

# ***OPERATOR'S MANUAL***

## ***OCEAN SEVEN 310***



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# OCEAN SEVEN 310 CTD

## Multi-parameter CTD OPERATOR'S MANUAL

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## IMPORTANT REMARKS

### INTERNAL BATTERY REPLACEMENT/RECHARGING

- 1) To gain access to the battery pack, remove the screws in the probe top cover. However, before doing this, please ensure to have removed any water droplets around the screw heads, to prevent them from running down inside the housing.  
**CTD Top-Cover removal, please follow the instructions in Appendix "A"**
- 2) **Rechargeable battery:** disconnect the battery pack from the top cover and connect it to the battery charger.
- 3) If the probe is not to be used for long periods (some months), remove the internal battery pack from the probe. This eliminates the possibility of damaging the electronic circuitry in case of battery leaks because a small amount of energy is drawn from the internal batteries by the probe electronic circuitry even if OFF. This phenomenon causes batteries to run down and they may be damaged (leak) in a very long time

### SELF-RECORDING USE

- The CTD internal Real-Time Clock (RTC) keeper is powered by the CTD main battery. If the battery run-off energy or is disconnected, the RTC loses date & time. **It is mandatory to set up the CTD date & time or/and check that the CTD date & time are correct before starting a self-recording data acquisition cycle.**
- The CTD is equipped with a rotary magnetic power ON/OFF switch, installed on the top cover. The CTD is ON when the switching arm is positioned over the red dot marker. Once the CTD self-recording configuration is completed, the CTD can be switched OFF and then ON again at the sampling site, when ready for the deployment. This procedure is indispensable to run self-recording data acquisitions, as described in the dedicated section of this manual.

**VERY IMPORTANT: Allow a 10-second interval between each ON/OFF cycle.**

### CONDUCTIVITY MEASUREMENT

- To obtain the best accuracy, the conductivity sensor and therefore the CTD sensor head, must be immersed in clean seawater or freshwater for at least 15 minutes before measurements.
- When the conductivity sensor is not in use, it is kept dry. Therefore, when the conductivity sensor is placed in water, very small bubbles may remain attached to the platinum ring electrodes (seven). If such a thing happens, the measured value of conductivity will be lower than the true one. To remove these air bubbles, degrease the inside of the conductivity cell using cotton buds wetted with the Conductivity Sensor Cleaning Solution or with liquid soap. Gently rotate the cotton bud against the whole internal surface of the quartz cell. This will wet the platinum electrodes, thus reducing the surface tension of the cell and considerably decreasing the risk of trapped air bubbles.

### OXYGEN MEASUREMENT

Most polarographic oxygen sensors take 5 to 10 minutes after they have been switched on to polarize and become stable. To overcome this limitation, the IDRONAUT OS310 has been fitted with a small internal rechargeable device, to maintain polarization of the oxygen sensor continuously for about three days. However, if the probe is not used for several days, the polarization device may become completely discharged. It is recommended that the probe should be switched ON (and streaming real-time data) for at least few minutes, to

fully recharge the polarization device in a healthy condition before starting the measurements.

### **BLUE CAP OPTICAL DISSOLVED OXYGEN SENSOR**

A black cap is provided to protect the membrane from light. When the CTD is not used protect the membrane by installing the black cap. Please, remove the black cap before calibration and before deploying the CTD in water.

### **pH MEASUREMENT**

The pH and reference sensors should never be allowed to dry out. For short-term storage of up to one day, the probe's sensor head can simply be immersed in water. If the probe remains unused for periods longer than one day, always place the hydrating caps on both sensors.

The pH sensor cap should be filled with the pH7 Buffer Solution (or simply with clean water). The reference sensor cap should be filled with the Idronaut Reference Sensor Storage Solution.

### **CTD SENSORS RE-CALIBRATION?CHECKING**

A dedicated Windows software described at section F.7.3 allows to correctly capture data from the CTD sensor during a re-calibration procedure or CTD sensors performance checking cycle. Captured data can be saved in a txt file. The "OceanSevenCalibration" software is freely distributed with the IDRONAUT ITERM software.

### **PROBE WASHING**

After use, the probe must be always washed with fresh water to remove any salt water residual or dirtiness.

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## **ABOUT THIS MANUAL**

This manual will serve as a guide to you when you use the OCEAN SEVEN 310 CTD.

- ❖ Use it to understand the purpose of each of the probe components and functions.
- ❖ It will help you to understand the probe behaviour.
- ❖ It will guide you through the probe capabilities.
- ❖ It will serve you as a reference when some problems arise when using the probe.

## **HOW TO USE THIS MANUAL**

The following topics are covered by this manual:

Section 1	A description of the OCEAN SEVEN 310 CTD.
Section 2	Installation and start-up operations.
Section 3	Data acquisition functions and data processing capabilities.
Section 4	Data storage functions.
Section 5	Sensor calibration functions.
Section 6	Service functions (configuration, diagnostics).
Section 7	Probe maintenance.
Section 8	Troubleshooting
Appendix A	Internal and external battery pack description.
Appendix B	Data Processing Function Priming.
Appendix C	OPTIONAL Sensor
Appendix D	Advanced configuration
Appendix E	Rosette interfacing.
Appendix F	IDRONAUT Windows Terminal Emulation Programme.
Appendix G	Antifouling device.
Appendix H	Wireless “Bluetooth™” – WiFi interface.
Appendix I	Submersible connectors and cable care.
Appendix L	Sensor cleaning and care.
Appendix M	AUV Version

## **GETTING STARTED**

To become familiar with the OCEAN SEVEN 310 CTD capabilities and operation, we suggest reading through sections 1 and 2. It is necessary to also read sections 3 and 5 and section 7 before starting to deploy the probe. The remaining sections and appendices could be consulted only when needed. If the probe is supplied with external sensors, deck unit or the IDRONAUT Portable Reader, useful information can be found in each dedicated Operator’s Manual.

Operator’s Manuals of all IDRONAUT products and software can be found on the USB-data storage key included with this product in the “Literature&Manuals\OperatorManual” folder.

## **NOTATIONAL CONVENTIONS**

Throughout this manual, the following conventions are used to distinguish the various elements of the text:

[PROBE COMMANDS]

They always appear in uppercase and between [ ] or <> brackets.

*Probe messages, user inputs*

They always appear in italics.

## **DEFINITION OF TERMS**

Throughout this manual, the following terms are used:

<i>Cast</i>	As a whole of the <i>data set</i> collected in the same way in a determined sampling point.
<i>Data set</i>	As a whole of configured parameters expressed in physical or chemical units and acquisition date and time, collected at programmed sampling interval, (i.e. once per second, once per depth increment).
<i>Raw data – ADC Counts</i>	As a whole set of data acquired by means of the ADC and the conditioning circuits, from the configured sensors and are expressed in numeric decimal or hexadecimal format.
<i>Non-verbose mode</i>	This term refers to a probe that has been configured to use a communication protocol (computer oriented) to communicate with the operator.
<i>Verbose mode</i>	This term refers to a probe that has been configured to use the MMI functions to communicate with the operator.
<i>ON condition</i>	This term refers to a fully operative probe, waiting for commands from the operator or running the requested command.
<i>OFF condition</i>	This term refers to a probe electronically switched off. In this state, the probe draws negligible amount of current from the battery.
<i>MMI</i>	This term refers to the set of common rules, which the operator must follow during the operation of probe in verbose mode.
<i>QAM</i>	Quadrature Amplitude Modulation.

#### **IDRONAUT DOCUMENTS PERTAINING TO THE OCEAN SEVEN 310**

The following documents are available in the “Literature & Manual” folder on the USB-data storage key distributed with the OCEAN SEVEN 310 CTD.

- ❖ OCEAN SEVEN Probes Data Transmission Protocol Description
- ❖ IDRONAUT Deck Unit Operator’s & Installation manual
- ❖ REDAS-5 Condensed Manual
- ❖ OCEAN SEVEN Portable Reader Operator’s Manual

#### **SOFTWARE UPDATES AND TECHNICAL SUPPORT**

Please visit our website download area for software updates and technical support: <http://www.idronaut.it>

#### **WARRANTY**

The OCEAN SEVEN 310 CTD is covered by a one-year limited warranty that extends to all parts and labour and covers any malfunction that is due to poor workmanship or due to errors in the manufacturing process. The warranty does not cover shortcomings that are due to the design, nor does it cover any form of consequential damage because of errors in the measurements. If there is a problem with your OCEAN SEVEN 310, first try to identify the problem by following the procedure outlined in the troubleshooting section of this manual. Please contact your representative or IDRONAUT S.r.l. if the problem is identified as a hardware problem or if you need additional help in identifying the problem. **Please make sure to contact IDRONAUT S.r.l. to obtain the relevant instructions before the OCEAN SEVEN 310 or any module is returned to IDRONAUT (see cleaning instructions).**

For systems under warranty, IDRONAUT S.r.l. will attempt to ship replacement parts before the malfunctioning part is returned. We encourage you to contact us immediately if a problem is detected and we will do our best to minimize the downtime. Every effort has been made to ensure the accuracy of this manual. However, IDRONAUT S.r.l. makes no warranties with respect to this documentation and disclaims any implied warranties of merchantability and fitness for a particular purpose. IDRONAUT S.r.l. shall not be liable for any errors or for incidental or consequential damages in connection with the furnishing, performance or use of this manual or the examples herein. The information in this document is subject to change without notice.

### **CLEANING INSTRUCTIONS**

Before the returned OCEAN SEVEN 310 can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected. Biological contamination is presumed for any instrument, probe, or other device that has been used with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source. If an OCEAN SEVEN 310 CTD, or other part is returned for service without following the cleaning instructions, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination has been completed.

When service is required, either at the user's facility or at IDRONAUT, the following steps must be taken to insure the safety of our service personnel.

- In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4 cup bleach to 1-gallon tap water are suitable for most disinfecting. Instruments used with wastewater may be disinfected with 5% Lysol if this is more convenient to the user.
- The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur. If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
- Any product being returned to the IDRONAUT S.r.l. laboratory for service or repair should be packed securely to prevent damage.
- Cleaning must be completed on any product before returning it to IDRONAUT S.r.l.

### **DISPOSAL OF WASTE EQUIPMENT BY USERS IN THE EUROPEAN UNION**

The recycling bin symbol on the product or on its packaging indicates that this product must not be disposed of with your other waste. It is your responsibility to dispose of your waste equipment by handling it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your waste disposal service.

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## 1 INTRODUCTION

This section describes the main components of the OCEAN SEVEN 310 CTD multi-parameter probe.

### 1.1 PROBE DESCRIPTION

The OCEAN SEVEN 310 CTD multi-parameter probe represents a real breakthrough in the concept of miniaturization, integration and performances. Thanks to the adoption of a new generation of electronic devices, the OS310 can interface up to 14 analogue sensors and three digital sensors (see list) and can guarantee sampling rates up to 28Hz, all of the above contained in a CTD with very small diameter (see housings) and very low power consumption. Operator can easily select the OS310 sampling rate among 2,4,8,12, up to 28 Hz (sample per second) according to the required monitoring or profiling activity.

The OCEAN SEVEN 310 is equipped with the well-known and proven IDRONAUT pressure balanced full ocean depth, pump free and long-term stability sensors. Central to which, is the high accuracy seven-platinum-ring conductivity sensor, which can be cleaned in the field without the need for re-calibration. Furthermore, an optional UV-LED (280nm) integrated into the conductivity cell, sterilize the sample under measurement, thus avoiding the early growth of biofouling inside the quartz measuring cell.

For added flexibility, the OCEAN SEVEN 310 CTD multi parameter probe can be operated in either verbose or non-verbose modes, the latter being especially convenient for system integrations on buoys data loggers, ROVs and AUVs, SAVs making this CTD an ideal choice for both on-line profiling and self-recording moored applications.

Data is output using the standard RS232C interface or the telemetry option available for on-line full ocean depth real-time data transmission. Other interfaces like RS485 and Wireless (Bluetooth, WiFi) can be optionally installed.

Submersible bulkhead connectors, installed on the top cover, provide optional external power supplies and data exchange with a suitable surface system. Also on the top cover, a stainless steel eyebolt is provided with which to attach the probe to a cable. The connector area and the sensors area are protected against accidental damage by titanium cages. Optional copper screens can be fitted to the sensor area to limit biofouling in situations where the probe will remain immersed for extended periods of time (see description in the dedicated appendix). The response time constant is 50ms for the CTD sensors and 3s for oxygen, pH and redox. Software compensation is provided for changes in the internal temperature of the probe, to guarantee both high performance and long-term stability. The electronic boards are fitted in a sealed housing made of either PPS white plastic, AISI316 Stainless Steel or Titanium, depending on favourite deployment pressure and weight requirements.

The OCEAN SEVEN 310 CTD in its basic configuration is equipped with three sensors: pressure, temperature and conductivity. Other bulkhead sensors can be optionally added, like: highly precise pressure transducer (0.01%), dissolved polarographic oxygen, optical dissolved oxygen, pH, redox, reference electrode and the OEM Seapoint Turbidity Meter. Oxygen concentration in ppm, salinity, density, sound velocity and other derived parameters are automatically calculated according to UNESCO recommendations and formulae.

It is possible to interface external sensors or equipment like: altimeters, fluorometers, transmissometers, PAR sensors, Rosette sampling systems, etc.

The following equipment is currently interfaced:

- ❖ GENERAL OCEANICS - Rosettes mod. 1018.
- ❖ IDRONAUT MISS miniaturized sampling system
- ❖ IDRONAUT – High precision 0.01% pressure transducer.
- ❖ IDRONAUT - String and Weight Bottom Sensor.



- ❖ IDRONAUT – Blue Cap Dissolved Oxygen sensor.
- ❖ WET Labs - C-Star Transmissometer and ECO single/three channel Fluorometer.
- ❖ CHELSEA - Unilux and Trilux Fluorometers.
- ❖ SEAPOINT - Fluorometers and Turbidity Meter.
- ❖ TURNER DESIGNS – Cyclops-7 Fluorometers.
- ❖ D & A INSTRUMENT COMPANY - OBS-3 Sensor.
- ❖ LI-COR - LI-192SA Underwater and LI-193SA Spherical Underwater Quantum sensors.
- ❖ BIOSPHERICAL INSTRUMENTS - QSP-2200 – QSP-2300 Quantum Scalar PAR Sensor.

*Other equipment or sensors can be interfaced upon request.*

### 1.2 SAMPLING MODES

The probe is microprocessor-controlled and can be programmed to acquire and process data by various methods. Processed or raw data can be either transmitted in real time or stored inside the instrument. Data acquisition methods includes:

- Pressure. Data is sampled at regular pressure intervals. Multiple profiles can be obtained by switching the probe ON and OFF.
- Timed. The probe collects a series of samples and then sleeps for the configured time interval before waking up again and repeating the acquisitions. Time interval can be configured from 5s up to 1 day. Battery power is conserved while the probe is in sleep mode.
- Conditional. Data is sampled at configurable sampling rates starting when the selected parameter overcomes the configured boundary. Sampling continues until the selected parameter falls below the configured boundary. Whenever the acquisition cycle starts, a configurable sampling rate 0.1..28Hz is used. Monitoring of the selected parameter occurs at the configurable interval between 5s up to 1 day.
- Continuous. Data is sampled at configurable sampling rates starting when the operator switches on the probe. Sampling continues until the probe is switched off. Multiple cycles can be obtained by switching the CTD ON and OFF.
- Burst. Burst sampling carried out at configured intervals: 5s up 1 day.
- Real-time. Data is sent to the control system at the chose sampling rates.

The slender profile of the probe and the pressure-compensated sensor suite permit operation in either high speed profiling or in fixed depth monitoring applications to full ocean depths.

### 1.3 REAL-TIME COMMUNICATIONS

The OCEAN SEVEN 310 multi-parameter probe communicates with a computer via a standard RS232C interface. Real-time data can be acquired by means of the REDAS-5 Windows software. An optional RS485 interface overcomes the limitation of the RS232C cable maximum length (200 m) and allows the probe to transmit data through distances up to 1000 m. The communication speed is user selectable among: 9600, 19200, 38400 and 115200 (**38400 default**). The probe can also be equipped with the IDRONAUT data telemetry, which overcomes the cable limitations and allows the real-time communication with the probe through the standard oceanographic coaxial cables. It is important to mention that the OCEAN SEVEN 310 CTD is insulated with respect to the communicating device, independently of the kind of interface that is used: RS232C, RS485, telemetry. Insulation guarantees that the sensors are not affected or disturbed by ground loops or stray currents.

Connection type	Max cable length	Max. transfer rate
RS232C	200 m	115k2 bps
RS485	1000 m	115k2 bps
Telemetry	10000 m	14k4 bps

The above performance is obtained using the 6.4 mm diameter (1/4 inch) Rochester cable 1-H-255 which has an electrical resistance of 23  $\Omega$ /km and a capacity of 138 pF/m.

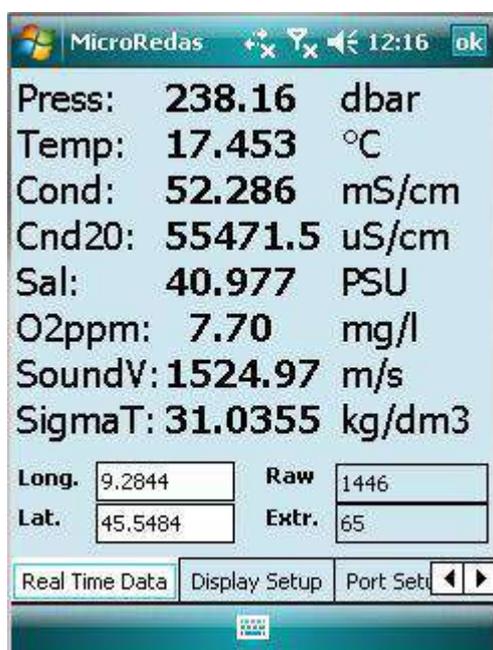
#### 1.4 WIRELESS COMMUNICATION MODULE "BLUETOOTH®", "WiFi"

The OCEAN SEVEN 310 probe can be optionally equipped with a wireless adapter which allows bidirectional full-duplex communications between the OCEAN SEVEN 310 probe and a personal computer (Desktop, Laptop) or PDA devices equipped with a compatible wireless device. A thorough description of the wireless adapter can be found in the dedicated appendix.

#### 1.5 PORTABLE READER

The OCEAN SEVEN 310 probe can be interfaced with a portable lightweight and extremely rugged reader based on the Windows Mobile™ software for Pocket PC. Through this device, it is possible to perform the operations usually carried out by means of a portable personal computer, but without all limitations that the use of a portable computer in the field and in hostile environments normally implies, like: battery endurance, display reading under sunlight, water and dust tightness, weight, etc.

The "Portable Reader" interfaces the OCEAN SEVEN 310 probe through a built-in RS232C interface and dedicated IDRONAUT programmes,



specifically developed for the Windows Mobile PC operating system: ZTERM and  $\mu$ REDAS. These programmes interface the OCEAN SEVEN 310 probe and allow the operator to directly dialogue with the probes directly, thus performing: sensor calibration, real-time data acquisition, probe configuration, etc. All these operations are possible because of the OCEAN SEVEN 310 probe functions included in the management firmware. Furthermore, the "Portable Reader" not only shows real-time data sent by the OCEAN SEVEN 310 probe, but also stores it. Data is stored in binary files using the "Portable Reader" main or extension "Flash" memory, which can be later transferred to a desktop personal computer. Data acquired by means of the " $\mu$ REDAS" programme can be imported later by the REDAS-5 programme. Data storage capability of the "Portable Reader" is only limited by the size of the installed



"Flash" compact memory card. The "Portable Reader" can operate for up to 15 hours continuously. Autonomy of operation of the interfaced OCEAN SEVEN 310 probe depends on the battery installed inside the probe and on the sensor suite.

