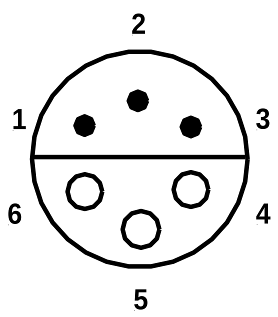
Sensorstecker



Signal	Colour	Lemosa
Power GND	Brown	Pin 1
Signal out	blue	Pin 2
Signal GND	green	Pin 3
Power +	yellow	Pin 4
Gain A	orange	Pin 5
Gain B	red	Pin 6

● pin ○ socket

Range [FTU]	Gain	Gain A	Gain B
0 - 25	100	open	open
0 - 125	20	open	PGND
0 - 500	5	PGND	open
0 - 4000	1	PGND	PGND



Platinenstecker
Sicht auf Steckseite

Lemosa Stecker FFA.1S.306.ZLA

Figure 48: Turbidity pin assignment

6.12 Seapoint Fluorometer Chl A

Figure 49: A seapoint fuorometer sensor.

The Seapoint fluorometer measures Chlorophyll A concentration in 4 different ranges, which are selected by two control lines A and B:

range	range code (A/B)		Concentration [µg/L]
1	0	0	0....150
2	0	1	0….50
3	1	0	0….15
4	1	1	0….5

The range can be selected by customer via SDA program. The instrument is delivered with the default range 0..50µg/l if no other range is requested.

The instrument has a six pin underwater plug (Impulse AG306) and has to be connected by a cable to the CTD.

Technical specifications

Power:	8 – 20 VDC, 15 mA average
Signal:	0 – 5 VDC (each range)
Light source:	blue LED 470 nm
Detector:	photodiode 680 nm
Min.detection level:	0,02 µg/l
Depth capability:	6000 m
Size:	64 mm diameter, 168 mm length

The instrument is also available in a version to measure DOC (dissolved organic matter or yellow substances).

6.13 Turner Cyclops-7 fluorometer Chl A

The Cyclops-7 used here for CTD90M is the standard Cyclops-7 instrument from Turner Design. In order to adapt the instrument to the probe´s end cap, the Subcon connector was skipped and instead our standard flange has been screwed into the connectors thread. To avoid corrosion problems the Cyclops-7 housing is made of titanium. The gain setting lines can be set to a range of 0..5 µg/l (gain=100), 0..50µg/l (gain=10) or 0..500µg/l (gain=1). The selection of the gain can be made by customer via SDA software. The instrument is delivered with the default range 0..50µg/l (gain setting = *10) if no other range is requested.

For more information please refer to the calibration documents of this sensor.

Figure 50: A Turner Designs Cyclops-7 chlorophyll A sensor.

For details and hints for application please refer to Turner´s user manual.

Technical specifications

supply voltage:	3 – 15 VDC
current consumption:	60mA@5V, 30mA@12V
housing diameter:	22 mm
total length:	135 mm
ranges:	0-5, 0-50, 0-500µg/l
range selection:	by electronic (*1, *10, *100)

Flange and pin assignment

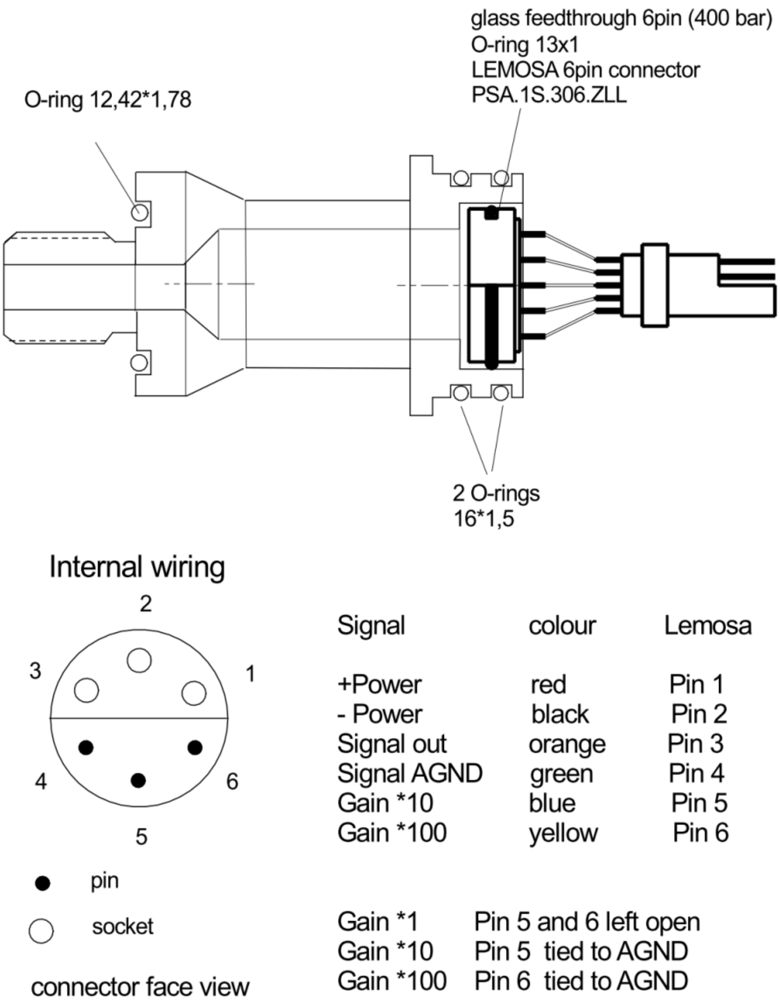


Figure 51: Flange and pin assignment.

Other sensors of the Cyclops-7 family are available too:

- Phycocyanin (Cyanobacteria),
- Phycoerithrin (blue green algae),
- Rhodamine WT,
- Fluorescein dye,
- Turbidity,
- CDOM chromophoric dissolved organic matter,
- optical brighteners,
- crude oil,
- refined fuels.

6.14 Multirange sensors

There are a number of sensors, which have several measuring ranges with different sensitivities on a single analogue output. The CTD90M supports these multirange sensors by automatic range switching and transmits measurement values and range information to the board unit in a single 16 bit word. Analogue values have 16-bit resolution. The range code consists of 2 bits and occupies the two least significant bit of the 16 bit measuring value. This limits the real resolution of the multirange sensors to 14 bits. But since all these sensors don’t need CTD resolution the overall accuracy is not affected by this procedure.

LI-COR Quantum sensor

The LI-COR Quantum sensor is used for measuring **P**hoto synthetically **A**ctive **R**adiation (**PAR**) in aquatic environments. Due to its 400 – 700 nm quantum response it is a suitable sensor for investigation of the primary production. LICOR offers two different underwater sensors:

LI-192SA cosine corrected quantum sensor (following Lambert’s cosine law) measures the **P**hotosynthetic **P**hoton **F**lux **D**ensity (**PPFD**) through a plane surface (photon or quantum irradiance between 400 and 700 nm)

Figure 52: Li-Cor 192SA

LI-193SA spherical quantum sensor determines specifically the **P**hotosynthetic **P**hoton **F**lux **F**luence **R**ate (**PPFFR**), the number of photons in the visible range incident per unit time on the surface of a sheer divided by its cross sectional area.

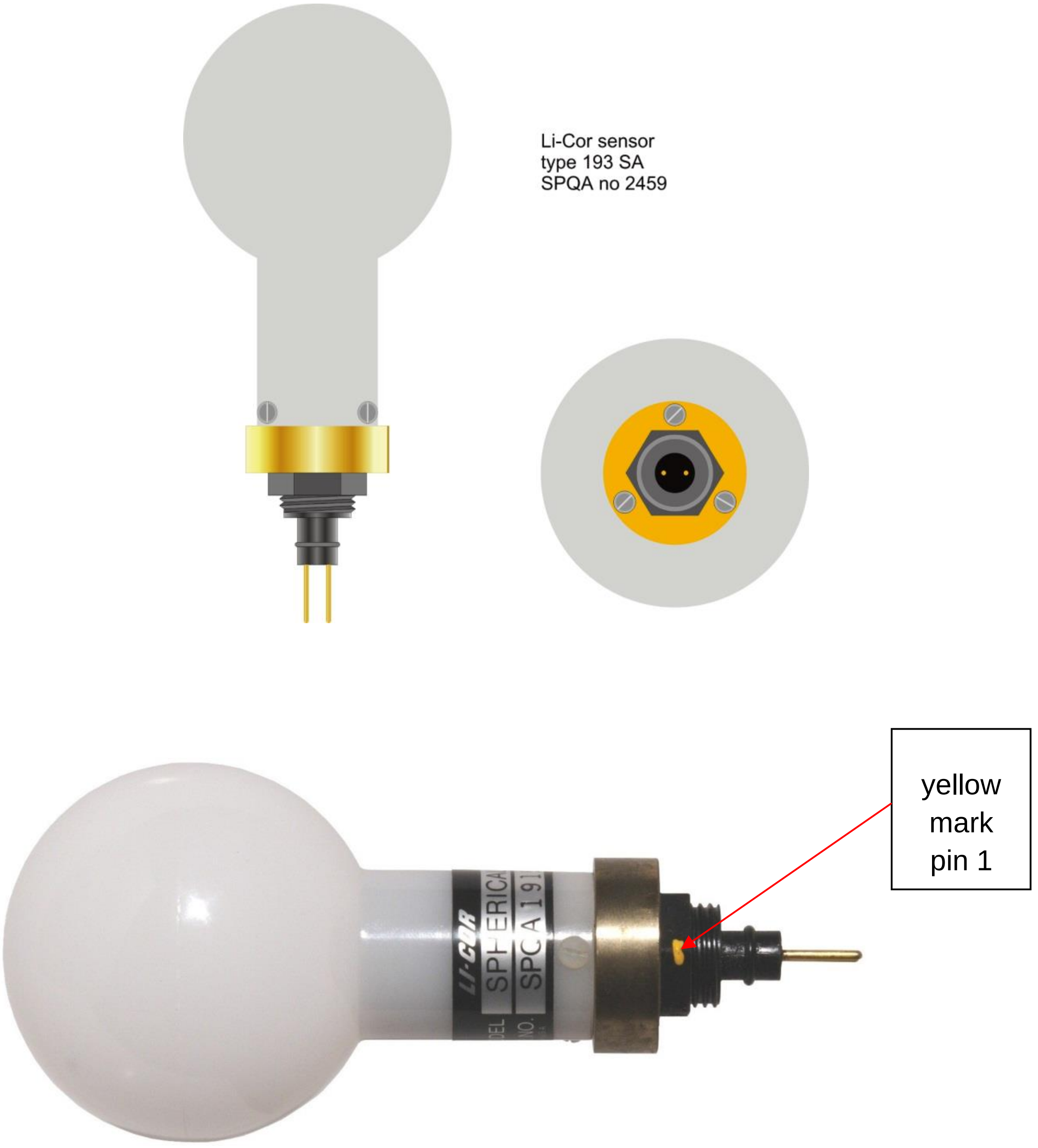


Figure 53: Li-Cor 193SA

Both instruments are calibrated in µmol/s*m^2 (µE) where 1 µmol is 6,022 * 10^{-17} photons.

Technical specifications

Detector:	silicon photodiode
Range:	0 ... 10000 µmol/s*m^2
Calibration accuracy:	5%
Linearity:	1%
Long term stability:	2% per year
depth capability:	350 m (LI-193SA) / 550 m (LI-192SA)
Sensitivity:	typical 3 µA / 1000µE

The dynamic measuring range (sensitivity of the photodiode) covers approximately 7 to 8 decades of light intensity. Logarithmic amplifiers have a different resolution depending on the current value. To avoid this disadvantage the complete range is divided into 4 decades each with 14-bit resolution.

range	range code		current [µA]	PPFFR / PPFD (*)
0	0	0	0.....0,05	0........12
1	1	0	0 0,5	0......125
2	0	1	0.....5	0....1250
3	1	1	0 50	0..12500

(*) calculated for LI-multiplier of 250

The result is a linear response from 0,001 up to 10000 µmol/s*m^2.

Range switching is executed automatically when the measuring value increases the 95% full scale level or decreases 5% FS of the current range.

Both sensors will be connected to the probe by a 2 wire underwater cable.

Pin 1 is marked on the sensor´s bulkhead with yellow colour (see picture above). Pin 1 of the mating inline cable has a small nipple as marking.

Please refer to the following drawings:

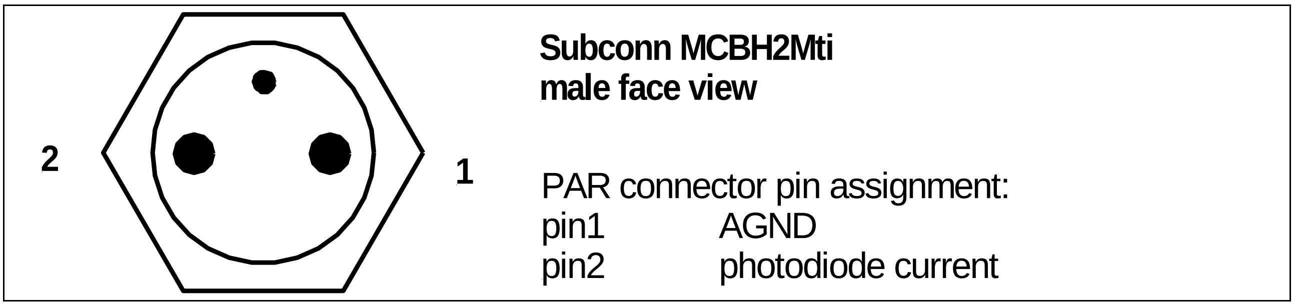


Figure 54: Li-Cor connector

The male bulkhead connector is located at the top end cap of the probe. The PAR sensor has always to be mounted on the top of the frame (probe)

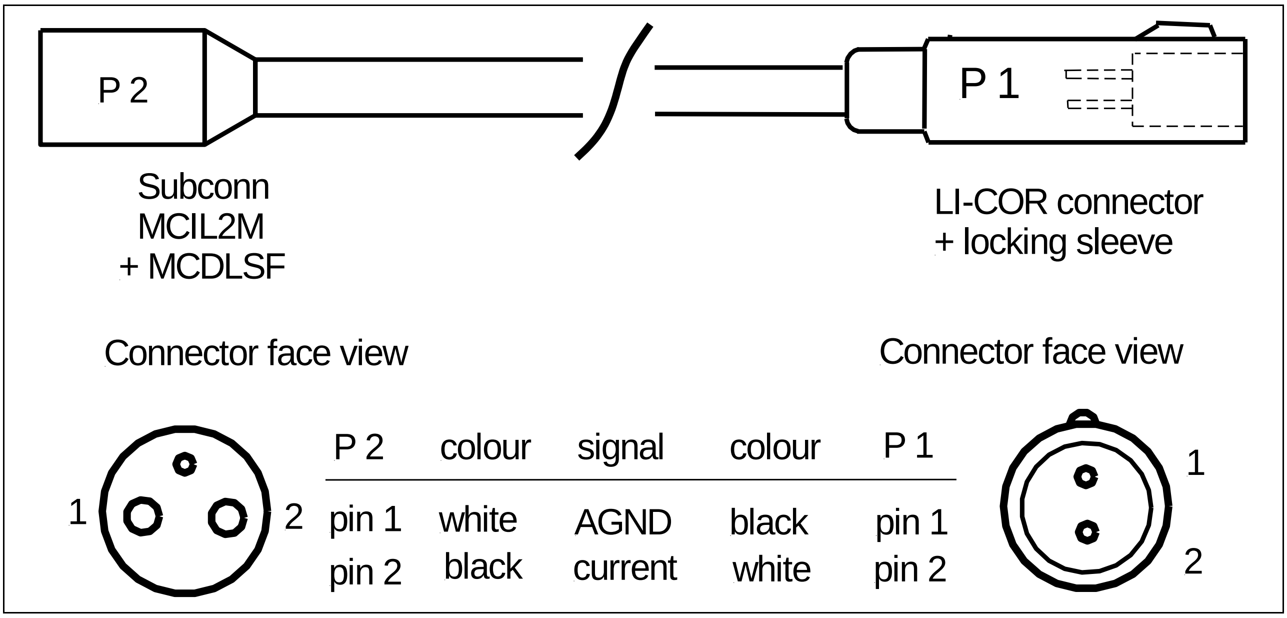


Figure 55: Li-Cor connecting cable

Please note: the light sensors must be mounted on the top of the probe to avoid shade of neighboured instruments or of the frame. During measurement the PAR sensor has to be fixed in the upper position of the rail, overlooking the frame and the probe. For transport and storage the PAR sensor has to be mounted in the lower position. The sensor is then completely inside the frame.

6.15 Replacement of sensors, opening the probe

When replacing a sensor the probe generally doesn't have to be opened (exception: pressure sensor and Cyclops). Proceed as follows:

- remove the M4-screws which hold the flange
- carefully remove the respective sensor whilst gently turning it out of its fitting in the base
- disconnect the plug contacts (pull lightly).

Reassemble in opposite order.

To remove the pressure sensor the probe has to be opened. This is done in the following order:

- remove the protection case
- take the lid off: first of all unscrew the 4M3-screws on the side of the tube-end and then pull the lid off whilst gently turning it without tilting it detach the base from the tube (as with the lid)
- disconnect all of the sensor plugs, unsolder the pressure sensor cable on the main board
- detach the bedplate from the base, unscrew the pressure sensor holding screw
- pull the sensor out carefully by its cable (from 100 m range upwards blow it out, if necessary, with compressed air from the front side)

Attention: When replacing the pressure sensor the progress-print must always be replaced as well because it contains the temperature compensation for the specific pressure sensor. When inserting the new pressure sensor grease the O-ring thoroughly. Reassembling is done in the opposite sequence.

7 Power supply and interfaces

The CTD90M can be supplied in different ways:

- by external supply via underwater connector,
- by internal battery set.

7.1 External supply

External supply is possible from any regulated power supply unit either via RS232 configuration cable or via USB cable from an USB-slot of a PC or laptop. Both cables are included in the scope of delivery and will be connected to the underwater connector MCBH8M. Mating cable is Subconn MCIL8F with locking sleeve MCDLSF.

MCBH8M (with internal USB-interface)

Pin 1 + power 9 – 15V
Pin 2 power GND = USB GND = RS232 GND
Pin 3 USB +5V
Pin 4 USB D+
Pin 5 USB D -
Pin 6 +IK (FSK)
Pin 7 RS232 RxD receive data
Pin 8 RS232 TxD transmit data

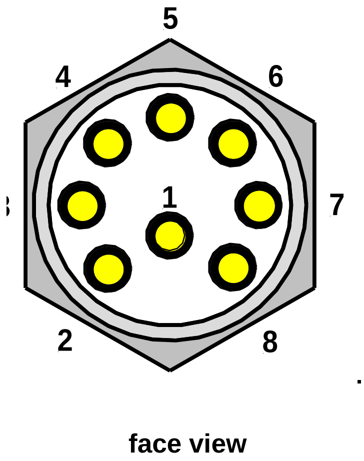


Figure 56: Connector pin assignment

The external supply voltage should range from 9 to 15 VDC. The internal batteries don't need to be removed. The CTD will be supplied automatically from the power source with the highest voltage. Therefore we recommend to use a power supply unit with 13,8 VDC. This ensures that the internal battery supply is cut off and the capacity will be saved.

The maximum allowed supply voltage is limited to 15 VDC. Exceeding the maximum external supply voltage may damage electronic components and voids warranty.

If the external supply is removed, the internal battery takes over the CTD supply without any interruption and data loss.

The CTD90M with bottom mounted sensors (P, T, C, DO, pH, ORP) can accept supply voltages down to 8 V. The minimum supply voltage level depends on the kind of connected third party devices. A connected Aanderaa optode AADI4175C requires 8 VDC as minimum supply voltage, a Rinko III optode or a current meter SM2001C approximately 10 VDC.

