# CTD90M – Probe

## Manual and operating instructions

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Contents

## 1. General description

The CTD90M memory probe is a microprocessor controlled multiparameter probe for precise online measurements as well as for self-contained operation in deep and shallow water. Apart of the CTD sensors it is possible to interface a number of chemical, physical and optical sensors and instruments. The housing of the probe is pressure resistant up to 500m depth, the maximum allowable operation depth depends on the sensors line-up. In spite of its relative big size the standard CTD has a weight of approximately 4,5kg due to the fact that it is completely made of titanium. The housing is inert against nearly all chemical compounds (except hydrofluoric acid) and absolutely corrosion free.

The housing diameter of 89 mm allows a maximum of 9 sensors or external units to be connected to the bottom cap. Additional sensors or instruments can be attached externally to the probes top cap (maximum 2 external instruments).

The standard CTD90M allows operation in different modes:

Time mode
Increment mode
Online (FSK or RS232C)

Time mode is is the most important mode for long term measurements, where the operator selects start and stop time and the measuring time interval.

Increment mode is mainly used during profiling and enables the user to carry out a great number of profiles without reading out the stored data files in between. After configuration of start and stop depth and the measuring depth interval the probe will store one data set at each predestined depth.

In online mode the CTD90M runs on standard single conductor cables with constant current, the measurement readings are transmitted as FSK-signals modulated on the DC supply current. This method of operation requires a specific probe interface which generates the constant current and convertes the FSK-signals into PC-compatible RS232-signals. This mode of operation allows the releasing of multi water samplers and plancton multi nets and to recognize the status of these units (number of bottles closed or number of net changes).

For shorter distances (several hundred metres) a multicore cable can be used. The probe is then supplied with constant voltage (battery or DC power supply).The PC received data directly from the probe as RS232C-signal. A specific interface is not required by this mode of operation.

The CTD90M is equipped with a 16 channel data aquisition system with 16 bit resolution. A high long-time stability and automatic self-calibration of the 20 bit analogue digital converter guarantees stable and precise CTD measurements for many years.

## 2 Mechanical characteristics

All parts of the probe, which are exposed to seawater, are made of corrosion-proof metals or plastics. Essentially the probe consists of the following mechanical structural components:

Housing: - Pressure tube
- Probe base
- Probe lid

Sensor protection cage
Sensors

The sensors are described in a separate chapter. The underwater housing consists of a cylindrical tube closed on both ends with caps and sealed with two O-rings each.

### 2.1 Pressure tube

The pressure pipe is made of a solid-drawn seamless titanium tube with an external diameter of 89 mm, a wall thickness of 3 mm and is able to withstand more than 500 m water depth. There are 4 holes ∅6mm in 90° graduation 6mm away from both tube ends. These holes are used for fixing both end caps of the housing to the pressure tube. Pressure pipe and end caps are sealed by two O-rings 76*2,5mm each.

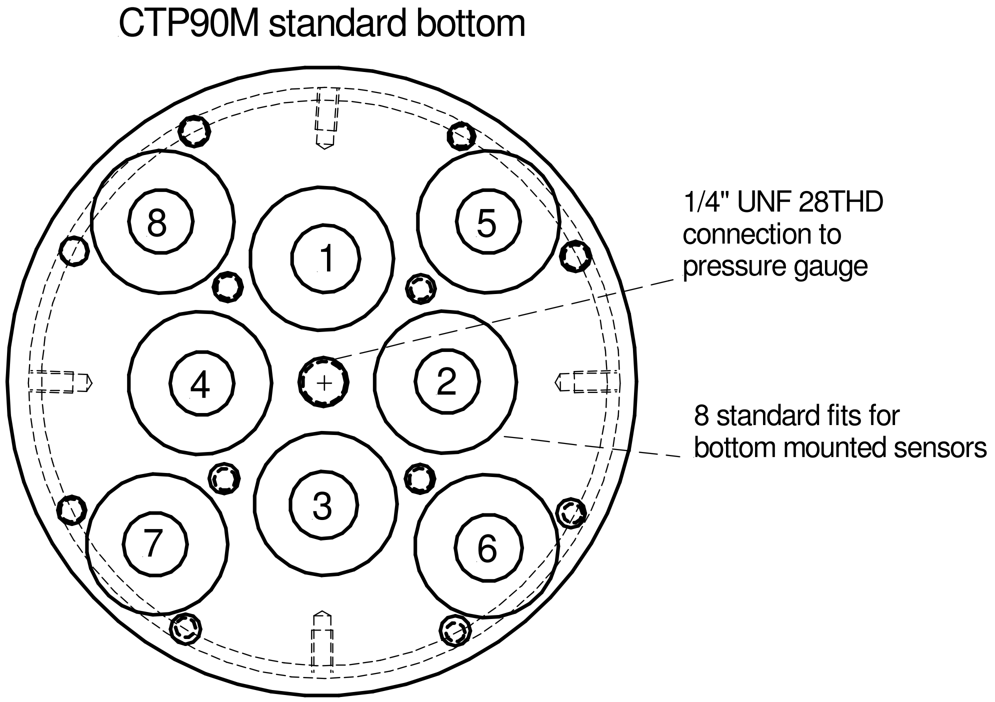
### 2.2 Probe base

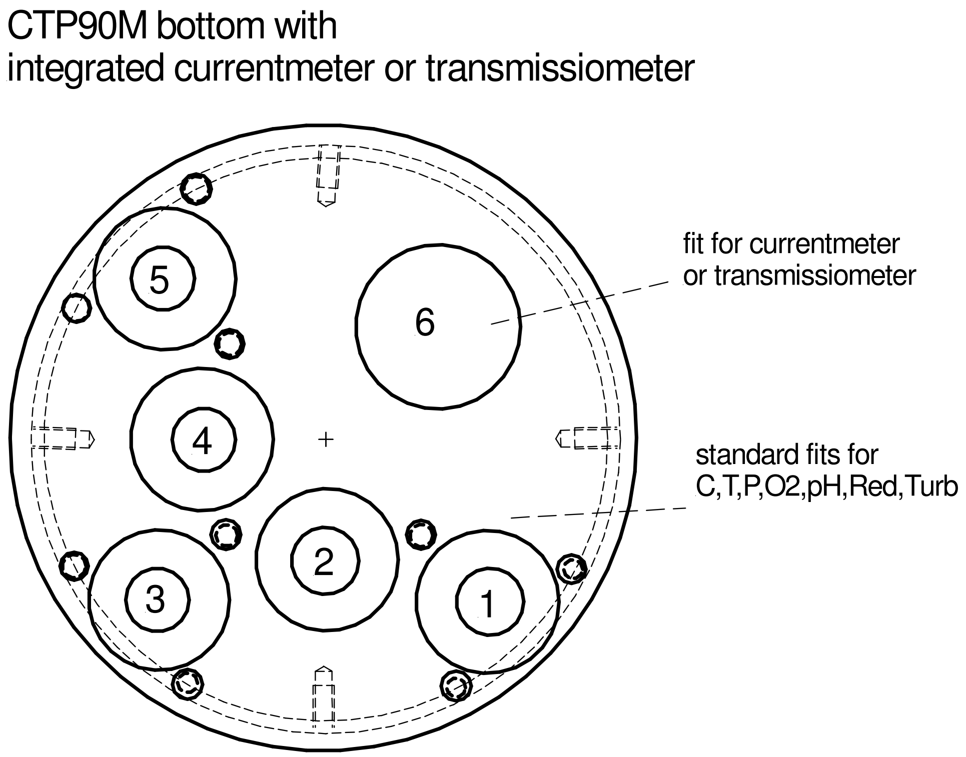
The probe base is made of solid titanium and is used for the attachment of nearly all sensors. Fig.1 shows the principle arrangement of the sensor positions.

Standard probe

The base offers space for 9 sensors: the pressure sensor is always mounted in the centre position. For the remaining sensors there are 8 fits. The sensors are inserted into these fits; the M4-tapped holes situated between the fits are for fastening the sensor flange with M4-screws. All sensors (except the pressure sensor) have identical flanges. The pressure transducer is inserted to the base inside and held by a M18*1 nut against the pressure from outside. A ¼"UNF28THD tapped hole is for connecting the base to a pressure gauge so that the pressure sensor can be calibrated when installed.