#### 1.6 IDRONAUT TELEMETRY DECK UNIT

The IDRONAUT Telemetry Deck Unit powers and interfaces, by coaxial oceanographic cables, the OCEAN SEVEN 310 probe with a personal computer RS232C interface. The Deck Unit is provided with a transceiver (modem) which allows half-duplex communication with the OCEAN SEVEN 310 probe. Two types of Deck Units are available: Portable and On-Board. The first one is provided with an internal rechargeable lead battery (12VDC, 7 A/h) which permits OCEAN SEVEN 310



probe operation even in the absence of the mains supply. The On-Board MKPlus Deck Unit is housed in a 19" rack-mountable unit and is designed for on-board operations. The On-Board MKPlus deck unit provides high voltage telemetry power supply: 220 VDC to allow the OCEAN SEVEN 310 probe to interface and power several additional instruments like: GENERAL OCEANICS Rosette 1018, Fluorometer, Turbidity meter, etc.

### 1.7 INTERNAL BATTERIES

The OCEAN SEVEN 310 probe housing has in its upper part enough space to accommodate an internal battery pack. This is used whenever the probe carry out unattended acquisition cycles without the connection in real time with a surface unit (PC). Different types of battery can be installed in the CTD housing:

- 1x Size “A” Li-SOCI<sub>2</sub> Lithium-thionyl chloride non rechargeable battery 3.6V, 2.4Ah
- 3x Size “AA” 1.5V Alkaline non rechargeable battery assembled in a single pack 4.5V
- 1x Size “C” Li-SOCI<sub>2</sub> Lithium-thionyl chloride non rechargeable battery 3.6V, 8.4Ah
- 1x Li-Ion rechargeable IDRONAUT custom battery pack 3.7V,4.5 Ah

Whenever the OS310 operates in *Timed*, *Burst* and *Conditional* modes, the battery endurance is considerably extended because the CTD enters a deep sleep mode between acquisitions. When the probe is not used for long periods (e.g. 2 weeks or more), we suggest disconnecting the internal battery pack connector from the probe electronics or removing the internal battery pack from the probe to prevent the internal batteries from damaging the probe due to battery acid leakage. This is why the



OCEAN SEVEN 310 is shipped without batteries installed. Please be aware that **it is not possible to recharge the battery pack when it is installed inside the probe**

### 1.8 EXTERNAL SUBMERSIBLE RECHARGEABLE BATTERY PACKS

To overcome the limited autonomy of the internal battery pack, IDRONAUT developed two external submersible rechargeable battery packs that considerably increase the probe operating autonomy.

- ❖ Submersible rechargeable battery pack (Ø 75 x 315 mm POM), 1500 m max depth operation.
- ❖ Submersible rechargeable battery pack (Ø 66 x 315 mm Titanium), 7000 m max depth operation.

The external battery pack is held by the probe by means of a POM flanges and connected to the RS232C input/output bulkhead connector by means of a submersible cable. The external battery pack is internally protected by means of a multi-fuse.

#### Note

*The presence of the external battery pack does not interfere with the installation of the internal battery pack. The CTD drains energy from the higher voltage battery pack.*

### 1.9 MAGNETIC POWER ON/OFF SWITCH

The OCEAN SEVEN 310 probe is equipped with a magnetic power ON/OFF switch, which allows the operator to effectively switch ON and OFF the probe. The probe is also able to switch on and off by itself whenever it performs self-recording acquisition cycles and uses the internal and/or external battery pack.



The magnetic power ON/OFF switch is not used and is bypassed when the probe is used with telemetry (please remove the internal batteries, if any, before operating the probe through the telemetry system).

This switch also allows the operator to easily deploy a probe that is pre-configured to carry out unattended data acquisition cycles. When switching ON/OFF the probe by means of the magnetic switch, **please wait at least 10 seconds** between consecutive ON/OFF cycles.



### 1.10 MANAGEMENT PROGRAMMES

IDRONAUT programmes designed for the Windows 32/64bit operating systems allow the operator to communicate with the OCEAN SEVEN 310 probe to perform attended or unattended data acquisitions. Programmes include functions to upload data from the internal non-volatile data memory when the probe acts as a logger. The available programmes are:

**ITERM:** IDRONAUT Terminal Emulation program and probe management to easily communicate with the OCEAN SEVEN 310 CTD multi-parameter probe. Diagnostic and dedicated functions are present.

**ZTERM:** Terminal Emulation Program for Windows Mobile Operating system. Terminal emulation program to easily communicate with the OS310 CTD multi-parameter probe.

**uREDAS** IDRONAUT real-time data acquisition software for Windows Mobile operating system. It allows acquiring and displaying data in real time storing it for later retrieval and processing using REDAS-5 program. While acquiring, up to six different parameters are shown on screen.

**REDAS-5:** Real-time data acquisition, processing and presentation program, which allows the numerical display and plotting of the standard sensors and the derived variables such as salinity, sound speed, density, according to the UNESCO formulas and recommendations.

**MULTIPLEX:** Multiplex programme, which allows the acquisition from up to 16 OCEAN SEVEN 310 CTDs connected to a single personal computer. Data acquired in real time by means of the Multiplex program can be later processed using the REDAS-5 program.

### 1.11 STANDARD SENSOR SPECIFICATIONS

The OS310 multiparameter CTD can be equipped with the following sensors to measure:

Parameter	Range	Accuracy	Resolution	Time Constant
Pressure	0..7000 dbar <sup>(3)</sup>	0.05 % FS	0.0015 % FS	50 ms
Temperature	-5..+50 °C	0.0015 °C	0.0001 °C	50 ms
Conductivity salt water	0..90 mS/cm	0.0015 mS/cm	0.0001 mS/cm	50 ms <sup>(1)</sup>
fresh water	0..7000 µS/cm	5 µS/cm	0.1 µS/cm	50 ms <sup>(1)</sup>
brine	0..350 mS/cm <sup>(5)</sup>	0.010 mS/cm	0.0001 mS/cm	50 ms
Oxygen (polarographic)	0..50 ppm	0.1 ppm	0.01 ppm	3 s <sup>(2)</sup>
	0..500 %sat.	1 %sat.	0.1 %sat.	3 s <sup>(2)</sup>
Oxygen (optical)	0.45 mg/l	0.1 mg/l	0.025 mg/l	5 s
	0.250 %sat.	±0.2 %sat.	0.05 %sat.	5 s
pH	2..12 pH	0.01 pH	0.1 mpH	3 s <sup>(4)</sup>
Redox	-1000..+1000 mV	1 mV	0.1 mV	3 s

(1) At 1 m/second flow rate. (2) From nitrogen to air. (3) Other standard pressure transducers: 10, 40, 100, 200, 500, 1000, 2000, 4000, 7000, 10000 dbar.

(4) Differential pH preamplifier,  $10^{13}$ - $10^{14}$  ohm input impedance. (5) Optional extended range, available upon request

The fundamental properties of seawater like: **Salinity, Sound Speed, Water Density, Oxygen ppm** are obtained using the algorithms described in the UNESCO "Technical papers in marine science no. 44". The fresh water properties like: **TDS (Total Dissolved Solids), Fresh Water Conductivity** corrected at 20°C and 25°C are automatically calculated.

### 1.12 OPTIONAL SENSOR SPECIFICATIONS

Among others, the OCEAN SEVEN 310 CTD can be optionally equipped with the Highly Accurate Precise (0.01%) Pressure Transducer, the optical IDRONAUT OEM SEAPOINT Turbidity and Fluorometer sensors, the IDRONAUT OEM CHELSEA Single-Channel and Three-Channel Fluorimeters.

Parameter	Range	Accuracy	Resolution	Time Constant
Pressure (highly accurate)	0..7000 dbar <sup>(1)</sup>	0.01 % FS	0.002 % FS	50 ms
Turbidity meter	0..>2500 FTU	0.1 FTU	0.025 FTU	3s <sup>(2)</sup>
Fluorometer	0..150 µg/l	0.02 µg/l	0.01 µg/l	3s <sup>(2)</sup>
PAR	0..10 µA	0.05 µA	0.01 µA	
UNILUX (single-channel)	0..100 µg/l <sup>(3)</sup>			
TRILUX (three-channel)	0..100µg/l <sup>(3)</sup>			
CYCLOPS fluorometers	0..100 µg/l <sup>(3)</sup>			
ECO fluorometers	0..100 µg/l <sup>(3)</sup>			
Water sampling system	General Oceanics 1018 Rosette, IDRONAUT MISS miniaturized 6 Bottle water sampling system			

(1) Other standard pressure transducers: 100, 1000, 2000, 4000, 7000 dbar. (2) Provided with auto-range ,25,125,500, >2500 FTU; 5,15,50,150 µg/l.

(3) **Chlorophyll a, Phycocyanin, Phycoerythrin** for algae monitoring; **Rhodamine WT** or **Fluorescein** for dye tracing applications;

**Nephelometer** for turbidity monitoring.

### 1.13 ELECTRONIC SPECIFICATIONS

Real-time and logging: up to 28 Hz

Interfaces: RS232C, RS485, TTL, Data telemetry (QAM) up to 10Km; Wireless: WiFi/Bluetooth

Real-time clock accuracy: 3 ppm/year

Power supply: Battery: 2.9..5.0 VDC; running: 90 mA @ 3.6VDC; standby 8 µA @3.6VDC

External power: 9..32 VDC; running: 67 mA @ 12VDC; standby 8 mA @12VDC

Data telemetry: Low voltage: 18..60 VDC; High voltage: 90..220 VDC

### 1.14 PHYSICAL CHARACTERISTICS

Housings:	1000 dbar (AISI316)	1500 dbar (POM)	2000 dbar (POM)	6000 dbar (Titanium)	7000 dbar (Titanium)	7000 dbar (Titanium)
Dimensions:						
diameter	48 mm	100 mm	75 mm	48 mm	75 mm	89 mm
length	715 mm	710 mm	660 mm	660 mm	630 mm	720 mm
Weight:						
in air	1.3 Kg	4.2 kg	3.3 Kg	2.1 Kg	5.0 Kg	8.0 Kg
in water	0.7 kg	0.2 Kg	1.7 kg	1.3 Kg	3.8 Kg	4.3 Kg

### 1.15 THE STANDARD SENSORS

This section provides a detailed presentation of the OCEAN SEVEN sensors.

#### 1.15.1 LIFETIME AND HOW TO REPLACE THE IDRONAUT SENSORS

The IDRONAUT sensors are all pressure compensated and, in particular, the physical sensors (pressure, temperature and conductivity) can last many years, if properly used. They are high-quality sensors, as they are well known by oceanographers to measure salinity with great accuracy.

If thoroughly maintained by their respective hydrating caps and solutions, the IDRONAUT pH and reference sensors can last several years. The sensor replacement requires that the closure screws on the top head of the probe be unscrewed with a common screwdriver and the cylindrical housing be removed (this takes very few minutes). The wire sensors are tin soldered on their respective connection points placed on the printed circuit board. All sensor heads have a standard 12 mm diameter and are provided with two O-rings (Parker 12-2) for sealing. This means that every sensor can be fitted in any of the five sensor head holes. The pressure sensor is a high-quality transducer, which lasts many years if properly used. Its replacement is not very easy and, moreover, it requires a Dead Weight Tester System to obtain the factory calibration accuracy of 0.05% full scale.

#### 1.15.2 The pressure sensor

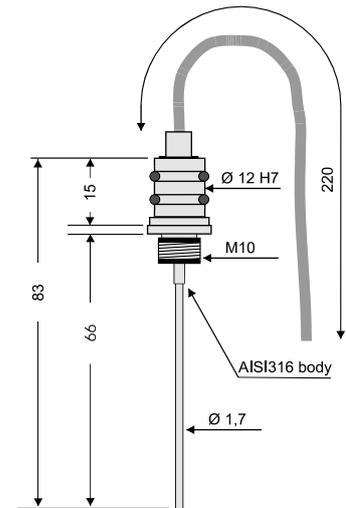
The pressure sensor is a high quality strain gauge, centrally mounted on the probe base, capable of generating a linear signal output, thus giving a resolution of 0.03% over the whole measuring range of 0 - 10000 dbar

Type:	strain gauge	
Measurement range:	0...10000 dbar	
Accuracy:	0.05%FS	
Resolution	0.002%FS	
Response time:	50 ms @1 m/s	
Measurement bridge resistance:	@ 25°C Ω 3500 ± 20%	
Excitation current:	0.6 mA	
Insulation:	@ 50 VCC MΩ 100	
Operating temperature:	°C -30...100	
Sensor body:	AISI 316L	
Compensation:	automatic compensation for temperature variations; not compensated for the barometric pressure variations.	
Life:	unlimited.	
Calibration frequency:	monthly.	
Maintenance:	offset calibration in air.	

### 1.15.3 The temperature sensor

The temperature sensor consists of a platinum resistance thermometer (type Pt 100 ohms at 0°C), fitted on a thin stainless-steel housing, able to withstand up to 700 bar. The sensor has a very low response time (50 ms) and a high stability of reading with ageing. The drift of reading (sensor plus associated electronics) is less than 0.0003 °C per year.

Type:	Pt100@0°C
Measurement range:	-3..+50 °C
Accuracy:	0.003 °C
Resolution:	0.0002 °C
Response time:	50 ms @1 m/s
Maximum pressure:	700 bar
Sensor body:	AISI 316L
Life:	unlimited
Calibration frequency:	yearly
Compensation:	none.
Maintenance:	none.



### 1.15.4 The conductivity sensor equipped with the "IDRONAUT seven-ring cell"

The conductivity sensor is a unique flow-through self-flushed cell with seven platinum ring electrodes. The central ring is excited with alternate current flowing to both the outermost rings. The two adjacent pairs of rings sense the relative drop in voltage due to the electrical conductivity of the measured water. The outermost pair of rings is grounded to shield the measuring cell from any outside electrical interference. The cell is mounted in a special cylindrical plastic body, which guarantees thermic insulation and is filled with silicone oil and provided with a rubber bellow to achieve pressure compensation.

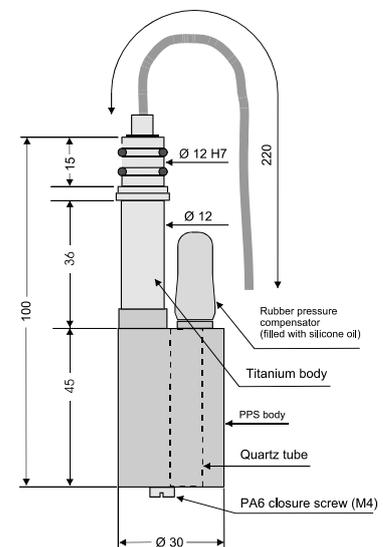
The IDRONAUT conductivity sensor and its associated electronics are designed to work both with plain and black platinised platinum electrodes. These electrodes have the advantage that, they can be used in both clean and dirty water without the fear of contamination. Should electrode contamination occur, they can be easily cleaned (even with up to 30% hydrochloric acid) without affecting the CTD performance or requiring re-calibration. Because of its big internal diameter and short length, the cell does not need a pump, as it is easily flushed during profiles.

The other conductivity flow cell sensors available on the market do not have the technology of the "IDRONAUT seven-ring cell".

The small, closely spaced temperature and conductivity free-flow sensors eliminate the need for adding pumping. Time constant of the conductivity sensor is 50 ms, at 1 meter per second water flow.

Measurement cell: 7 platinum rings deposited inside a quartz tube. Internal diameter 8mm, length 45mm.

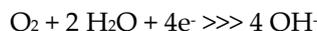
Measurement range:	0..70 mS/cm
Accuracy:	0.003 mS/cm
Resolution:	0.0003 mS/cm
Response time:	50 ms @1 m/s
Max pressure:	700 bar
Sensor body:	black plastic and titanium
Compensation:	automatic compensation of the pressure and thermal effect on the cell geometry are performed by the acquisition software.
Life:	unlimited.



Calibration frequency:	yearly.
Maintenance:	cleaning using the IDRONAUT “Conductivity sensor cleaning solution”.

#### 1.15.5 The oxygen sensor (standard 150bar and 700 bar versions)

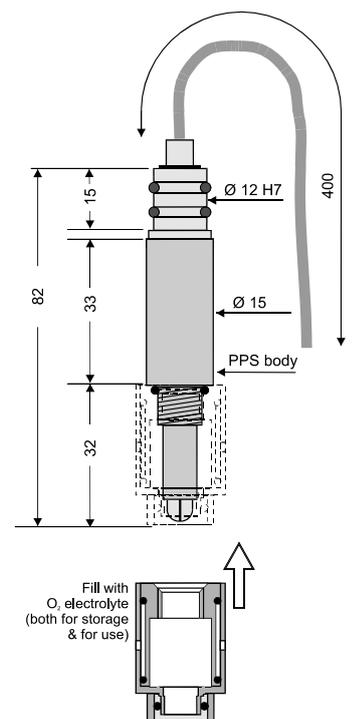
The oxygen sensor is of the polarographic type and consists of two half-cells, the anode and the cathode. The anode is a silver tube inside the sensor, which encircles a glass body where a platinum wire, forming the cathode, is sealed. The platinum wire (cathode) ends at the tip of the sensor where the glass body is rounded. A special membrane cap with a gas-permeable replaceable membrane screws onto the sensor. The inside of the cap is filled with a special electrolyte which allows the current (measuring) to flow between the anode and the cathode. The membrane is shielded from accidental bumps by a protective ring. The anode acts as a reference cell, providing a constant potential with respect to the cathode. The cathode, where oxygen is consumed or reduced, is separated from the sample to be analyzed by a thin layer of electrolyte and a special composite membrane. The electrolyte permits the chemical reaction to occur whereas the membrane constitutes a barrier against ions and other substances. By applying a polarizing voltage to the half-cells, the sensor develops a current proportional to the concentration of oxygen in the sample in front of the cathode. Oxygen from the sample is drawn across the membrane, at the sensor tip, in the area of the cathode. The applied polarization voltage is such that the sensor only responds to oxygen. The sensor is insensitive to nitrogen, nitrous oxide, carbon dioxide and other gases. In order to avoid stray ground current leaks, in case of membrane leaks, the anode is kept at ground potential while the cathode is polarized at a fixed negative voltage. The oxygen sensor limits stirring effects on the measurement and reads at least 97% of the true value, even with a stagnant aqueous sample. This is because the very small cathode area and special cathode geometry, associated with a unique composite membrane, minimize the consumption of the oxygen contained in the sample in contact with the membrane. The function of this sensor depends on the reduction of oxygen at the cathode, as expressed by the formula:



The developed electrons represent the measuring current and are supplied by the silver/silver chloride anode.