7.2 RS232 Configuration cable

It is delivered with the memory probe and is intended to be used for RS232 communication between probe and PC as well as power supply from a 12V battery or regulated DC power source. It can be used for:

- configuration of the operation modes,
- data readout of stored files,
- online transmission of data in laboratory.

The length of the configuration cable is about 5m. The wet end is absolutely watertight and can be submerged in water. The wiring is described in Figure 57.

memory probe MCIL8F		PC serial port / Power supply	
Pin 8	TxD	RxD	Pin 2 (9 pole SUB D)
Pin 7	RxD	TxD	Pin 3 (9 pole SUB D)
Pin 2	GND	GND	Pin 5 (9 pole Sub D)
Pin 2	Power GND	Power GND	Banana plug black **-**
Pin 1	+ Power in	+ Power out	Banana plug red **+**

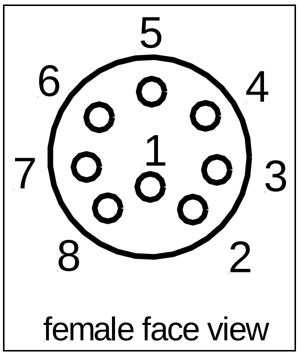


Figure 57: The RS232 Configuration cable.

Online operation is possible up to cable length of 200 m using the same wiring as described above. It is important to connect the probe´s RxD to the PC´s TxD line. The CTD needs to detect a valid RS232 level at the RxD input (< -3V) in order to enable serial data output on the RS232 port.

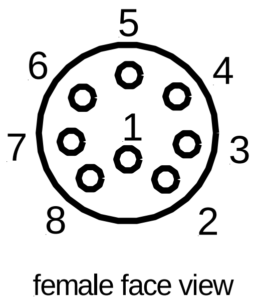
7.3 External supply via USB port (optional)

The main reason for introducing USB as additional interface is to reduce the time for data retrieval. Data readout of 128 MByte requires approximately 6 hours with RS232 (115 kBaud). The same procedure with USB costs approximately 1 hour.

The USB slot of a laptop or desktop PC is able to supply the CTD90M with regulated 5 volt. The supply current of the USB slot is limited to approximately 100mA. Some of the sensors like Seapoint turbidity and nearly all third party devices require supply voltages of more than 5 volt. These sensors are automatically switched off when the CTD is supplied by USB port. The same consideration is valid for Cyclops-7 fluorometers due to their high start current after power on.

When connected to USB the necessary supply current drain is less than 30mA.

The USB-cable is approximately 2m long and only useful for operating the CTD in laboratory. The probe connector end is protected against splashing water but **should not be immersed permanently in water.**



Pin 1	n.c.	
Pin 2	USB GND	Pin 4
Pin 3	USB +5V	Pin 1
Pin 4	USB D+	Pin 3
Pin 5	USB D-	Pin 2
Pin 6	n.c.	
Pin 7	n.c.	
Pin 8	n.c.	

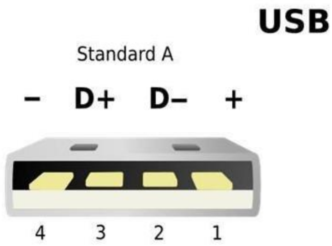


Figure 58: Wiring and pin assignment of the USB cable.

7.4 Internal battery set

The battery box is a cylindrical shaped housing of 75 mm diameter and approximately 145mm height and is mounted on the top cap. The box is designed for 8 alkaline batteries of size C. The batteries are packed in series which guaranties a supply voltage of 12 VDC (8 * 1,5 volt) at full capacity of 7..8Ah. All battery contacts are springs which are loaded and they assure a safe operation without power interuption even under stress and shock conditions and rough handling. For exchange of batteries you have to pull carefully the top cap off the pipe (after having unscrewed before the four screws M3 at the tubes end). Then separate the cable connection to the electronics and remove the cover of the battery box (screw M6). Insert the new batteries in the correct sequence as depicted on the battery box housing. Closing of the instrument is done in the opposite order. Please take care that the O-rings of the top cap are always lubricated with silicone grease. Spare O-rings are part of the delivery.Typical alkaline battery specifications:

Battery:	1,5 volt size C
System:	alkaline non-rechargeable
Size designation:	LR14, AM2, MN1400
Size:	26 * 50 mm
Temperature range:	-25....55°C
Nominal capacity:	6….8 Ah, depends on model and manufacturer
Power consumption:	20mA for C, T, D, O2, pH, Redox
Lifetime:	approximately 300 hours continious operation

The CTD90M is protected against low battery. In memory mode (data storage active) the probe is switched off when the battery voltage falls below 9 VDC and can only be activated by connetion to a PC via RS232 communication. (9V is standard for PTC. If other sensors are equipped the shut down valtage might be 10V or higher)

Connection of further third party instruments like optical DO, current meters, transmissiometers a.s.o. reduce the continuous operation time.

> Alkaline batteries have a significant loss of capacity at lower temperatures. Please remember this fact when calculating continuous operating time!

The capacity of a battery at 0°C is approximately 50% of the room temperature value.

Low battery cut off

The firmware of the CTD90M has a programmable threshold for the low battery cut-off. If the battery voltage once drops below that threshold the microcontroller sets a **“battery empty”** flag, switches the power off and leaves the probe in the standby mode.

The low battery cut-off function is enabled in all configurable modes where internal data storage is required and the power is supplied by the internal battery set.

If external power is supplied to the probe, the low battery cut-off function is disabled. In this case the user has to make sure, that the external supply voltage is sufficient for the proper operation of the probe and within the specified limits.

If the **battery empty** flag is once set the user will not be able to start the probe again until he fulfilled one of the following two conditions:

1. Insert a new battery set **and** connect the probe to an external supply
2. Clear the **battery empty** status by data readout or restart the probe via the RS232 port using the SDA menu **options↓**, **memory probe↓** and **start communication↓.**

(*) Connecting the CTD90M to an external supply is not sufficient to clear the Battery empty status.

Exchange of batteries

Do not leave the alkaline batteries in the instrument during longer out of use periods! Leakage of old or empty batteries may lead to serious damage inside the probe!

To change the batteries, please dry the probe before opening the top cap. Keep the instrument in a horizontal position to prevent water drops being sucked into the housing by the under-pressure. Traces of salt water on the boards can lead to malfunction of the probe. This kind of damage is not covered by warranty.

7.5 Inserting the batteries

The CTD90M is shipped without batteries in the battery box. To insert the batteries remove the top cap in the following way:

- Remove the four screws M3 x 6 with the 2,5 mm T- handle hexagon key.

Top end cap and tube are sealed by 2 O-rings 76 x 2,5 mm and are fixed with 4 screws M3 x 6 mm.

Figure 59: Top end cap of CTD90M.

- Pull the top cap carefully out of the tube until the cable is straightened.
- Avoid pulling at the cable.

Figure 60: View inside the top end cap.

– To open the battery box, unscrew the cap with the T-handle hexagon size 5mm.

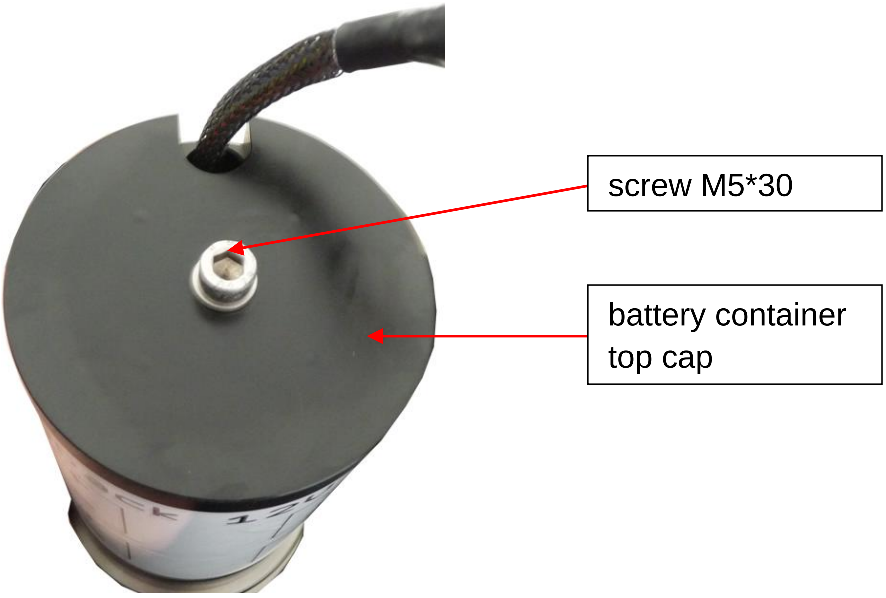


Figure 61: View onto the battery container.

– when inserting the 8 batteries please pay attention to the polarity of the batteries. The 4 compartments are marked either with red + symbols or with blue – symbols.

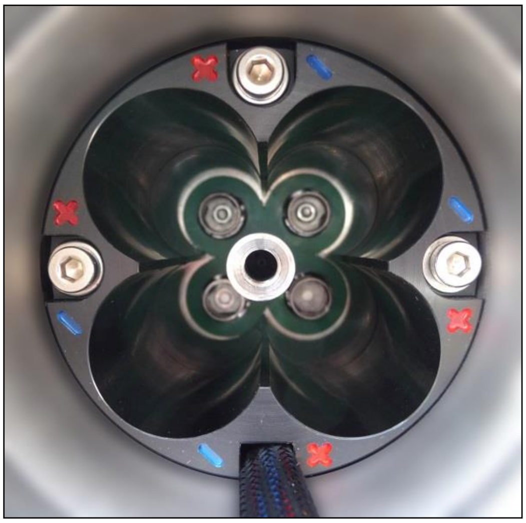


Figure 62: Top view into the battery housing.

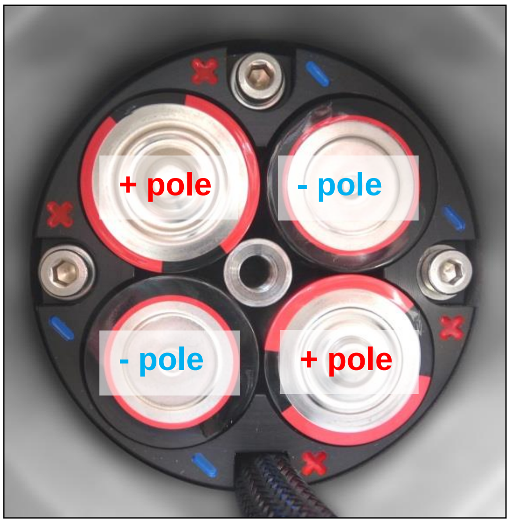


Figure 63: The figure shows how to insert the batteries correctly.

In the compartments marked with **+ red** the positive battery pole is directed upwardly and inverse in the **-** blue marked compartments. Unintended confusions of polarity or even wrong polarities do not lead to damage. The battery input line of the instrument is polarity protected.

- When all batteries are inserted correctly close the cap of the battery box and fix it by screwing clockwise. Please take care that the cable is not clamped between cap and housing.

- Reconnect the cables.

- Close the probe´s top cap not before having carefully checked the proper condition of the O-rings. Take care that the O-rings will be lubricated.

- The red LED on the top cap is on, indicating the working condition of the CTD probe. Switch off the probe to save battery capacity.

7.6 Current consumption considerations

The current consumption is a function of the supply voltage. The graphic representation below is valid for both supply lines (external power via underwater connector and internal battery supply).

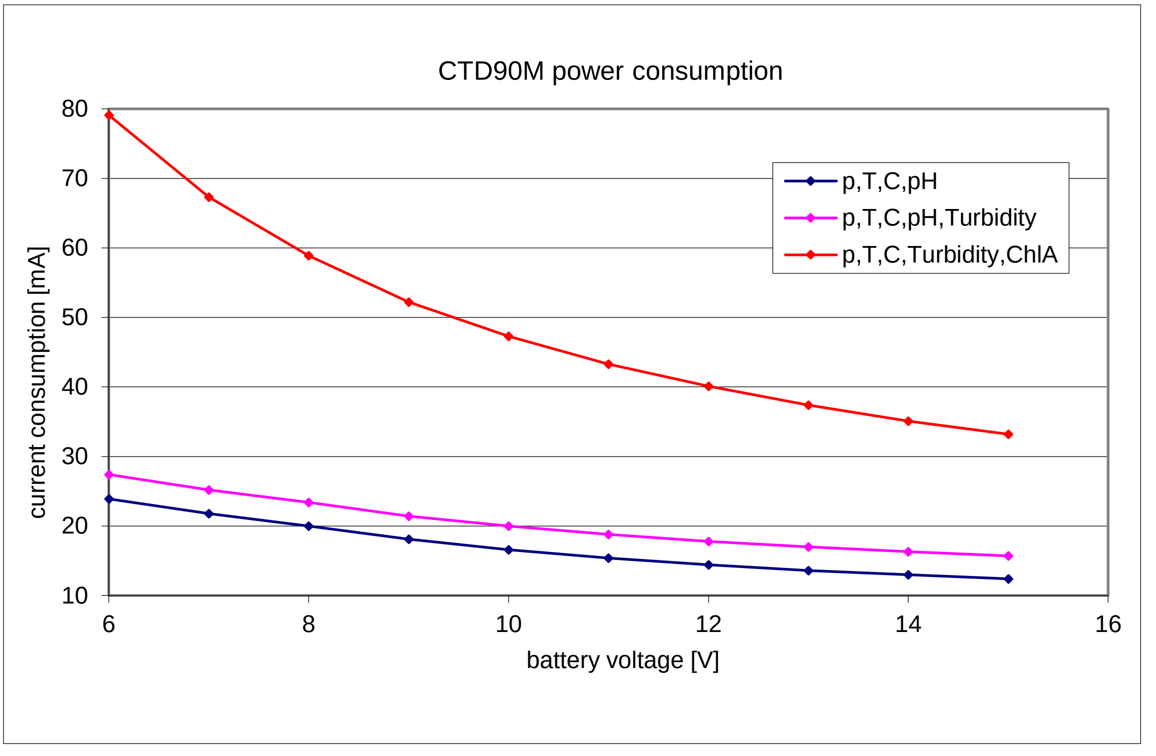


Figure 64: Voltage-current dependency for different sensor equipments.

- Blue line — is for standard CTD90M with P, T, C, DO, pH, ORP and LI-COR.
- Pink line — additional Seapoint turbidity sensor needs constantly 3,5mA more in the full supply voltage range.
- Red line — additional Cyclops-7 fluorometer consumes more power than the complete CTD90M. The current consumption ranges from 35mA at 15VDC to 80mA at 6VDC.

Standby current

During the inactive periods the microcontroller is in the sleep mode, but some components must be supplied with power in order to ensure the wake-up for the next measurement. This current will be drawn either from the internal battery or from the external power supply. There exists no internal lithium backup battery as buffer.

Standby current is <100µA in the full supply range. The standby current requires less than 1Ah capacity per year. Obviously the capacity loss by self-discharge exceeds the standby discharge of the alkaline batteries.

8 Probe electronics

The electronics consist of several printed circuit boards. The principal mounting style is presented on the following picture.

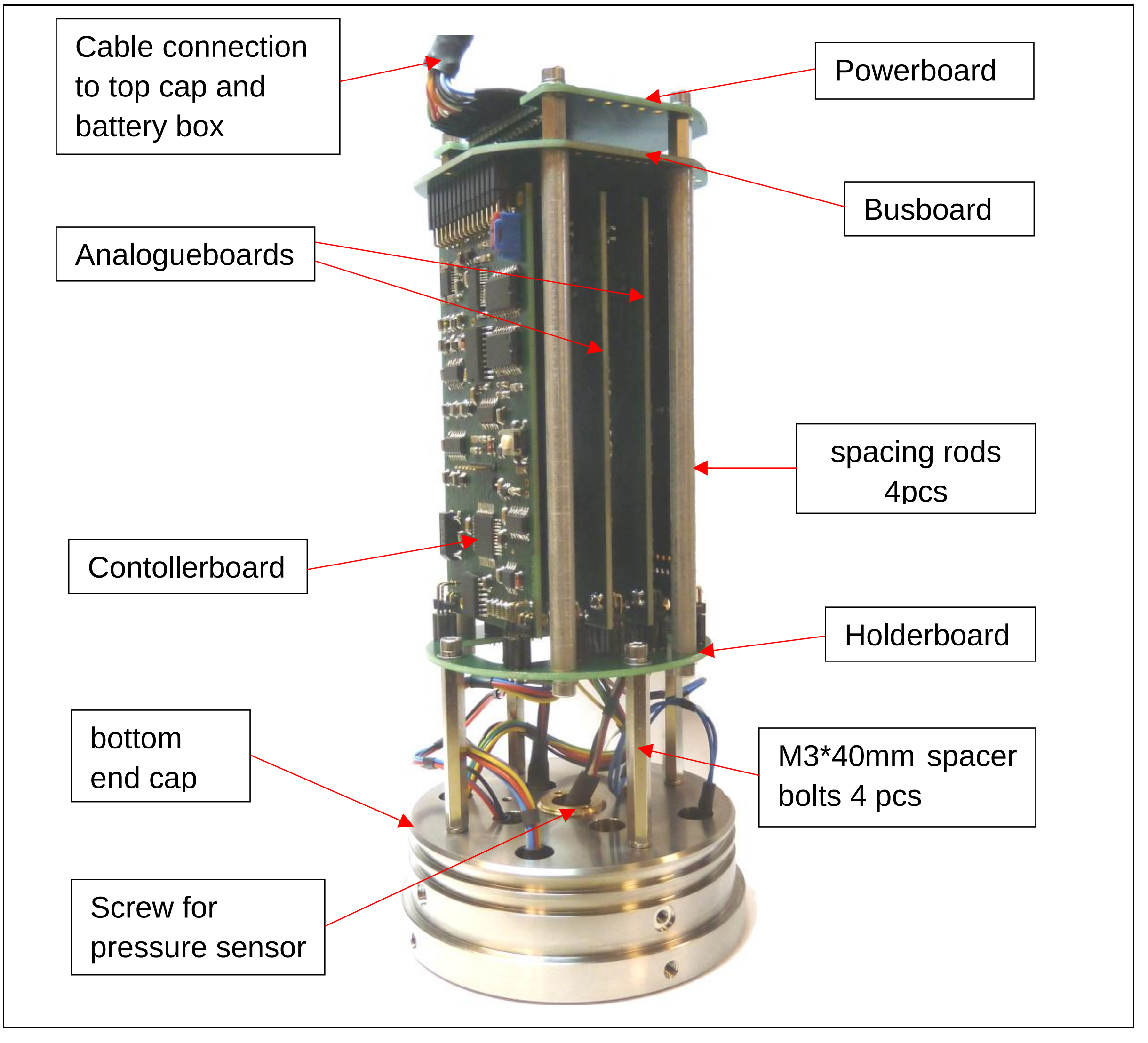


Figure 65: The complete electronic assembly.

The complete electronic assembly is mounted on the bottom end cap. Between the end cap and the lower supporting board is approximately 40mm space for the sensor connectors. The mating cables are connected directly to the correspondent analogue printed circuit board.

Each analogue board is equipped with a 4-channel ADC for data acquisition of up to 4 parameters. Controller board and analogue boards are connected by a control bus.