Figure 1


CTP90M standard bottom
8
1
5
4
+
2
7
3
6
1/4" UNF 28THD
connection to
pressure gauge
8 standard fits for
bottom mounted sensors


CTP90M bottom with
integrated currentmeter or transmissiometer
5
6
4
+
2
3
1
fit for currentmeter
or transmissiometer
standard fits for
C,T,P,O2,pH,Red,Turb

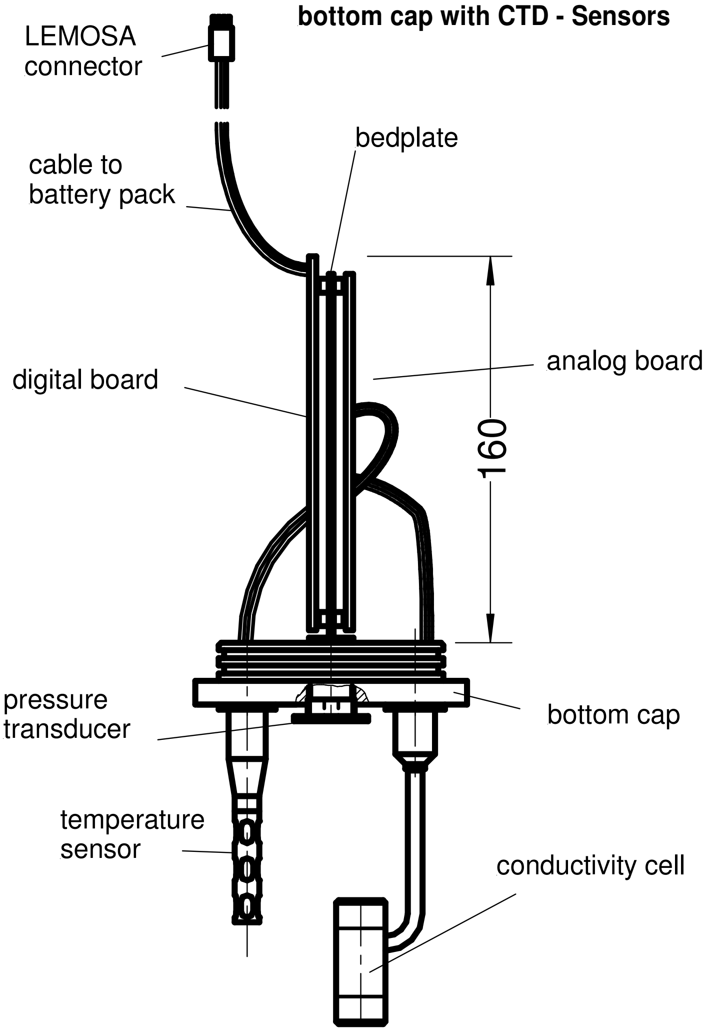
CTD90M probe with integrated current meter or transmissiometer

The flange of the current meter and transmissiometer have a diameter of 40 mm and requires more space on the bottom than the standard sensors (approximately 25 mm diameter). It is not possible to mount the pressure transducer in the centre position. Hence the pressure sensor get its own housing and is plugged in one of the five remaining standard fits. The calibration connection thread for the pressure gauge then has the ISO size M8 * 1,25 mm.

The printed circuit boards (PCB) are screwed on a bedplate made of 1,5 mm aluminium sheet which is mounted on the inside of bottom cap.

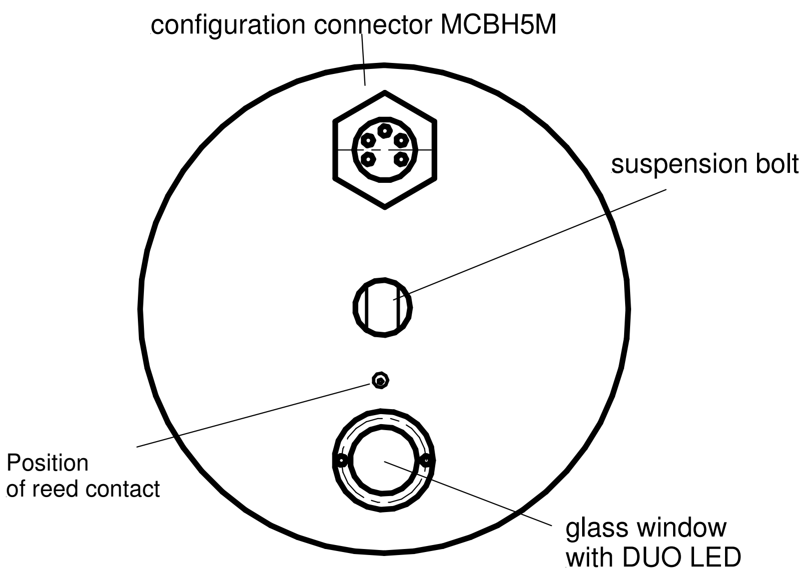
Lid and pressure tube are sealed by two O-rings 76 * 2,5mm and are bolted onto the side with 4 screws M3*4.

**bottom cap with CTD - Sensors**



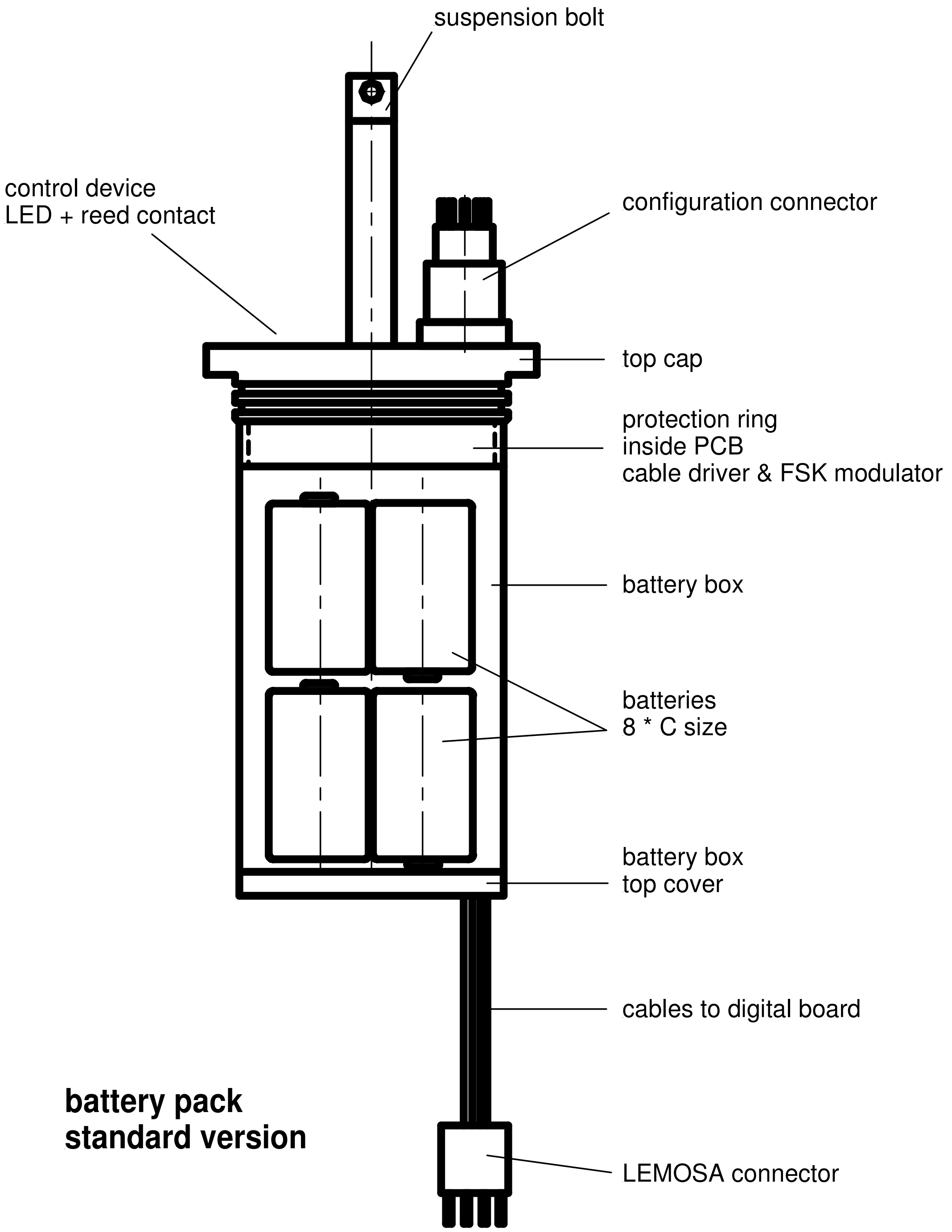
## 2.3 Probe lid

The lid has the same dimensions as the base and is also made of titanium. Fastening and sealing are identical to that of the base. Screwed into the lid is a supporting bolt with a loop for hanging it onto a shackle. The standard version includes one underwater bulkhead connector SUBCONN MCBH5M which is used for communication (configuration and data readout) and external power supply and one operating control device. The control device consists of a two colour LED for the display of operation conditions and messages and a magnetic switch (reed contact) to turn on and off the instrument. The Duo LED is located behind a pressure resistant glass window, the position of the reed contact is marked by a small borehole in the top cap surface.