#### Standard version, 150 bar

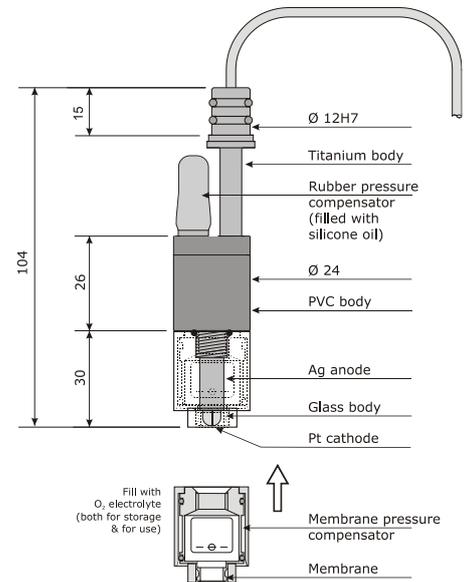
Type:	polarographic with Pt/Ir cathode and Ag(99.99%) anode.
Measurement range:	0... 50 ppm 0... 500% sat.
Accuracy:	0.1 ppm 1 % sat.
Resolution:	0.01 ppm 0.1% sat.
Polarization voltage:	650 mV DC.
Response time:	3s (green membrane @20°C) 0.9 s (blue membrane @20°C)
Max Pressure:	150 bar.
Sensor body:	plastic and titanium.
Compensation:	automatic compensation of pressure and thermal variations.
Life:	2 years if intensively used to perform continuous monitoring, up to 4 years if used weekly to perform daily profiling or monitoring.
Calibration frequency:	weekly.



Maintenance: measuring membrane replacement, electrolyte replacement

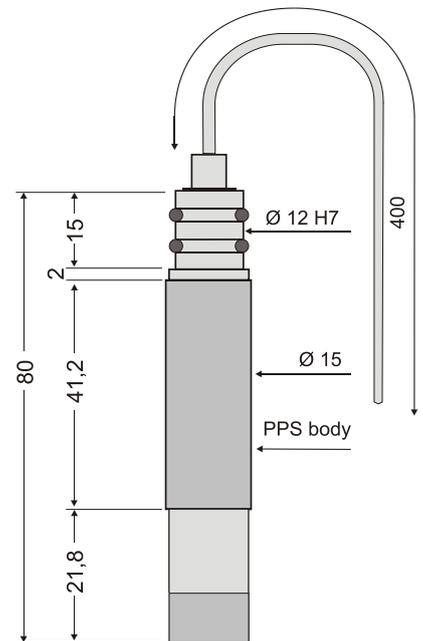
**Standard version 700 bar**

Type: polarographic with Pt/Ir cathode and Ag(99.99%) anode  
 Measurement range: 0... 50 ppm 0... 500% sat.  
 Accuracy: 0.1 ppm 1 % sat.  
 Resolution: 0.01 ppm 0.1% sat.  
 Polarization voltage: 650 mV DC  
 Response time: 3s @20°C  
 Max Pressure: 700 bar  
 Sensor body: titanium.  
 Compensation: automatic compensation of pressure and thermal variations.  
 Life: 2 years if intensively used to perform continuous monitoring, up to 4 years if used weekly to perform daily profiling or monitoring.  
 Calibration frequency: weekly.  
 Maintenance: measuring membrane replacement, electrolyte replacement.



**1.15.6 The oxygen sensor maintenance-free version - 5 bar only**

Type: polarographic with Pt/Ir cathode and Ag(99.99%) anode  
 Measurement range: 0... 50 ppm 0... 500% sat.  
 Accuracy: 0.1 ppm 1 % sat.  
 Resolution: 0.01 ppm 0.1% sat.  
 Polarization voltage: 650 mV DC  
 Response time: 30 s (membrane @ 20°C)  
 Max Pressure: 5 bar  
 Sensor body: black plastic (PPS)  
 Compensation: automatic compensation of pressure and thermal variations.  
 Life: 2 years if intensively used to perform continuous monitoring, up to 4 years if used weekly to perform daily profiling or monitoring.  
 Calibration frequency: weekly.  
 Maintenance: maintenance free.



**1.15.6.1 Polarographic Oxygen sensor measurement priming**

The OCEAN SEVEN 310 CTD allows the operator to obtain the oxygen data either expressed in ppm or % Saturation. The formula which connects these two functions is given as by:

$$\text{ppm} = \text{Saturation} \times \text{Solubility} / 100$$

The relevant formulae for the computation of saturation and solubility can be found in the below

“Calculation” section. The oxygen sensor for practical purposes is normally calibrated in air. The reading obtained during the calibration is defined as the 100% saturation value for that particular air temperature. This reading will vary with both temperature (3% per °C) and to a lesser extent with barometric pressure (about 1% every 10 mBar or 7.6 mmHg). For the above reason during calibration, the temperature is also automatically recorded and used by the OCEAN SEVEN 310 CTD to immediately compensate the calibration sensor slope for the temperature effect. This operation is performed during real-time acquisition as well. Although the effect of barometric change is much smaller, the OCEAN SEVEN 310 CTD allows the operator to manually enter a correction coefficient during the calibration procedure.

#### **1.15.6.2 Oxygen depletion / Stirring effect and/or Barometric pressure correction coefficients**

The oxygen sensor, like all the oxygen polarographic Clark sensors, sometimes needs that one or more correction coefficients be applied to the final readings in order to account for extraneous factors. The OCEAN SEVEN 310 CTD has been designed such that, the application of such correction factors by the operator is a relatively straightforward procedure. The oxygen sensor calibration and the correction coefficient calculation are both described in the “Sensors Calibration” section of this manual.

#### **1.15.7 Blue Cap Optical dissolved oxygen**

The description of the IDRONAUT blue cap optical dissolved oxygen can be found in the Appendix C section 6.

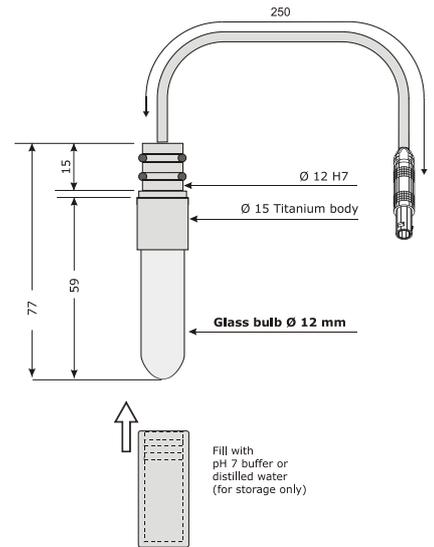
#### **1.15.8 pH and reference sensors**

The measurement of pH in seawater demands high accuracy since seawater has a high ionic strength and is weakly buffered. The pH range in the oceans is particularly restricted and, only in very special cases, the observed values are outside the range of 7.8 and 8.4 pH and, in some seas, the range extends from 6.5 to 9.0 pH. Some problems have always arisen from the use of traditional reference sensors with porous diaphragms, when measuring the pH in seawater, in particular at pressures in excess of a few bars, due to the high and variable junction potentials that are generated. The IDRONAUT reference sensor is in contact with the unknown solution by means of a small hole in the glass tip. This minimizes and stabilizes the junction potential between the inner gel electrolyte and the liquid to be measured. The reference sensor is a Silver/Silver Chloride cell in a saturated potassium chloride solid gel and the sensor head is made of titanium.

It is also available a reference sensor specifically developed for long-term monitoring of seawater where the internal cell is 0.7 mol NaCl. The glass body of the sensor is fitted with a plastic hydrating cap filled with the IDRONAUT REFERENCE SENSOR STORAGE SOLUTION based on 3-mol KCl (or NaCl) or, if not available, even with KCl saturated solution to avoid drying of the gel when not in use. **This cap must be removed before measurements.** The pH sensor has a titanium head, a glass body and a pH sensitive glass tip, which can withstand pressures up to 150 bar or even 700 bar (special version). During all periods of inactivity, the glass tip must be fitted with a white plastic hydrating cap filled with the pH 7 Buffer Solution, or simply with clean water. This is to prevent the pH-sensitive glass from dehydration, which slows down the sensor response. **This cap must be removed before measurements.**

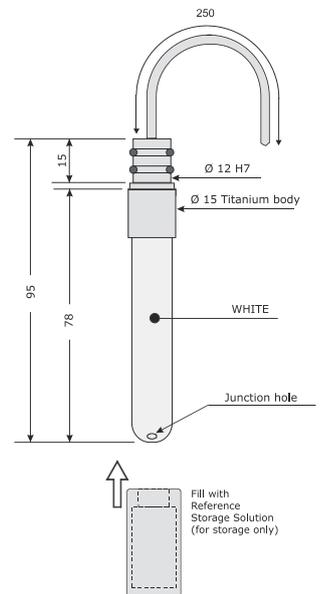
**pH sensor**

Type: blue glass membrane (100 Mohm @ 20°C).  
 Measurement range: 0..14 pH  
 Accuracy: 0.01 pH  
 Resolution: 0.001 pH  
 Drift: 0.05 pH/month  
 Response time: 3 s  
 Max pressure: 700 bar  
 Sensor body: titanium  
 Compensation: automatic thermal compensation.  
 Life: 2 years if intensively used for monitoring, up to 4 years if used weekly for daily profiling or monitoring  
 Calibration frequency: monthly.  
 Maintenance: glass membrane renewing using the pH Sensor Etching Solution.



**Reference sensor**

Internal cell: Ag/AgCl – using solid gel  
 Max pressure: 700 bar  
 Sensor body: titanium  
 Life: 1 year if intensively used for monitoring, up to 2 years if used weekly for daily profiling or monitoring.  
 Maintenance: stored with the Reference Sensor Storage Solution.

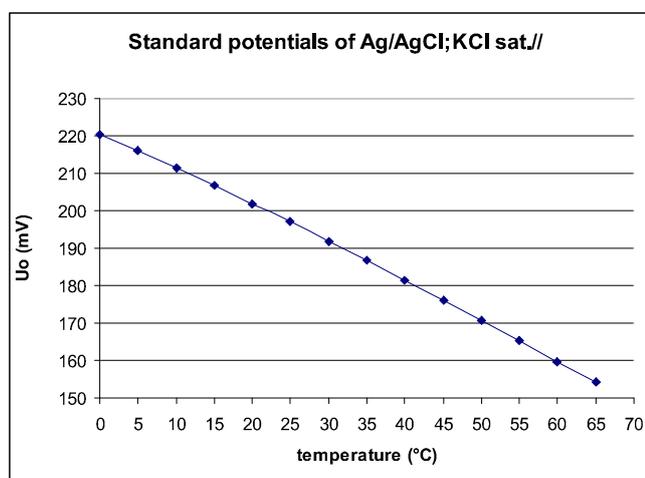


**WARNING**

The above stated life performance implies that the pH and reference sensors are properly hydrated by means of the hydrating plastic cap filled with distilled water for the pH sensor and with the Reference Sensor Storage solution for the reference sensor.

**STANDARD POTENTIALS OF THE SILVER/SILVER CHLORIDE  
REFERENCE ELECTRODE FILLED WITH SATURATED KCl  
WITH RESPECT TO THE HYDROGEN ELECTRODE**

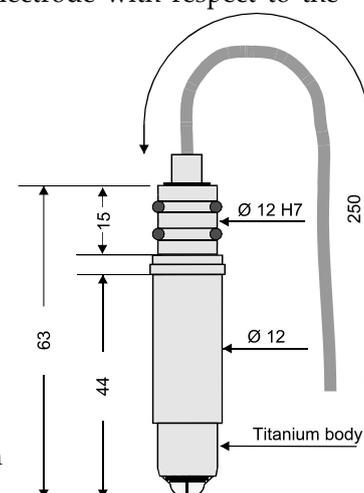
<u>Temperature °C</u>	<u>U<sub>0</sub> (mV)</u>
0	220,5
5	216,1
10	211,5
15	206,8
20	201,9
25	197
30	191,9
35	186,7
40	181,4
45	176,1
50	170,7
55	165,3
60	159,8
65	154,3



### 1.15.9 The redox sensor

The REDOX sensor measures the oxidation-reduction potential of the REDOX couples present in the medium; it makes use of the same reference sensor of pH as a reference. The sensor itself consists of a platinum wire, which ends at the tip of the glass body (in which it is embedded), where the glass body is rounded. The REDOX state of any natural environment is the result of a combined effect of chemical and biological processes of reversible and/or irreversible nature and, therefore, difficult to define. Because of the number of unknown reactions and lack of reversibility, the measured potential is not representative of a true Eh value but is only the e.m.f. of an electrochemical cell (e.g. Pt + reference electrode). Such cell difference potentials measured in natural environments are still very often referred to the hydrogen scale and expressed as REDOX potentials or Eh. The potential of our reference electrode (Ag/AgCl;KCl sat.) is +202 mV at 20° C which is to be added to the measured value. Therefore, if for example we measure a value of 100 mV, the true Eh value is +302 mV, whereas, if we measure a value of -100 mV, the true Eh value is +102 mV, and so on. In other words, the positive potential of the reference electrode with respect to hydrogen must be always added to the value measured by our CTD. When using reference electrodes different from the hydrogen ones, it is usual practice to present data as Eh by obviously taking into account the potential of the reference electrode with respect to the hydrogen electrode. For this reason, we present REDOX data as Eh.

Type:	platinum electrode.
Measurement range:	-1000 to +1000 mV.
Accuracy:	1 mV.
Resolution:	0.1 mV.
Max Pressure:	700 bar.
Response time	3s.
Sensor Body:	titanium.
Compensation:	none.
Life:	unlimited.
Calibration frequency:	not available.
Maintenance:	cleaning of the glass/Pt surface with special sandpaper.



**1.16 CALCULATIONS**

Unless otherwise specified, the computation of algorithms is taken from UNESCO technical papers in the marine science document no. 44 "Algorithms for computations of fundamental properties of seawater" 1983. The shown algorithms are written in ANSI "C" language.

**1.16.1 Polarographic Oxygen sensor**

Calculation of the oxygen content in parts per million (ppm) is carried out in three steps.

**1.16.1.1 Calculation of solubility**

The following constants are required for calculation of solubility:

$$\begin{array}{llll} a1 = -173.4292 & a3 = 143.3483 & b1 = -0.033096 & b3 = -0.001700 \\ a2 = 249.6339 & a4 = -21.8492 & b2 = 0.014259 & cnv = 1.428 \end{array}$$

The following variable is required for the calculation of solubility:

$$\text{tempK} = \text{tempC} + 273.15$$

the formula is:

$$\begin{array}{ll} r1 & = a1 + (a2 \times (100/\text{temp})) + (a3 \times \ln(\text{temp}/100)) + (a4 \times \text{temp}/100) \\ r2 & = \text{salinity} \times (b1 + (b2 \times (\text{temp}/100)) + (b3 \times (\text{temp}/100 \times \text{temp}/100))) \\ \text{Solubility (mg/l)} & = \text{cnv} \times \exp(r1 + r2) \end{array}$$

**1.16.1.2 Calculation of % saturation**

The following proprietary coefficients are required for the calculation of % saturation to compensate the IDRONAUT membrane permeability to oxygen due to the temperature and pressure variation respectively.

$$\text{Saturation \%} = \text{Coeff.} \times \text{O}_{2(1)} \times \text{SlopeO}_2 \times \exp(T_1 \times C_1 + \text{Pressure} \times C_2)$$

Where:

$$\begin{array}{ll} C_1 & = -0.029 \\ C_2 & = 0.000115 \\ \text{Coeff.} & = \text{Stirring effect and barometric pressure compensation (*)} \\ \text{SlopeO}_2 & = 1 / \exp(T_2 * C_1) \times \text{O}_{2(2)} / 100 \\ \text{O}_{2(1)} & = \text{Oxygen sensor reading in counts} \\ \text{O}_{2(2)} & = \text{Oxygen sensor reading in counts during calibration} \\ T_1 & = \text{Temperature sensor reading in } ^\circ\text{C} \\ T_2 & = \text{Temperature sensor reading in } ^\circ\text{C during calibration} \\ \text{Pressure} & = \text{Pressure reading in dbar} \end{array}$$

(\*) Description of the stirring effect and barometric pressure compensation coefficient can be found in the section describing the oxygen sensor.

**1.16.1.3 Calculation of ppm**

The formula is:  $\text{ppm (mg/l)} = \text{Saturation} \times \text{Solubility} / 100$

**1.16.2 pH calculation and pH correction in relation to the sample temperature**

This calculation corrects the pH value as read by the sensor taking into account the temperature at the moment of acquisition.

$$\begin{array}{ll} \text{pH} & = (((\text{sensor reading} + \text{sensor offset}) \times \text{pH transfer coefficient}) / \text{pH temperature compensation}) + 7.0 \\ \text{where:} & \\ \text{sensor reading} & = \text{sample value in counts (ADC output)} \\ \text{sensor offset} & = 7.0 \text{ buffer value in counts (ADC output) read during the calibration procedure} \\ \text{pH transfer coefficient} & = 58.168 / \text{counts per pH unit} \\ 58.168 & = \text{Nerst constant at } 20^\circ\text{C} \end{array}$$

counts per pH unit	=	Delta counts per pH unit (value factory set)
pH temperature compensation	=	54.2 + (Temperature x 0.1984)
Temperature	=	sample temperature
54.2	=	Nerst constant at 0° C
0.1984	=	mV per pH unit per Centigrade degree

The above calculation is based on the following assumption:

The NERST equation,  $E = E_0 + 2.303 RT/nF \log a$ , predicts the theoretical output of any electrochemical cell. Applying this equation to the glass electrode system, it can be shown that the mV response per pH unit varies with centigrade temperature in the following way:

0°C	54.20 mV/pH	37°C	61.53 mV/pH
25°C	59.16 mV/pH	50°C	64.12 mV/pH
30°C	60.15 mV/pH	100°C	74.04 mV/pH

The potential response of the electrode system changes 0.1984 mV per pH unit per Centigrade degree.

### 1.16.3 Conductivity compensated at 20 °C

As reported in the Ambühl formula, the conductivity is compensated with the following calculation:

$$K = a - b \times \text{temp} + c \times \text{temp}^2 - d \times \text{temp}^3$$

$$\text{cond } 20^\circ\text{C} = \text{cond} \times K$$

Where:

cond	=	conductivity sensor output	a = 1.721183	c = 0.0011484224
temp	=	temperature sensor output	b = 0.05413696	d = 0.00001226563

### STANDARD SEA WATER K15 0,99999 - VERSUS TEMPERATURE TABLE

TEMP	COND	TEMP	COND	TEMP	COND
°C	mS/cm	°C	mS/cm	°C	mS/cm
10.00	38.08	16.75	44.64	23.50	51.49
10.25	38.32	17.00	44.89	23.75	51.75
10.50	38.56	17.25	45.14	24.00	52.01
10.75	38.79	17.50	45.39	24.25	52.27
11.00	39.03	17.75	45.64	24.50	52.53
11.25	39.27	18.00	45.89	24.75	52.79
11.50	39.51	18.25	46.14	25.00	53.05
11.75	39.75	18.50	46.39	25.25	53.32
12.00	39.99	18.75	46.64	25.50	53.58
12.25	40.23	19.00	46.89	25.75	53.84
12.50	40.47	19.25	47.14	26.00	54.10
12.75	40.71	19.50	47.40	26.25	54.36
13.00	40.95	19.75	47.65	26.50	54.63
13.25	41.20	20.00	47.90	26.75	54.89
13.50	41.44	20.25	48.16	27.00	55.15
13.75	41.68	20.50	48.41	27.25	55.42
14.00	41.93	20.75	48.67	27.50	55.68
14.25	42.17	21.00	48.92	27.75	55.94
14.50	42.42	21.25	49.18	28.00	56.21
14.75	42.66	21.50	49.43	28.25	56.47
15.00	42.91	21.75	49.69	28.50	56.74
15.25	43.15	22.00	49.95	28.75	57.01
15.50	43.40	22.25	50.20	29.00	57.27
15.75	43.65	22.50	50.46	29.25	57.54
16.00	43.89	22.75	50.72	29.50	57.80
16.25	44.14	23.00	50.98	29.75	58.07
16.50	44.39	23.25	51.24	30.00	58.34

## **1.17 PROBE FIRMWARE OVERVIEW**

The probe is equipped with a firmware that manages all the probe operations. The most important management functions are described in the following subsection.