8.1 Analogue board 1

The Board measures 100 mm * 48 mm and contains the following circuitry:

- 4 channel analogue to digital converter,
- Pressure
- Oxyguard DO
- PAR
- Analog channel 1   input 0-5 V

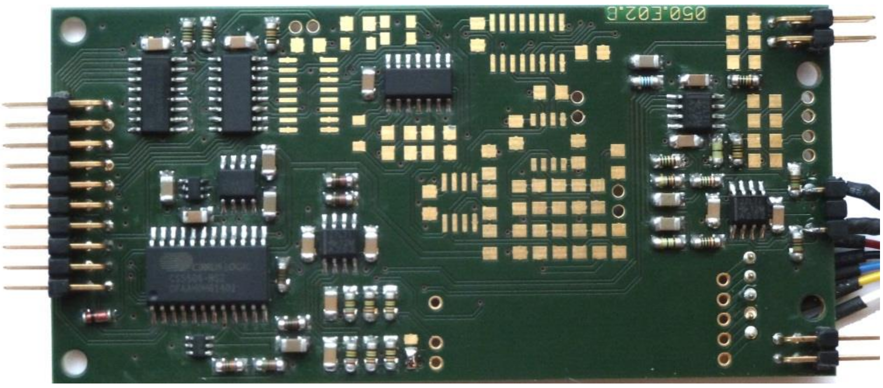


Figure 66: The analogue board 1.

8.2 Analogue board 2

The Board measures 100 mm * 48 mm and contains the following circuitry:

- 4 channel analogue to digital converter,
- Temperature Wheatstone bridge
- pH
- Range sensor (ChlA)
- Analog channel 2   Input 0-5V

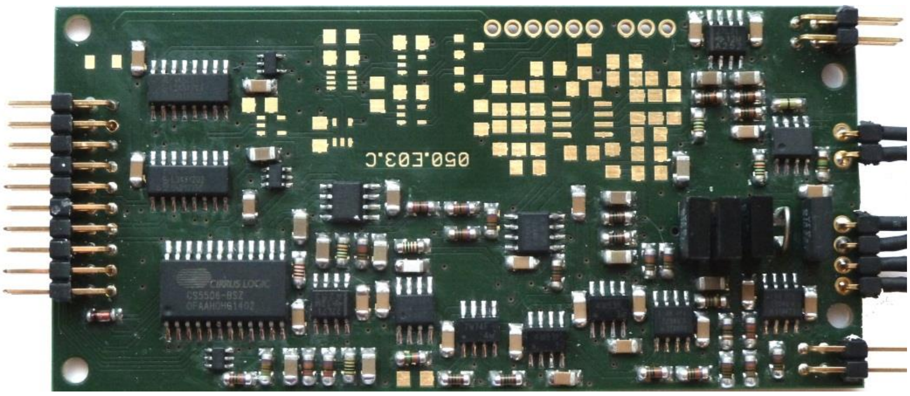


Figure 67: The analogue board 2.

8.3 Analogue board 3

The Board measures 100 mm * 48 mm and contains the following circuitry:

- 4 channel analogue to digital converter,
- Conductivity
- Redox
- Range sensor (CDOM)
- Analog channel 3 Input 0-5V

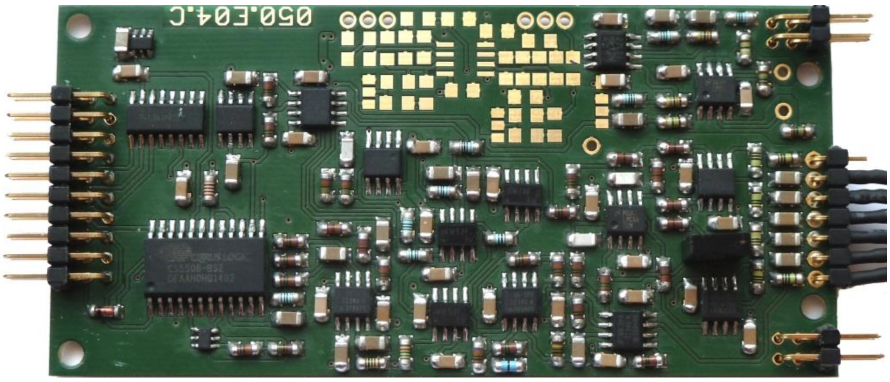


Figure 68: The analogue board 3.

8.4 Analogue board 4

The Board measures 100 mm * 48 mm and contains the following circuitry:

- 4 channel analogue to digital converter,
- DO SST
- Ti SST
- Range Sensor (Turbidity)
- AMT-DO / AMT-H2S

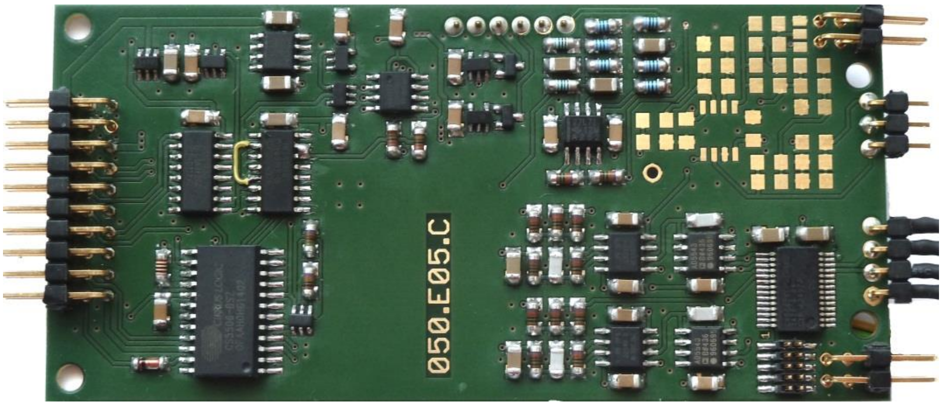


Figure 69: The analogue board 4.

8.5 Controller board

The controller board provides all the essential features of the probe:

- control of the four A-D converters (data acquisition)
- storage of the sensor data in a memory card (µSD-µSDHQ)
- 32k separate FRAM
- 8 bit input port
- 8 Bit output port
- serial port RS232 for communication
- serial port USB for data retrieval
- acquisition of battery voltage

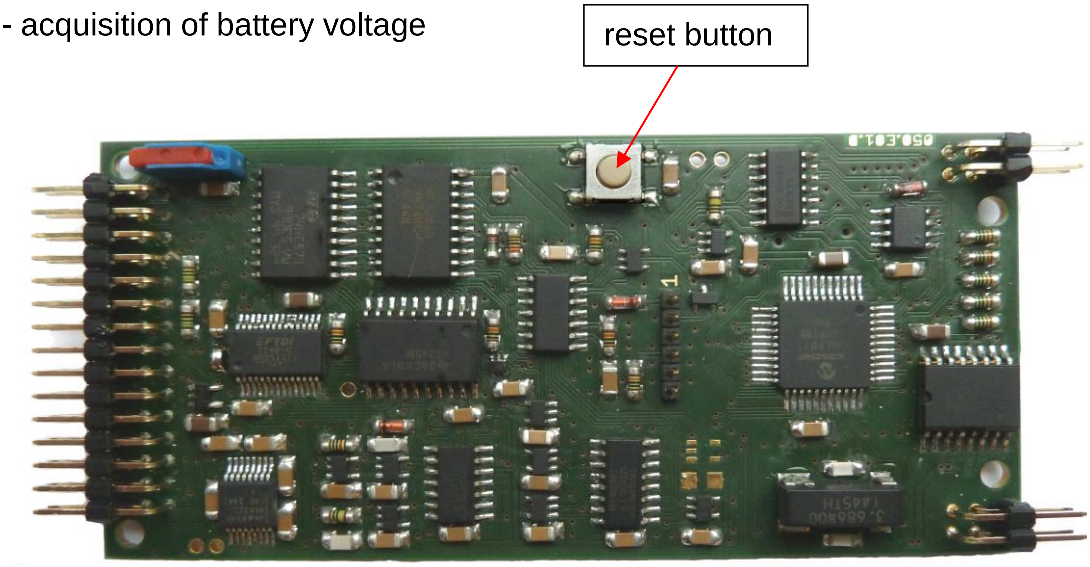
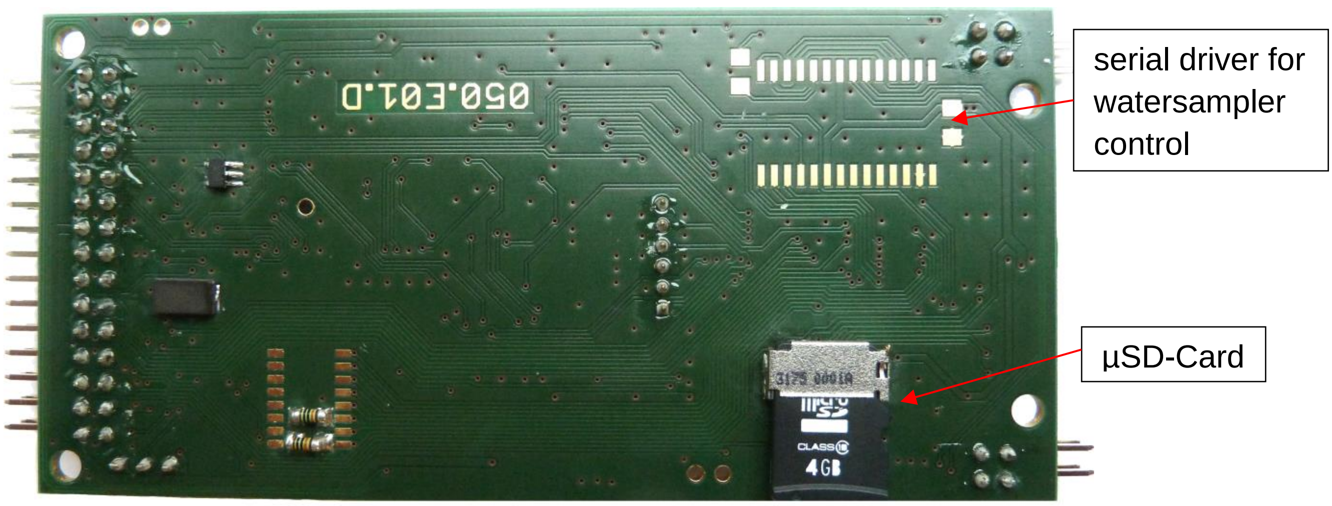


Figure 70: The controller board. Topview and bottom view



Pressing reset button leads to loss of the actual configuration!

8.6 Powerboard

The powerboard is the top PCB of the electronic tower.
It measures 64 mm * 50 mm and contains the following circuitry:

- Power supply and regulation (+3,3V, +5V, -5V)
- Power switch for external devices
- Status signals of power supply
- Cable connection to top cap with battery box

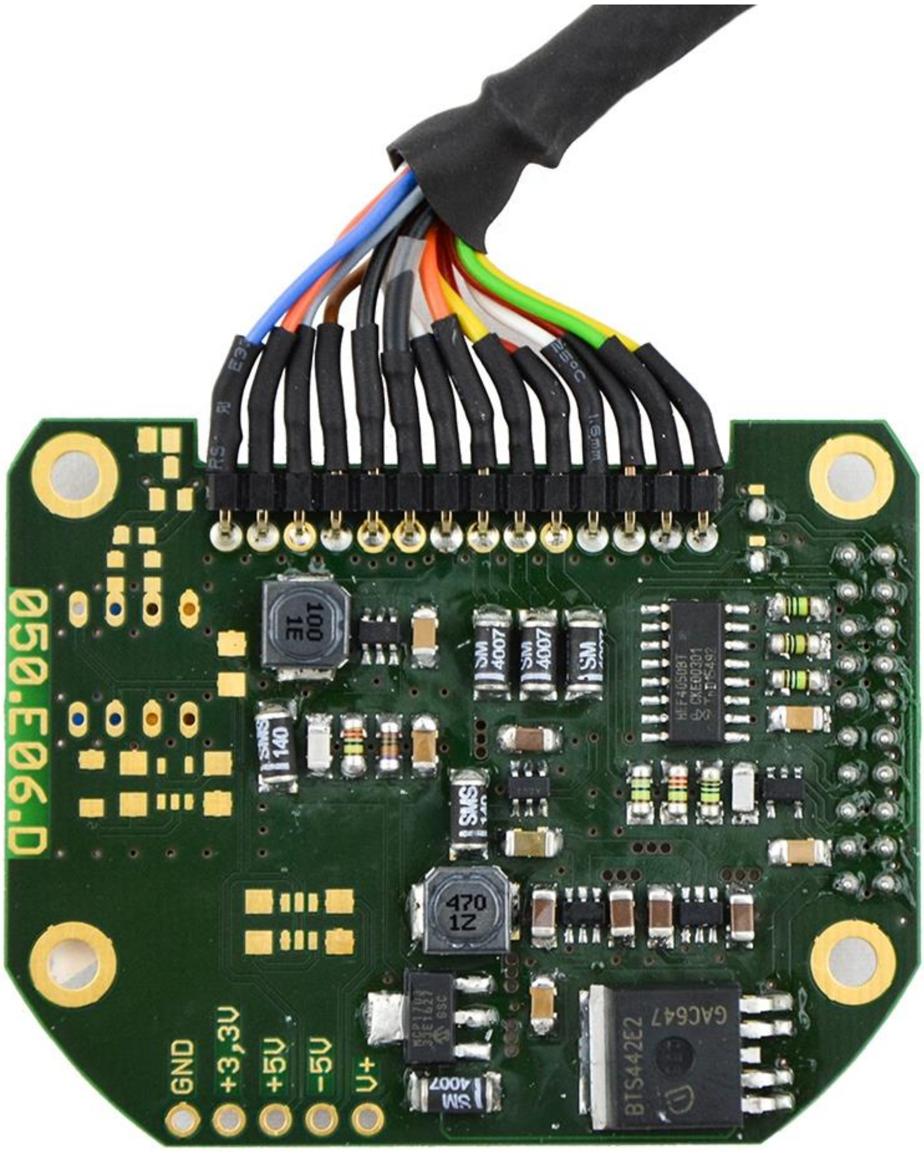


Figure 71: Powerboard

8.7 FSK (optional)

The standard application of CTD probes is profiling performed via winches with slip rings and single conductor cable. The CTD90M is then supplied by constant current, the FSK signal is superimposed on the constant current as voltage modulation. An interface between PC and winch (probe) produces the constant current and convertes the FSK-signal from the probe into PC-compatible RS232C data. The maximum voltage of the current source depends on the cable resistance (cable length). The wiring is as follows:

Inline cable	Signal	coax cable
Pin 6	+ current/FSK-signal	inner wire
Pin 2	- current loop return	shield

The basic version has a constant current of about 130 mA, this can be distinctly higher when external devices are connected. The voltage drop between Pin 1 and Pin 3 is approximately 17 to 19 volt. The FSK signal is a sinusoidal signal of approx. $5V_{SS}$ and modulated on the constant voltage level. A logic LOW-level is the equivalent to the low frequency, a functional HIGH-level is equivalent to the higher frequency. Standard baudrate is 2400 Baud, FSK frequencies are 35 and 45 kHz. The FSK signal runs synchronically with the data signals.

The TxD signal on pin 2 of the probe connector is identical with the RS232 output of the probe interface.

When the FSK driver board is installed, external power is needed for RS232 communication with the probe.

The telemetrieboard is located behind the protection ring between top cap and battery box (Figure 12, page 25). It works as signal distributor for power and signal lines coming from and going to the underwater plug and control elements (reed contact and LED). It contains the cabel-driver circuitry and FSK modulator and all the necessary wiring to cable driver transistors.The connection to the probe electronic / powerboard is established by a separable 16 wire cable-connection.

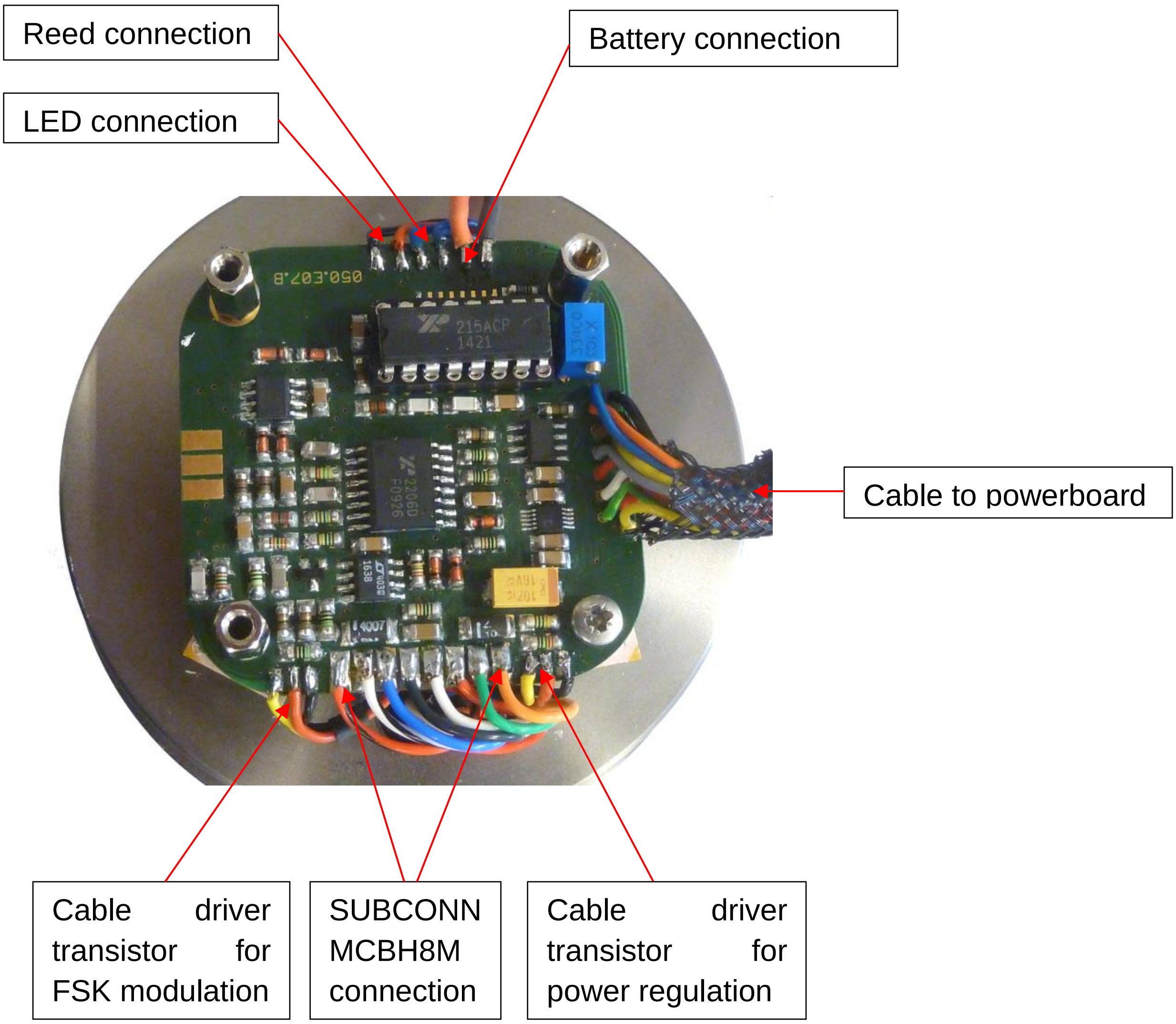


Figure 72: Telemetrieboard

9 Operating the memory probe

9.1 Control elements

On the top cap of the memory probe you can see a red LED and a deepening where the reed contact is behind (see Figure 73).

The LED is used to display operating conditions:

- *red LED on* Power on,
- *red LED off* Power off,
- *red LED blinking* Power on + write access to memory.