The battery box is fixed directly on the inside of the top cap. A circular printed circuit board is mounted between lid and battery box. It contains the the cabel-driver circuitry and FSK modulator and all the necessary wiring of connectors, control device and battery pack. The connection to the probe electronics is established by a separable 10 wire cable-connection.

Top cap with battery box



## 2.4 Sensor protection cage

A sensor protection cage made of 6 mm titanium rods with a diameter of 120 mm and a length of 220 mm is delivered with the standard version. The protection cage protects the sensors on the water-floor against shocks and ground contact and guarantees a fine water-flow through the sensors. The protection cage is fastened with a single screw at the lower end of the pressure pipe. As option any other size can be supplied. The version with integrated current meter is supplied with a big size protection cage of 780mm length and 220 mm diameter covering the complete probe.

## 2.5 CTD90M dimensions and weights

pressure tube

| | |
|---|---|
| material: | titanium grade 2 |
| length: | 390 mm |
| diameter: | 89 mm |
| wall thickness: | 3 mm |
| depth capability: | 500 m |

bottom cap:

| | |
|---|---|
| material: | titanium grade 2 |
| diameter: | 89 mm |
| thickness | 30 mm |

top cap:

| | |
|---|---|
| material: | titanium grade 2 |
| diameter: | 89 mm |
| thickness: | 30 mm |

protection cage

| | |
|---|---|
| material: | titanium grade 2 |
| diameter | 150 mm |
| length | 200 mm |

standard probe:

| | |
|---|---|
| gross length | 650mm |
| total weigth | 4,8 kg |
| bouyancy | 2,7 kg |

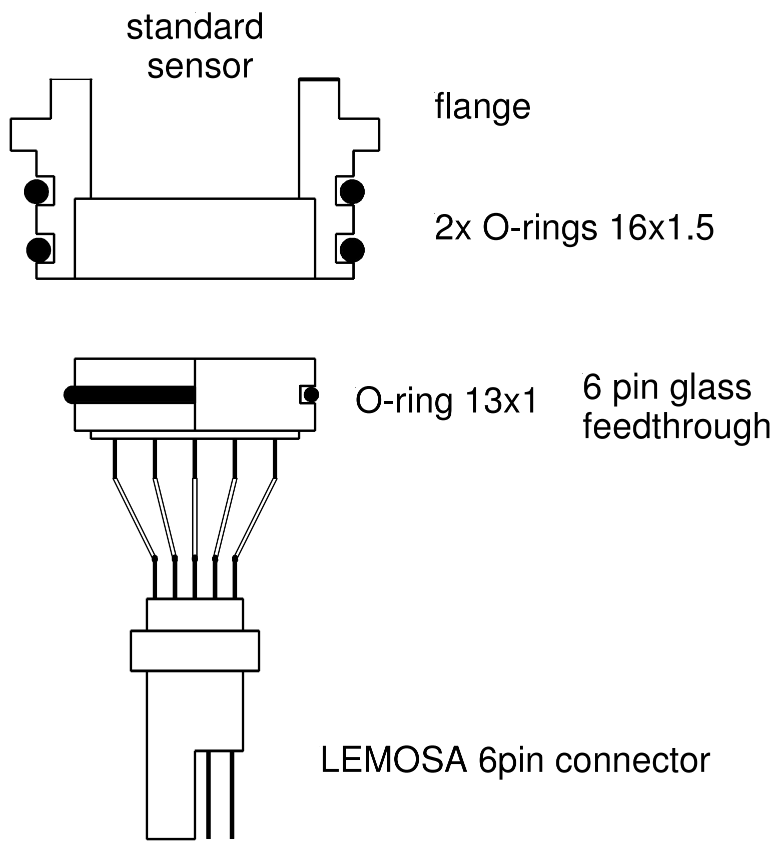
# 3 Sensors

The CTD90M has a maximum of 16 analogue channels and 8 digital inputs or outputs for the connection of different sensors. A maximum of 9 sensors fit onto the bottom. The other sensors or instruments have to be connected externally via additional underwater plugs in the sensor lid.

The following sensors can be accommodated in the sensor-base (bottom mounted sensors without cable connection)

- Pressure transducer
- Ground runner
- Temperature sensor Pt 100
- Conductivity cell
- Oxygen sensor
- Ph and redox sensor
- Seapoint turbidity meter

The standard sensors have the same flange with an integrated six-pin glass feed through (400 bar) equipped with a small six-pin round connector (see figure below). All of these sensors can therefore be removed from the outside and can easily be replaced without having to open the probe.



External sensors

with analogue outputs and cable connection to the top cap of the CTD90M

fluorometer (Seapoint, TRIOS, Cyclops7)
current meter (hs engineers)
transmissiometer
light sensors (LI-COR)
multi water samplers (Hydro-Bios)
multi plankton nets (Hydro-Bios)
fast oxygen sensor (AMT), also available with standard flange
$H_2S$ sensor (AMT), also available with standard flange
methane sensor (CAPSUM)

can be attached and operated as external sensors. Power for external sensors has to be supplied by the CTD90M. Standard supply voltage is 12 volt; supply up to 26 VDC is possible.

## 3.1 Pressure transducer

A piezo-resistive full bridge in OEM version with a diameter of 15 mm and a total height of 6 mm is used as pressure transducer (produced by the Swiss manufacturer KELLER). The casing and diaphragm are made of alloy C276. The transducer is delivered with a small SMD-PCB and includes a temperature compensation of the pressure measurement. The sensor is mounted in the base of the probe; the SMD-board has contacts and is plugged onto the main board of the probe.

Pressure transducer

Technical characteristics

| | | |
|---|---|---|
| - | Manufacturer | KELLER, Switzerland |
| - | Model | PA7-XXX Progress<br>(XXX:= full scale range in bar) |
| - | Dimensions | 15 mm diameter, 5,6 mm height |
| - | Full scale range | 1, 2, 5, 10, 20, 50, 100, 200 bar |
| - | Bursting pressure | 150 % of FS range |
| - | Repeatability | 0,1 % of FS range |
| - | Hysteresis | 0,1 % of FS range |
| - | Zero drift | 0,01 %/°C<br>reduced to 0,1%FS by Progress |
| - | Precision | 0,1 % in the range of –5°...35°C. |

## 3.2 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 release 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.

## 3.3 Temperature sensor

The temperature sensor is a platinum resistor Pt100 in a tiny ceramic carrier of 15 mm length and 0,9 mm diameter. 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.

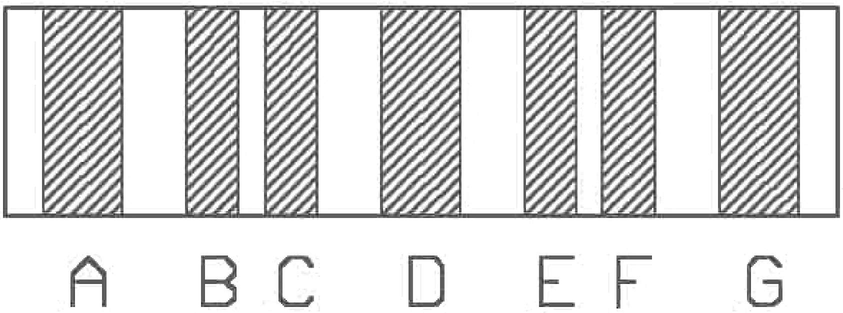
Technical data

| | |
|---|---|
| Manufacturer | SST |
| Type | Merz Pt 100/1509 |
| Measuring range | -2℃ – 35℃ |
| Response time | approx. 150 msec. |
| Repeatability | < 0,001℃ |
| Accuracy | 0.005℃ |
| Maximum depth | 6000 m |

## 3.4 Conductivity cell

Short description of measuring principle

All models of conductivity sensors use 7 electrodes in a cylindrical arrangement. The cell is always constructed symmetrically as depicted in the following sectional drawing.