### **1.17.1 User interface**

Whenever the CTD runs in “VERBOSE MODE”, interaction with the user is carried out by means of the “USER INTERFACE”. With the term “USER INTERFACE” or “MMI” (Man Machine Interface), we mean the firmware layers that react to the user input and instruct the lower layers of the firmware to perform the desired action. The “USER INTERFACE” is a so-called menu driven interface, that is, at any time it is possible to select just one option among various possible choices. Each option will in turn perform the desired action or invoke a sub-menu containing further topics. The “USER INTERFACE” makes extensive use of different kinds of menus, among which we have: menu, sub-menus and data entry menus. A brief and exhaustive description of these menus will follow in the next subsection.

#### **1.17.1.1 Menu & Submenus**

A menu is shown mentioning first the menu title, firmware release and current date & time and then a list of the available items, one for each line. Each item is shown with four capital letters contained in two square brackets followed by an explanatory message. A number contained in the “<>” brackets allows fast selection of items. The programme has one main menu and four submenus. The “MAIN MENU”, which is shown at the end of the “START-UP PROCEDURE”, allows the selection of the underlying menus. To select an item (and invoke the related submenu), the user must enter the four capital letters contained in the square brackets or the number contained in the “<>” brackets. Once one of the submenus is shown, it is possible to return to the upper layer by means of the <ESC> key. Typing the <ESC> key from the “MAIN MENU” makes the CTD operate in the “LOW POWER MODE” (see the related subsection). The <ENTER> key re-displays the shown menu. Although the selectable items are shown in capital letters, the command can also be invoked with lower-case letters or numbers indicated inside the <> bracket.

#### **1.17.1.2 Data entry functions**

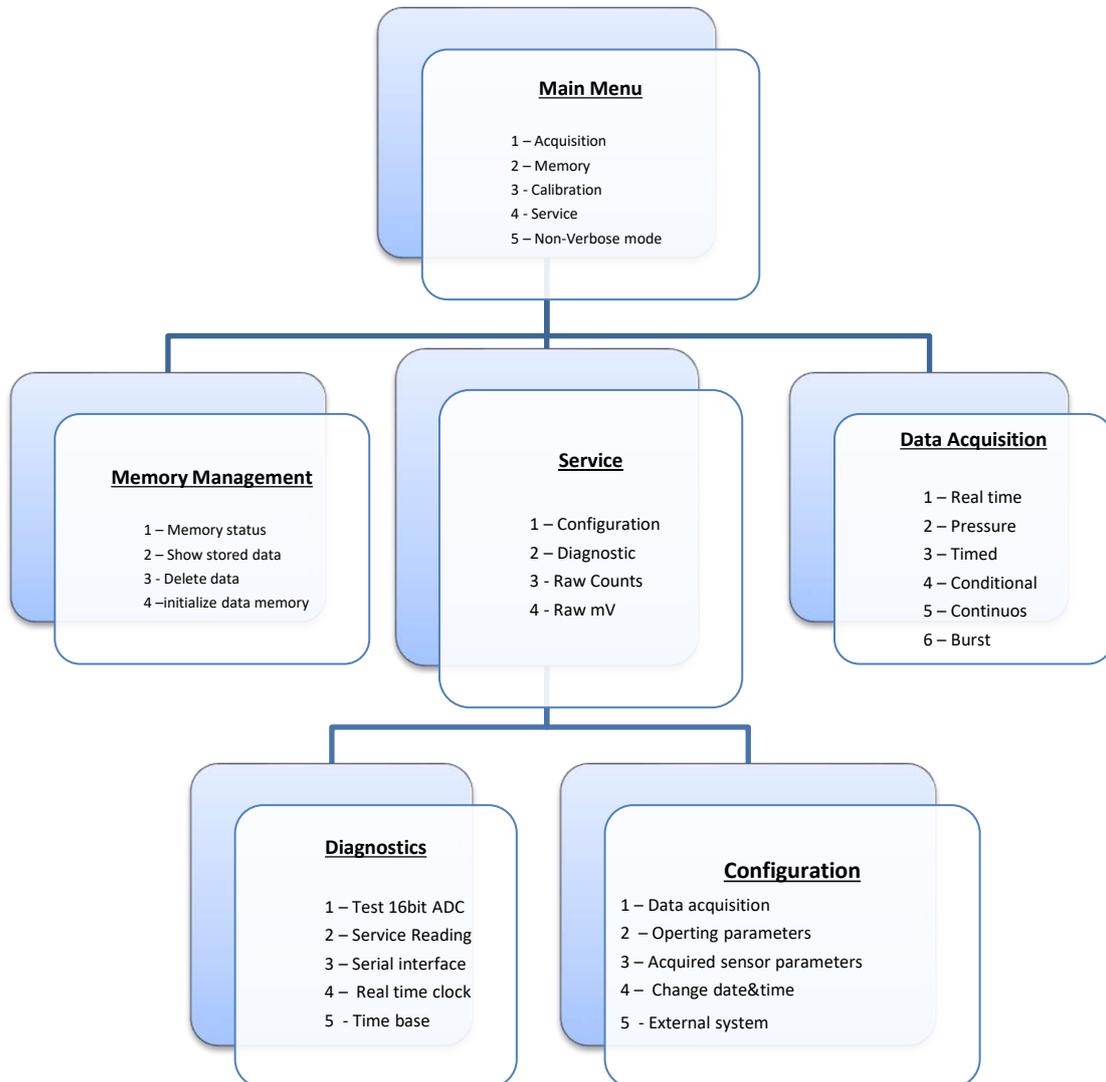
These kinds of functions allow the user to modify the shown items. The way the items are modified depends on the type of data itself. A set of rules guides the user during the item modification:

- ❖ The <ENTER> key, whenever the item is shown, skips the data entry to the next available item, without changing the item itself.
- ❖ The <ESC> key always aborts data item modification; the value reverts to its initial values.
- ❖ Any key different from <ESC> and <ENTER> starts data entry for the shown item.
- ❖ Whenever the modification of the item starts, the <ENTER> key confirms the new item.
- ❖ The numerical entry is automatically range checked. If the modified value is outside the range, this is shown and the user is requested to re-enter the data.
- ❖ Numerical data input is performed following the English rules such as “.” for the decimal point. The introduction of coefficients can be accomplished by means of the exponent notation (i.e. 10e-37).

Data entry functions automatically end after a pre-defined time-out (30 s). This prevents the probe from halting during a data entry function inadvertently not completed by the operator. Whenever the data entry function terminates due to the time-out, the item under modification remains unchanged.

### 1.17.2 Menu & submenu structure

Top-down diagram of the OCEAN SEVEN 310 menu structure.



### 1.17.3 Menu header structure

The menu and submenus show a list of commands preceded by two header lines, which identify the menu or submenu and show the relevant information about the probe in square, round and glyph brackets.

OCEAN SEVEN 310 - Id:0317003 {USR}[sw](1.0\_10 05/17)Oct 01 14:19:51.61 2017

They are:

OCEAN SEVEN 310  
Id:0317003  
{USR}

[sw] or [fw]  
(1.2\_10 01/18)

Type of probe and name.

Identification Code. This code corresponds to the serial number too.

Indicates the access rights to the probe functions and configuration. It dynamically changes whenever the access rights command is carried out and according to the entered password. The access rights acronyms are: USR, SRV, ADM (see the dedicated description).

Conductivity measuring range: sea water or fresh water.

Probe firmware release number and firmware release date.

**1.17.4 Probe Access Rights**

Some OCEAN SEVEN 310 configurations and functions are password protected to avoid unwanted modifications or running of functions that can led to probe unpredictable behaviours. In each menu and sub-menu, it is present a hidden command <CNHI>, which allows the operator to modify the probe access rights. Three different access rights are foreseen by the OCEAN SEVEN 310 management firmware:

**USR** User access to perform daily operations and standard probe configuration and management. At this level, it is not possible to modify certain sensors configuration or probe operating parameters. Moreover, some probe commands are hidden.

**SRV** Service access to allow the operator to carry out advanced set-up and advanced diagnostic functions.

**ADM** Administrative access to allow full control of the OCEAN SEVEN 310. This access is reserved to IDRONAUT technicians or to trained operators. Upon request and under IDRONAUT control, administrative access can be granted to the operator to carry out dedicated functions or configurations.

The probe access right is indicated on the menu headers with an acronym shown inside {} brackets:

OCEAN SEVEN 310 - ID:0317003 {USR}(1.0\_10 05/17)Oct 01 14:19:51.61 2016

At the start up, the probe operates in user “USR” mode. Service or Administrator access must be configured using the access rights configuration command. Once the <CNHI> command is invoked, the following message appears on screen:

*Set the PROBE Access rights<<*

The customer must reply to the password request with a 10-character message. The possible answers are

“SERVICE310” to grant SERVICE access to the probe functions and configuration.

“\*\*\*\*\*” to grant ADMINISTRATIVE access to the probe. Administrative password can be obtained from IDRONAUT only.

It is worthwhile mentioning that the probe always wakes up with “USR” access right. The modification of the access right remains valid until the probe is switched off or the access right is modified. Typing an arbitrary password causes the probe access right returning to the USR level.

**1.17.5 Data transmission protocol**

Whenever the probe runs in “NON-VERBOSE MODE”, interaction with the user is performed by means of the “DATA TRANSMISSION PROTOCOL”. Selection among the data transmission protocols can be done by means of the configuration parameters.

**1.17.6 Data transmission protocol: PTP Point-to-point**

The ASCII based protocol is easy to use and allows data transmissions point by point. The protocol implies bidirectional half-duplex data transmission between the probe and a PC. The probe, which is always the slave device, does not send any message unless requested by the master PC. Special characters used by the PTP protocol are:

<CTRL-T> switches the probe immediately from verbose to non-verbose operating mode.

<CTRL-J> special character used to terminate the PTP protocol messages.

<DEL> special character used to clean the probe PTP protocol message input buffer.

---

**1.17.7 Acquired data processing and post-processing**

Conversion of the raw data measurements (ADC Counts) into engineering units is configurable by the user; please see the description in the dedicated appendix and in the section “Calculations”.

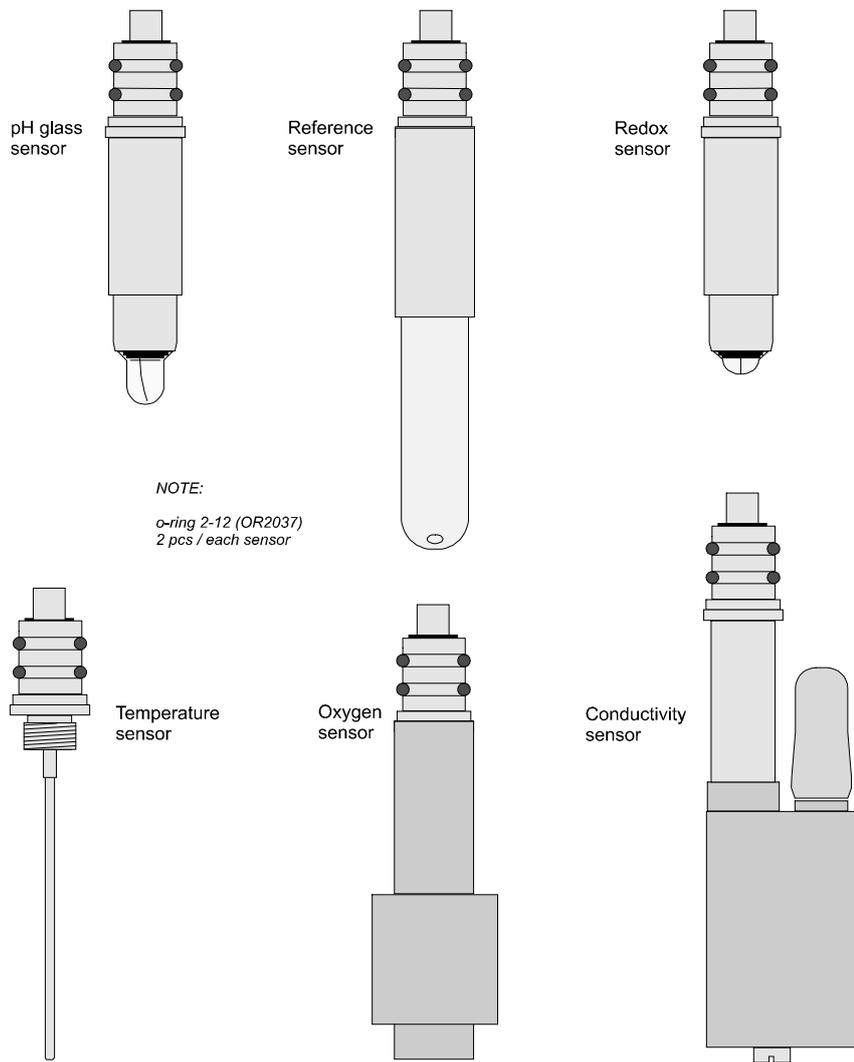
**1.17.8 Low power consumption**

Probe electronics is built using high integration electronic devices, low power consumption integrated circuits, and discrete components. The power consumption of the OCEAN SEVEN 310 probe is very low if compared to its high performance. The low power consumption is further reduced whenever the probe is not used for more than 2 minute. In fact, the management firmware powers OFF all unused resources while waiting for a command from the operator. Whenever the probe remains in this low power condition for more than five minutes, it automatically shuts down by itself, further decreasing the power consumption.

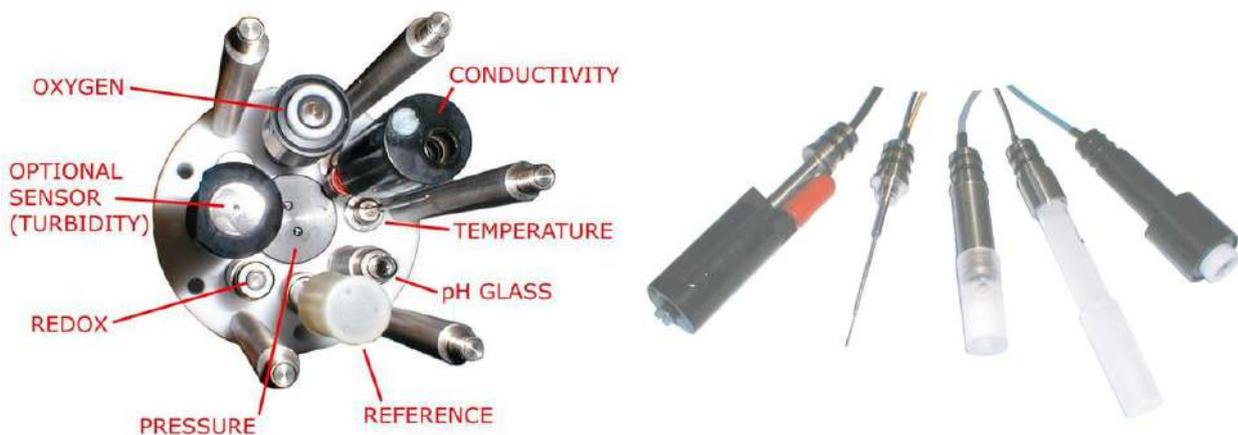
**1.17.9 Configuration**

The OCEAN SEVEN 310 configuration parameters are stored in the probe non-volatile memories. The configuration parameters are checked at the probe start-up using a CRC 32- bit wide algorithm. By means of the CRC 32-bit code, corruption of probe configuration is promptly detected and restoration of the “factory” default configuration is automatically carried out by the probe by itself.

**OCEAN SEVEN 310 SENSORS**



**SENSOR BODIES ARE MADE OF TITANIUM (TO PREVENT CORROSION) APART FROM THE TEMPERATURE SENSOR, WHICH IS MADE OF AISI 316L TO ACHIEVE THE BEST TIME CONSTANT.**



## 2 INSTALLATION AND START UP

Unpacking, installation and start-up procedures concerning the OCEAN SEVEN 310 are described in the "Installation & Start-up" flyer supplied with each probe.

### 2.1 SHIPPING LIST

Description	Quantity
A. OCEAN SEVEN 310 probe	1
B. Telemetry Deck Unit	1
C. Cable for probe connection to a PC via RS232C	1 x 3 m
D. Cable simulator to connect the probe to the Telemetry Deck Unit	1 x 3 m
E. Cable to connect the Telemetry Deck Unit to a PC	1 x 3 m
F. Cable to power the Telemetry Deck Unit	1
G. Dummy cap for probe bulkhead connector/s	1 x connector
H. Sensor maintenance kit, including:	
❖ Conductivity sensor cleaning solution	1x 25 ml
❖ Spare membrane cap for oxygen sensor	1
❖ Oxygen maintenance kit	1
❖ Oxygen electrolyte	2 x 25 ml
❖ pH calibration cup	1
❖ Spare pH sensor hydrating cap	1
❖ Spare reference sensor hydrating cap	1
❖ pH buffer solution - pH 7	1x100 ml
❖ pH buffer solution - pH 4	1x100 ml
❖ pH reference sensor storage solution	2 x 25 ml
❖ pH sensor etching solution	1x 3 ml
I. USB data storage key with software and documentation	1
J. Internal rechargeable battery pack and international charger	1
K. "AA" Battery holder	1x3 AA; 1x1 AA

#### Note

- Items B,D,E,F are present only when the purchase order includes the telemetry optional interfaces.
- Item B includes the battery charger, if it is a Portable Deck Unit.
- Sensor maintenance kit contents (item H) depends on the probe sensor suite.
- Customized submersible cables can be included in the shipping list if external sensors are interfaced with the OCEAN SEVEN 310 probe
- Item J is present only if the optional battery pack is ordered.

#### 2.1.1 Laboratory RS232C cable

A laboratory RS232C cable is provided to interface the probe to a personal computer: its 6-pin female underwater connector fits the 6-pin male connector of the probe; its 9-pin female connector (Cannon DB9) fits a standard AT type RS232C serial interface. Wiring of the cable can be found in the documents enclosed to the Operator's Manual and describing the bulkhead connectors and cables completing the probe package. The laboratory RS232C cable comes complete with a probe international power supply AC/DC converter.

## 2.2 INSTALLATION

Unpack and inspect the shipped parts; check the materials of the above shipping list and be sure that no damage has occurred during transport.

### 2.2.1 Internal and external battery packs

The probe is shipped without batteries installed. Therefore, if needed, install the battery. A detailed description can be found in Appendix "A" and on the OS310 flyer. In case the high-voltage telemetry is installed, the internal battery must not be present or installable. In this case it is mandatory to use external submersible battery pack for unattended self-recording operations.

### 2.2.2 **Telemetry Deck Unit installation**

To install the Telemetry Deck Unit, please refer to the IDRONAUT Telemetry Deck Unit Operator's and flyer.

### 2.3 **START-UP**

The OS310 probe can communicate through two interfaces: the RS232C/RS485 and the telemetry interface. Furthermore, the probe can be equipped with an internal and/or external battery pack. In the following paragraph, you can find the description to start up the OS310 probe using the telemetry or the RS232C/RS485 interface and in each of the two operating modes: "verbose" and "non-verbose". In addition to the probe and cable, even a personal computer is needed to interface the OS310. Therefore, before proceeding with the probe start-up operations, please turn the personal computer ON, install and run the ITERM IDRONAUT terminal emulation programme.