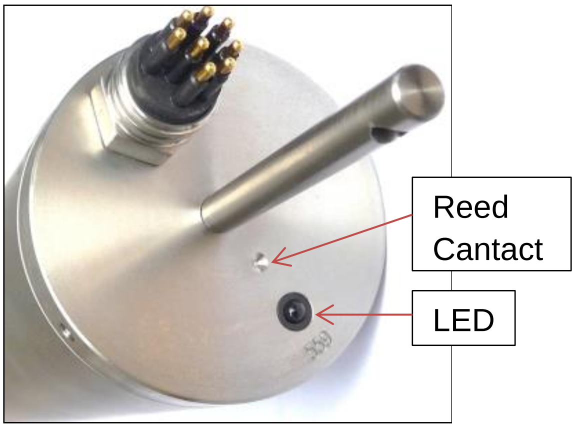


Figure 73: The top cap.

Reed contact:

The activation of the reed contact is made by a magnetic rod (part of the delivery). The rod should be led vertically with the magnetic tip to the front of the mark on the end cap for no more than a second. The **ON**- condition is displayed by the red LED. A second activation turns the power off (red LED off).

9.2 Operation modes

The probe has 3 configurable data storage modes:

- time mode,
- increment mode,
- continuous mode,

and one non configurable mode:

- RS 232 on-line mode (no data storage).
- FSK mode

The first 3 operation modes can be configured by the supplied Windows(tm) software package "Sea & Sun Technology´s Standard Data Acquisition". Please refer to the separate manual for a complete software description. Generally the memory probe has to be configured by use of this software prior to data storage applications. Data readout and conversion to ASCII-files is done by this software, too. In addition to storage modes the probe can be used like a standard direct reading probe using RS232 data transmission. During all data storage modes the measured data is transmitted via the RS232 output to a connected PC. To save battery power the RS232 output is powered down if no valid RS232 voltage level is present at the RXD line of the probe.

Power switching

1. After being connected for the first time to any power source (either battery or external power supply) the probe performs a power on reset (hardware and software reset) and starts data transmission in the non configurable mode. For this online mode the magnet has to be used to switch the probe off. Activation of the reed contact turns the power on and off (toggle switch) in all operation modes except time mode.

2. A signal on the RxD line turns the power on in any mode. The **start communication** or **restart probe** command in the SDA user menu is used to switch the probe on and **interrupts the current operating mode**.

3. Detection of turn on time (time mode) switches the power on.

4. Detection of **battery empty flag** switches the power off.

5. Detection of FSK status bit turns the probe automatically on

> After configuring, the probe should not be disconnected from the power supply or battery, otherwise the configuration will be lost!

Time mode

Time mode is configured by several parameters to best suit the data acquisition tasks of the application. The most obvious is the time interval between two consecutive wake-up periods. The second is the length of time the probe is switched on after wake-up. There is a "**Start time**", where the first interval starts and an optional "**Stop time"** after that the probe will terminate the time mode. During the **On Time** either all datasets are stored or only those at a defined time grid. The parameters for **Start Time** and **Interval** are mandatory, all others are optional for convenience.

Increment mode

Mostly this mode is used to obtain depth profiles with datasets stored at user-defined depth levels in order to achieve appropriate data reduction. Select **Press** in the sensor choice. The **"delta interval**" between two consecutive depth levels has to be entered. Optionally, a **start limit** and/or a **stop limit** can be defined. After crossing one of those depth levels one complete dataset is stored and the internal processor of the probe calculates the next depth level to be crossed. Even if the same limit is crossed again later on, no additional data is stored!

More than one profile can be obtained without the necessity for data readout to a PC in between. A maximum of 250 files can be stored in this mode as long as the capacity of the internal solid state memory is not exhausted (128 Mbytes). For each profile the probe has to be switched on by use of the magnetic rod. At that moment the next file is created in the memory. If a stop depth was defined the probe will automatically switch-off at that depth and close the current data file. Otherwise the probe has to be switched off manually when it is raised to the surface (and switched on again for the next profile and data file).

Continuous mode

At this mode all acquired datasets are stored in the internal memory of the probe. Each time the probe is turned on using the magnetic rod a new (additional) file is created in the probe and all further datasets are stored until the probe is switched off again.

RS 232 on-line mode

Is an operation mode without valid configuration. The memory probe enters this mode after power-on under following conditions:

- after each power on reset
- after the stop-time in time mode operation is reached
- when the internal data storage memory is full
- further data storage is disabled by the PC-software. Memory capacity is limited by firmware to 128MByte.

No data storage is possible. The probe awaits another configuration and acts like a direct reading probe after being switched on with the magnetic rod. The probe can operate in this mode for an unlimited time until it is switched off with the magnetic rod or the battery is empty.

FSK mode

Connecting the memory probe to an Interface for single conductor cables enables the memory probe to enter FSK mode. In this mode all data storage operations are disabled. The probe turns on automatically when it is powered by the Interface and finishes the FSK mode after power down. The probe acts like a true direct reading probe, i.e. all previous storage configurations are terminated (and have to be activated later on by connecting the probe to the PC software).

This mode is the only mode where the probe cannot be switched off by the magnetic rod!

Command mode

When the PC-software is urged to "**Start communication**" with the memory probe, then it switches the probe into the command mode to start configuration or readout data. During command mode no data is acquired and any data storage in progress is temporarily disabled and will be resumed after the end of command mode (if wanted). If time mode is active during command mode the time-grid updates are done in the background, but no data acquisition is performed! Time mode will resume after leaving the command mode and starts at the next configured interval in the future.

During data readout the communication baudrate is (automatically) set to 115200 Baud to speed up the process. Due to the high baud rate data readout should only be made with the short laboratory cable in order to avoid data transmission errors.

Command mode has to be left by closing the configuration window of the PC software, otherwise the probe will not respond to magnetic rod nor will transmit data.Operating the memory probe

10 Service and maintenance information

We expect the user to peruse this chapter and to follow the recommendations given here. The ignorance or disregarding of the following service and maintenance instructions may lead to malfunction or damage of sensors and components and involves the loss of warranty for the corresponding parts.

10.1 Underwater connector

is nearly maintenance-free. Absolutely necessary is the observance of the next rule:

> Ensure the sealing lips of the connectors are lubricated with grease in order to reduce the forces during plugging. Damages of the pin´s sealing surfaces are not covered by warranty.

The following handling procedures should be adopted:

- Connectors are best cleaned with fresh water, they do not have to be dried
- Avoid the use of chemical cleaners do not disconnect by pulling on the cables and avoid sharp bends at the cable entry
- When disconnecting, pull straight, not in an angle. Angular loads can destroy the connectors.
- To prevent corrosion of the contacts never plug or unplug the connectors under water.
- Unused connectors should never be left open. They should be protected with dummy caps.

10.2 Pressure sensor

The pressure sensor doesn't require any special attendance or maintenance.

> Do not touch the membrane with any tool in order to check the function of the transducer. Doing so will affect the calibration and long term stability and may lead to lasting damage.

10.3 Temperature sensor

The temperature sensor is maintenance free. Dirt and sediments only increase the response time but do not affect the accuracy. Be careful when cleaning the sensor. Do not bend the extremely sensitive needle.

> Avoid lateral forces during handling and cleaning. The use of high pressure cleaners will lead to destruction of the temperature sensor

10.4 Conductivity cell

Is principally not maintenance free. It must regularly be inspected for plant cover and electrolytic calcification. Both effects reduce the measured conductivity. It is appropriate for the probe to be rinsed on deck with fresh water (better distilled) after each application. This prevents the formation of salt crystals on the cell´s surface. Calcareous deposits, which originate from the electrical current flow in the cell, are easily removed if the cell is immersed for a few minutes in a diluted acetic acid. The quantity of rising CO_2-bubbles gives information on the rate of calcification. The cell is completely decalcified when the bubble formation has ceased. Afterwards the cell has to be rinsed with fresh or destilled water. Depending on the operating time this procedure is only necessary monthly. Particular care has to be taken, that the platinum coated electrode surfaces are not scratched and never been contacted with other metals. Otherwise the lifetime of the cell and the long-time stability of the conductivity measurements will be impaired. After the electrodes have been treated with acid, a short-term increased conductivity reading may occur. This effect should vanish within an hour.

10.5 Seapoint turbidity meter

The turbidity sensor has to be cleaned from time to time. Especially the optical sensitive flat surfaces have always to be kept clean. Avoid the use of chemical solvents. Do not scratch the flat optical surfaces. When mounting the sensor protection cage, keep the measuring volume in front of the flat side free from reflective materials (rods of the frame). The sensitive beam has a horizontal angle of approximately 120°.

10.6 Oxyguard DO

The oxygen sensor requires some attention from time to time. All necessary maintenance like exchange of electrolyte and membrane is described in an OxyGuard leaflet in the appendix of this manual.

Exposure to H_2S reduces the service interval. H_2S generates hardly soluble deposits on the electrode which reduce the oxygen reading. The deposits have to be removed with the sponge of the oxygen service set.

The red O-ring has two different positions:

a) The **front position** (shown in the picture below) should never be selected for measurements but only for storage. The O-ring prevents leakage of the electrolyte through the thread during storage.

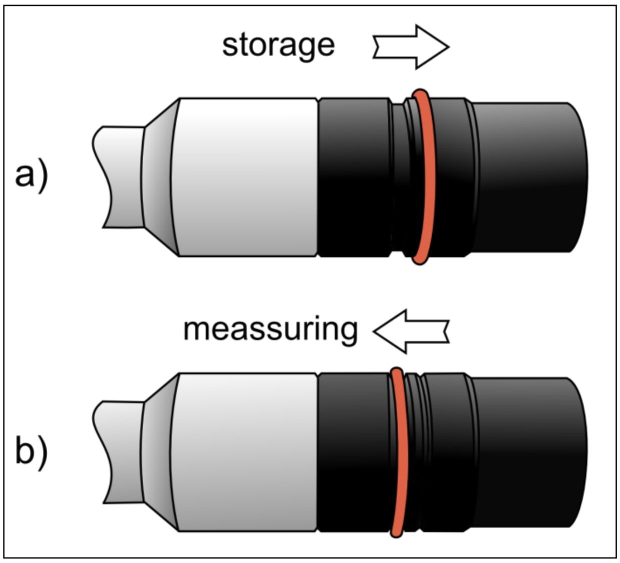


Figure 74: a) O-ring in front position, b) O-ring in rear position.

Never measure DO with red O-ring in front position. Use this position only for storage.

b) The **rear position** allows the electrolyte to build a high impedance electrolytic connection between medium (sea water) and electrolyte volume behind the membrane. This position is necessary for accurate measurements. Please take care that during membrane exchange the O-ring is always in the backward position.

Rear position is necessarily required for measurements and membrane and electrolyte exchange.

c) The protection cap

The Oxyguard DO sensor is supplied by us with a sensor protection cap made of POM. To achieve a tight fit to the sensor´s head the cap is equipped with an O-ring 21*1 mm and a 2 mm hole in the centre of the bottom (see photo). The cap should be used as protection during transport and shipment for the membrane and sensor´s head as well as useful tool for oxygen field calibration.

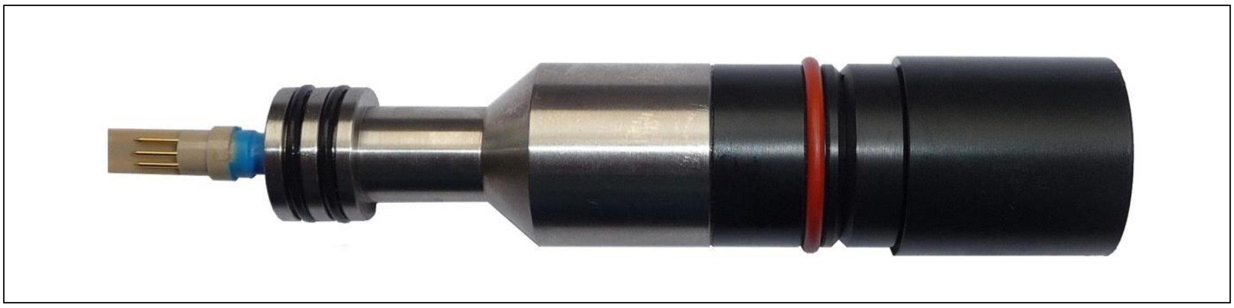


Figure 75: Oxyguard DO sensor with protection cap.

If the membrane tension is dropping during operation the sensor´s output signal is changing too. The zero point of the oxygen sensor remains fixed during it´s lifetime but the sensitivity (slope) can vary. The user can execute a field calibration after each membrane exchange or when it is suspected the measured values are faulty.

Oxygen field calibration

The SDA software offers the possibility to perform a field calibration and to change the reading automatically. The SDA program needs to run with the probe connected to the PC. The field calibration procedure is very simple:

- Keep the membrane of the DO sensor dry.
- The red O-ring should be in the backward position.
- Plug the protection cap onto the sensor head with a proper fitting O-ring.

- Fill a small plastic cup with water and immerse the sensor head up to the flange. After a short time the enclosed air in the cap is water vapour saturated and the oxygen reading should have 100% saturation.

- If the oxygen reading is stable click SDA menu point **Calibrate** and **02 Field Calib.**

- When **O2 Field Calib** is selected, the current oxygen reading is automatically stored. The default value **100**% is accepted when clicking on the button **Calculate slope now.**

- The SDA program calculates the new oxygen Field calibration coefficient (originally 1) and the reading is now 100%.

The field calibration method works in any basin or tank and the result is independent of the salinity. When putting the complete probe into a basin you have to estimate the immersion depth of the oxygen sensor (measured from the membrane to water surface). Every 10 cm immersion depth leads to an increase of the oxygen reading of 1%. So for example, if the procedure is executed with the DO sensor 30 cm below the water surface, the default value in the button field **Enter** desired value has to be changed to 103%.

Problem: Increasing oxygen values with increasing depth.

This problem occurs sometimes after exchange of membrane and electrolyte. The reason is too much electrolyte in the cap with the consequence that the distance between membrane and centre electrode is too far. The membrane should always lie tightly on the head. If not, the membrane will be moved by the increasing static pressure more and more towards the head, until a final and stable position is reached. During pressure relieving the oxygen display decreases to its start value.

What to do in such a case?

1. Check if the red O-ring is in the backward position. Notice the oxygen value in air.

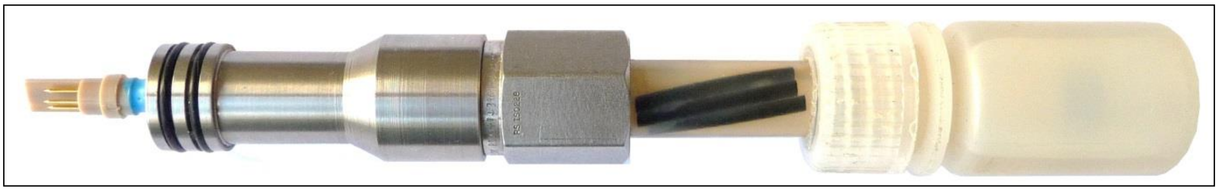
2. Take the calibration cap, close the small front hole with the finger and press the cap tightly on the head. The oxygen reading may increase to several hundred percent saturation but as result of this the enclosed air presses the excessive electrolyte through the thread out off the electrolyte reservoir. After relieving the pressure check your oxygen reading. The value is surely different from the start reading.

3. When this reading is stable after two successive trials you can finish the procedure.

10.7 pH / ORP sensor

Never touch the sensitive tip! Protect the pH-sensor with the delivered soaker bottle containing the storage solution and to avoid drying out.

Figure 76: AMT-pH



Avoid any air inside the bottle, completely fill it with 3 M KCl storage solution (pH 4 buffered). Make sure, that only 3 M KCl is used for storage.

It is not allowed to use other wetting caps in order to avoid air pressing through the diaphragm into the reference electrolyte volume. Damage or malfunction caused by using other wetting caps or storage without any wetting cap will void guarantee.

The pH sensor has to be rinsed carefully with fresh water after finishing the measurements.

The pH sensor is a replacement part and has to be changed, when the sensor has reached the end of its lifecycle. The sensor has a stainless steel thread G1/4A which is screwed into a flange. The electrical contact is made by a socket in the flange. Sealing between sensor and flange is achieved with an O-ring which is part of the sensor.

During handling with the bottle do not apply lateral forces to the sensor shaft. Mechanical stress caused by lateral bending often leads to breaking of the inner glass lead-off element near the hexagonal socket.

10.8 Industrial sensors with S7/S8 heads

Both sensors are principally maintenance free. After their life span have ended the corresponding sensor has to be replaced. Exchange of such a sensor has to be carried out only in dry condition. Water traces in the socket and S7/S8 heads cause total failure of pH or ORP measurement.

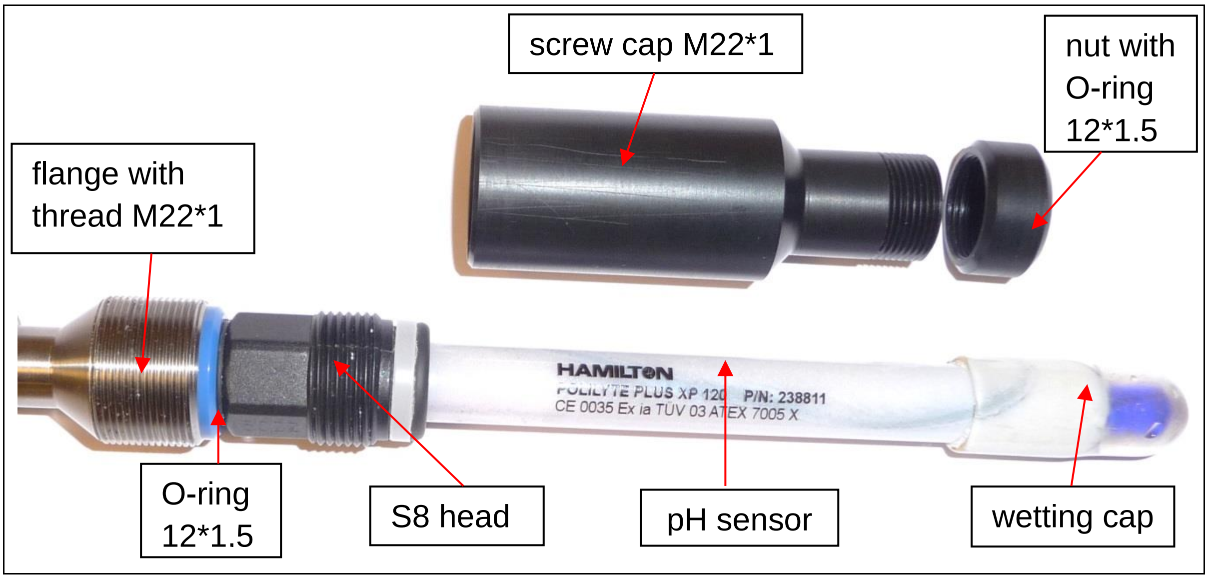


Figure 77: Hamilton-pH

After having removed the plastic caps (see picture above) dry carefully the connection between flange and S8 head with a paper tissue. Unscrew the sensor and check if the contacts of the S8 socket are clean and dry. Be very careful when screwing the new sensor into the socket. Do not damage the fine plastic thread of the S8 head, tighten the sensor by hand without using any tool.

Tighten the sensor slightly only by hand. Damaged S8 threads are not covered by warranty.

Finally fasten the sensor with the screw cap and the nut (only by hand). This is very important for the safe handling with the pH or ORP sensors during transport and measurement.

The industrial sensors are available worldwide. The user can use any other model with polymer electrolyte provided that the maximum pressure of the sensor is sufficient high. An exchange will be necessary in following cases:

- the response time of the sensor increases drastically,
- the polymer electrolyte is dissolved up to the S8 head rim,
- after exposure to H_2S,
- the long term stability of the sensor decreases.

Special care has to be taken for air bubbles behind the ion-permeable glass bulb. Air bubbles in the pH electrolyte can disturb the electrical connection to the pH electrode. The air bubble has to be shaken out similar to the shaking of a fever thermometer. The air-bubble often occurs when the sensor has been stored horizontally for a longer time.