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 hold the voltage drop across the sensing electrodes on a constant level, while the current is proportional to the actual conductivity value.

## Conductivity sensor for profiling

The conductivity cell consists of a quartz glass cylinder with 7 platinum coated electrodes. Because of the small inner diameter of 8 mm the cell needs a minimum vertical flow velocity to obtain full accuracy. The cell is vulcanised with rubber in a mould. The cleaning procedure must be carried out very carefully hence the glass cylinder is sensitive against shock and impact.

Technical characteristics:

| | |
|---|---|
| Manufacturer | ADM |
| Model | 7-pole electrode cell |
| Cell factor | K= 1,2 |
| Ranges | 0 – 6 mS/cm – 65ms/cm |
| Response time | 100 msec at 0,5 m/sec flow |
| Reproducibility | < 2µS/cm |
| Accuracy | 10 µS/cm |
| Maximum depth | 6000 m |
| Min. flow through the cell | 5 cm/sec |

Conductivity sensor (6000 m)

## Combined CT sensor

Can be used up to 2000m instead of single sensors T and C

Specifications and description see 3.3 and 3.4.

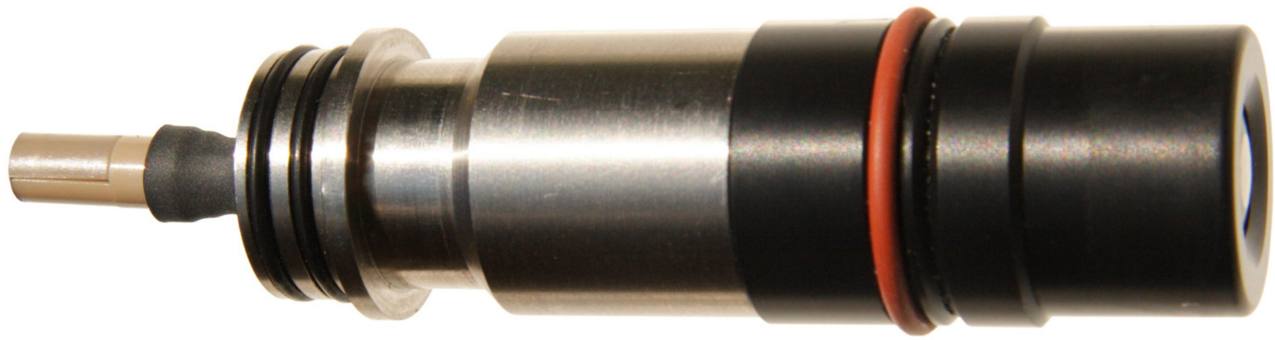
### 3.5. Oxygen sensor

The oxygen sensor measures the dissolved oxygen in the water using polarographic methods. The platinum 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 platinum wire. The relative high current consumption requires a minimum current flow of 10 cm/sec in order to avoid oxygen depletion in front of the membrane.

Technical data:

| | |
|---|---|
| Manufacturer | SST/Oxyguard DO522M18 |
| Type | Clark electrode, self galvanizing |
| Polarisation voltage: | -0,7 VDC |
| Range | 0 – 150 % |
| Oxygen current | 0 – 12 nA |
| Temperature range | -2℃ – 30℃ |
| Response time | approx. 10 sec (98%) |
| Accuracy | + /-3% |
| Maximum depth | 2000 m |

Oxygen sensor without protection cap



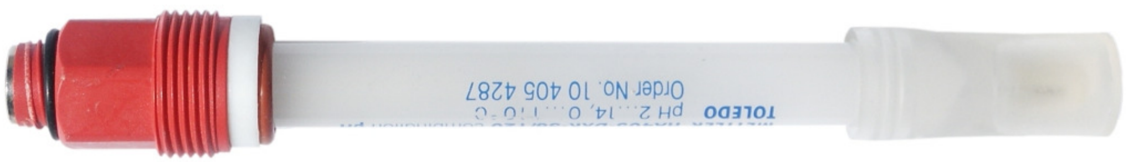
Oxygen sensor with protection cap

## 3.6. pH and Redox sensors

### 3.6.1 Depth range 0..160m

pH and redox 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 sensor has a thread PG 13,5 and is screwed into a flange. A coaxial socket makes the electrical contact in the flange. Sealing between sensor and flange is achieved by an O-ring, which is part of the sensor.

| Technical data: | pH | Redox |
|---|---|---|
| Manufacturer | METTLER-TOLEDO | METTLER-TOLEDO |
| Model | 405-DXK-S8/120 | Pt 4805-DXK-S8/120 |
| Measuring range | 4-10 | -2000mV – 2000 mV |
| Maximum depth | 160m | 160 m |
| Shaft diameter | 12 mm | 12 mm |
| Length with flange | 167 mm | 167 mm |
| Response time | approx. 1 sec | approx. 1 sec. |




### 3.6.2. Depth range 0..500 m

pH and redox combined electrodes based on the same principles as described in §3.6.1 but more pressure resistant.

| Technical data: | pH | Redox |
|---|---|---|
| Manufacturer | Hamilton | Hamilton |
| Model | Polylite PRO 120 XP | Polylite RX 120 XP |
| Maximum depth | 500m | 500m |

Other technical data same as above (see picture next page).


### 3.6.3. Depth range 1200m

This pH/ORP Sensor uses a pressure-balanced glass electrode with a reference to provide in-situ measurements up to 1200m depth. The sensor is equipped with a reference system using a solid gel (stiff polymer mass containing $Ag^+$-free KCl) and a ceramic pore diaphragm and with a pressure stable pH-sensitive glassy electrode.The pH probe is permanently sealed and supplied with a soaker bottle attachment. The bottle contents must be 3 M KCl solution (pH 4) that prevents the reference electrode from drying out during storage.

This sensor is absolutely **$H_2S$ resistant**.

| | PH | Redox |
|---|---|---|
| Manufacturer | AMT GmbH | AMT GmbH |
| Measuring range | 4-10 | -2000mV.. – 2000 mV |
| Maximum depth* | 1200m | 1200 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 | 84mm | 84mm |
| Length with flange | 117 mm | 117 mm |
| Response time | approx. 1 sec | approx. 1 sec. |

* This sensor is pressure resistant up to several thousand meters depth with a slight increase of pH/ORP values.

### 3.7. Seapoint turbidity sensor

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´s manual.

The Turbidity sensor measures the concentration of suspended matter. It is equipped with a pulsed infrared 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.

Specifications:

Power: 7 – 20 VDC, 3,5 mA average
Signal: 0...5 VDC (each range)
Scatterance angle: 90° avg. (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, 0-2500 FTU

Picture shows the bulkhead version with flange

The turbidity sensor is available in two different versions: **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. The **Bulkhead** version is plugged into a fit of the bottom cap of the probe and hence needs no underwater connection cable. The range can be selected by hardwiring according to the customers requirements.

### 3.8. Cyclops7 Fluorometer

The Cyclops 7 used here for MSS90 is the standard Cyclop-7 instrument from Turner Design. In order to adapt the instrument to the probes end cap the Subconn connector was skipped and instead our standard flange was screwed into the connectors thread. To avoid corrosion problems the cyclops7 housing is made of titanium. The gain setting lines can be set to a range of 0..5, 0..50 or 0..500µg/l. The selection of the gain is made inside the profiler by the use of two SIL switches. The instrument is delivered with the default range 0..50µg/l (gain setting = *10)


For details and hints for application please refer to turner´s user manual.
The manual is available on the CD ROM.

### 3.9. 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 doesn't need CTD resolution the overall accuracy is not affected by this procedure.

#### 3.9.1. Seapoint turbidity meter

Description is given in §3.7. Beside the hardwiring of the selected range the CTD90M offers the possibility of automatic range switching.