Please be aware that, after its installation, the ITERM automatically selects the PC communication port #1. In case the communication port #1 does not exist, it is assigned to another device or it is not installed in the PC please proceed to properly select the communication port to be used and to setup the communication parameter: 3800bps, 8bit data, 1 Stop, No parity.

Details about the ITERM programme set-up can be found in a dedicated appendix.

#### 2.3.1 **RS232C/RS485 interface - Probe power ON**

Remove the underwater cap from the OS310 6-pin male bulkhead connector marked as "RS232C & Battery input". Connect the 6-pin female connector of the 3-m laboratory serial cable to the 6-pin male connector on the probe top cover. Connect the other end of the cable to the serial port of the PC. Insert the AC/DC converter in a mains supply socket. Afterwards, rotating the arm of the magnetic switch on the probe top cover to the red dot switches the probe ON. When ON, the probe immediately sends the start-up messages to the PC and they immediately appear on PC screen.

#### 2.3.2 **Telemetry interface probe power ON**

Before proceeding, install the telemetry deck unit as explained in the Telemetry Deck Unit Operator's & Installation manual. Then, remove the underwater cap from the OCEAN SEVEN 310 2-pin male bulkhead connector, marked as "Telemetry". Connect the 2-pin female connector of telemetry simulator cable to the 2-pin male connector on the probe top cover. Connect the other telemetry end connector to the IDRONAUT telemetry deck unit probe input.

Remove the internal battery if installed and rotate the ON/OFF switch to the ON position.

Turn ON the probe by acting on the Telemetry Deck Unit "CTD HIGH VOLTAGE" power switch. The probe immediately turns on and the standard start-up messages will appear on PC screen.

#### **Note**

- 1) *When the OCEAN SEVEN 310 is interfaced through the telemetry interface, it is necessary to modify the FLOW CONTROL of the ITERM/REDAS5 programme configuring it to CTS/RTS. Related information can be found in the appendix describing the ITERM/REDAS5 programme.*
- 2) **Position the top cover magnetic switch to the ON position before turning on the telemetry.**
- 3) *It is mandatory removing the internal battery or the external submersible battery, if any, when the CTD is interfaced through the telemetry.*

#### 2.3.3 **Standard start-up messages**

Independently of the hardware interface and operating mode, the following messages will appear once the probe is turned ON.

```
OS3xx-Startup ID:0317003 (1.0_10 05/17) Oct 01 14:55:22.04 2016
Mem.  Cnf[Ok].Sta[Ok]Cal[:.....oK]
Data  [2.0]GByte!-..oK
Port  [Main,]..oK
StartUp (OPERATOR),Verbose WakeUp[USR]
Analog .Pwr.Brd.Ok
Warmup [1]s -
```

*PwrExt [3.72]VDC Batt.[3.24]VDC  
PwrInt iT[10.7]C uP[3.19]VDC Vref[3.34]*

If one (or more) of the start-up procedures is unsuccessful, an explanatory error message will be shown. In this case, the probe will automatically accomplish the restoring procedure by itself. The probe operating modes can be:

*Start-Up (OPERATOR) Verbose*

or

*Start-Up (OPERATOR) Non-Verbose protocol [PTP]*

If the probe is operating in "Verbose" mode, at the end of the above message, the probe "Main Menu" appears; otherwise, if the probe is operating in "Non Verbose" mode, at the end of the above messages, it will show the following message, waiting for instructions.

*Start of Non-Verbose Point To Point protocol--  
--return to the verbose mode by means of--  
--<VT^> command where: ^= CONTROL KEY PRESSED--  
ER 000*

Details about the PTP protocol and the relevant command and communication protocol rules can be found in the "OCEAN SEVEN 3xx probes Data Transmission Protocol" manual. The manual can be freely downloaded from the IDRONAUT web site "<http://www.idronaut.it>". To switch the probe to verbose mode, type the VT characters followed by the CTRL-J sequence (keep pressed the CTRL key while typing the J character). Alternatively, use the "Identify" function available under the "PROBE" menu of the ITERM programme.

## 2.4 THE MAIN MENU

At the end of start-up, when the probe initialization process is completed, the probe main menu appears:

*OCEAN SEVEN 310 - ID:0317003 {USR}(1.0\_10 05/17)Oct 01 14:55:23.95 2016  
<0>[SHUT]-Shutdown  
<1>[DATA]-Data acquisition  
<2>[MEMO]-Memory  
<3>[CALB]-Calibration  
<4>[SERV]-Service  
<5>[OPMD]-Non-Verbose mode  
cmd>*

- <0>[SHUT]** This command starts the "SHUTDOWN PROCEDURE" which saves the probe status and powers OFF the probe. To complete the shutdown software procedure, please rotate the probe magnetic switch and the deck unit power on switch to OFF position.
- <1> [DATA]** This command gives access to the data acquisition menu.
- <2> [MEMO]** This command gives access to the memory management menu.
- <3> [CALB]** This command gives access to the calibration menu.
- <4> [SERV]** This command gives access to the service menu.
- <5> [OPMD]** This command allows the operator to immediately switch the probe from "VERBOSE MODE" to "NON-VERBOSE MODE". The probe automatically wakes up and starts up with the last operating selected mode.
- [ESC]** Enter the probe in "LOW POWER CONSUMPTION MODE". Whenever the probe is in "LOW POWER CONSUMPTION MODE", the prompt command disappear.

---

### 2.5 LOW POWER CONSUMPTION

If the probe is not used for more than two minutes, it goes into the low power consumption mode automatically. This condition is identified by the presence of messages on PC screen.

*Unused CTD StandBy*

*Present time Oct 01 14:58:34.32 2016*

*Next timeout Oct 01 15:00:34.32 2016*

In this condition, the OS310 probe power consumption is reduced by about 70%. If the probe is interfaced through the RS232C interface, it remains in this condition for 2 minutes, waiting for the operator's instructions. Afterwards, to enhance the life of the internal batteries further, the probe automatically shuts down by itself. The probe can be re-started after by typing a character on the PC keyboard which executes a new "START-UP PROCEDURE". Alternatively, switch off the probe by rotating the magnetic switch to OFF position and, after one minute, rotate back the switch to ON position to wake up the probe.

#### Note

*When the probe is operated by means of the telemetry interface, the "low power consumption" is activated but the probe does not automatically shut down even if it is not used for a long time.*

### 3 DATA ACQUISITION

Data acquisition functions are the core of the OS310 management firmware. Aim of data acquisition functions is to collect, convert, show and store in memory (if needed) data acquired from all the probe sensors. Acquired data is stored in ADC counts (probe digitizer output) but is shown in engineering format to simplify the comprehension of the acquired values by human operators. Conversion from ADC counts, and engineering units takes place using the algorithm described in the calculation section and by means of the calibration values. Invalid data is obtained if the sensors have not been calibrated at least once. In this situation, acquired data is represented by the -9999.9 value.

The operations performed by the probe for each data acquisition function are described below. Data acquisition can be run with the probe operating in “Verbose” and/or “Non-verbose” mode. In the latter case, procedures on how to start and stop data acquisition are described in the “Ocean Seven 3xx PTP Data Transmission protocol” manual. The below paragraphs describe data acquisition functions once the probe operates in “Verbose” mode.

#### 3.1 THE DATA ACQUISITION MENU

Whenever data acquisition is selected from the probe Main Menu, the following message appears:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Oct 01 15:02:42.02 2016
<0>[DAUP]-Leave data acquisition menu
<1>[DAMD]-RealTime data acquisition
<2>[DALD]-Linear data acquisition
<3>[DATD]-Timed data acquisition
<4>[DACN]-Conditional data acquisition
<5>[DACO]-Continuous data acquisition
<6>[DABU]-Burst data acquisition
cmd>
```

Selection of the desired function is performed by typing one of the acronyms contained in the square brackets or pressing the corresponding digit contained in the <> bracket. Pressing <ESC> key or [DAUP] command forces the programme to go back to the "Main Menu"; pressing <ENTER> key re-displays the "Data Acquisition Menu".

#### 3.2 ACQUIRED PARAMETERS

Acquired and shown parameters are those that have been configured using the probe commands available under the “Configuration” menu. All data acquisition functions use the configuration information to acquire, show and store data in memory. Details about data storing method and processing can be found in the dedicated section of this manual. While data acquisition cycles are running, the CTD shows data in scrolling up rows, with a column assigned to each parameter.

#### 3.3 COMMON RULES TO SET UP THE DATA ACQUISITION CYCLE

Configuration of wrong parameters during the set-up of a measurement cycle can cause the malfunction of the probe and, in some cases, the probe cannot respond to the operator’s request to perform or interrupt the configured data acquisition cycle. Should this accident happen, please contact IDRONAUT to obtain the relevant instructions on how to revive the probe operation. As a general rule, **never configure** a value to 0 unless explicitly foreseen or requested by the configuration procedure and well described in the manual.

#### 3.4 COMMON RULES TO STORE ACQUIRED DATA

At the end of an acquisition cycle, data “temporarily” stored in memory must be confirmed. The data acknowledgement procedure for all the data acquisition methods is different if the probe is working on line or if it is performing unattended acquisitions.

**3.5 ON-LINE ACKNOWLEDGEMENT**

Operator can freely decide to confirm the stored data by opportunely answering the following question:

*Cast[5] Dataset[300]  
Confirm data stored?: Yes*

The operator confirms the acquired and stored data by answering <YES>. If the operator answers *Yes*, the data acknowledgement procedure goes on the probe automatically updates data in memory and returns to the data acquisition menu.

*Updating Flush\_EXT Memory...Ok  
Done*

**3.6 UNATTENDED ACKNOWLEDGEMENT**

When the probe operates in unattended mode, the operator is not present when the probe terminates a data acquisition cycle. Therefore, the probe automatically confirms the stored data and carries out an automatic acknowledgement procedure. This procedure identifies the acquired data by assigning to the sampling area identification code a message that later allows the operator to distinguish between the causes of termination. The first three characters of the sampling area identification code are configured as "ER-", while, the remaining four characters are used to represent a numerical code, which uniquely identifies the causes of data acquisition cycle termination, like:

0102 - Memory full  
0105 - All data has been acquired  
0111 - Data acquisition error  
0112 - Operator ends the unattended data acquisition  
0113 - Probe internal batteries exhausted  
0115 - Date&Time calculation error

Thus: ER-0102

**3.7 UPLOADING DATA STORED IN THE PROBE MEMORY**

At the end of the unattended acquisition, data stored in the probe memory can be retrieved. The following instructions explain how to do that with the IDRONAUT programs: ITERM and REDAS-5.

**"ITERM"**

1. Run "ITERM" programme.
2. Switch the probe ON by means of the magnetic switch.
3. Wait until the probe Main Menu appears.
4. From the "ITERM" probe menu, select the identify command. Wait until the ITERM program identifies the connected probe and the probe main menu appears again.
5. From the "ITERM" probe menu, select upload stored data.
6. Wait until ITERM shows the probe memory cast area contents in the pop-up upload window.
7. Select the folder where data will be saved.
8. Select the cast to be uploaded. CTRL and SHIFT can help to select more than one cast at a time.
9. Start the uploading of the selected cast.

**REDAS-5**

1. Run REDAS-5 programme.
2. Switch the probe ON by means of the magnetic switch.
3. Run the upload cast function from the remote menu.
4. Wait until the list showing the casts stored in the probe memory appears in the pop-up window.
5. Using the mouse, select the cast to upload. CTRL and SHIFT can help to select more than one cast at a time.
6. Press the OK key and wait until REDAS-5 retrieves the selected cast from the probe memory.

**3.8 UNATTENDED ACQUISITIONS – IMPORTANT TIPS**

The following points are important when an unattended cycle is carried out using the OS310 probe.

**3.8.1 Power consumption reduction**

The probe is equipped with a firmware protection to prevent the battery pack from running down. At the beginning of the unattended acquisition cycles and each minute during the unattended acquisitions, the battery energy is monitored and compared to a configurable limit. If the battery voltage falls below the configured limit, the unattended acquisition is immediately terminated.

**3.8.2 Warm-up**

A warm-up time-out to stabilize the sensor reading is mandatory. In case of physical sensors, a 3-second time-out is sufficient, while, a 5-second time-out is needed if the probe is equipped with chemical sensors like oxygen and pH. If the probe interfaces the GO-1018 rosette the warm-up time-out must be at least 30s.

**3.8.3 ON/OFF cycles**

Whenever the probe is switched OFF, please wait 10 seconds before switching it ON again. This waiting time allows the probe to perform a correct shutdown and start-up procedure.

**3.9 SHIPPING CONDITIONS**

The probe is shipped without batteries and with the pH and reference sensor hydrating caps installed. The latter must be routinely refilled with the proper solutions to guarantee the pH and reference sensor hydration.

**3.10 SENSORS**

<i>Pressure sensor</i>	Before executing a data acquisition in relation to pressure, calibrate (null) the pressure sensor offset.
<i>Conductivity sensor</i>	After using the probe in seawater, wash the conductivity sensor with fresh water. Do not leave the probe exposed to direct sunlight. Wet the conductivity sensor immersing the probe in salt water for one night before starting the measurement campaign.
<i>Oxygen sensor</i>	Calibrate the sensor before starting the acquisition cycles. Do not perform any calibration on the deck where air concentrated of water and/or oil aerosol can disturb the calibration.

**3.11 REAL TIME DATA ACQUISITION**

Real-time data is immediately shown on PC screen. This method allows the shown data sets to be collected in the probe data memory upon operator's request. Data collection is achieved by pressing <S> key. Once pressed at the end of data, an "M+" appears indicating that the shown data has been stored in the probe memory. The <ESC> key terminates the manual data acquisition. At the end of data acquisition, in case some data has been collected, the data acknowledgement procedure is performed (see the descriptive paragraph at the beginning of this section).

*Place the CTD on the sampling point - type<any key>to start,<ESC>to abandon*

*Manual data acquisition - type<S>to toggle data storage,<ESC>to leave*

*Press Temp Cond Sal Dens O2ppm O2sat% pH eH Time & Memory*

*0.12 17.05545.35335.3521.02582.35 30.1 7.895 214.8 11:14:26.8 M+*

*0.19 17.01045.30435.3501.02582.17 27.8 7.902 208.7 11:14:27.0 M+*

*0.09 17.01145.30035.3451.02582.17 27.8 7.901 208.7 11:14:27.4 M+*

### 3.12 LINEAR DATA ACQUISITION

This data acquisition method allows the data sets to be collected at pre-set pressure intervals, during the probe immersion. This procedure is commonly used whenever the probe must be used without a real-time connection with a surface PC; in this case, the probe is pre-set before deployment. Afterwards, the probe can be deployed for profiling at different sampling sites. Acquisition is performed acting on the magnetic switch. Once invoked, the following message appears on PC screen.

*LINEAR PROFILE DATA ACQUISITION*

*Acquisition step:0.5*

Data collection step expressed in dbar. Please be aware that data will be collected only during downward profile, or better, only if the pressure increases!

*Number of data sets to acquire per each sampling point:2*

For each pressure step, it is possible to collect in memory more than one data set contemporaneously.

*Do you confirm the above ?:No type [Y]es or [N]o < y*

Answer **NO** return to the data acquisition menu.

Answer **YES** the probe shutdown waiting the next wakeup to start a data acquisition cycle in function of pressure

*----- UNATTENDED Linear Profiles -----*

*To start switch-ON the CTD*

*To stop while switched-ON type <ESC> until confirmation message appears*

Now, the operator must switch off the probe by rotating the magnetic switch to OFF position.

Once the probe is operated in unattended mode, the operator is unaware of the probe operations. The predefined data acquisition cycle end conditions are:

- the probe is switched off by means of the magnetic switch;
- the probe internal battery is below the minimum operating limit;
- the probe data memory is full;
- the operator wakeup the probe and interrupt the acquisition cycle

#### Note

*If the probe interfaces a "Rosette" water sampling device, some questions about the water sampling method and steps are presented to the operator. Details about the water sampling set-up can be found in the Rosette appendix.*

#### 3.12.1 Routine operations to perform unattended linear profiles

Once the probe is switched ON by means of the magnetic switch, it watches the pressure sensor waiting for pressure increments (probe lowering in water). Ending of data acquisition is achieved once the probe returns to the surface and the operator switch the probe OFF.

#### Note

- ❖ The magnetic power ON/OFF switch can start and/or stop an unattended measuring cycle.
- ❖ Please be aware that, during the unattended linear profiles, the probe does not reduce its power consumption nor does it switch OFF by itself when back from a profile. To reduce the power consumption, it must be turned OFF by means of the ON/OFF switch once on the surface.
- ❖ Please protect the not-in-use bulkhead connectors with the proper dummy connectors.
- ❖ When carrying out the unattended linear profiles, the probe monitors the battery voltage. In case

it reaches the lower operating limits, the unattended profile immediately ends and the probe switches OFF by itself. No other profiles will be accomplished. It is therefore important to verify the battery conditions before starting a series of profiles.

- ❖ Each unattended linear profile is stored in a different cast.

### 3.12.2 Terminate the unattended linear profile

To terminate the unattended linear profile, connect the probe to a PC and then switch the probe ON. It will try to start an unattended linear profile again. When the probe shows the acquired data waiting for pressure increment, type the <ESC> key and answer <YES> to the following answer:

*Do you want to terminate the unattended linear profile Yes, No*

The probe will terminate the current acquisition and returns to the Data Acquisition Menu.

### 3.12.3 Step-by-step Linear Profile procedure

This paragraph describes a step-by-step procedure to perform an unattended linear profile. After establishing a valid connection with the probe using the "Verbose operating mode", proceed as follows:

#### A) Preliminary configuration

1. Run the "ITERM" programme.
2. Switch ON the probe.
3. Using the ITERM function PROBE -> SET TIME setup the probe RTC
4. If the Main Menu does not appear, type <VT> followed by a <CTRL-J>. The Main Menu must appear.
5. From the Main Menu, select the "Calibration sub-menu" by means of the **CALB** command.
6. From the Calibration Sub-menu, select the sensor calibration by means of the **CASE** command.
7. From the list of sensors, select the **Pressure** transducer and then follow the on-screen instructions.
8. At the end of the pressure sensor calibration, perform any other sensor calibration procedure you judge indispensable.
9. At the end of sensor calibration type the <ESC> key twice and you will return to the Main Menu.
10. From the Main Menu, select the "Data Acquisition sub-menu" through the **DATA** command.
11. From the "Data sub-menu", select the "Linear profile" by means of the **DALD** command.
12. The first question concerns the pressure step in dbar to use during the data acquisition.
13. The second question concerns the number of data sets to acquire for each sampling point. You can decide to acquire more than one data set for each sampling depth.
14. The last question concerns the confirmation of the above parameters. Answer **YES**.
15. Now, the probe switches OFF by itself and is ready to perform the data acquisition.
16. Switch the probe OFF by means of the magnetic switch.

#### B) Field operations

1. Once you have reached the sampling site, switch ON the probe by means of the magnetic switch; the probe watches the pressure sensor value to start the acquisition. Lowering the probe in water starts the data acquisition and data storing. Before starting the profile we suggest immersing in water the probe and, wait at least 30s to stabilize the sensors.
2. When the probe returns to the surface, switch it OFF by means of the magnetic switch; data acquisition ends immediately. The probe is ready to carry out a new profile.

The above operations can be executed repeatedly until the probe batteries have run down or until the probe memory is full of data. Each time a data acquisition is performed, a new data header is automatically generated.

#### C) Ending the unattended data acquisitions

1. Run the "ITERM" programme.
2. Switch the probe ON by means of the magnetic switch.

- 
3. After the start-up messages, the probe starts to acquire data watching for depth increments.
  4. Type the <ESC> key until a message appears.
  5. Answer YES to the given question.
  6. The unattended profile is ended and the probe is working in the standard VERBOSE mode.

The acquired data is stored in memory and you can have a quick look at it by means of the functions available in the "DATA STORAGE" menu.

### 3.13 TIMED DATA ACQUISITION

Timed data acquisition method allows the acquisition of data sets in relation of predefined time intervals. This method allows the probe to perform acquisitions in function of time intervals for short or very long periods by means of the probe integrated data logger capabilities. These capabilities mainly consist in the fact that the probe carry out the power OFF and ON cycles at pre-set time intervals and can operate in an unattended mode. This capability prolongs the battery life because, once the probe waits for the data acquisition interval time, it does not consume power as it is in OFF condition. The built-in real-time clock calendar is used to automatically and precisely set up the time intervals and wake up the probe at the right time. **Before starting the probe time and date must be set.**

When selected from the main menu, the following message appears on the PC screen:

```
OCEAN SEVEN 310 - Jun 13 08:35:24.61 2017
Timed data acquisition configuration
Data acquisition step: 00:00:00
```

This time, entered in the format [hh:mm:ss] (from 00:00:05 to 23:59:59), represents the time interval between two consecutive data measurements. The operator is requested to enter the time in the format: hours, minutes, seconds. When the built-in OFF/ON power capabilities of the probe are used to perform unattended time measurements, the step cannot be shorter than 5 seconds.

After the data acquisition interval is configured, the following message appears:

```
Number of acquisitions:0 enter new value< 100
```

The operator must enter the number of timed acquisition cycles he intends to perform.