10.9 Cyclops7 Fluorometer

The Chlorophyll A sensor has to be cleaned from time to time. Especially the optical sensitive flat surface has always to be kept clean. Avoid the use of chemical solvents. Make use of the protection cap if the sensor is not in operation.

11 Online data format

The serial probe data is a RS232 signal with the following specifications:

Baud rate:	2400
Character length:	8
Number of stop bits:	1
Parity:	odd
Protocol:	non, asynchronous
Signals:	GND, TxD, RxD

Serial data is transmitted in binary format. Each sensor is transmitted with 3 bytes (16 bit measured raw data values, 5 bit address and 3 bit status). The transmission format of any sensor is presented in the following chart:

Sensor	**LSB**							**MSB**
1.Byte	H	D0	D1	D2	D3	D4	D5	D6
2.Byte	H	D7	D8	D9	D10	D11	D12	D13
3.Byte	L	D14	D15	A0	A1	A2	A3	A4

DO – D15	16 bit binary data (decimal value 0 – 65535)
AO – A4	5 bit binary address (decimal sensor address 0-31)
H, H, L	3 status bits. (H = logic HIGH level, L = logic LOW level)

Transmission starts with the first byte and ends with the third byte. Each byte is transmitted with LSB first. Every sensor in the probe has a specifically assigned binary address. Address and corresponding measuring value are transmitted in a 3 byte block. The status bits are necessary for the PC data acquisition firmware to compose the 3 bytes in the correct sequence.

A complete data set begins with the lowest address and ends with the highest. The transmitted physical addresses are identified by the data acquisition program and compared to those registered in the configuration file e.g.

Address 0	pressure
Address 1	temperature
Address 2	conductivity
Address 3	DO
Address 4	ph
Address 5	Redox
Address 6	Turbidity
Address 7	chlorophyll A
Address 17	battery voltage

Multirange sensors:

A multirange sensor with databits D15…D0 carries the range information in the least significant two bits D1, D0:

Range	D0, D1
Range 0	(0, 0)
Range 1	(1, 0)
Range 2	(0, 1)
Range 3	(1, 1)

The true resolution of a multirange sensor is therefore 14 bit, but the sensor data is handled by the SDA program like any other 16 bit value. The range information is used by the SDA software to load the correct calibration coefficients for the calculation of the engineering units.

12 Calculation of the physical data

Data transmission and data storage are performed solely in binary data. The calculation of the engineering values from the raw data and their display is carried out by the PC data acquisition program. The calculation of physical values for standard sensors is generally made by polynomials of nth order. There exist several calculation formulas for the different sensors. They are signified in the SDA program with a code of maximum three letters.

Conventions:

n = 16 bit raw data counts 0<n<65536 (10 bit raw data count for battery voltage)

i = index

A[i] = calibration coefficients

B[i] = calibration coefficients

12.1 Calculation type N (temperature, pH, ORP, conductivity)

SDA calculation type **N** is used for temperature, conductivity, pH and ORP.

engineering value: = $\Sigma A[i] * n^i$

(*) Don´t forget to enter the temperature [°C] of the buffer solutions when recalibrating pH. The temperature value has to be entered as third calibration coefficient under temperature compensated **pH_Tc.**

12.2 Calculation type P (pressure)

is used for the calculation of pressure.

P [dbar] = $- A[5] + \Sigma A[i] * n^i$

Normally imax = 1 or imax = 2. The calibration coefficients are determined by the manufacturer in comparison measurements against a normal or subnormal and subsequent regression calculation. The pressure coefficient A[5] is used for air pressure compensation via SDA menu.

12.3 Calculation type RR4 (PAR, Seapoint Turbidity,ChlA)

Calculation type RR4 is used for sensors with three or four different ranges.

PAR with LI-COR sensor

has four ranges with decimal graded sensitivity on the analogue output. The LI-COR sensor supplies a photo current in the range 0 – 50µA depending on the incident radiation. The analogue input of the CTD is calibrated over 7 decades of current with the result of 4 individual calibrated ranges. The four ranges are denoted with PAR1 to PAR4 and

PARi [µA] = Ai[0] +Ai[1]*n   i = 1, 2, 3, 4

The LI-COR sensor is equipped with a factory calibration factor M [µmol/µAm²s] that describes the conversion of PAR to current (LI-multiplier).

PAR [µmol/m²s] = M * PARi   i = 1, 2, 3, 4

PAR range switching is done automatically based on the range information transmitted by the CTD. More details are given in the appendix *LI-COR 193SA spherical quantum sensor on SST CTD´s.*

Seapoint Turbidity

The Seapoint Turbidity sensor has four different ranges as described in chapter 6.11 The range switching is not executed automatically. The user can select any range by the SDA software (default setting is 500 FTU). Please refer to calibration documents for this sensor.

The analogue input of the probe is calibrated in volt.

U [V] = A[0] + A[1] * n

The four ranges are factory type calibrated with

0[V] = 0 [FTU] and 5 [V] = FS [FTU]   FS = 25, 125, 500, 4000

Turb [FTU] = FS/5 * U [V] = FS/5 * (A[0] + A[1]*n)

The calibration coefficients for each range are calculated according to this formula and stored under the calculated sensors **Tur_1 ...Tur_4.**

The zero points of each range are individually adjusted. Therefore the Ai[0] coefficients of Tur_i differ slightly from the calculated values.

When checking the turbidity zero points in air avoid any bright natural light and all artificial light which causes 50/100Hz noise on the signal and shifts the zero point to wrong values.

The complete turbidity coefficient set requires five sensors (e.g. CTD558)

7 RR4 Turb [FTU] **23 24 25 26** 1 0
23 Tur_1 CAL polym -2.27 0.0377976 0 0 0 0
24 Tur_2 CAL polym -0.521 0.00755952 0 0 0 0
25 Tur_3 CAL polym -0.22 0.00188988 0 0 0 0
26 Tur_4 CAL polym -0.123417 0.000377976 0 0 0 0

7 is the sensor number of the turbidity sensor, **23...26** are the SDA sensor numbers of the Tur_i sensors.

Cyclops-7 fluorometer

All Cyclops-7 models have three ranges with analogue outputs 0 – 5 volt. The ranges differ from model to model e.g. **Chlorophyll A.**

The range switching is not executed automatically. The user can select any range by the SDA software (default setting is 50 µg/l). Please refer to calibration documents for this sensor.

First the analogue input channel of the probes electronics has to be calibrated in volt:

(1) $U[V] = A[0] + A[1] * n$

U voltage at analogue input channel in volt
n digital raw value (output of the 16 bit A/D converter, value between 0 and 65535)

A correlation between voltage and chlorophyll A concentration [Chl A] can be established using formula (2):

(2) Chl A[µg/l] = B[0] + B[1] * U[V]

U analogue output of Cyclops7 sensor in volt
B[i] calibration coefficients (valid for all Cyclops7 fluorometers)

range 2	0..5µg/l	B[1] = 1	B[0] = 0
range 3	0..50µg/l	B[1] = 10	B[0] = 0
range 4	0..500µg/l	B[1] = 100	B[0] = 0

Using the voltage U from formula (1) into formula (2) generates formula (3) below:

(3) Chl A[µg/l] = B[0] + B[1] * (A[0] + A[1] * n) = C[0] + C[1] * n

Comparing the coefficients leads to **SDA coefficients C[0], C[1] with**

C[0] = B[0] + B[1] * A[0] **C[1] = B[1] * A[1]**

Zero point adjustment

Measured values generated in air are slightly different from values obtained in deionized water. Thus the zero point should be determined in a glass beaker of approx. 10 cm in diameter and roughly 15cm deep, filled with deionized water. It has to be obeyed that the emitted light from the sensor does not reflect on the walls of the beaker which could lead to faulty readings.

The obtained zero value has to be added to C[0] and delivers **C[0]*,** which has to be entered into the SDA program

The complete Chl_A coefficient set requires five sensors (e.g. CTD558)

7 RR4 Chl_A [µg/l] **27 28 29 30** 1 0
27= -1 CAL Chl_1 Polym 0 0 0 0 0 0
28= -1 CAL Chl_2 Polym -0.0258113 7.66016E-5 0 0 0 0
29= -1 CAL Chl_3 Polym -0.258113 0.000766016 0 0 0 0
30= -1 CAL Chl_4 Polym -3.51113 0.00766016 0 0 0 0

Range 1 is not allowed and has always coefficients 0

12.4 Calculation type NFC (Oxyguard DO)

The NFC calculation is used for third party instruments with a factory hardware calibration.

Oxyguard DO522M18

The Oxyguard DO sensor 522M18 has an internal thermistor for temperature compensation with the result of a linear response of the oxygen saturation signal. The nominal signal output is approximately 30 – 40 mV for a 100% saturation value in air. The oxygen amplifier outputs a signal of 0 – 5 V for 0 – 300% oxygen saturation. Calibration is done in two steps:

1. Determine the zero point (sensor disconnected, raw data =n_0) that is generally a value short above zero.
2. Then calibration in 100% saturated water or in water vapour saturated air (100% relative humidity in equilibrium state). The result is a two point calibration with only 2 coefficients.

DO[%] = A[0] + A[1]*n

If the user wants to check oxygen calibration, there exists a field calibration procedure.

DOnew[%] = B[0] + B[1] * DO[%]

That allows corrections of the oxygen reading without the change of the original calibration coefficients.

When delivered, the oxygen coefficients are

NFC Oxygn [%] A[0] A[1] 0 0 B[0] B[1] B[0] = 0, B[1] = 1

The field calibration procedure is detailed described in chapter 10.6.

All calibrations are executed according to the national or international standards (ITS90, IEC751).

Further calculations such as salinity, density and sound velocity are carried out with the current UNESCO-formulas.

13 Spares and consumables

13.1 Connectors and O-rings

O-ring 16 * 1,5 mm	Sensor (flange)
O-ring 13 * 1 mm	pressure Sensor
O-ring 76 * 2,5 mm	Base and lid
O-ring 12,42 * 1,78 mm	Underwater connector
MCBH8M titanium	probe connector
MCIL8F	mating inline connector
MCDLSF	locking sleeve
MCDC8F	dummy cap

13.2 Oxyguard DO522M18

Membrane kit DO5XMF
Sponge
Membrane spanner
Protection cap
Red O-ring
Electrolyte DO5XE 50mL

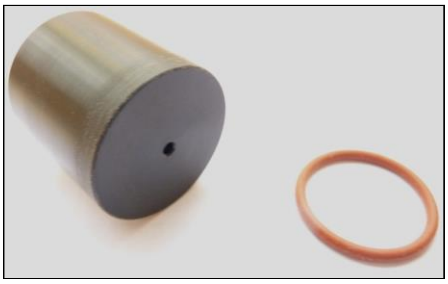


Figure 78: Protection cap and O-ring for Oxyguard sensor.

13.3 pH/ORP sensor

pH4 buffered storage solution 50mL **Hamilton P/N 238931/00**

Figure 79: pH buffer solutions set3 * 500mL.

Figure 80: ORP buffer solutions set 2 x 500mL.

14 Appendix

Appendix pages are only part of this document if the sensor where the appendix belongs to is part of the delivered probe. Sometimes the appendix pages are part of the portfolio with calibration documents.

14.1 Declaration of Conformity

CE	**Konformitätserklärung** **Declaration of Conformity**	Sea & Sun Marine Tech

gemäss EN ISO/EC 17050-1
in accordance EN ISO/EC 17050-1

Die Firma: The company:	**Sea & Sun Technology Gmbh** **Arndtstraße 9-13** **D-24610 Trappenkamp**
Erklärt, dass das Produkt: declares that the product:	**CTD90M** **CTD90M**
Verwendungszweck: Product description:	**CTD Sonde für Seewasser** **multiparameter profiler for seawater**

den folgenden Richtlinien der Europäischen Union entspricht
complies with the following EC directives

2004/108/EG EMV-Richtlinie
2004/108/EC Electromagnetic Compatibility (EMC) Directive

Das Gerät erfüllt im Einzelnen die folgenden Normen
The instrument meets the requirements of the following standards

DIN EN 55022
DIN EN 55024

Trappenkamp, 17.06. 2013

Heinz Schelwat, Geschäftsführer
Heinz Schelwat, CEO

14.2 D-Cell battery pack

This battery pack was designed to operate third party instruments with high supply current consumption. The main feature is an extended operation time due to the greater capacity of the D cells (16 – 20Ah, depending on type and manufacturer).

Inserting of the batteries:

- Unscrew the 4 fastening screws of the top cap of the probe.
- Remove carefully the top cap with the battery case out of the tube and unplug the electrical connection.
- Move the mounting supports of the batteries as shown in the picture below to lower position.

- Set first the 4 lower batteries into the case. Afterwords fill the pack with the upper ..batteries.

Please take care to insert the batteries in the correct polarity as shown on the label at the mounting bracket.

- Relocate the mounting brackets to the middle of the box to supports both batteries (as depicted in the next picture).

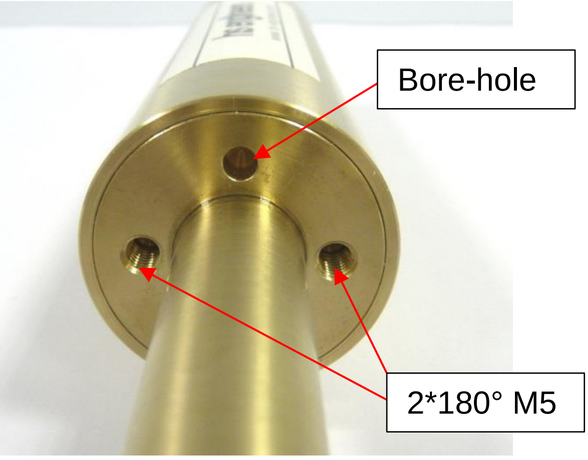
- Reconnect the battery case with the probe electronics. Now the probe is set on power and is operating online (red LED on).

Check the O-rings for damages and take care that the O-rings and the O-ring surface inside the tube are well lubricated with silicone grease.
If there are damages on the O-rings replace them with spare parts.

- Put the battery case carefully back into the tube. Switch off the power with the magnetic rod.
- Fix the top cap on the tube with the 4 screws M3 * 6 mm.

14.3 CTD90M with current meter ISM2001C

The Inductive Current Meter ISM2001 is a stand allone unit and is connected to the CTD90M by a 8 position Subconn cable. It is produced by HS-Engineers. The housing and shaft is made of sea water resistant bronze. The bottom cap of the electronic housing has two tapped holes M5 and a bore-hole as direction indicator (negativeY-axis)
For descriptions of the current meter please refer to HSE manual ISM2001 C.



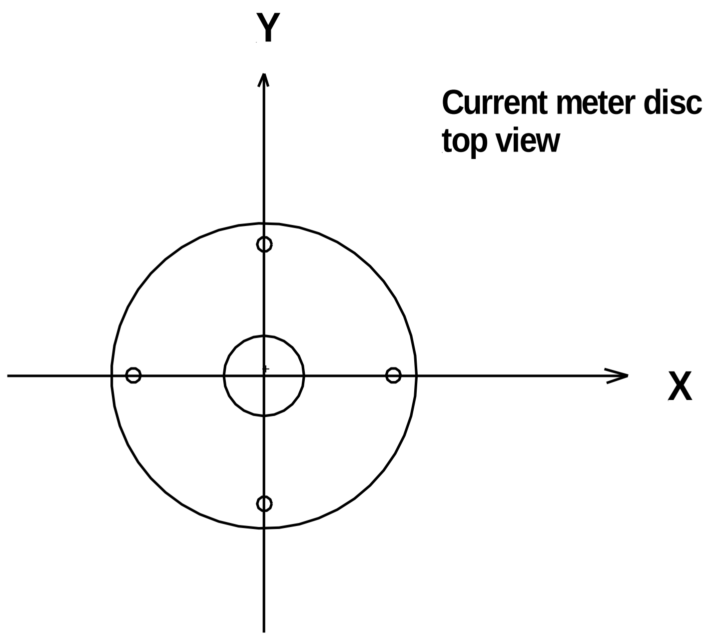
Underwater connector Subcon MCBH8M
Internal 2-axis magnetometer (option)
without gimbal

Supply voltage:	9 – 15VDC
Supply current:	115mA@12V
Analogue outputs:	0 – 5V
Standard range:	-2.5…. 2.5m/s
Optional range:	-5….5m/s

The right picture shows the probe and the currentmeter assembled in the protection case.
The user should take care that the current meter is always in vertical position during employment. Deviations from the vertical position result in cosine errors of the correspondent components.

Definition of terms

The instrument axes of current meter and compass connected to the CTD90M are defined by an orthogonal co-ordinate system depicted in the diagram below:



The positive y-axis is marked according to the ISW2001C manual
The CTD90M allows the acquisition of the 4 analog signals:

Cvx, Cvy	x,y-components of the current vector related to instrument axes calibrated in m/s
Hx, Hy	x,y-components of the magnetic field intensities related to instrument axes, calibrated in arbitrary units.
DIR	angle between positive y-axis and North direction
VDIR	angle between positive y-axis and current vector
CDIR	angle between North direction and current vector
VCSP =	magnitude of current vector
VCSP =	magnitude of current vector {cvx2 +cvy2}1/2
CDIR =	VDIR – DIR = arctanCvx/Cvy - arctanHx/Hy

Calibration procedure

The CTD provides four analogue inputs 0 – 5 volt for data acquisition of current and magnetic field intensity components.

The current analogue inputs of the CTD are calibrated with a high precision voltage reference:

(1) Ux,y[V] = A[0] + A[1]*n

Ux,y is the input voltage [V]
n is the raw data output of the corresponding x,y-axis

Please refer to SST calibration document.

The current meter is supplied with factory calibration documents for current magnitude. The document states zero points S0 and sensitivities S1 for each current axis separately.

Sx0[mV] , Sy0[mV], Sx1[mV/(m/s)], Sy1 in [mV/(m/s)]

The SDA software uses the following algorithm for the calculation of the current components:

(2) CVx,y[m/s] = B[0] + B[1]*Ux,y[V]

The connection between the HSE and SDA coefficients can be simply derived from considerations of analytical geometry: a straight line is unambiguously determined by a point (0,S0) and the slope 1/S1 in the CV-U plane. With respect to the dimensions we get for each CVx,y -component:

(3) ΔCV[m/s] / ΔU[V] = (CV – 0) / (U – S0/1000) = 1000/S1

The factor 1000 is used for the conversion of [mV] into [V], 1000/S1 is the slope of the straight line in [(m/s)/V].