Both versions 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...2500 FTU (linear up to 1000 FTU) |
| 1 | 1 | 0 | *5 | 0.....500 FTU |
| 2 | 0 | 1 | *20 | 0 125 FTU |
| 3 | 1 | 1 | *100 | 0 25 FTU |

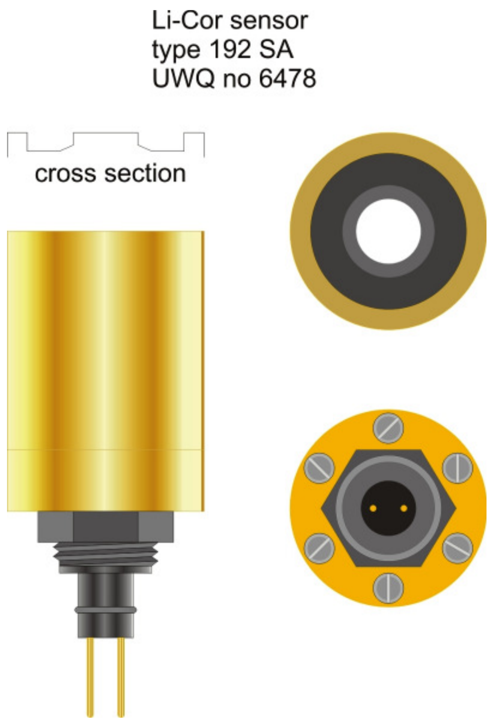
0:= line tied to GND 1:= line left open

The CTD electronic monitors the signal output of the turbidity sensor and selects automatically the next suitable range if a certain limit is exceeded or dropped. The limits are approximately 10% resp. 90% of the current range. The instrument is factory calibrated with a formazine turbidity standard.

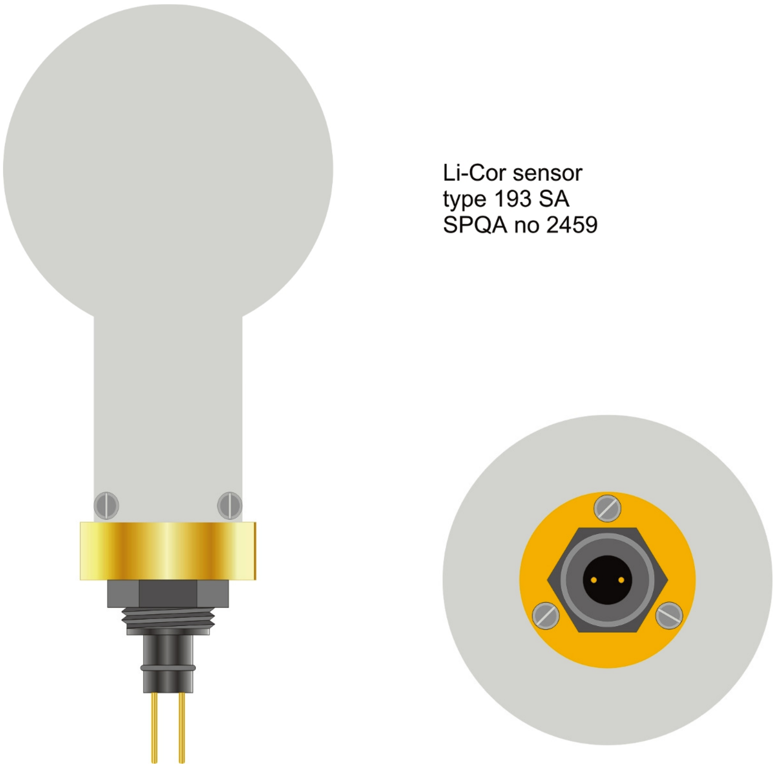
### 3.9.2. LI-COR Quantum sensor

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)



**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.




Both instruments are calibrated in µmol/s*m$^2$ (µE) where 1 µmol is 6,023 * $10^{-17}$ photons.

Specification:

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

Both sensors will be connected to the probe by a 2 wire underwater cable. Please note: the light sensors must be mounted on the top of the probe to avoid shade of neighboured instruments.

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.

### 3.9.3. Seapoint Fluorometer

measures chlorophyll A concentration in 4 different ranges, which are selected by two control lines A and B

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

The range switching procedure is similar to the turbidity meter; the limits are 90% and 10% of full scale.

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

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).

# 4 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.

# 5 Probe electronics

The electronics of the basic version consists of 3 printed circuit boards

1. Power supply and cable driver (located between battery box and lid)
2. Analog main board and plug-in modules.
3. Digital main board
4. Expansion board

## 5.1 Probe power supply

is situated on a small circular board (40 mm diameter), which is screwed to the inside of the lid. This board contains the FSK modulator, the cable driver and the zenerdiode for constant current supply. Components, which produce a considerable heat, are screwed onto the lid, thus using the good thermal contact for heat abduction to the metal housing and seawater (cable driver transistor, zenerdiode). The wires of the probes underwater connector are soldered onto this board; the connection to the main board is separable by a plug.

## 5.2 The main board

Measures 150 mm * 50 mm and contains the following circuitry:

- Data acquisition
- 16-channel analogue multiplexer
- RS-232 driver
- Water sampler releaser
- Temperature module
- Conductivity module
- Pressure amplifier (with Progress-print as plug-in module)
- Oxygen amplifier
- Redox amplifier
- PH amplifier
- Differential amplifier for sensors with analogue output

The main board has an expansion plug which contains all necessary signals for a system extension to 32 sensors. On the backside of the bedplate a further same sized additional printed circuit board can be attached which incorporates the electronics for further sensors.

The heart of the probe is a microprocessor controlled 20-bit analogue digital converter, which generates an auto calibration cycle each time the probe is switched on. This results in an exceptionally good long-term stability. This is especially important for the stability and precision of the CTD sensors.

## 5.3. Digital board

Contains the following circuitry

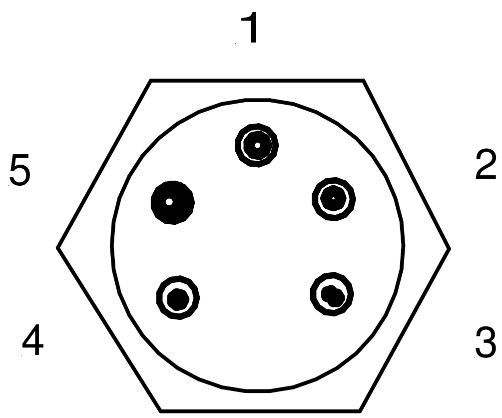
- Processor in and out ports
- Toggle switch for reed contact
- RS232 driver and receiver
- Flash memory
- Power supply and regulation (+5V,-5V, 3,3V)
- Power switch for external devices

## 5.4. Expansion board

The expansion board is equipped with a second 8-channel analogue multiplexer for the upper address range from 16 to 23. This board provides the plug in position for all multirange sensor electronics and the interface circuitry for current meter and compass.

## 6. Connector pin assignment, power supply and interfaces

The CTD90M has a 5-pin underwater connector which allows the probe to be operated in different modes. The standard connector is SUBCONN MCBH5M made of titanium and neoprene.




Face view of bulkhead underwater connector

Connector pin assignment:

Pin 1.....Constant current loop, FSK Signal (option)
Pin 2 TxD, transmit data RS232C
Pin 3 Constant current loop return, Power GND, RS232 GND
Pin 4 + Power input (10..15 Volt)
Pin 5 RxD, receive data RS232C

Mating cable is Subconn MCIL5F with locking sleeve MCDLSF

### 6.1. Internal batteries

#### 6.1.1. 12V Battery

The battery box is a circular shaped housing of 75 mm diameter and approximately 140 mm height and mounted on the top cap of the memory probe. 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.

Specifications:

| | |
|---|---|
| Batteries: | 8 * 1,5 volt C cells |
| Type | alkaline |
| Nominal capacity: | 7 - 8 Ah |
| IEC designation: | LR14 |
| Size: | 26 * 52 mm |
| Power consumption: | 20mA for C;T,D,O2,pH,redox |
| Lifetime: | approximately 300 hours continious operation |

The CTP90M is protected against low battery. In memory mode (data storage active) the probe probe is switched off when the battery voltage falls below 9,5 VDC and can only be activated by connetion to a PC via RS232 communication.

**For units with high current consumption a batterie box with 8 D cells is available (see appendix)**

### 6.1.2. 3V Battery

If there is no need to supply third party instruments with higher voltages than 5V , a 3 volt supply is more effective. The length of the probe is 50mm shorter than the basic version.