```
Data set to be stored per each acquisition:2 enter new value< 2
```

For each timed acquisition cycle, it is possible to acquire more than one data set. The number of data sets and the number of timed acquisition cycles are controlled to guarantee that there is enough space in memory to store the data that will be acquired. If the request overpasses the memory capability, a message informs the operator that the configuration cannot be accepted. In case the time step used is hundredths of seconds, the number of data set must be configured as 1.

```
Enter the starting acquisition time [HH:MM:SS]
Starting time: 00:00:00
```

The operator can decide the time when the first measurement cycle will be carried out. In case the entered time is higher than the present time by more than 10 seconds, the interval time will be automatically spent with the probe in an OFF condition. Confirming the default value of 0 tells the probe to perform the first measurement immediately.

```
Do you confirm the above ?:No type [Y]es or [N]o < y
```

Answer **NO** return to the data acquisition menu.

Answer **YES** the probe shutdown waiting the next wakeup to start a data acquisition cycle in function of time. Afterwards, the probe automatically executes a "Shut-Down procedure" and switches off by itself if the time interval to wait is greater than 30s:

```
Press Temp Cond Sal Dens O2ppm O2sat% pH eH Time & Memory
Timed acquisition Keyb.Cmd: <ESC>Leave data acquisition
Press Temp Cond Sal O2Sat% O2ppm pH Eh Time&Memory
```

-292.51 0.073 4.318 4.480 96.4 13.62 6.511 2.2 08:59:34.35M+

OCEAN SEVEN 310 - Timed acquisition power OFF

Present time Jun 13 08:59:34.37 2017

Next timeout Jun 13 09:00:32.37 2017

Next acquisition on Jun 13 09:00:32.37 2017

Acquisitions left to do 9

CAST temporary updating...Flush\_EXT Memory...Ok done

OCEAN SEVEN 310 - ID:0317003 {USR}(1.0\_10 05/17)Jun 13 08:59:34.40 2017

SHUTDOWN..RTC alarm setup..Completed

Afterwards, the probe waits in OFF condition that the next data acquisition time is met.

#### Note

If the probe interfaces a "Rosette" water sampling device, some questions about the water sampling method and steps are presented to the operator. Details about the water sampling set-up can be found in the dedicated appendix.

### 3.13.1 Terminate a timed data acquisition

The timed data acquisition ends whenever one of the following events occurs:

#### Battery has run down

The probe automatically checks the battery voltage against the preset boundary each time it wakes up or at regular intervals when it is always ON. In case the battery has run down, the following message appears:

*No more power supply to continue the timed data acquisition*

After this message is shown, the timed data acquisition procedure is automatically concluded and the probe shows again the "Data Acquisition menu". Acquired data is automatically confirmed in the probe memory.

#### Operator stops the acquisition

The operator can terminate the timed data acquisition by pressing the <ESC> key while the probe is ON or by pressing <ESC> once the probe is OFF and by answering <YES> to the question about the intention to conclude the timed acquisition cycle. In this case, the following message appears on the PC screen at the end of the probe start-up.

*Timed data acquisition illegal acquisition time*

*Do you want to terminate the timed data acquisition ? (Y)es (N)o*

Pressing <Y> for Yes immediately terminates the timed data acquisition. Pressing <N> for No, the probe immediately starts an automatic power OFF procedure calculating the next data acquisition time. The operator has 30s to answer the question. If no answer is received from the probe, it shuts down by itself configuring the next acquisition time.

#### Data acquisition error

In case the probe does not complete a data acquisition procedure due to hardware or sensor problems, the following message appears:

*Error during the timed data acquisition*

After this message is shown, the timed data acquisition is automatically concluded as this error is unrecoverable. Data acquired since the accident is automatically confirmed in memory.

#### Acquisition completed

The timed data acquisition automatically ends whenever the total

number of time data acquisition cycle has been carried out. Data acquired and stored is automatically confirmed in memory.

### 3.13.2 Automatic power OFF procedure

During the timed data acquisition, once the configured data set has been acquired and stored, the power OFF procedure is carried out by the probe to save battery energy. When this happens, the following message appears:

*Number of acquisitions left: 100  
Next data acquisition on Fri March 31 15:49:45.6 2007  
Shut-down procedure successfully completed.*

### 3.13.3 Accidental power ON cycle

In case of accidental power ON cycle, while the probe is OFF waiting for the next acquisition time, the probe wakes up and allows the operator to interrupt the timed acquisition cycle.

*Timed data acquisition illegal acquisition time  
Do you want to terminate the timed data acquisition ? (Y)es (N)o*

In case no answer to the above probe request is received in 30s, the probe shuts down by itself and configures the next timed acquisition time.

### 3.13.4 Magnetic power ON/OFF switch

The magnetic power ON/OFF switch can be used to temporarily interrupt the time sequence of the timed data acquisition cycle. When the probe is switched ON again, it immediately starts a data acquisition cycle and then continues with the measurement cycles using the configured time step. The successive acquisition time is calculated by adding the configured interval to the last wake-up time until it is greater than the wake-up time.

### 3.13.5 Step-by-step procedure

After establishing a valid connection with the probe using the "Verbose operating mode", proceed as follows:

#### A) Preliminary configuration

1. Run the "ITERM" programme.
2. Switch ON the probe.
3. Using the ITERM Probe->Set Time setup the probe date and time
4. If the Main Menu does not appear, type <VT> followed by a <CTRL-J>. The Main Menu appears.
5. From the Main Menu, select the "Data Acquisition sub-menu" through the **DATA** command.
6. From the "Data sub-menu", select the "Timed Data acquisitions" by means of the **DATD** command.
7. The first question concerns the data acquisition interval or step.
8. The second question concerns the number of acquisition cycles to perform.
9. The third question concerns the number of data sets that must be acquired during each acquisition cycle.
10. The fourth question concerns the data acquisition starting time.
11. Now the probe, depending on the previous configuration, acts according to one of the following possibilities: i) it executes a data acquisition cycle, then switches OFF by itself and waits for the next acquisition time. ii) it waits for the data acquisition starting time.
12. Switch OFF the probe.

#### B) Field operations

1. Once you have reached the sampling site, switch ON the probe by means of the magnetic switch; the probe performs the first acquisition cycle and then configures the successive acquisition time by itself.
2. When the probe is recovered and returns to the surface, you can switch it OFF by means of the magnetic switch and the data acquisition is temporarily interrupted.

#### C) Ending the unattended data acquisitions

1. Run the "ITERM" programme.
2. Switch the probe ON.
3. After the start-up messages, the probe starts by showing a warning question about the intention to stop the measurement cycle.
4. Answer **YES** to the given question.
5. The unattended timed acquisition is ended.

The acquired data is stored in memory and you can have a quick look at it by means of the functions available in the "DATA STORAGE" menu.

### 3.14 CONDITIONAL DATA ACQUISITION

Conditional data acquisition is used to perform burst measurements whenever a sensor reading is greater than a configured trigger limit. The sensor can be selected among those installed in the probe and the trigger limit can be freely configured by operator. To perform the monitoring of the sensor reading, the probe asks the operator for the configuration of a monitoring interval (from 10s to 1day).

During the measurement cycles, the probe wakes up at the configured interval to monitor the sensor reading and to compare the sensor reading against the configured trigger limit. To save the battery energy, the probe waits in OFF condition for the time between two consecutive sensor measurements.

Whenever the sensor reading is greater than the configured trigger limit, the probe starts to acquire a burst of data. Data acquired from sensors is shown and stored in the probe data memory.

The data acquisition (burst measurements) takes place at the configured sampling rate and continues until the selected sensor reading does not fall again under the configured trigger limit. There is no limit to the amount of data acquired during a burst measurement. The cycle continues indefinitely until it is interrupted by operator. Acting on the magnetic switch, it is possible to temporarily interrupt and restart the measurement cycle. Each time the burst measurement cycle starts, a new cast is automatically generated to separate the acquired data from the one stored before.

Whenever this command is selected from the data acquisition menu, the following message appears on the PC screen:

```
Conditional Sampling setup
Monitoring time-out: 00:00:00 enter time [hh:mm:ss] < 00:01:00
```

The operator must enter the time-out used by the probe to monitor the sensor reading. The time-out can be configured from 10s to 1day. Afterwards, the sensor to be used to condition the measurements can be selected:

```
Parameter   Logical Code
Press       000
Temp        001
Cond        002
O2Sat%      006
O2ppm       005
pH          007
Eh          008
Sensor logical code:0 enter new value< 2
```

The probe shows on the PC screen a list representing all the sensors installed in the probe. The operator can select one of the shown sensors to be used as an acquisition condition by entering the numerical value indicated under the **logical code** column. Once selected, the operator can enter the trigger value used to start and/or stop the data acquisition cycle.

```
Sensor trigger value:0 enter new value< 30.0
```

The value must be entered in engineering values (ppm, dbar, °C, mS/cm, etc.) taking into consideration the selected sensor, its measuring unit and its measuring range.

Therefore, a value of 100 is fine if the selected parameter is the oxygen saturation, but it is completely wrong if the selected parameter is the temperature sensor, as 100°C cannot be measured by the OCEAN SEVEN 310 probe. Therefore, this condition, even if accepted, will be never met by the temperature sensor reading. Configuration of wrong trigger value may led the probe to misbehave.

The last parameter to enter is the sampling rate that will be used by the probe whenever the burst data acquisition cycle starts.

```
1/Sample rate=[35..60000ms]:50
```

The operator can select a sampling rate between 0.1 and 28 Hz by configuring the associated time between measurements expressed in ms, the most common are:

Sampling rate	Interval to configure
28 Hz	35 ms
20 Hz	50 ms
10 Hz	100 ms
5 Hz	200 ms
1 Hz	1000 ms
0.1 Hz	10000 ms

After the sampling rate has been entered, the probe is ready to start the conditional data acquisition cycle. The following message appears on the PC screen:

*Do you confirm the above?:No type [Y]es or [N]o <y*

Answer **NO** return to the data acquisition menu.

Answer **YES** the probe shutdown waiting the next wakeup to start the continuous data acquisition cycle.

*----- UNATTENDED Conditional Acquisitions -----*

*To start the measuring cycle Switch OFF now the probe and then Switch it ON when ready*

*To stop while the probe is ON, type <ESC> until a message appears*

*Between acquisition cycles, while the probe is on surface, wait 1 minute before switching OFF the probe*

*Wait at least 30 seconds before executing a new Start-Up*

Now, the operator must switch OFF the probe using the magnetic switch on the probe top cover. Afterwards, when the probe will be switched ON to start the conditional data acquisition cycle when the operator is ready to deploy the probe in the field.

Once switched ON, the probe starts to monitor the trigger condition according to the configured interval.

#### Note

*If the probe interfaces a "Rosette" water sampling device, some questions about the water sampling method and steps are presented to the operator. Details about the water sampling set-up can be found in the dedicated appendix.*

#### **3.14.1 Terminate the Conditional data acquisition**

The conditional data acquisition ends whenever one of the following events occurs:

##### Memory is full

Whenever the data memory is full, the probe stops to acquire data and automatically concludes the conditional data acquisition cycle. Acquired data is automatically confirmed in the probe memory.

##### Battery has run down

The probe automatically checks the battery voltage against the preset boundary each time it wakes up or at regular intervals when it is always in ON condition (burst measurements). In case the battery has run down, the following message appears:

*No more power supply to continue the conditional data acquisition*

After this message is shown, the conditional data acquisition procedure is automatically concluded and the probe shows the "Data acquisition menu" again. Acquired data is automatically confirmed in the probe memory.

##### Operator stops acquisition

The operator can terminate the conditional data acquisition by pressing the <ESC> key, while the probe is ON, or by pressing the <ESC> key once the probe is OFF and answering positively to the question about the intention to conclude the conditional acquisition cycle. In this case, the following message appears on the PC screen after the start-up procedure is concluded:

*Do you want to terminate the Conditional data acquisition ? (Y)es (N)o*

Pressing <Y> for Yes immediately terminates the conditional data acquisition cycle. By pressing <N> for No, the probe immediately starts an automatic power OFF procedure calculating the next sensor monitoring time. The operator has 30s to answer the question. If no answer is received, the probe shuts down by itself going on with the conditional cycle.

**Data acquisition error**

In case the probe does not complete a data acquisition procedure due to hardware or sensor problems, the following message appears:

*Error during data acquisition*

After this message is displayed, the conditional data acquisition is automatically concluded. Acquired data is automatically confirmed in the probe memory.

### 3.15 CONTINUOUS DATA ACQUISITION

The continuous data acquisition is a very simple and straightforward acquisition method. After the cycle configuration, all the times the probe is switched on, it starts to acquire, show and store in memory the acquired data according to the configured sampling rate (0.1 Hz to 28 Hz). An indefinite number of measurements can be performed for each cycle. An indefinite number of cycles can be performed by switching ON and OFF the probe.

*Continuous data acquisition setup*

*Data acquisition scan rate [50ms]:50 enter new value< 250*

The operator can select a sampling rate between 0.1 and 28 Hz by configuring the associated time among the samplings expressed in ms, the most common are:

Sampling rate	Interval to configure
28 Hz	35 ms
20 Hz	50 ms
10 Hz	100 ms
5 Hz	200 ms
1 Hz	1000 ms
0.1 Hz	10000 ms

After the data acquisition rate has been entered the probe is ready to start the continuous data acquisition cycle, and the following message appears on the PC screen:

*Configuration updating. Done*

*----- UNATTENDED Continuous Acquisitions -----*

*To start the measuring cycle, switch OFF the probe now and then switch it ON when ready*

*To stop while the probe is ON, type <ESC> until a message appears*

*Between acquisition cycles, while the probe is on surface, wait 1 minute before switching OFF the probe*

*Wait at least 30 seconds before executing a new start-up*

Now, the operator must switch off the probe using the magnetic switch on the probe top cover. The probe will be switched on again to start the first continuous data acquisition cycle when the operator is ready to deploy the probe in the field.

Once switched on, the probe starts to acquire, show and store data in memory until one of the terminate conditions is met.

#### 3.15.1 Step-by-step procedure

After establishing a valid connection with the probe using the "Verbose operating mode", proceed as follows:

##### A) Preliminary configuration

1. Run the "ITERM" programme.
2. Switch ON the probe.
3. Using the ITERM Probe->Set Time setup the probe date and time
4. If the Main Menu does not appear, type <VT> followed by a <CTRL-J>. The Main Menu appears. 5  
From the Main Menu, select the "Data Acquisition sub-menu" through the **DATA** command.
5. from the "Data sub-menu", select the "Continuous Data acquisitions" by means of the **DACO** command.
6. The first question concerns the data acquisition interval.
7. The probe switch off by itself
8. Switch OFF the probe using the top cover magnetic switch.

##### B) Field operations

1. Once you have reached the sampling site, switch ON the probe by means of the magnetic switch; the probe starts the acquisition using the configured step. Lowering the probe in water starts the data

acquisition and data storing. Before starting the profile, we suggest immersing in water the probe and, wait at least 30s to stabilize the sensors.

2. When the probe returns to the surface, switch it OFF by means of the magnetic switch; data acquisition ends immediately. The probe is ready to carry out a new profile.

The above operations can be executed repeatedly until the probe batteries have run down or until the probe memory is full of data. Each time a data acquisition is performed, a new data header is automatically generated.

#### C) Ending the unattended data acquisitions

1. Run the "ITERM" programme.
2. Switch the probe ON.
3. After the start-up messages, the probe starts by showing acquired data. Type **ESC** to stop data acquisition answering **YES** to the given question.
4. The unattended timed acquisition is ended.

The acquired data is stored in memory and you can have a quick look at it by means of the functions available in the "DATA STORAGE" menu.

#### **3.15.2 Routine operations to perform unattended continuous profiles**

Once the probe is switched ON by means of the magnetic switch, it starts to acquire data. Ending of data acquisition is achieved once the probe returns to the surface and the operator switch the probe OFF.

#### Note

- ❖ The magnetic power ON/OFF switch can start and/or stop an unattended measuring cycle.
- ❖ Please be aware that, during the unattended continuous profiles, the probe does not reduce its power consumption nor does it switch OFF by itself when back from a profile. To reduce the power consumption, it must be turned OFF once on the surface.
- ❖ Please protect the not-in-use bulkhead connectors with the proper dummy connectors.
- ❖ When carrying out the unattended continuous profiles, the probe monitors the battery voltage. In case it reaches the lower operating limits, the unattended profile immediately ends and the probe switches OFF by itself. No other profiles will be accomplished. It is therefore important to verify the battery conditions before starting a series of profiles.
- ❖ Each unattended continuous profile is stored in a different cast.

#### **3.15.3 Terminate the Continuous data acquisition**

The continuous data acquisition ends whenever one of the following events occurs:

##### Memory is full

Whenever the data memory is full, the probe stops to acquire data and automatically concludes the continuous data acquisition cycle. Acquired data is automatically confirmed in the probe memory.

##### Battery has run down

The probe automatically checks the battery voltage against the preset boundary each time it wakes up or at regular intervals when it is always ON. In case the battery has run down, the following message appears:

*No more power supply to continue the continuous data acquisition*

After this message is shown, the continuous data acquisition procedure is automatically concluded and the probe shows the "Data acquisition" menu again. Acquired data is automatically confirmed in the probe memory.

##### Operator stops acquisition

The operator can terminate the continuous data acquisition by pressing the **<ESC>** key while the probe is ON or by pressing the **<ESC>** key once

---

the probe is OFF and answering positively to the question about the intention of concluding the continuous acquisition cycle. In this case, the following message appears on the PC screen at the end of the probe start-up.

*Do you want to terminate the Continuous data acquisition ? (Y)es (N)o*

Pressing <Y> for Yes immediately terminates the continuous data acquisition cycle. By pressing <N> for No, the probe continues the data acquisition. The operator has 30s to answer the question. If no answer is received, the probe shuts down by itself going on with the continuous cycle.

**Data acquisition error**

In case the probe does not complete a data acquisition procedure due to hardware or sensor problems, the following message appears:

*Error during data acquisition*

After this message is shown, the continuous data acquisition is automatically concluded. Acquired data is automatically confirmed in the probe memory.

### 3.16 **BURST DATA ACQUISITION**

Burst sampling allows collecting a “burst” of data at regular time intervals. During each single burst, data is acquired using a configurable sampling rate. To save the internal battery energy, the probe switches OFF and ON by itself between bursts. Burst sampling is somehow complementary to “time” acquisitions. Whenever this command is selected from the data acquisition menu, the following message appears on the PC screen:

From the Main Menu, select the data acquisition menu and then the “Burst Sampling” function answering the following question:

*Burst data acquisition cycle setup*  
*Burst time step: 00:05:00*

The time interval between consecutive burst acquisitions. Afterward the burst acquisition sample rate must be configured

*Data acquisition scan rate [50ms]:50 enter new value< 250*

The operator can select a sampling rate between 0.1 and 28 Hz by configuring the associated time among the samplings expressed in ms, the most common are:

Sampling rate	Interval to configure
28 Hz	35 ms
20 Hz	50 ms
10 Hz	100 ms
5 Hz	200 ms
1 Hz	1000 ms
0.1 Hz	10000 ms

The number of acquisitions to be carried out for each burst must be configured.

*Burst acquisitions:10*

The number of burst cycle can be configured

*Number of burst cycle repetition:1*

Afterward the burst cycles starting time can be configured.

*Enter the starting burst time [HH:MM:SS]*  
*Starting time: 00:00:00*

Data acquisition starting time. If the default value of 00:00:00 is configured, the CTD immediately performs a burst cycle and then switches OFF configuring the next acquisition time and adding the “time between burst cycles” to the present date and time. Otherwise, the next acquisition time will be the configured first acquisition time and the CTD switches OFF.

#### 3.16.1 **Field operations**

At the sampling site, switch ON the probe by rotating the magnetic switch rotating to the ON position. When the CTD returns to the surface, switch it OFF by rotating the magnetic switch back to the OFF position. The Burst sampling cycle is suspended.

#### 3.16.2 **Ending the unattended data acquisitions**

1. Run the “ITERM” programme.

2. Switch the probe ON.
3. After the start-up messages, the probe starts by showing acquired data. Type **ESC** to stop data acquisition answering **YES** to the given question.
4. The unattended timed acquisition is ended.

#### 4 DATA STORAGE

During the data acquisition cycle, the probe not only shows acquired data in real time but also acts as a data logger, storing the acquired data in its internal non-volatile memory. The probe is equipped with 2-GByte or bigger SD FLASH memory.

##### 4.1 MEMORY ORGANIZATION

The probe, data memory is organized in two main areas. The first area is called "CAST"; it stores the information about "when" and "how" data has been acquired by the probe. The second area is called "DATA"; it stores acquired data subdivided into data records, 4 bytes long. A data record is associated to each physical sensor installed on the probe. The probe acquires and stores data relative to all the installed sensors. A group of data records about all the installed sensors becomes a single "data set". The probe stores and retrieves single or groups of "data sets".

Acquired data is stored in memory in ADC counts. Only data belonging to physical installed sensors are stored in memory. Parameters relative to derived units, like salinity, are not stored in memory. They are immediately calculated once the operator asks to show stored data or to transfer stored data to a PC. The conversion from ADC count into engineering units is done by means of the algorithms described in the introduction section and by means of the sensors calibration values. A copy of calibration values is associated to each set of data "CAST" stored in memory. A dedicated non-volatile memory stores the copy of calibration values.

As a common-sense rule, it is important that the probe internal memory **is not used** as an archival memory to keep data for very long time. It is important that stored data is transferred to a PC and then archived there, immediately after the field campaign is concluded. Increase of the probe performance can be obtained if, before starting a new measurement campaign, the probe memory is initialized.

Therefore, we strongly suggest that you upload data immediately after the field campaign and initialize the probe memory immediately before starting the next field campaign.

##### 4.1.1 Cast area

Allocated space of the "CAST" area is for 5000 casts. The number of data records, associated with a certain number of casts, is only limited by the number of free data records. This means that a single cast can head a set of data, which uses all the data area, or that the data stored for 5000 casts does not use all the data area. The number of storable casts does not depend on the memory size. It is fixed at 5000.

The header information stored for each cast is:

- ❖ data acquisition starting time;
- ❖ sampling area identification code;
- ❖ type of data acquisition;
- ❖ time intervals or depth steps used to acquire and store data;
- ❖ number of parameters stored for each acquisition;
- ❖ number of data records stored for this cast;
- ❖ first data record stored for this cast.
- ❖ Indexing to the calibrations records associated to this cast

The above information is presented to operator when the [\[Show Memory Status\]](#) command is used (see below).

##### 4.1.2 Data records

Each data record is 4 bytes long. Either data record can contain a parameter value in raw format (ADC counts) or the acquisition time expressed in hundredths of second. The number of data records that can be stored in the probe internal memory depends on the size of the probe memory. A bigger memory allows storing more data records.

### 4.1.3 Data Sets

Data records are grouped in sets to form single "Data Sets". Each data set is composed of the recorded data for each installed sensor plus one dedicated to store the date & time of acquisition. Memory capacity of the OCEAN SEVEN 310 is judged in terms of available "CASTs" and available "Data Sets".

#### Note

The IDRONAUT "OS3xx PROBE Autonomy" program is distributed together with the probe electronic documentation and ITERM. This tool allows calculating the probe autonomy by means of a simplified user interface.

## 4.2 MEMORY MANAGEMENT

The "Memory menu" is presented on the computer screen by selecting: <MEMO> from the probe "Main menu". Once selected, the following message is displayed:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 10:43:08.96 2017
<0>[MEUP]-Leave memory menu
<1>[MESM]-Show memory status
<2>[MESD]-Show stored data
<3>[MEDM]-Delete data
<4>[MEIN]-Initialize data memory
cmd>
```