(4) CV = - S0/S1 + (1000/S1)*U

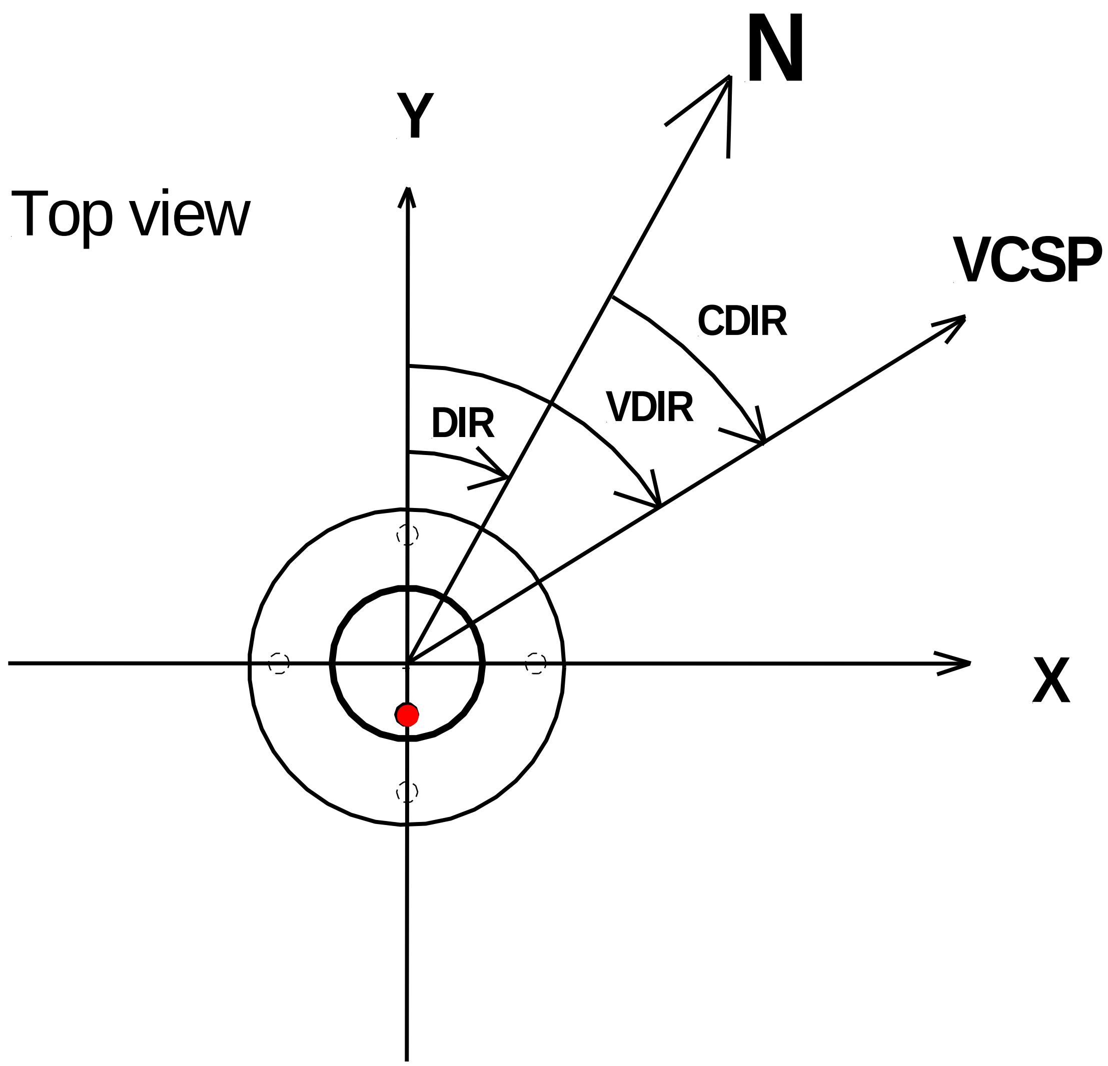
Coefficient comparison between equation (2) and (4) leads to:

(5) B[0] = - S0/S1 and B[1] = 1000/S1

The SDA software calculates the values for both current components according equation (1) and (2). The SDA designation of the calculation formula is **N42** and requires six coefficients in the probe file or the SDA calibration menu:

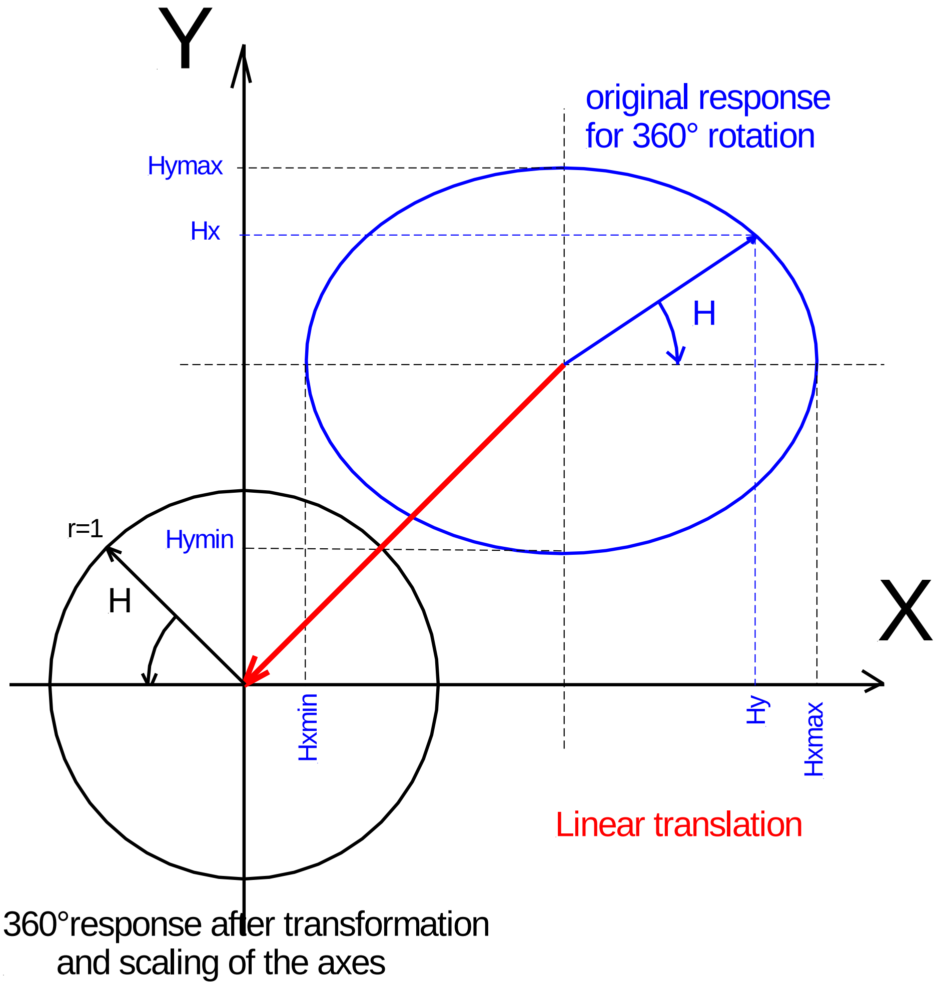
Sensor: CVx or CVy   Calculation type: N42

A[0] = Ax,y[0]
A[1] = Ax,y[1]
A[2] = 0
A[3] = 0
B[0] = - S0/S1
B[1] = 1000/S1



Compass calibration

The two magnetometer axes are generally different in centre point and slope. If the instrument is turned 360° around its vertical axis, the vector of the magnetic field vector rotates on an ellipsoid in the Cartesian Y-X coordinate system of the instrument. This ellipsoid is marked blue in the drawing and is located completely in the first quadrant of the Y-X plane due to the model version with analogue outputs 0 – 5V.



What we need for the proper geometrical rotation of the current vector in the magnetic field is a circular motion of the magnetic vector on a concentric circle (black colour in the drawing). The original 360°response of the instruments magnetic field outputs has to be transferred into a concentric circular 360°response by a linear transformation. This can be achieved in two successive steps first by a linear translation and then by a suitable scaling of the y and x axes. The linear translation vector T is marked red in the drawing and its components are:

Tx = - (Hxmax + Hxmin) / 2   Ty = - (Hymax + Hymin) / 2

The scaling of the axes is very easy, the absolute value is not important but both sensitivities should be the same. So we decide to let the magnetic vector rotate on a circle with radius r=1. Both axis sensitivities have then to be multiplied with a scaling factor Sx and Sy.
Sx = 2 / (Hxmax – Hxmin)   Sy = 2 / (Hymax – Hymin)

The new magnetic field vector H_{new} can be calculated from the extreme values of the original components Hx and Hy:

(6) Hx_{new} = - (Hxmax + Hxmin) / 2 + 2*Hx / (Hxmax – Hxmin)

(7) Hy_{new} = - (Hymax +Hymin) / 2 + 2*Hy / (Hymax – Hymin)

The extreme values can be found by orientating the Y-axis (resp. X-axis) towards North or South.

Please note:

The definition of **CDIR** requires a negative sign for the expression arctan (Hx/Hy), but the SDA program uses a positive sign in the formula.

CDIR = arctan(Vx/Vy) + arctan(Hx/Hy)   SDA formula

Therefore in practise the Hx-values are inverted (multiplied by -1) in order to receive the proper results.

Practical compass calibration procedure

The compass calibration is executed in a single step: linear translation, scaling of the axes and inverting of the Hx-values: The following table shows the four possible orientations of the Y-X-coordinate system in the magnetic field of the earth, the corresponding extreme values and the transformed values.

+Y	+X	Hy-Hx raw data	transformed values	
N	E	(Hymax, xxxxx)	(1, 0)	
S	W	(Hymin, xxxxx)	(-1, 0)	
W	N	(yyyyy, Hxmax)	(0, -1)	inverted
E	S	(yyyyy, Hxmin)	(0, 1)	inverted

xxxxx, yyyyy raw data values = don´t care

The two pairs (Hymax,1) and (Hymin,-1) for the Y-axis and the two pairs (Hxmax,-1) and (Hxmin,1) describe the linear transformation completely ambiguous (two point linear approximation). The coefficients are calculated by a software regression analysis:

$$\mathbf{Hy_{new} = Ay[0] + Ay[1]*ny}$$

$$\mathbf{Hx_{new} = Ax[0] + Ax[1]*nx}$$

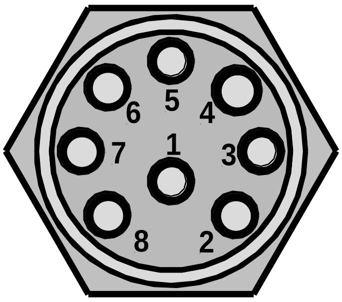
n = magnetic field raw data values ($0 < n < 65535$)

A[0], A[1] regression coefficients, refer to equation (6) and (7)

Connection to a CTD

The CTD is equipped with a 20° adapter carrying a Subconn MCBH8Funderwater plug for the connection of the current meter. The adapter is designed to be mounted in a fit of the inner or outer pitch circle and allows easy handling and access to the adjoining sensors.

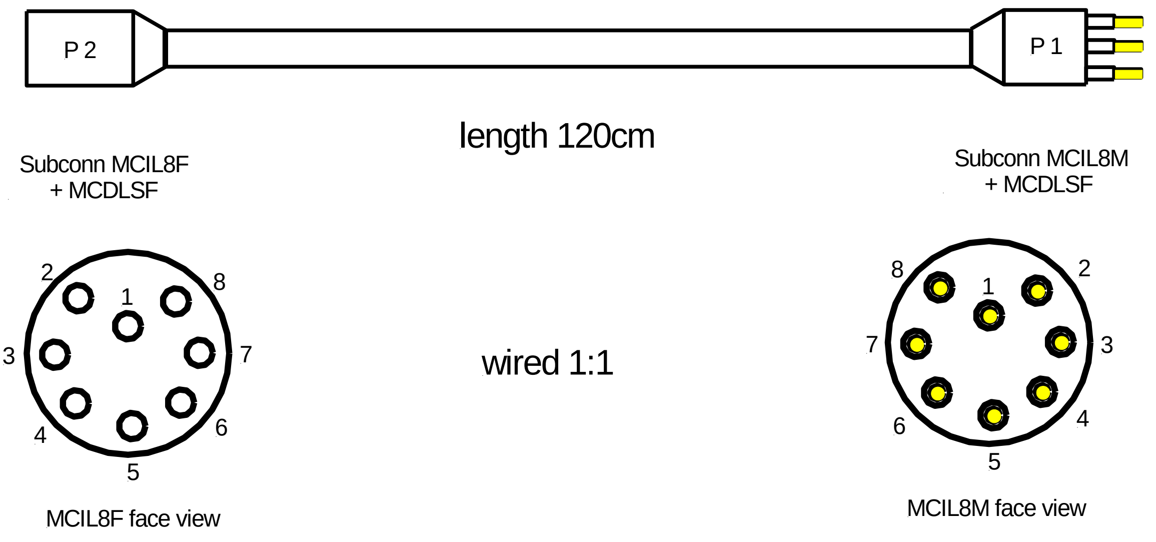
Subconn
MCBH8F
Face View



Pin	Signal
1	+Vout (10..13V - depending on battery condition)
2	SX input (0…5V)
3	GND
4	M2 input (0…5V)
5	–Vout / GND
6	M1 input (0…5V)
7	not connected
8	SY input (0…5V)

The current meter is joined to the CTD by an inline connection (L=120cm) with plugs MCIL8F an MCIL8M and wired 1:1. The cconnectors are protected by locking sleeves MCDLSF against unintended separation

Keep the sealing lips of the male connector lubricated in order to reduce the forces during plugging and unplugging. Never leave unused plugs open. Always close the open ends by proper dummy caps. The dummy caps are part of the delivery



Please keep the cable always fixed to the vertical or horizontal struts of the mounting frame by tie-raps. Unfortified cable links can be damaged by persistent motion and may have shorter lifetime.

14.4 Hydro-Bios Water-Sampler

WS3 Hydro-Bios Motor rosette (new, via RS232) for CTD90M

The new central unit of the Hydro-Bios motor rosette is operated via a protocol on RS-232 basis. The CTD90M memory probe already has an internal interface for controlling the new rosette.

The firmware of the CTD90M can optionally contain a table with trigger depths, at which a new bottle is automatically closed (controlled by the CTD90M). This table can be entered by the user in the SDA and transferred to the CTD probe.

In order for the "actuator" menu item for the water sampler triggering to be activated in the SDA menu, a sensor **WS_VB** as well as a calculated sensor **WS3** must be present in the PRB file.

Example CTM919:

[Sensors]

10=16 N WS_Vb Volt 0 0.000390625 0 0 0 0

[Calculated]

37= -1 WS3 Sampl Bottl 10 6 1 5 1 0

WS3	SDA-Type of calculation routine
Sampl	sensor designation "Sampler"
Bottl	Dimension “Bottl”
A[0]	SDA address of the feedback channel sensor
A[1]	n Number of bottles
A[2]	Ordinal number of the probe (according to sensor configuration), on which serial port the commands are sent to the probe.
A[3]	Waiting time in seconds, between 2 consecutive triggers. During this time, the triggering is locked.
A[4]	SDA address of the pressure sensor
A[5]	0

The feedback channel Sensor 10 in the above example contains both, the internal battery voltage of the Hydro-Bios control unit as well as the information about already closed bottles. With this information, the SDA creates a graphic with the schematic representation of a rosette and a pointer to the bottle to be closed next.

The battery voltage is contained in the upper 8 bits of this 16 bit rawvalue, while the status bits and bottle numbers are encoded in the lower 8 bits.

Bit 15 to Bit 8 = Battery voltage in tenths of volts;

Bit 7 to Bit 5 = Status: Motor running / N is n_max / is unlocked;

Bit 4 to Bit 0 = N = already closed bottles

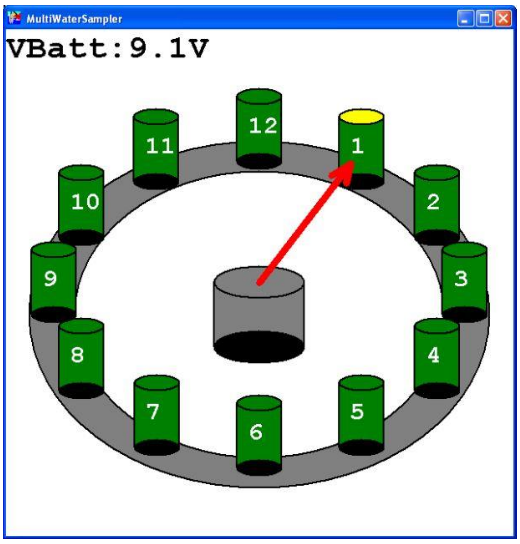
With this distribution of the available bits, it is possible to calibrate the feedback channel sensor 10 completely as a voltage value (in 1/10th volt), since the lower 8 bits of the raw value are lost in the decimal places when the battery voltage is displayed. The calculated WS3 sensor, on the other hand, only evaluates the lower 8 bits of the raw value and obtains information about the bottle status.

In this way, the probe can accommodate both informations on a single channel.

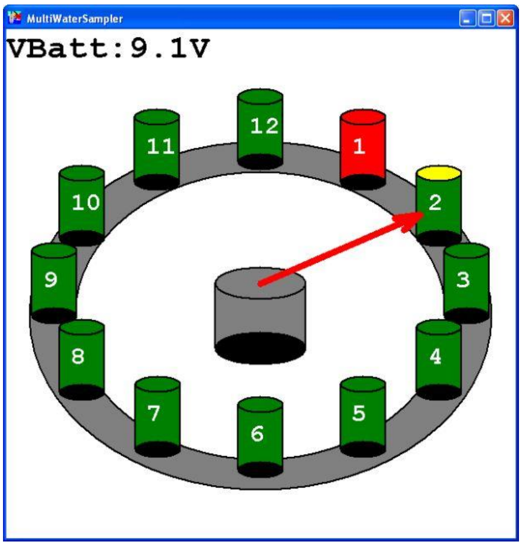
The water sampler triggering is achieved via the pull-down menu **"Options – Actors - Water Sampler - CTDxxx"**

To activate the Water Sampler just klick on the grey cylinder in the middle of the diagram. The next bottle will be closed. Go on until all bottles in the diagram are red. Now the releaser is locked.

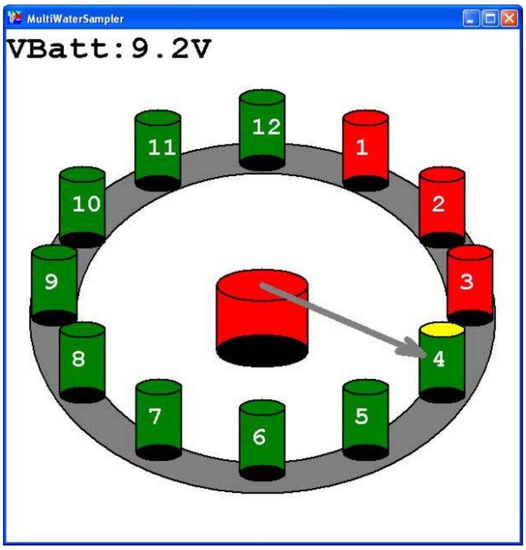
On the next pictures you can see some feedback diagrams of the water sampler:



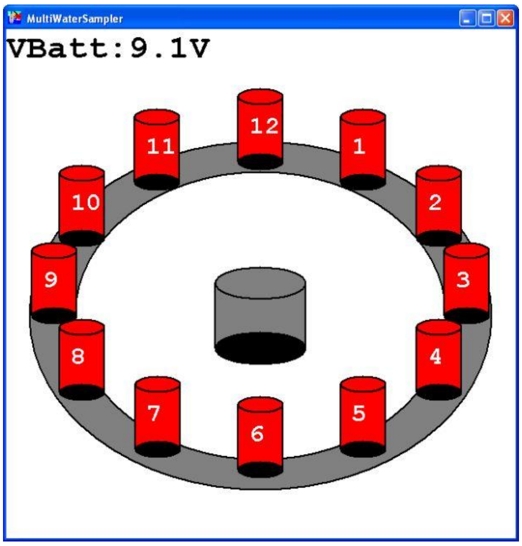
Communication with the WS present,
all bottles open.