Specifications:

| | |
|---|---|
| Batteries: | 4 * 1,5 volt C cells |
| Type | alkaline |
| Nominal capacity: | 7 - 8 Ah |
| IEC designation: | LR14 |
| Size: | 26 * 52 mm |
| Power consumption: | 50..80mA for C;T,D,O2,pH,redox |
| Lifetime: | approximately 250 hours continuous operation |

## 6.2. External power supply

The memoryprobe can be powered externally via cable connection to an external battery or a DC power supply (regulated or unregulated). The external supply voltage may range from 9 to 15volt. The internal batteries need not to be removed, they are polarity protected by a diode against higher voltage. The memory probe is then supplied by the source with the higher voltage.

| | | |
|---|---|---|
| External Power Connection: | Pin 3 | Power GND |
| | Pin 4 | Power In (9...15 VDC) |

## 6.3. Operation with multicore cables

The use of multicore cables is adviseable for shorter distances between probe and PC and paricularily in a laboratory. The probe is then supplied either by a battery or an external power supply. The voltage is applied to Pin3 (negative) and Pin4 (positive). Online data transfer to the PC is via pin2 (Transmit data TxD) and pin3 (GND). The RxD input line of the probe must be connected to the PC in order to enable the data transfer.

| **memory probe** | | **PC / Power supply** | |
|---|---|---|---|
| inline cable | Signal | Signal | connector |
| Pin 2 | TxD | RxD | Pin 2 (SUB D 9) |
| Pin 3 | GND | GND | Pin 5 (SUB D 9) |
| Pin 5 | RxD | TxD | Pin 3 (SUB D 9) |
| if external supply is provided | | | |
| Pin 3 | Power GND | Power GND | banana plug black |
| Pin 4 | Power In | Power out | banana plug red. |

The maximum length of the multicore cable data link depends mainly on the cable resistance and capacitance and can at best be several hundred meters. An advantage is that a specific interface between probe and PC is not necessary.

## 6.4. Configuration cable

It is delivered with the memory probe and is intended to be used for all kind of communication between probe and PC:

- Configuration of the operation modes
- Data readout of stored files
- online transmission of data in laboratory

The length of the configuration cable is about 5 m, the wiring is described below:

| memoryprobe | | PC serial port / Power supply | |
|---|---|---|---|
| Pin 2 | TxD | RxD | Pin 2 (9 pole SUB D) |
| Pin 5 | RxD | TxD | Pin 3 (9 pole SUB D) |
| Pin 3 | GND | GND | Pin 5 (9 pole Sub D) |
| Pin 3 | Power GND | Power GND | Banana plug black **-** |
| Pin 4 | Power in | Power out | Banana plug red **+** |

### 6.5. Operation with single conductor cables

The standard application of CTD probes is profiling performed via winches with slip rings and single conductor cables. 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 1 | + current/FSK-signal | inner wire |
| Pin 3 | - current loop return | shield |

The basic version has a constant current of about 100 mA, this can be distinctly higher when external devices are connected. The voltage drop between Pin 1 and Pin 3 is approximately 17 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 1200, FSK frequencies are 2400 and 4800 Hz. The FSK signals 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.

## 7. Operating the memory probe

### 7.1. Control elements

On the top cap of the memory probe there is a duo coloured LED and a reed contact located behind a glass window. The LED´s are used to display operating conditions:

- red LED on.......................Power on
- red LED off.......................Power off
- green LED blinking..........Storage of data

The green LED is on only the short time, data is written to the flash eprom. Red and green LED on at the same time result in light yellow colour.

When the probe is connected to a power source (either battery or external power supply) it is always operating in an unconfigurated mode (without valid configuration) transmitting data without data storage. The probe then can be switched off with the magnet.

Power switching is executed under several conditions:

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

2. Activation of the reed contact turns the power on and starts the selected operation mode (except FSK mode and time mode).

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

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

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 indicated borehole near the glass window for not more than a second. The on condition is displayed by the red LED. A second activation turns the power off (red LED off).

### 7.2. Operation modes

The probe has 3 configurable data storage modes :

- time mode
- increment mode
- continuous mode

and 2 on-line modes :

- FSK mode
- RS 232 on-line mode

The first 3 operation modes can be configured by the supplied Windows(tm) software package "Sea & Sun Technology´s **S**tandard **D**ata **A**cquisition" . See 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  FSK or RS232 data tranmission. 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.

### 7.3. 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 OnTime 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.

### 7.4. 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. The "**delta interval**" between two consecutive depth levels has to be entered.

Optionally a **start depth** and/or a **stop depth** 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 ( 64 MegaBytes). 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).

### 7.5. Continuous mode

At this mode all acquired datasets are stored in the internal memory of the probe. Each time the probe is turned on by use of 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.

### 7.6. 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!

## 7.7. 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 first Power On (Battery exchange)
- The stop-time in time mode operation is reached.
- FSK-mode has been finished
- The internal data storage memory is full
- Further data storage is disabled by the PC-software

No data storage is possible, the probe awaits another configuration and acts like a direct reading probe after being switched on by the magnetic rod. Power is derived from the internal battery or external power supply. The probe can opperate in this mode for unlimited time until it is switched off by the magnetic rod.

## 7.8. 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 end of command mode ( if wanted). If time mode is active during command mode the time-grid updates are done in background, but no data acquisition is performed! Time mode will resume after leaving the command mode and start 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.

Command mode is left by closing the configuration window of the PC software.

## 8. Service and maintenance

The best maintenance for the probe is to handle it with care. Despite the fact that the probe is sturdily and stabile designed, unnecessary strains like knocking and shocks should be avoided. Apart from that, there are only few instructions and maintenance rules, which should be heeded or met to, so as to ensure a longer life span and correct measuring, results.

### 8.1. The underwater connector

Is actually maintenance-free. However it has proved itself to be advisable to lubricate the sealing surfaces of the pins with sea waterproof grease. This reduces wear whilst plugging and unplugging. Further tips:

- clean the plugs with warm soapy water. They do not have to be dried. Chemicals should be avoided.
- To avoid corrosion never plug or unplug whilst under water
- To conserve the cable plug never unplug by pulling on the cable. Avoid bending radiuses and above all narrow, sharp kins.
- Plugs that are not in use should never be left blank. They should always be protected against corrosion by a dummy cap.

### 8.2. Pressure sensor

The pressure sensor doesn't require special attendance or maintenance. Personally experience has shown however, that the pressure sensors should never be tested by pressing a pin onto the membrane. This often causes damage of the membrane or dents it, which can lead to pressure reading mistakes or to a total damage. Pressure sensors damaged in such a way are not covered by the guarantee.

### 8.3. The temperature sensor

The temperature sensor is maintenance free. Dirt and plant cover only prolong the time constant but have no effect on the precision. When cleaning the sensor take special care of the sensitive tip, which should not be bent.

## 8.4. The conductivity cell

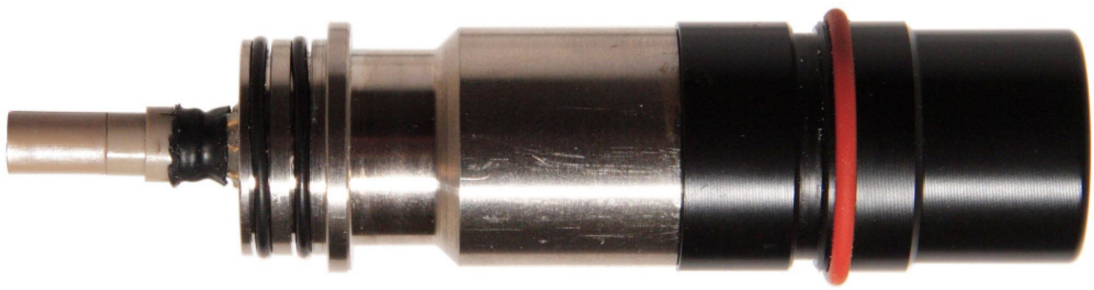
Is principally not maintenance free. It must regularly be inspected for plant cover and electrolytic calcification. Both effects reduce the measured conductivity. It is appropriate if the probe is rinsed on deck with fresh water after each application. This prevents the formation of salt crystals on the cell 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 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 water. Depending on the operating time this procedure is only necessary every few months. Cleaning is more difficult after long-time application especially during warm months, when heavy sea-pest growth densely populates the cell within a short time (2 weeks). In this case the cell has to be placed into diluted acid (if necessary for a longer time) and then a plastic bottlebrush has to be pushed through it. This procedure may have to be repeated until the cell is completely cleaned. Then the cell is rinsed with fresh water. Particular care has to be taken, that the metal components on the electrode surfaces are not scratched, nor must they come into contact 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 should normalize itself within an hour.