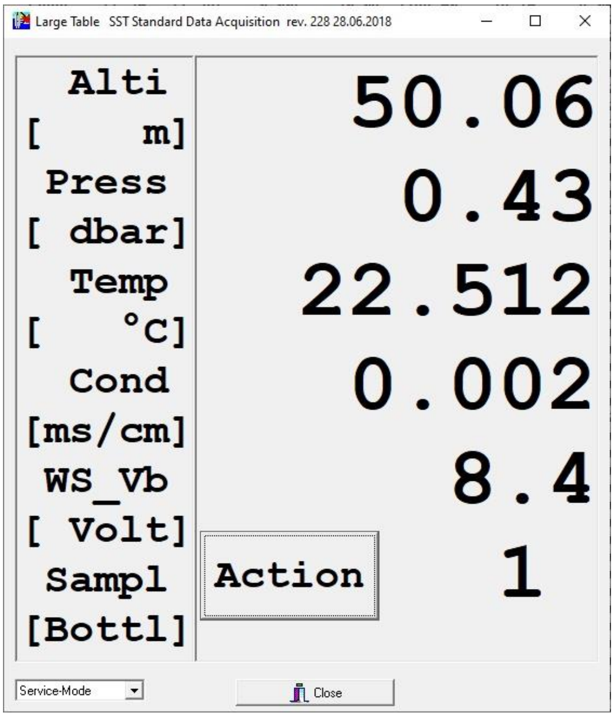
Bottle 1 closed.



Bottle 4 will be closed, the motor is still running. The motor-cylinder in the middle turns to red while motor is running.

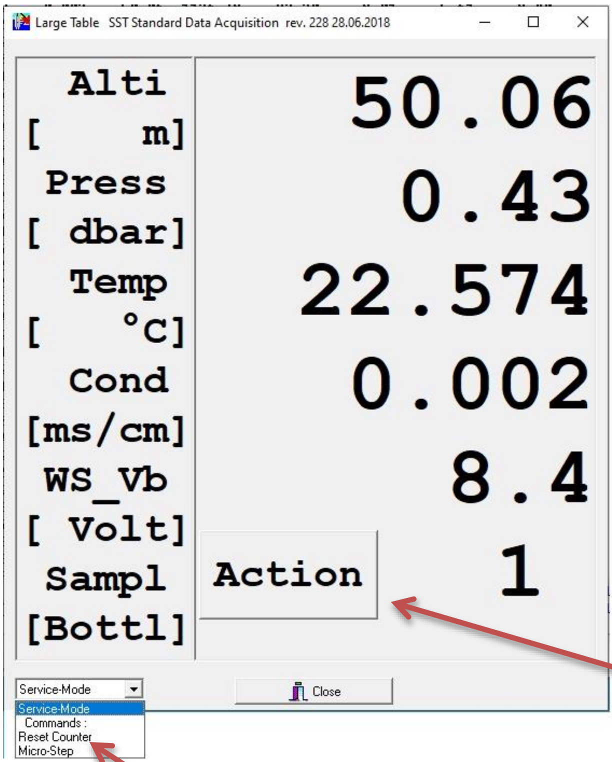


All bottles are closed. For a re-triggering the motor unit must be switched off and switched on again.



Display in “Large Table” mode:

Bottle 1 is closed.
The battery voltage of the motor unit is 8.4Volt



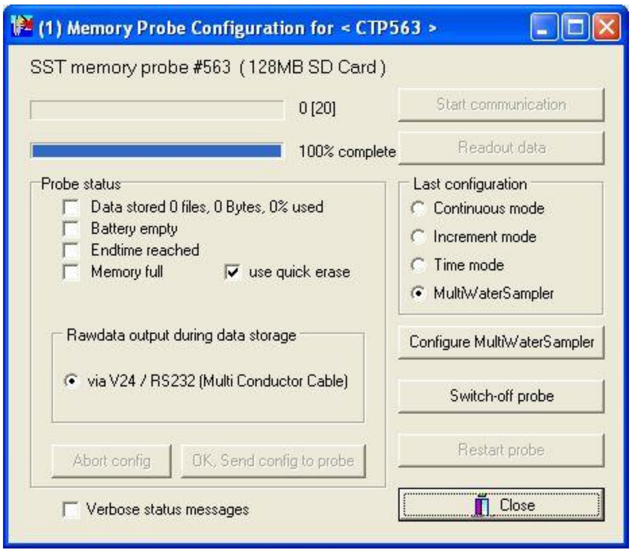
Click on „Action“-button to release the next bottle.

With “reset counter” in the pull down menue of the “Large Table” diagram the motor unit can be resetted.

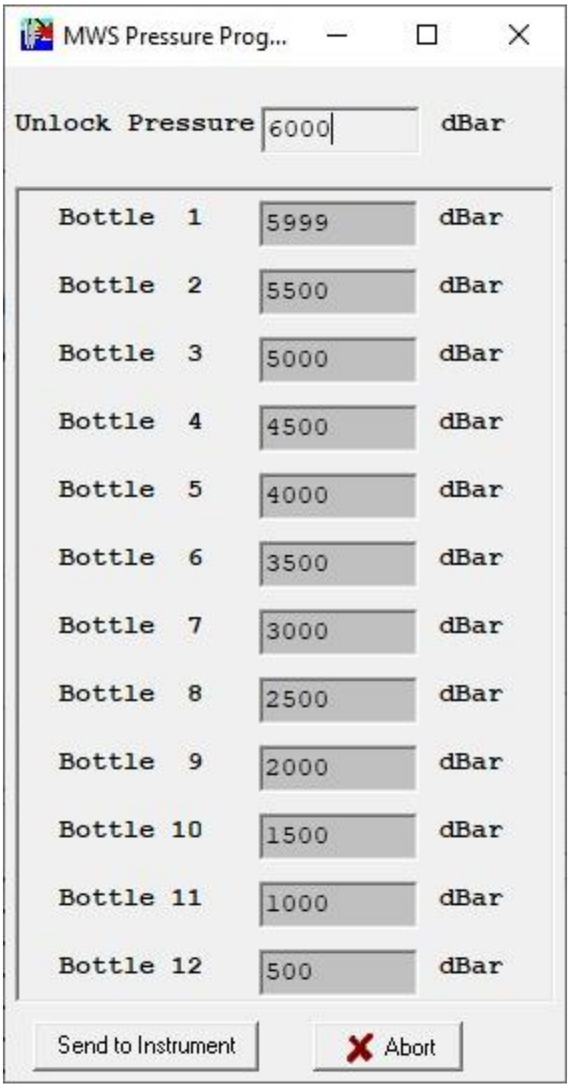
Warning!
Attention! Use the “Reset Counter” button only when all bottles are closed and the motor unit is locked. Otherwise the bottle / number assignment can be disturbed!

In the automatic triggering via a memory probe, the bottles are triggered after reaching the starting depth (highest value / maximum depth) during pulling up at the predetermined depths.

To configure the trigger depths, open the menu **"Options – MemoryProbe - CTMxxx"** in the SDA and then click on **"Start communication"**.



Here the menu item **"MultiWaterSampler"** is selected and then start to configure with **"Configure Multi Water Sampler"**



Now the unlock depth as well as the trigger-depth for the individual bottles can be entered.

After successful input, the data will be transmitted to the memory probe via the menu item **"Send to Instrument"**.

After reaching the “Unlock Pressure” dephts with the water sampler system all bottles will be closed at the individual depths during pulling up.

14.5 Probe configuration and data readout

A storage probe requires configuration before the probe can be deployed. For example, time has to be set, memory has to be read out and deleted, and the operating mode (continuous, incremental or time-dependent) has to be selected. To configure the storage probe, connect the probe with the SDA software using an RS-232 connection. After connecting the storage probe to the serial port of the PC and opening the SDA software, select "Accessories", "Storage probe" and "CTMxxx" in the SDA menu (xxx = serial number of the probe from the configuration files). The storage probe configuration window opens (Fig. 45).

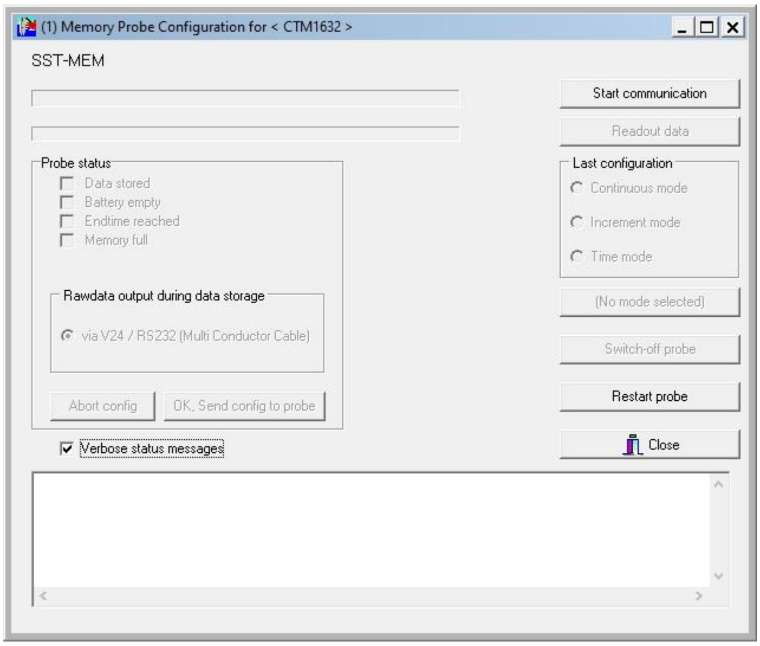


Figure 1: Start display of configuration menu of storage probe

Opening the configuration display stops the display of data although the probe continues transferring data.

Selecting “Start Communication” stops the data output on the serial interphase and switches the probe to command mode. The probe waits for input.

14.5.1 Short Description of the Operating and Display Panels:

In order to make operation easier for the user, the currently active and operable control elements and entries are marked in black letters. Control elements marked in gray are temporarily inactive and locked for any entries. They are activated (occur in black) if certain conditions prevail during the operating sequence.

- Start Communication

Figure 46 shows the first display, which allows contact to the probe and access to further options.

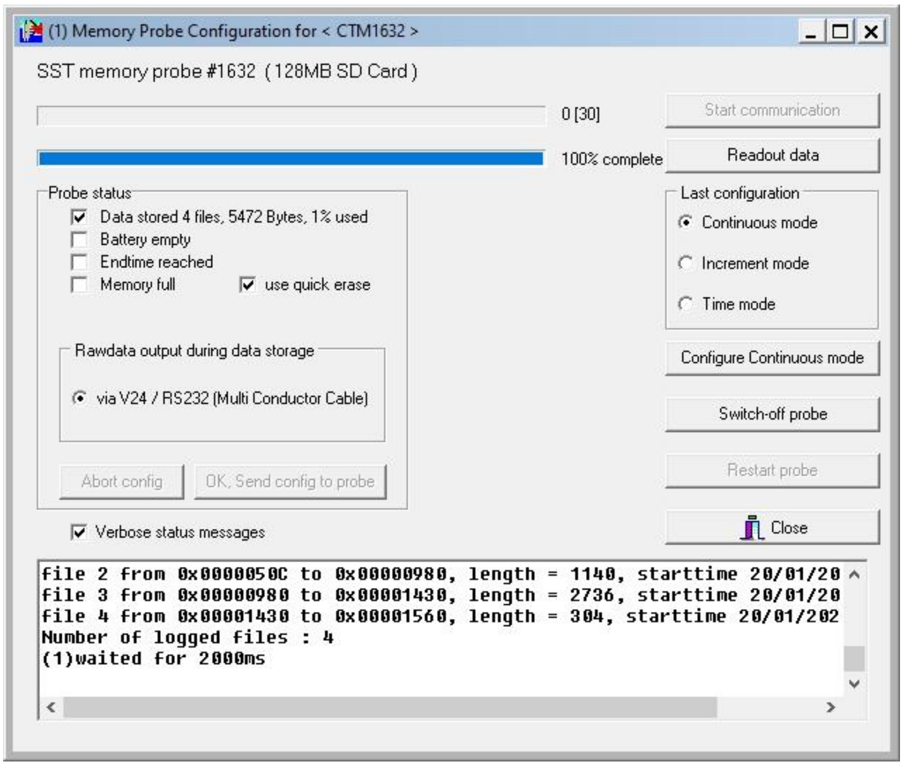


Figure 2: Display of configuration menu of command mode

Pressing the "Begin Communication" button (Fig. 45) puts the probe into command mode. The probe stops transferring data via the serial port. The SDA software queries the probe to determine the state of the probe. The two progress bars in the top left of figure 46 move and if the time deviation is greater than 60 seconds, the following message appears:

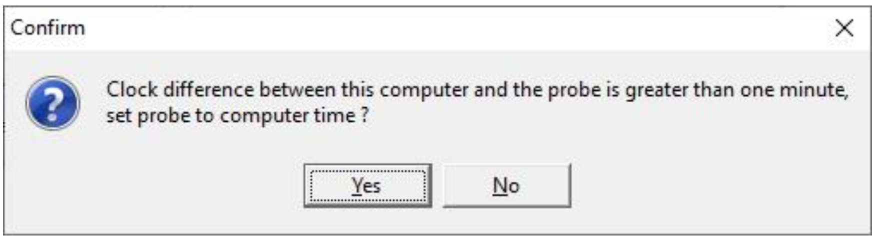


Figure 3: Time setting

If you click on "**Yes**", the probe automatically sets the time to the PC time. If you click on "**No**", the difference remains. If a probe is prepared for a measurement, the PC time is forwarded to the probe, because the probe would otherwise record a time that differs from the PC time during the measurement.

The connection between SDA-software and probe is established, if a status message with the following inputs is displayed in the top left of the window:

„SST memory probe #xxx (yyyMB company)

xxx = serial number of the probe

yyy = size of memory in Mbytes

Company = manufacturer of the memory chip (Samsung, Toshiba or similar).

If any of these information are missing, there is a serious technical problem, and in most cases the probe has to be returned to the factory for service.

- Read Memory

If there are any measurement data in the internal memory of the storage probe, the data should always be read out first. Once the probe is prepared to receive new configuration settings, any existing measurement data on the probe will be erased. The "Read out memory" button is only active if there are measurement data on the internal memory of the probe, otherwise this button is inactive (displayed in gray). The rest of the process is described in section 6.2 "Reading out the measurement data".

- Last Configuration

By changing to command mode, the SDA program queries the probe about its status. In the checkboxes labeled "Last configuration" the last used storage mode is displayed. The user can keep the storage mode or select another checkbox. Depending on the selected mode, further settings are commonly required. These settings are made by pressing the "set <mode>" button. <Mode> is thereby replaced by the respectively selected mode. See section 6.3 Configuration of data storage modes.

- Status of the probe

The SDA program determines the status of the probe by querying it and displays the status with the help of the 4 checkboxes under the label “Probe Status.”

There are the following checkboxes:

- Stored data (with additional information: number of files, total size of files, disk space usage)
- Battery depleted (when the switch-off voltage is reached, the probe switches off)
- End time reached (probe switches off when reaching the end time in time mode)
- Memory full (probe continues), no data is overwritten

- Feature “use quick erase“

When the "Set <Mode>" button is pressed in the probe configuration window and subsequent query is confirmed to prepare for transfer of configuration settings to the probe, the probe's internal measurement data memory is always deleted first. The memories are organized in blocks, each block (page) contains 512 bytes. If a large memory is completely erased, the erasing process takes many minutes. If you use the "quick erase" function, only the previously described part of the memory is erased. This procedure generally takes much less time than clearing the entire memory. With a check mark in the corresponding checkbox "use quick erase" the duration for a reconfiguration of the probe is significantly reduced.

- Raw data output during storage

This checkbox is irrelevant in measurement systems with the firmware version of the probe CTD_2.9a and newer SDA versions. Depending on the mode set, the raw data are usually output on the serial interface parallel to the data storage. This process cannot be further controlled and the check box always appears checked.

In previous versions of the SDA software, in combination with previous firmware versions of the probes, it was possible to select whether or not to output the probe data on the serial interface to the PC parallel to the internal data storage. This is not possible with the firmware version of the probe CTD_2.9a.

Reading of Measurement Data

Pressing the **“Read memory”** button initiates the reading process of the measured data. The probe sends the measured data via the serial port with 115 kBaud to the PC. The stored measurement data are divided into memory data sequences in the probe. After reading the memory and transferring the measurement data from the probe to the PC, each individual memory data sequence is stored on the PC in a file with the file name extension .srd.

Depending on the size of the memory data sequences and the performance of the PC, the transfer can take up to more than 2 hours at 128 Mbyte. Once all data has been transferred to the PC, the **“Save as”** window will open.

Here you can set the directory for storing the .srd measurement data files. The default directory is **\SST_SDA\rawdata**. The filenames of the measurement data files can also be specified in this window. By default, the SDA software offers a string of characters with an underscore followed by a run number.

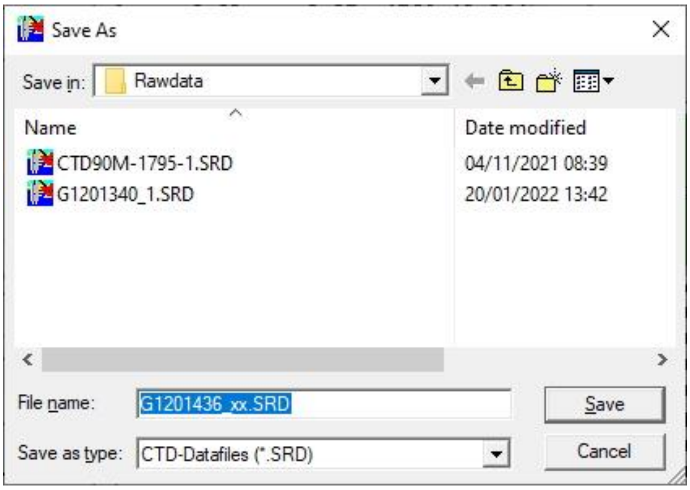


Figure 4: Save as

If there are several memory data sequences in the probe, all memory data sequences are transmitted to the PC in one block. However, each single transmitted memory data sequence must then be stored in a separate measurement data file. The file names for these memory data sequences can be generated by the SDA software with the help of the serial numbers. To do this, you must first answer the corresponding query with **“Yes”** in the confirmation window as shown in Figure 49.

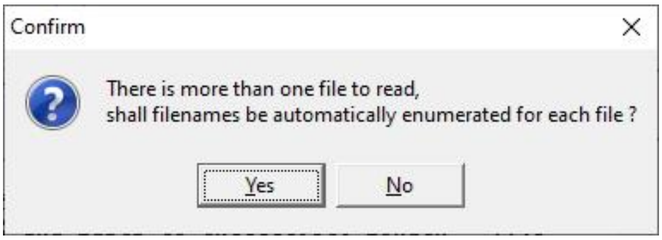


Figure 5: Automatic numbering of measurement data files

If the answer to the above question is **"No"**, the **"Save As"** window in Figure 48 is opened after each individual file and a file name with appropriate numbering is suggested. Each file with its own name is then saved individually. Please not, that only characters permitted for Windows-filename are allowed for the filename.

A further query during data readout is whether additional information should be entered in the file header (Figure 50). Information on editing the header can be found in Section 5.2 (Fill the header submenu). Depending on the choice of numbering (automatic or manual), this query takes place only once (automatic numbering) or each time (manual numbering).

Figure 6: Query "Fill File Header"

If you do not want to enter information in the file header, you still have the option to include this information in the file name.

14.5.2 Configuration of data storage modes

Generally, a configuration is carried out in 5 steps:

- Switch the probe to command mode
- Determine the status of the probe (and read out previously recorded measurement data if necessary)
- Select the new data storage mode and other settings
- Transfer the new configuration from PC to probe
- Exit command mode (and switch the probe to active mode if necessary).

Never disconnect the cable between PC and probe while the probe is in command mode.

If the measurement data stored on the probe from a previous measurement task has been read out, the configuration for the next measurement task can be carried out.

The probe has three configurable data storage modes:

- Time mode
- Increment mode
- Continuous mode.

14.5.2.1 Continuous Mode

It is the easiest data storage mode to program: all data is recorded at the fastest possible speed (record rate as in RS232 online mode) and, if necessary, transmitted via the RS232 interface of the probe. No serial data is output without a connected PC, because the RS232 driver of the probe only sends data if it detects a valid level on the RxD line.

If necessary, set the marking in the marking field “use quick erase” for the fast deletion of the internal measurement data stores.

In the **“Last configuration”** check box, select the option **“cont. mode”** and press the button **“Set Cont. mode”**. The following warning message appears immediately:

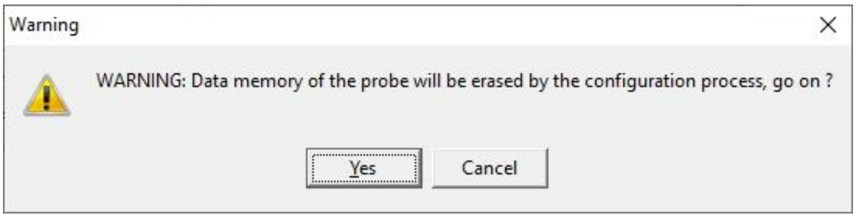


Figure 7: Warning

If the old measurement data has already been read out, the answer may be **“Yes”**, otherwise click on **“Cancel”** and read out the measurement data of the probe first.

Once the question is answered with **“Yes”**, the data is prepared for the probe and the progress bars signal the ongoing process. The button **“Transmit OK to Probe”** is activated (identified by the black font). A mouse click on the field starts the transmission of the configuration data to the probe. The actual configuration is now finished.

Exiting command mode

To exit the command mode, press the **“Enable/Off”** button. This switches the probe to the sleeping sub-state of the just configured mode.

The probe can be brought into the active sub-state of the mode just configured via the "Restart probe" button or by actuating it with the magnetic wand. The probe then sends measurement data via the serial interface depending on the configuration. As long as the "(N) Probe configuration for <XXX>" window is not closed, no newly received measured values are displayed by the SDA software in the windows for measured value display. If necessary, close the "(N) Probe configuration for <XXX>" window.

14.5.2.2 Increment Mode

The increment mode essentially serves data reduction and uniform standardization in the display of the measurement series without the need for extensive post-processing. The procedure is similar to that described in Section 6.3.1 above.

If necessary, check the “use quick erase” check box for the fast deletion of the internal measurement data memory.

- Select increment mode
- Click the button “Set Increment Mode”
- Warning appears: Data memory will be deleted → **Yes**
- The window “(N) settings for value-controlled recording” opens (Figure 52)

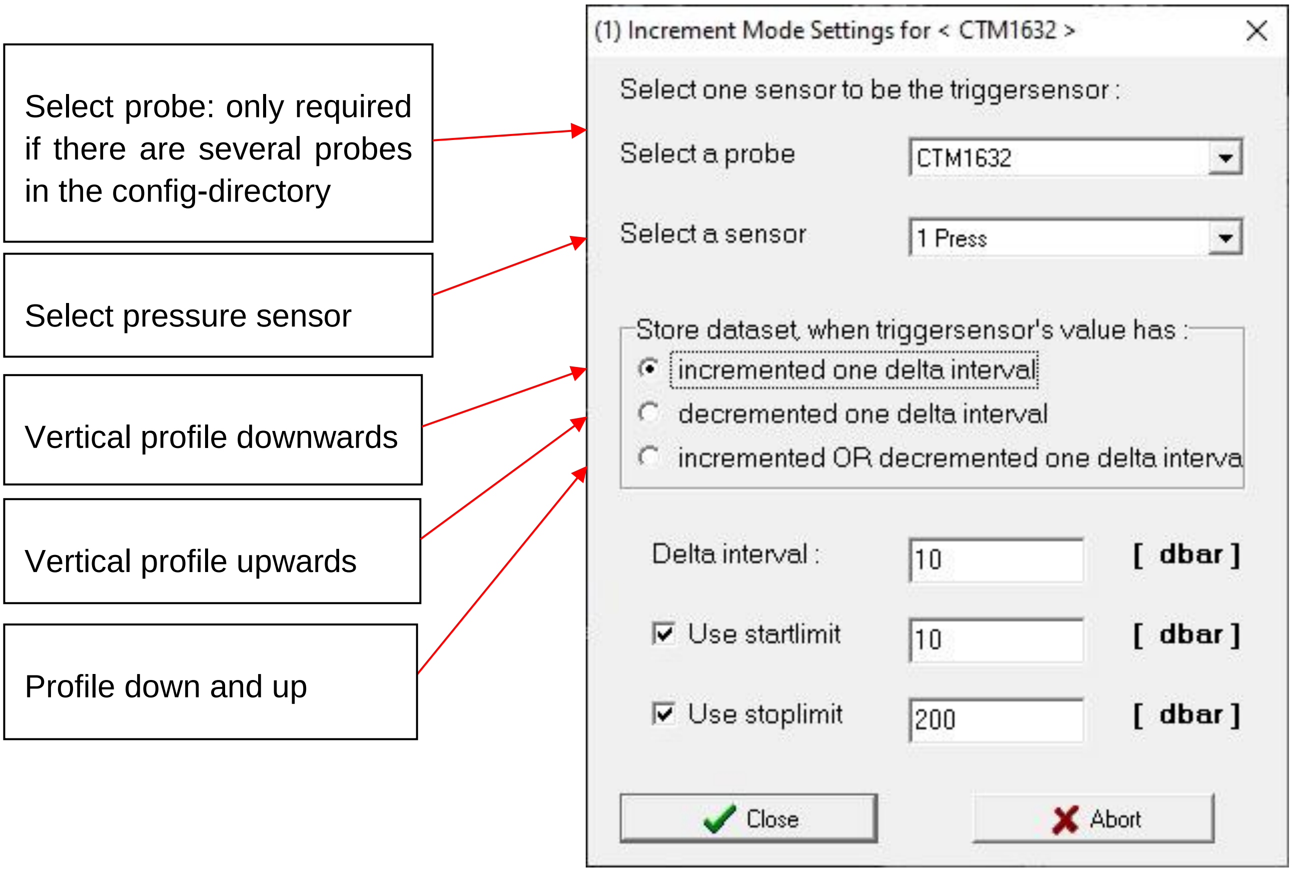


Figure 8: Window increment mode

The input fields for start and stop value open when the associated check boxes are marked.

The numerical values for increment, start and stop value are edited directly in the input fields.

In Figure 52, an example of a profile measurement from the water surface to a depth corresponding to 50 dbar is programmed. The first record is saved when the pressure measurement value of 0 dbar is reached for the first time. Every 5 dbar a further data record is stored. The last data record is stored when the pressure measurement value of 50 dbar is reached for the first time. After that, no further records are stored in the memory data sequence. The recorded memory sequence consists of a total of 11 data sets.

It is also possible to select one of the following entries via the checkboxes under the heading “Save data record if the measured value…”:

1. “increased by a delta interval (referred to as “vertical profile downwards” in the screenshot above, hereinafter referred to as increment mode in simplified terms)
2. “decreased by a delta interval (referred to as the “vertical profile upwards” in the screenshot above, hereinafter referred to as the decrement mode)
3. “increased or decreased by a delta interval (referred to as “profile up and down”, hereinafter referred to as increment-decrement mode).

Please note:

1. The input for delta intervals must always be positive (no minus sign).
2. The entry of start or stop value is not mandatory. The first record is then saved after switching on the probe.
3. In increment mode, the start value must always be smaller than the stop value.
4. In decrement mode, the start value must always be greater than the stop value.
5. In increment decrement mode, no start or stop values are allowed and the input fields remain locked.

After all entries have been made, the window “Settings for value-controlled recording” has to be close by pressing the “Close” button. The configuration must then be transmitted to the probe. To do this, press the button **“OK, transfer to the probe”** in the configuration window.

Then press the **“Enable/Off”** button. Thus, the memory probe leaves the command mode and switches to sleep increment mode.

- Practical implementation of the measurement

The measurement is started by using the magnetic rod; thus a new memory data sequence is opened in the memory for recording the measured data. When the probe is lowered, data are recorded at the pre-programmed intervals until the final depth is reached, as indicated in the “Use Stop Value” input field. When the final depth is reached, the recording is terminated and the probe is switched off automatically. If the final depth has not been reached, the probe has to be switched off with the magnetic rod after pulling the probe out of the water. The memory data sequence is closed at the same time.

If you want to record an additional data sequence after the first profile has been taken, the probe must be switched on again with the magnetic rod. Then, the next memory sequence is opened and the next vertical profile can be collected. This way up to 255 data sequences can be recorded in the probe memory.

Please note, that if the final depth cannot be reached, the memory data sequence is correspondingly shorter, because then the unreached depth values are missing. The ascending measurement profile is not recommended, because the sensors do not record data from freely flowing water (due to pulling the instrument up, water gets already mixed) and therefore the fluctuations of the measurements are greater.

14.5.2.3 Time Mode

The time mode is particularly important for long-term measurements, as battery and storage capacity allow only data recording over a certain period until the battery runs empty or storage capacity is exceeded. The probe measures in a pre-selected time frame and switches off during the intermediate measuring breaks (in sleep time mode). In this way, as in 6.3.2, data reduction is achieved. The procedure is as follows:

If necessary, check the “use quick erase” check box for the fast deletion of the internal measurement data memory.

- Choose time mode
- Click the "Set time mode" button
- Warning appears: Data memory will be deleted → **Yes**
- The "(N) Time Mode settings for <XXX>" window opens (Figure 53).

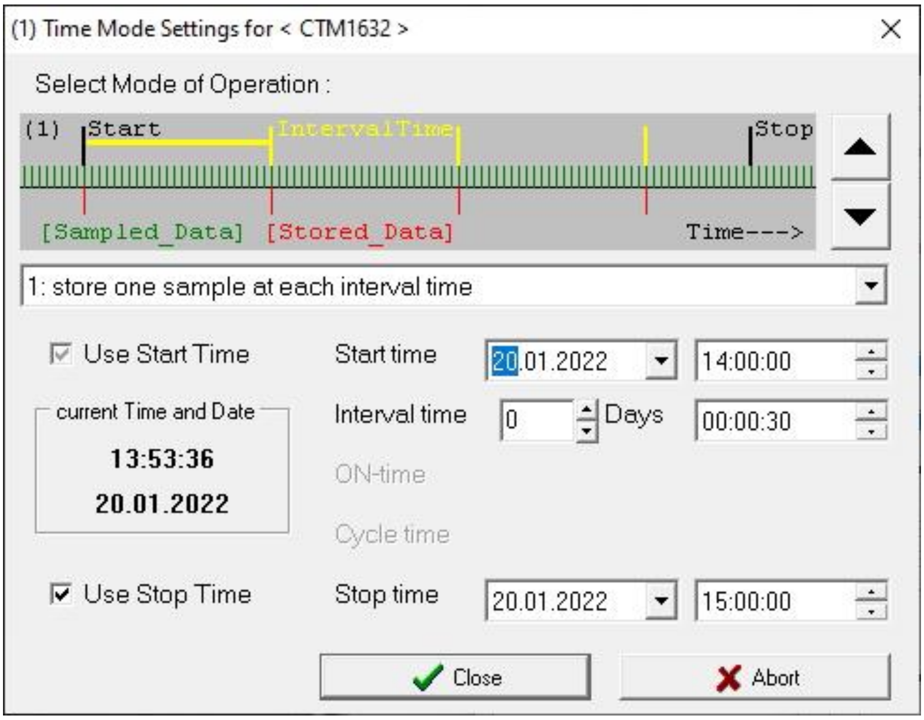


Figure 9: Window Time Mode

It is also possible to select one of the following entries via a list box under the heading “Save – Select Mode:”:

1. One record per interval time (hereinafter referred to as storage mode 1)
2. All records during the ON time (hereinafter referred to as storage mode 2)
3. One record per cycle during the ON time (hereinafter referred to as storage mode 3).

To set the save mode, click the▲+▼ button to the right of the graphic or click the▼ button in the selection box below.

The graphic display serves to provide an easy overview of the description. Different colors display different time settings (Figures 53-56):

Green	each record is marked by a vertical dark green line
Black	start and stop time of the measurement are marked by a vertical black line
Yellow	measurement time grid, each vertical yellow line represents an interval
Red	stored records (vertical red lines)
Blue	ON-time, duration characterized by horizontal blue line.

Select the appropriate storage mode and make further settings. Details are described in sections 6.3.3.1, 6.3.3.2, 6.3.3.3, and 6.3.3.4 below.

After all entries have been made without errors, close the "(N) Time Mode Settings for <XXX>" window.

Then, transfer the configuration to the probe. To do this, press the **"OK, transfer to probe"** button in the configuration window.

Afterwards exit the command mode. To do this, press the **“Enable/Off”** button. The probe is then in sleep time mode.

There are different **memory modes** within the time mode.

14.5.1.1 Time Mode – Storage Mode 1

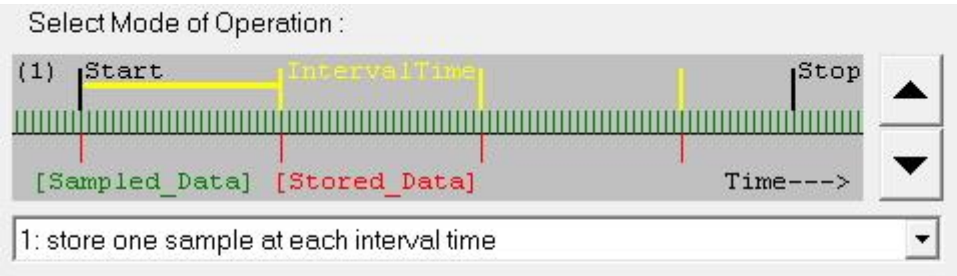


Figure 10: Time mode – storage mode 1

Exactly one record is stored at each time interval.

14.5.1.2 Time Mode – Storage Mode 2

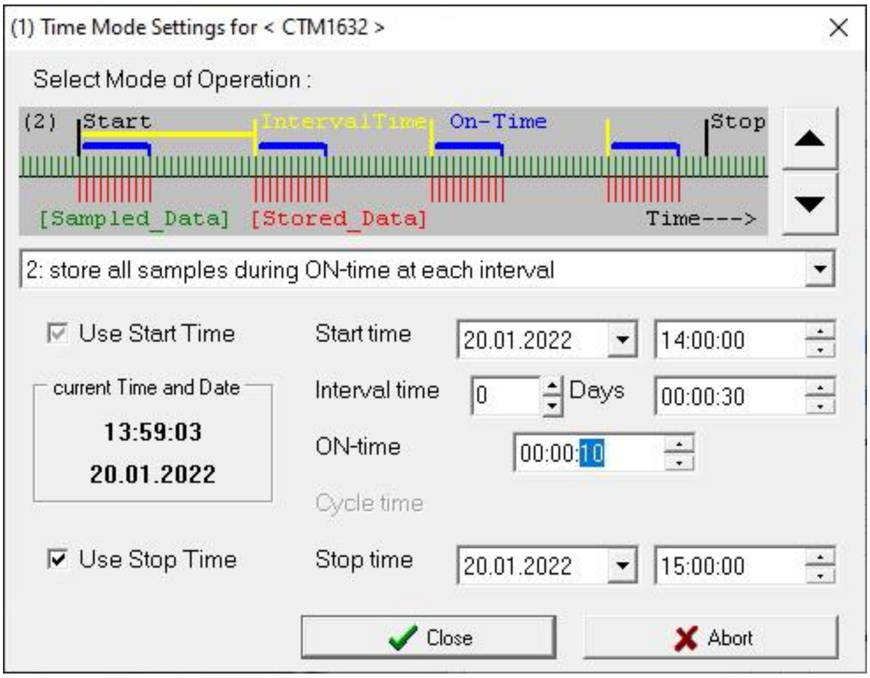


Figure 11: Time mode – storage mode 2

All records are stored during the ON-time of each interval. Selecting storage mode 2 opens the input field for the ON-time; the input is done in hours, minutes, and seconds.

14.5.1.3 Time Mode – Storage Mode 3

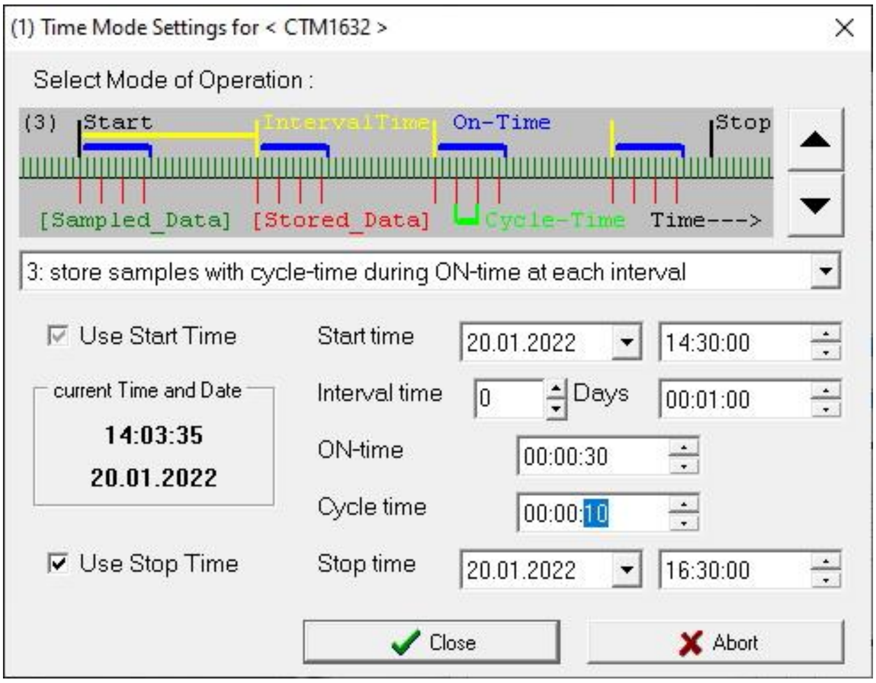


Figure 12: Time mode – storage mode 3

One record is stored per cycle time during each ON-time. When selecting storage mode 3, the input fields for the ON-time and the cycle time are opened; the cycle time must in any case be less than the ON-time; it is represented graphically by the spacing of the red lines. The input format is the same for both times.

14.5.1.4 Notes on Settings in Time Mode

The entry of the start time is mandatory for all storage modes within the time mode, therefore the checkmark in the check box is always set. The start time should always be far enough ahead of the current PC time to complete the configuration and prepare the probe for the intended use. The current PC time is displayed in the time mode setting window (below the selection box). The default start time is 5 min after calling the "(N) Time Mode Settings for <XXX>" window. At the time of closing the window, the remaining time between the set start time and the current PC time must be greater than 1 min, otherwise an error message appears and the selected setting is not accepted.

Time grid: Entering an **interval time** is also mandatory. The interval time must not be zero, otherwise an error message will appear when leaving the window.

ON-time: In storage modes 2 and 3, a window will open for entering the ON-time. In any case, this time must be less than the interval time and greater than zero. Otherwise, an error message is displayed.

Cycle time: In storage mode 3, a window for entering the cycle time will open. The cycle time must be greater than zero and less than the ON time, otherwise an error message will appear when leaving the window (Figure 57).

Stop time: This time can be entered optionally by clicking in the corresponding check box and entering the time in the corresponding input field. The stop time must be after the start time, otherwise an error message will appear.

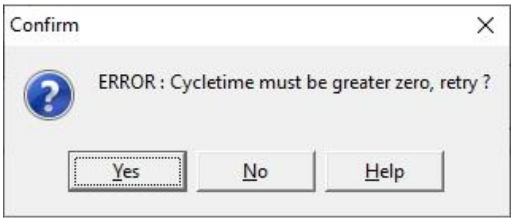


Figure 13: Error message (example)

All different error messages should be acknowledged with **"Yes"**, then the SDA program jumps back to the "(N) Time Mode Settings for <XXX>" window and the errors can be corrected. If you answer **"No"** by mistake, the SDA software jumps back to the configuration menu of command mode (Figure 46) and you have to end the configuration with **"Config Cancel"**.