## 8.5. Oxygen sensor

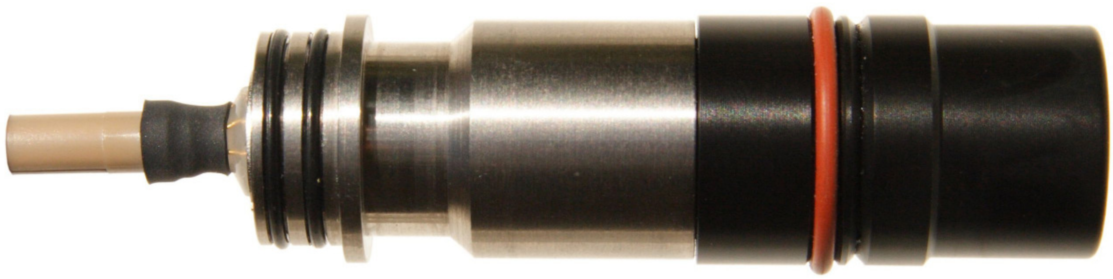
The oxygen sensor requires some attention from time to time. All the necessary maintenance like exchange of electrolyte and membrane is described in an OxyGuard leaflet in the appendix of this manual.

**The red O-ring** has two different positions:

1. in the **front position** (shown in the picture below) the O-ring prevents leakage of the electrolyte through the thread during storage. **This position should not be used for measurements but only for storage.**



2. in the **backward position** it allows the electrolyte to build a high impedance electrolytic connection between medium (sea water) and electrolyte room behind the membrane. This connection is **necessary for proper measurements. Please take care that during measurements the O-ring takes always the backward position**



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

If the membrane tension is dropping during operation or time the sensors output signal is changing too. The zero point of the oxygen sensor remains fix during its lifetime but the sensivity (slope) can vary. The user can execute a field calibration after each membrane exchange or when he doesn´t trust the measured values anymore.

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

- Keep the membrane of the DO sensor dry
- Put the red o-ring 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 (small white plastic cup is part of the delivery)
- after a short time the enclosed air in the cap is water vapour saturated and the the oxygen reading should have 100% partial pressure.
- If the oxygen reading is stable click 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 programm 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 lead to an increase of the oxygen reading of 1%. So e.g. if the procedure is executed with the DO sensor 30cm below the water surface, the default value in the button field **Enter desired value** has to be changed to 103%.

## 8.6. pH and Redox sensor (160m + 500m)

Both sensors are principally maintenance free. After its life span has ended the corresponding sensor has to be replaced. When unscrewing the sensors no moisture (e.g. water drops) what so ever must reach the contacts (dry beforehand). A single drop of saltwater is enough to cause long-lasting incorrect measurements – this is due to the high output impedance of 100 – 400 MΩ. So only replace sensors under clean and dry conditions please.

**Please note: screwing the Mettler Toledo pH or ORP into the socket of the flange must be executed very carefully in order not to damage the plastic thread of the sensor. Tighten the sensor only by hand, don´t use a tool. Damaged threads are not covered by warranty.**

The life span of the sensors ceases when the response time of the pH or redox measurement drastically increases. The life span also ends when the reference electrolyte is dissolved down to the screw thread rim. Water can then possibly leak in through the bolting.

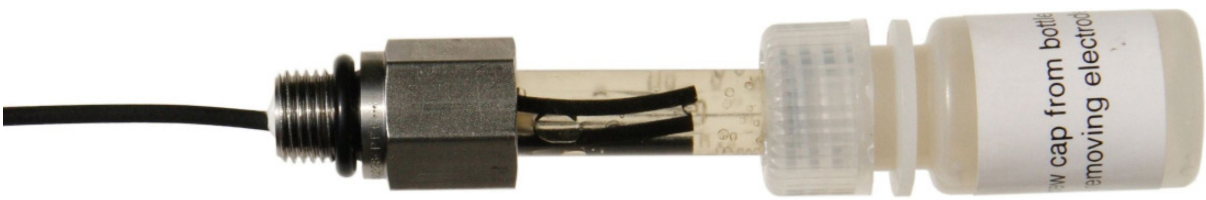
**Caution: Do not expose these pH or ORP sensor to $H_2S$**

The pH and Redox sensors are particularly endangered when they get into contact with $H_2S$ in water. Some minutes in water containing hydrogen sulphide is enough to irreparably ruin the sensor. In most cases stable-measuring results cannot be achieved anymore despite lengthy rinses with cleansing or buffer solutions. If measurements in $H_2S$-concentrations are necessary we recommend to remove the sensors and to screw on locking caps (or to use the 1200m sensor; refer to 8.7.)

Special care has to be taken that before using the sensor no air bubble is to be found in the pH electrolyte directly behind the ion-permeable glass layer because it would interrupt the internal electrical connection to the pH electrode. The air bubble has to be shaken out – similar to the shaking of a thermometer. The air-bubble often occurs when the sensor has been stored horizontally for a longer time.

## 8.7. pH/ORP sensor (1200m, $H_2S$ resistant)

Do never touch the sensitive tip. Protect the pH-sensor with the delivered soaker bottle containing the storage solution and avoid any dry out of the sensitive tip.



Avoid any air inside the bottle, fill completely with 3 M KCl. Make sure, that only 3 M KCl with pH 4 buffer is used for storage. It is not allowed to use other wetting caps in order to avoid any air pressing into the diaphragm leading to sensor malfunctions or damage. Damage because of using other wetting caps or storage without any wetting cap is not covered by 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, if the sensor has reached the lifetime. The sensor has a stainless steel thread G1/4A (titanium on request) which is screwed into a flange. The electrical contact is made by a socket in the flange. Sealing between sensor and flange is achieved by an O-ring which is part of the sensor. After the sensor's life span has ended, the sensor has to be replaced.

### 8.8. 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.

### 8.9. 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.

# 9. Probe data format

The probe data can be fed into the PC serial ports COM1 to COM4. The standard settings of the probe are:

| | |
|---|---|
| Baud rate | 1200 (2400, 4800, 9600) |
| Character length | 8 |
| Number of stop bits | 1 |
| Parity | odd |
| Protocol | non, asynchronous |
| Signals | GND, TxD |

The data is transmitted as binary data. 3 bytes (24 bit) per sensor are required, 16 bits are measuring values, 5 bits are address and 3 are status bits. The transmission format 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 1,1,0 |

A sensor data transmission starts with the 1. Byte (LSB first) and ends with the third byte (MSB last). Every sensor in the probe has a specifically assigned binary address which identifies the kind of sensor. The status bits are useful for the PC data acquisition programmes to compile the 3 bytes in the correct sequence.

A complete data set begins with the lowest address and ends with the highest address. All addresses between 0 and 31 may occur. The transmitted physical addresses are identified by the data acquisition program and compared to those registered in the configuration file. As an example the addresses for the CTD90M:

| | |
|---|---|
| Address 0 | light transmission |
| Address 1 | battery voltage |
| Address 2 | pressure |
| Address 3 | temperature |
| Address 4 | conductivity |
| Address 5 | oxygen |
| Address 6 | pH |
| Address 7 | redox |

The remaining vacant addresses can be used for external probes or sensors.

**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.

## 10 Calculation of the physical data

Data transmission and data storage when online are performed solely in binary dates. The PC-data acquisition program carries out the calculation of the physical values from the raw data and their display. The calculation of physical values for standard sensors is made by a polynomial of n.th order:

Measurement value: = $\Sigma$ Ai * $n^i$

Ai calibration coefficients, i = 0...4

Normally $i_{max}$ = 1 or $i_{max}$ = 2. The coefficients are determined by calibration measurements against a normal or subnormal and subsequent regression calculations.

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

# 11. Spare parts

## 11.1. Sensors

| | | |
|---|---|---|
| - | pH senor 160m | METTLER-TOLEDO HA405-DXK-S8/120 |
| - | Redox sensor 160m | METTLER-TOLEDO Pt4805-DXK-S8/120 |
| - | PH sensor 500m | HAMILTON Polylite PRO 120 XP |
| - | ORP sensor 500m | HAMILTON Polylite RX 120 XP |
| - | PH and ORP 1200m | on request |
| - | Pressure sensor | KELLER PA7-XXX Progress 0,1 - 2 Volt<br>(XXX Full scale range in bar) |

## 11.2. O-rings

| | | |
|---|---|---|
| - | Base and lid | 76 * 2,5 mm |
| - | Sensors (flange) | 16 * 1,5 mm |
| - | pressure sensor | 13 * 1 mm (stainless Steel 316L)<br>12 * 1,5 mm (alloy C276) |
| - | PH/Redox sensor | 12 * 1,5 mm (160m, 500m) |
| - | Underwater connector | 12,42 * 1,78 mm |

## 11.3. Plugs and cables

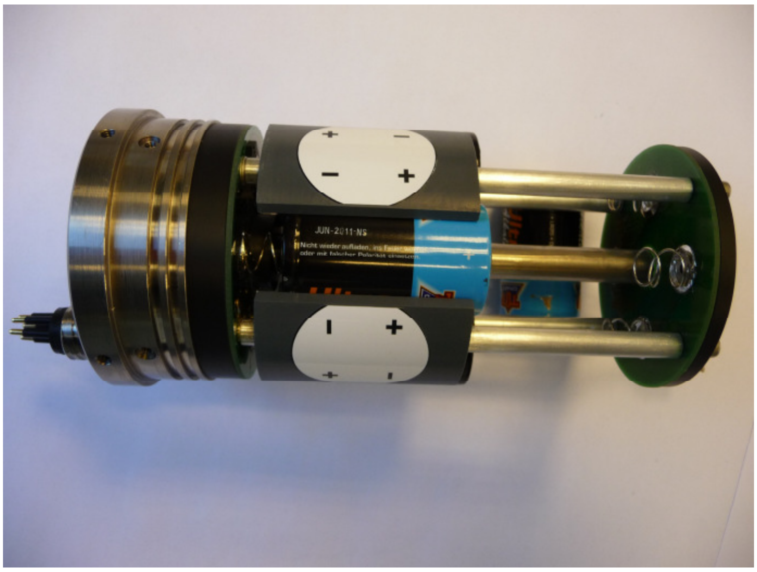
| | | |
|---|---|---|
| - | Dummy cap | SUBCONN MCDC4F / DC4F |
| - | Locking sleeve | SUBCONN MCDLS-F / DLSA |
| - | Inline connector | SUBCONN MCIL4F / IL4F |

# Appendix Battery pack for D cells

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.
- Displace the mounting supports of the batteries as shown in the picture and set the 4 upper batteries into the case. Insert the batteries in the correct polarity.



- 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 operating online (red LED on).
- Put the battery case back into the tube,switch off the power with the magnetic rod .
- Fix the top cap on the tube with 4 screws M3 * 4 mm.

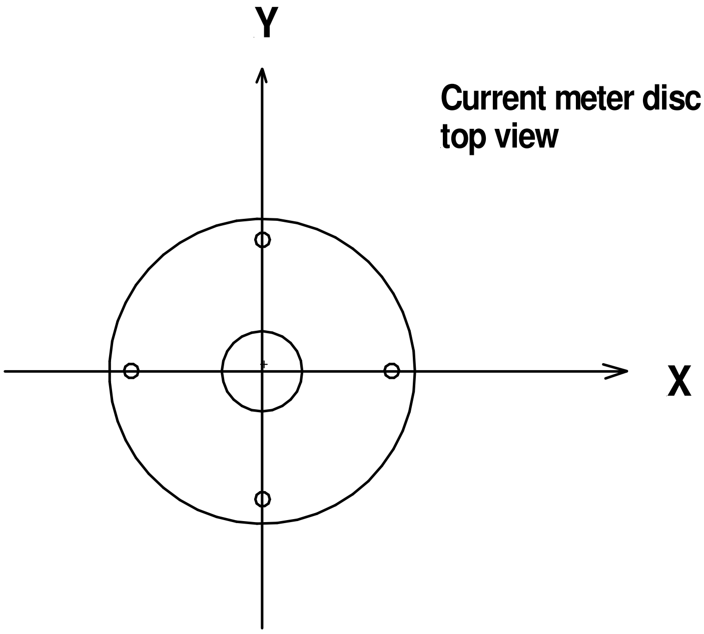
## Appendix CTD90M current meter and compass

The Inductive Current Meter ISM2001 is a stand allone unit and connected to the CTD90M by a cable. For descriptions of the current meter please refer to HSE manual ISM2001 C.


The picture shows the probe and the currentmeter assembled in the protection case.

**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:

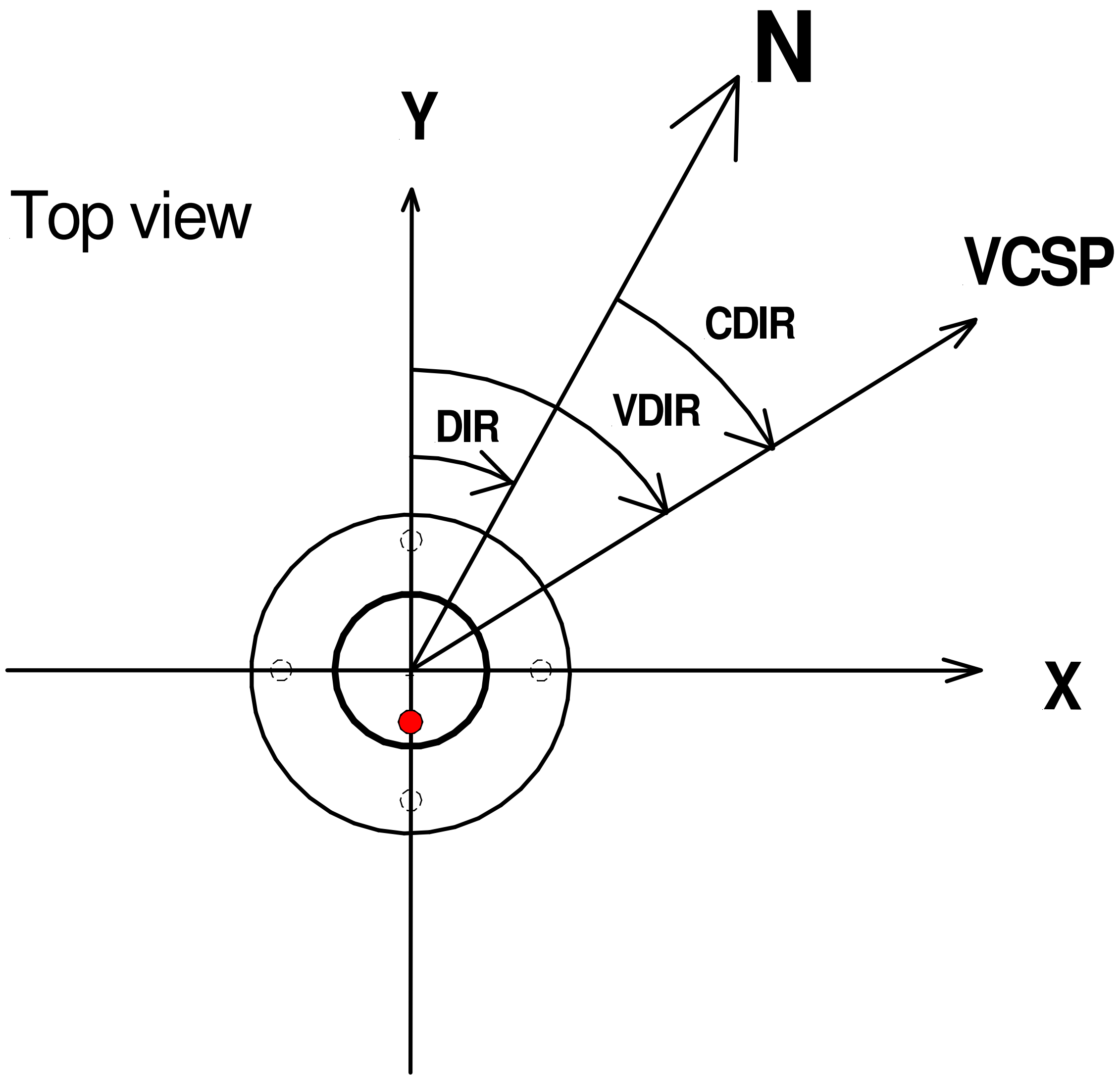
| | |
|---|---|
| Cvx, Cvy | x,y-components of the current vector related to instrument axes calibrated in m/s |
| Hx, Hy | x,y-components of the magnetic field intensities related to instrument axes, calibrated in arbitrary units. |

| | |
|---|---|
| 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 = $\{cvx^2 + cvy^2\}^{1/2}$

CDIR = VDIR – DIR = arctanCvx/Cvy - arctanHx/Hy


N
Y
Top view
VCSP
CDIR
VDIR
DIR
X

## 12. History of document

Version 4 17.11.08
Appendix "Corrosion protection for pressure transducer" removed
Inserting of battery case for D-cells

Version 5 02.06.2009
Appendix "Currentmeter and compass" revised edition