Selection of the desired function is performed by typing one of the acronyms contained in the [] square brackets or the number in the <> brackets. By pressing the <ESC> key or <0>[MEUP] command, the programme returns to the "Main menu", while pressing the <ENTER> key re-displays the "Memory menu".

## 4.3 SHOW MEMORY STATUS

This function shows the information about the probe memory status. Once invoked, the following message appears:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 10:44:38.27 2017
Data memory statistics
Type           Maximum   Used      Free
Cast area      5000     51        4949
Data area (Data byte) 2005948928 456092    2005492836
Estimated dataset 55720803
SD Card sectors 3921920   1         3921919
-----
000000 MByte:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
000640 MByte:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
001280 MByte:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
          X = 10MByte free      . = 10MByte used
-----
Type <any key>To continue Stored casts
```

The operator must type any key to terminate this function and return to the "Memory Menu".

## 4.4 SHOW STORED DATA

This function allows the operator to inspect stored data. The operator must choose the cast to inspect before stored data is shown on the PC screen. Once invoked, this function shows the following messages containing the list of stored casts: Concerning the shown information, apart from the obvious

information, it is worth mentioning that the type of acquisition can be: MANUAL, TIMED, LINEAR, CONTINUOUS, CONDITIONAL, BURST and BOTTLE. The date and time refer to the starting of the acquisition cycle and the status can be: OK, BAD, DEL, USED.

*Stored casts*

```
-----
| Data | Sensors | | EXT Mem Sector | Acquisition
Cast| Bytes |Acq. Stored| Dataset| First - Last |Stat Type Area code Date&Time
-----
1 28 9 7 1 4051 4051 OK CONTIN *00112* Oct 01 12:13:04.92 2016
2 28 9 7 1 4052 4052 OK CONTIN *00112* Oct 01 12:14:07.92 2016
3 28 9 7 1 4053 4053 OK CONTIN *00112* Oct 01 12:19:00.92 2016
4 103208 9 7 3686 4054 4255 OK CONTIN *00112* Oct 01 12:37:32.92 2016
5 150976 9 7 5392 4256 4550 OK CONTIN *00112* Oct 01 12:13:12.92 2016
6 28 9 7 1 4551 4551 OK CONTIN *00112* Oct 01 12:13:40.92 2016
7 131880 9 7 4710 4552 4809 OK CONTIN *00112* Oct 01 13:52:20.92 2016
8 2100 9 7 75 4810 4814 OK TIMED *00113* Mar 28 15:03:13.92 2017
Type <any key>To continue, <ESC>To leave
```

The operator must select the cast to be shown from the stored ones. After choosing the cast, the following message appears:

*Show stored data records in engineering units*

```
Press Temp Cond Sal Dens O2ppm O2sat% pH eH Time&Date
0.12 17.055 45.353 35.352 1.0258 2.35 30.1 7.895 214.8 11:14:26.8
0.19 17.010 45.304 35.350 1.0258 2.17 27.8 7.902 208.7 11:14:27.0
Type <any key>To continue
```

Typing a character on the PC keyboard terminates the show data function and the probe "Memory Menu" appears again.

#### 4.5 MEMORY DELETE DATA

This function allows stored cast data to be deleted. Deleted cast can be retrieved later-on. After invoked, this function shows the following message:

*Stored casts*

```
-----
| Data | Sensors | | EXT Mem Sector | Acquisition
Cast| Bytes |Acq. Stored| Dataset| First - Last |Stat Type Area code Date&Time
-----
1 64 9 8 2 202 202 OK LINEAR ER-0112 Tue Jan 02 14:06:35.62 2007
2 640 9 8 20 203 204 OK TIMED ER-0112 Tue Jan 02 14:48:40.62 2007
3 96 9 8 3 205 206 OK MANUAL sample Wed Jan 03 12:04:38.62 2007
Select the cast to delete: 0 enter new value = 3

3 96 9 8 3 205 206 DEL MANUAL sample Wed Jan 03 12:04:38.62 2007
```

At the end of the deletion process, the "Memory Menu" appears again. Delete only change the status of the cast from OK to DEL (Deleted). The status can be reverted to OK later-on by means of the DELETE command.

#### 4.6 INITIALIZE DATA MEMORY

By means of this function, it is possible to initialise the probe memory. Obviously, after the initialization, all stored data will be lost. However, the operator must answer two questions before the initialization starts. Once invoked, the following message appears:

*Initialize data storage area*

---

*Warning, the initialize procedure deletes all data records and casts stored permanently  
Are you sure ? :No type [Y]es or [N]o < y*

The operator must confirm his intention to perform a data memory initialization.

*Confirm again your intention !:No type [Y]es or [N]o < y*

The operator must confirm again his intention to perform a data memory initialization

*Data storage area has been initialized..*

After this message appears, the programme returns to the "Memory menu".

## 5 SENSOR CALIBRATION

This section provides general information about how the probe manages and keeps the sensor calibration coefficients stored and describes the functions available in the "Calibration Menu". The aim of the "Calibration Menu" is to allow the operator to carry out the calibration procedures needed by any sensor installed. The aim of the calibration information is to define the coefficients and the mathematical procedure needed by the probe to convert the ADC counts acquired from a particular sensor into engineering units like: ppm, mS/cm, °C, dbar, etc..

### 5.1 CALIBRATION STORING LAYOUT

Information on calibration is stored in a non-volatile memory, which can keep up to 48 calibration records. Each record is associated to a sensor. When a cast is stored in memory a copy of the sensor calibrations is automatically stored with the data. Calibration is retrieved when the cast data is shown or uploaded. This means that stored casts can have different calibration records associated to the same sensor.

The items stored for each calibrated sensor are:

- ❖ Calibration date & time.
- ❖ Calibration status.
- ❖ Index of the stored cast, if any.
- ❖ Index of the sensor configuration.
- ❖ Sensor logical code.
- ❖ Number of coefficients or/and degree of polynomial.
- ❖ Polynomial coefficients or calibration values.

#### 5.1.1 Parameter/Sensor logical codes

The management firmware uniquely identifies a derived parameter or sensor among the others by means of a predefined logical numerical code. The most common logical codes can be found in document describing the "Ocean Seven 3xx Data Transmission protocol" document.

### 5.2 CALIBRATION GLP (GOOD LABORATORY PRACTICE)

The Ocean Seven 310, according to the GLP European directive: *"Good Laboratory Practice (GLP) embodies a set of principles that provides a framework within which laboratory studies are planned, performed, monitored, recorded, reported and archived. These studies are undertaken to generate data by which the hazards and risks to users, consumers and third parties, including the environment, can be assessed for pharmaceuticals (only preclinical studies), agrochemicals, cosmetics, food additives, feed additives and contaminants, novel foods, biocides, detergents etc.... GLP helps assure regulatory authorities that the data submitted are a true reflection of the results obtained during the study and can therefore be relied upon when making risk/safety assessments"* keeps trace of the calibrations carried out on the sensors.

The stored calibration information can be then used by the operator to further analyze the sensors behaviour with the passing of time. The OCEAN SEVEN 310 keeps up to 1024 calibration log records. Each calibration log record registers, apart from the date and time of calibration, the most important information about the status and calibration coefficients of a sensors.

### 5.3 SENSOR CALIBRATION FUNCTIONS

The "Calibration Menu" is displayed on the user's terminal by selecting: <CALB> from the "Main Menu". The following menu is displayed:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 10:44:38.27 2017
Calibration menu
<0>[CAUP] - Leave calibration menu
<1>[CASE] - Calibrate sensors
<2>[CALO] - Calibration log
```

Selection of the desired function is performed by typing one of the acronyms contained in the square brackets, or by typing the number between the <> brackets. By pressing the <ESC> key or [CAUP] command, the programme returns to the "Main Menu", while, pressing the <ENTER> key re-displays the "Calibration Menu".

**5.3.1 Updating the calibration information**

At the end of the sensor calibration procedure, the probe automatically updates the calibration record storage area in the dedicated non-volatile memory.

```
Update calibration parameters
Configuration updating. Ok
[xxx][xxx] calibration values updated..
```

This message notifies the operator that the calibration record storage area has been updated. The “xxx” fields depend on the type of calibrated sensor and on the calibration record associated to the sensor.

**5.4 CALIBRATE THE SENSORS**

This function allows the operator to perform the sensor calibration. Once invoked, the following message appears:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 14:00:27.25 2017
Sensors Calibration.....
Index  Sensor      Data&Time
00 - Leave sensor calibration
01 [ 0] 000 Press   Oct 01 17:42:22.25 2016
02 [ 1] 001 Temp    Oct 01 17:42:57.25 2016
03 [ 2] 002 Cond    Oct 01 17:43:40.25 2016
05 [ 7] 006 O2Sat%  Oct 01 16:47:15.25 2016
07 [ 3] 007 pH      Oct 01 17:44:04.25 2016
08 [ 4] 008 Eh      Oct 01 17:44:18.25 2016
Select the sensor:0
```

The operator must select the sensor to be calibrated from the shown sensor list. After choosing the sensor by means of the **index** (the number indicated in the first column of the above list), the programme goes on depending on the chosen parameter, as described in the paragraphs below. Selecting 0 causes the immediate exit from the “calibrate sensor” function and the “Calibration Menu” will be shown.

**5.4.1 Selecting a wrong sensor**

If the operator selects a sensor that cannot be calibrated or a sensor not well configured, the following message appears:

```
The selected parameter is not correctly configured; before
going on with calibration, you must properly configure it
```

This message also terminates the calibrate sensor function. The program returns to the "Calibration Menu".

**5.5 CUSTOMIZED CALIBRATION PROCEDURE**

Some sensors have specialized data processing and calibration methods, which mainly depend on the kind of answer to physical or chemical variations in the measured samples and on the conditioning circuits. They are:

- ❖ Pressure
- ❖ Dissolved Oxygen
- ❖ pH
- ❖ Redox
- ❖ Fluorometer
- ❖ Turbidity meter

- ❖ PAR
- ❖ Transmissometer
- ❖ Single Channel – Three channel Fluorimeters

We recommend that the operator does not change the calibration and data processing method, even though permitted by the management firmware, otherwise the sensor specifications stated on the IDRONAUT documentation cannot be guaranteed.

### 5.5.1 Pressure sensor

The aim of the pressure sensor calibration is the offset zeroing. It is preferable to immerse the probe in water, up to about 10 cm from the probe housing, and wait for few seconds before starting the calibration. Once the pressure sensor calibration is chosen, the following message appears:

*Do you intend to review the calibration coefficients?*

By answering <NO> (the default choice), the operator will continue with the sensor calibration sensor, whereas, answering <YES> will allow the operator to see and modify the calibration coefficients.

$$\text{Pressure} = a + bx + cx^2$$

The calibration coefficients: a, b, and c are indicated on the probe "Calibration Certificate".

*Pressure sensor calibration  
Zeroing pressure offset - Immerse the probe and wait few seconds to stabilize  
the sensors temperature  
Type <any key>To continue, <ESC>To leave*

The operator must type any key to continue with the pressure calibration, whereas, if the <ESC> key is typed, the calibration procedure immediately terminates. The pressure calibration procedure goes on with the following message:

*Pressure calibration in progress  
Calibration statistics  
Sensor Offset - ADC counts dbar  
111.0 0.8*

At the end of this procedure, the programme updates the calibration values and shows the "Calibration menu".

### 5.5.2 Temperature & Conductivity sensor calibration

Once selected the sensor to be calibrated, the following message appears:

*Current calibration values  
Polynomial coefficients  $a + bx + cx^2 + dx^3$   
 $a = x.xxx$   
 $bx = x.xxx$   
 $cx^2 = x.xxx$*

At the end of the current calibration value, the following message appears:

*Enter the polynomial degree and number of coefficients  
Polynomial degree:*

The operator is requested to enter the degree of polynomial (1..3), and then to enter the coefficient values

for each degree:

*Coefficients :*

The above request is repeated for the degree of polynomial. At the end of the coefficients data entry, the sensor selection list appears again.

### 5.5.3 **Simple check of conductivity sensor calibration**

The conductivity sensor is usually very accurate. A check of any drift with time or calibration can be performed by using a Standard Seawater. A worldwide used Standard Seawater for conductivity is the so-called "Copenhagen Water" which is supplied by I.A.P.S.O. - Standard Seawater Service. The certified value of Chlorinity is 19.371 ppt, that corresponds to a Practical Salinity of 35.00 ppt. The temperature value is used in the salinity calculation, as explained in the sensor description paragraph; nevertheless, since the temperature sensor is much less prone to drift than the conductivity sensor, it is assumed that any variation, with respect to the certified value, is totally due to the conductivity sensor. The probe must be carefully rinsed with distilled water, in order to remove any salt residue, and then dried. These precautions are necessary for not diluting or contaminating the Standard Seawater. Transfer some Standard Seawater into a beaker provided with a magnetic stirrer and immerse the probe into it. From the data acquisition functions, check that the value for conductivity and temperature can be read. The conductivity value is supposed to be coincident or very close to the theoretical one which can be found in the "STANDARD SEA WATER K15 0,99999 - CONDUCTIVITY VERSUS TEMPERATURE TABLE". If a considerable difference is present, a calibration procedure must be performed.

### 5.5.4 **Oxygen sensor calibration**

The dissolved oxygen sensor requires most attention of all the OCEAN SEVEN 310 sensors. maintenance (mostly membrane and electrolyte replacement) should be carried out at least every three months and assembling/disassembling requires great care. Calibration of the sensor should be carried out:

- ❖ after a long period of disuse;
- ❖ once a day during an extended field survey;
- ❖ once a month if the probe is installed on a Buoy Profiler or is used in a continuous monitoring.

It is preferable to calibrate the oxygen sensor in a liquid (ideally distilled water) saturated (i.e. in perfect equilibrium) with ambient air and well stirred to have homogeneous temperature. If possible, check the oxygen saturation using the Winkler method. However, this procedure is rarely used because of the difficulties of obtaining a solution homogeneous in temperature and at saturation, particularly on the field. **For this reason, the calibration is usually carried out in air.** Once selected the sensor to be calibrated, the following message appears:

*O2sat% sensor calibration  
Gently wipe O2 membrane and Temperature sensor  
Type <any key>To continue, <ESC>To leave*

Before calibration, it is important to be sure that both the oxygen and temperature sensors are perfectly dry. The oxygen sensor may be dried with a piece of clean towelling taking particular care not to damage the membrane. Dry the temperature sensor with clean towelling taking care not to touch the sensor or heat it in any other way above ambient temperature. After drying both sensors, leave them in a well ventilated atmosphere, far from heat sources and direct sun rays, for at least one minute before proceeding with calibration. When ready, press any key to continue; the following message appears:

*Oxygen calibration in progress*

*Calibration statistics*

<i>Sensor Current</i>	<i>% Last cal.</i>	<i>Drift</i>	<i>Temperature</i>
<i>64.80 nA</i>	<i>118.8 %</i>	<i>19.6 Count</i>	<i>18.013 C</i>

“% of last calibration” is given by (new cal/old cal) x100 and gives a measure of ageing of the membrane and the electrode. Sensor drift is automatically checked by the probe and is compared against pre-defined limits. If excessive drift is detected, this message appears:

*Oxygen sensor error, see Operator’s Manual*

Please proceed with the maintenance procedures, as illustrated in the probe maintenance section. If the last message does not appear, it means that the calibration procedure can continue, and the atmospheric pressure coefficient should be entered:

*Oxygen correction coefficient for*

*1 - Barometric pressure deviation from the 760 mmHg*

*2 - Stirring effect on the sensor*

*Enter Altitude above sea level [m]:0*

If the atmospheric pressure is 760 mmHg (sea level) and no correction is required, leave the shown coefficient (0); the probe will propose a correction coefficient of 1.0. If a value different from 0 is entered, the probe calculates the correction coefficient by itself and then propose it to the operator for approval.

*coefficient = 1.0*

At the end of this procedure, the programme shows the "Calibration menu".

**NOTE REGARDING VARIATIONS IN BAROMETRIC PRESSURE (ALTITUDE) AND THE SENSOR MEMBRANE COEFFICIENT ALSO CALLED “STIRRING EFFECT”**

The correction coefficient different from the nominal one 1.0 is needed for the following reasons:

- 1) To enter barometric pressure values differing from the 760 mmHg standard which represents the nominal B.P. at sea level. For example, if the measurements to be made are carried out in an area which is at 1.340 metres above sea level, then the nominal local barometric pressure is only 655 mmHg. In this case, the correction coefficient is given by the formula:

$$\text{Correction Coefficient} = \frac{\text{Local nominal B.P.}}{\text{Standard nominal B.P.}}$$

- 2) To correct (if considerable) the possible differences in readings from the gaseous phase (calibration) and the liquid measurements due to the oxygen consumption of the sensor during measurements.
- 3) If both of the above coefficients 1) and 2) are simultaneously requested, then the two relevant correction coefficients must be multiplied together to obtain the correction coefficient to be entered.
- 4) To expand the scale of the oxygen sensor readings. For example, on entering a correction coefficient of 10, the readout will be multiplied by a factor of 10.
- 5) In case of moored applications, where the probe remains steady measuring for long periods, the coefficient 1.05 should be entered to compensate for the stirring effect on the surface membrane. For instance, to apply a double compensation due to the barometric effect and to the oxygen depletion, the following operation must be used

---

i.e.  $\frac{760}{625} = \text{Barometric correction coefficient} = 1.216$

1.05 = Stirring effect or oxygen depletion coefficient standard value (5%)

$1.05 \times 1.216 = 1.2768$  Total coefficient to be applied.

**Note**

The latest probe firmware release takes one further step forward in the simplification of the dissolved oxygen sensor calibration by introducing the automatic calculation of the barometric pressure compensation using an algorithm which calculates the coefficients depending on the altitude. The above procedure is therefore replaced by:

*Oxygen correction coefficient for*  
 1 - Barometric pressure deviation from the 760 mmHg  
 2 - Stirring effect on the sensor  
 Enter Altitude above sea level [m]:0

The operator must enter the elevation above sea-level in meters. Afterwards, the probe calculates by itself the new correction coefficient. The new coefficient is then shown for the operator's approval.

*New correction coefficient:1*

The new coefficient can be approved or modified. In the latter case, the rules explained above are still valid.

**5.5.5 pH sensor calibration**

The pH sensor calibration is carried out using a single buffer solution: pH7. A second buffer pH4 can be used, to verify the calibration and the good state of the sensor. After the "pH sensor" has been selected from the list of sensors to be calibrated, the operator must enter the pH buffer value (in pH units) which he intends to use during the pH calibration.

*pH Sensor calibration*  
*pH buffer value : 7.0*

Afterwards, the following message appears:

*pH Sensor calibration*  
*Place the buffer cup*  
*Type any key to continue, <ESC> to abort*

Pull out the calibration buffer cup from the accessory kit and fill it with the pH7 buffer solution. The buffer cup has been designed to simultaneously fit over the pH and reference sensors and should be placed under these sensors with the probe in its vertical position (sensor looking at the floor). When the preparation is complete, press any key to continue. In case of trouble, type <ESC> to abandon the pH sensor calibration.

The following message appears:

*pH calibration in progress*  
*Calibration statistics*  
*Sensor offset — Drift Temperature*  
*0.09 pH 0.09 pH 0.76 mV 19.679*

The sensor offset is intended as the offset from 7.0; values  $\leq \pm 0.6$  can be considered reasonable, whereas, higher values indicate that the sensors (pH and/or reference) require some maintenance. The drift is automatically controlled by the probe during the calibration. If the drift is lower than the preset limit during the following 20 seconds, the calibration is achieved; otherwise, the message:

*pH sensor error, see Operator's Manual*

will appear after which the system returns to the "Calibration Menu". If no error is detected, the probe asks the operator to select the pH temperature compensation mode.

*Automatic temperature compensation ?*

Should a special and fixed temperature compensation be requested, the reference temperature value must be entered:

*pH reference temperature:*

At the end of this procedure, the programme shows the sensor list.

#### Note

*pH variations in function of temperature of the pH7 (Phosphate) and pH4 (Phthalate) buffer solutions:*

Temperature (°C)	pH4	pH7
0	4.00	7.12
10	4.00	7.06
20	4.00	7.02
25	4.00	7.00
30	4.01	6.99
40	4.03	6.97
50	4.05	6.96
60	4.08	6.97
70	4.12	6.98
80	4.16	7.00
90	4.21	7.03

#### 5.5.6 Redox sensor calibration

Once selected the sensor to be calibrated, the following message appears:

*eH sensor calibration*

*Select the available number of Redox Buffers*

*Buffer solutions:*

This message allows the operator to enter the number of "REDOX buffer" solutions from a minimum of 2 to a maximum of 10. Selecting 0 enables a special calibration function, which imposes a factory default calibration value and immediately terminates the calibration procedure (the default coefficients are used to convert the sensor readings in mV).

Selecting a value of buffer solution greater than 1 starts the REDOX sensor calibration sequence.

*Immerse Redox and Reference sensors into*

*the calibration cup filled with the 1st REDOX BUFFER*

*Type <any key>To continue, <ESC>To leave*

Pull out the calibration buffer cup from the accessory kit and fill it with the redox LOW concentration buffer solution. The buffer cup has been designed to simultaneously fit over the eH and the reference

sensors and should be placed under these sensors with the probe in its vertical position. When the preparation is complete, press any key to continue. The following message appears:

```

Reading [1st] BUFFER Redox      Temperature
                    -18336.3 Count  19.894 C

```

After few seconds during which the probe acquires and shows the redox sensor reading, the following message appears:

```

Enter the BUFFER concentration value corrected for temperature
Concentration [units]:-700

```

The operator is requested to enter the calibration value (units) of the "REDOX Buffer" solution corrected for the shown temperature. Calibration goes on with the next "BUFFER" until all the selected standard solutions have been acquired.

At the end of the acquisition process, the programme automatically calculates the coefficients of the straight line that interpolates all the acquired REDOX Buffers and shows the following message:

```

REDOX                = a + bx
a                    = -0.412418
b                    = 0.0381531
r correlation coefficient = 1
c % of variability    = 100

```

At the end of this procedure, the REDOX calibration values are updated and the programme shows the list of sensors.

## 5.6 EXTENDED CALIBRATION PROCEDURES

Apart from the standard IDRONAUT sensors, the OCEAN SEVEN 310 probe can interface additional probes, like:

- SEAPOINT - Fluorometers and Turbidity Meter.
- WET Labs – C-Star Transmissometer and ECO Triplet Fluorometer.
- LICOR – LI-192SA Underwater and LI-193SA Spherical Underwater Quantum sensors.
- SINGLE/THREE-CHANNEL FLUORIMETERS.
- TURNER DESIGNS – Cyclops-7 Fluorometers

Below are described the calibration procedures of the listed sensors. Sensors not included in the above list are described in dedicated appendix enclosed to this manual.

### 5.6.1 SEAPOINT OEM Turbidity Meter

The SEAPOINT OEM Turbidity Meter is a sensor that measures turbidity by detecting scattered light from suspended particles in water. Its small size, very low power consumption, high sensitivity, wide dynamic range and 6000-m depth capability allow this sensor to be used in most applications where turbidity or suspended particle concentrations are to be measured. The sensor is also insensitive to ambient light when underwater and has a very low temperature coefficient. The SEAPOINT Turbidity Meter senses scattered light from a small volume within 5 centimetres of the sensor windows. Confining the sensing volume allows the sensor to be calibrated in relatively small water containers without errors from surface and wall reflections. It also allows the sensor to be used in tight spaces such as crowded instrumentation packages, pipes and shallow streams.

Each sensor is factory calibrated using formazine Turbidity Standard. The user may also calibrate the sensor with particles of interest to measure their suspended concentrations. The SEAPOINT Turbidity Meter is constructed from rugged, corrosion-free materials and quality surface mount electronic components for durability and high reliability. Some more information can be found in an application note distributed with the Operator's Manual.

Once the Turbidity Meter is selected from the list of sensors to be calibrated, the following message and questions appear:



```

Turb. sensor calibration
Measuring scale 1, Full scale [>750 FTU]
Current Calibration values
Offset                = 0.0
Slope                 = 1.0
r correlation coefficient = 1
c % of variability    = 100
Do you already know 'SLOPE & OFFSET' coefficients?:No
  
```

The operator can decide to enter the calibration coefficients received with the probe or to let the probe calculate new coefficients using experimental data obtained from the turbidity sensor in the laboratory (please refer to the dedicated application note).

Answering <YES>, the following messages appear in sequence:

```
Offset = 0.0   Slope = 1.0
```

The operator must enter the offset and slope coefficients indicated in the calibration certificate.

By answering <NO>, the following message appears:

```
Number of calibration points:0 enter new value< 2
```

Answer with the number of solutions used to calibrate the 750 FTU measuring scale. Now, starting from the lowest solution and going towards the most concentrated solution, the operator must enter the value acquired during the laboratory calibration procedure

```

Sample value (units)   Answer with the concentration value of the solution.
Sample reading (bit)   Answer with the probe reading.
  
```

The above questions about the units and bit (ADC Counts) are repeated for the number of "Calibration points" entered. Afterwards, the probe shows the result of the linear interpolation:

```
Turbidity = a + bx
```

*offset* = 0.0  
*slope* = 1.0  
*r correlation coefficient* = 1.0  
*c % of variability* = 100%

The operator can now confirm or modify the offset and slope coefficients.

*Offset = 0.0    Slope = 1.0*

The Turbidity meter sensor calibration proceeds as above with the calibration of the remaining measuring scales :

Measuring scale 2, Full scale [500 FTU]  
 Measuring scale 3, Full scale [125FTU]  
 Measuring scale 4, Full scale [25 FTU]

After the last coefficients have been confirmed, the operator must choose the measuring scale that the probe sets up after the wake-up. During data acquisition, the turbidity meter measuring scale is automatically selected by the probe management firmware to be the most sensitive one.

*Turbidity meter scale:(1)>750 FTU,(2)500 FTU,(3)125 FTU,(4)25 FTU*

### 5.6.2 SEAPOINT OEM Fluorometer

The SEAPOINT Fluorometer allows the user to monitor chlorophyll concentration by directly measuring the amount of fluorescence emission from a given sample of water. The sample media is pumped through a quartz tube mounted through the long axis of the instrument. Chlorophyll, when excited by the presence of an external light source, absorbs light in certain regions of the visible spectrum and re-emits a small portion of this light as fluorescence at longer wavelengths. SEAPOINT uses two bright blue LEDs (centred at 455 nm and modulated at 1 kHz) to provide the excitation. Blue interference filters are used to reject the small amount of red light emitted by the LEDs. A detector, positioned at 90° to the axis of the LED mounts, measures the emitted light from the sample volume. The approximately 0.25 cm<sup>3</sup> sample volume is defined by the intersection of the excitation light with the field of view of the detector, within the quartz flow tube. A red interference filter is used to discriminate against the scattered blue excitation light. The red fluorescence emitted at 90° is synchronously detected at 1 kHz by a silicon photodiode. The amplified and demodulated voltage output of the photodiode is provided to the user for connection to a digital voltmeter or an a-d converter.



The calibration procedure is the same described for the turbidity meter. The only differences are the measuring scales, which in the case of the fluorometer are: 5, 15, 50 and 160 µg/l.

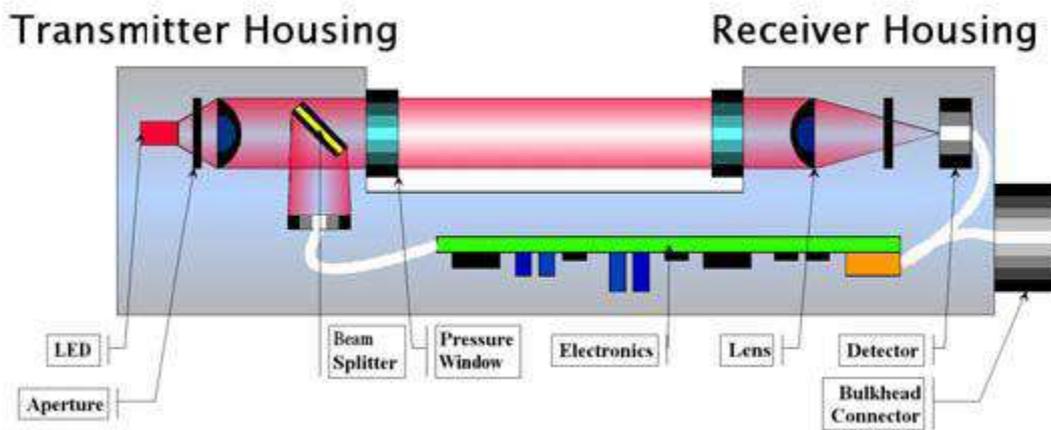
### 5.6.3 WETLabs - C-STAR Transmissometer

The C-Star Transmissometer measures light transmittance at a single wavelength over a known path. The instrument is configured at the time of purchase to have a path length of 25 or 10 cm and wavelengths of either 370, 470, 530, or 660 nm. In general, losses of light propagating through water can be attributed to two primary causes: scattering and absorption. By projecting a collimated beam of light through the water and placing a focused receiver at a known distance away, one can quantify these losses. The ratio of light gathered by the receiver to the amount originating at the source is known as the beam transmittance (Tr). This is the fundamental measurement performed by the C-Star. Suspended particles, phytoplankton, bacteria and dissolved organic matter all contribute to the losses sensed by the instrument. They, combined with the intrinsic optical properties of the water itself, govern the radiative transfer properties within the earth's natural waters. Thus, the information provided by the C-Star provides both an indication of the total concentrations of matter in the water as well as a value of the water clarity. The beam attenuation coefficient is an absolute term to represent these losses. For a given wavelength, transmittance is related to the beam attenuation coefficient by the following transfer equation.

In the expression

$$Tr = e^{-\alpha x}$$

where  $x$  is the path length (10 or 25 cm) of the water volume being measured. The below figure is a simple description of the C-Star configuration. The appropriate LED light source (depending on the wavelength) provides light that is focused and collimated by an aperture and lens that transmit the light within a given narrow bandwidth. The light passes through a beam splitter so that a portion of the transmitted light can be monitored by the reference detector and used in a feedback circuit to account for variations in the LED source over time as well as changes in the instrument's internal temperature. The light enters the sample volume after passing through the first pressure window, transmits the sample volume and enters the receiver optics after passing through the other pressure window. The light passes through additional focusing optics and finally strikes a silicon photodiode detector which converts the amount of received light to a corresponding 0–5 V analogue output signal which represents the amount of light received.



The

Calibration procedure of the C-Star implies the following preliminary calculation that must be done using the probe and the C-Star calibration certificate:

$$\begin{aligned} V_{\text{dark}}(\text{wetlabs}) &= 60 \text{ mV} \\ V_{\text{refWater}}(\text{wetlabs}) &= 4786 \text{ mV} \\ \text{OS310 Hw scale} &= 2.00032688 \end{aligned}$$

from which the following parameters must be calculated:

$$\begin{aligned} V_{\text{dark}}(\text{bit}) &= (V_{\text{dark}}(\text{wetlabs}) / \text{HwScale}(\text{Idronaut})) * 52.4288 \\ V_{\text{refWater}}(\text{bit}) &= (V_{\text{refWater}}(\text{wetlabs}) / \text{HwScale}(\text{Idronaut})) * 54.4288 \end{aligned}$$

Example:

$$\begin{aligned} 1570.29750 &= (60\text{mV} / 2.0032688) * 52.4288 \\ 125257.3977 &= (4786\text{mV} / 2.0032688) * 52.4288 \end{aligned}$$

The  $V_{\text{dark}}(\text{bit})$  and the  $V_{\text{refWater}}(\text{bit})$  are therefore associated to the 0 and to the C-STAR full scale transmittance or 100 %. Thus, a table of experimental data can be generated as follows:

Units (Tr %)	OS310 ADC Counts
0	1570.29750
100	125257.3977

From the above table of data, the offset and slope coefficients to be entered during the C-STAR calibration procedure must be calculated by the operator. This can be done using the “Interpolate” tool distributed with the IDRONAUT ITERM program or by using the probe calibration procedure. Selecting the C-STAR sensor from the list of sensors, the following calibration procedure arises:

*Do you already know 'SLOPE & OFFSET' coefficients?:No*

The operator can decide to enter the calibration coefficients received with the probe or to let the probe calculate new coefficients using the table calculated as above described.

Answering <YES>, the following messages appear in sequence:

*Offset = 0.0 Slope = 1.0*

The operator must enter the offset and slope coefficients, while answering <NO> the following message appears:

*Number of calibration points:0 enter new value< 2*

The operator must answer using the tabled data:

*Sample value (units)  
Sample reading (bit)*

The above questions about the units and bit (ADC Counts) are repeated for the number of “Calibration points” entered. Afterwards, the probe shows the result of the linear interpolation:

*Tr% = a + bx  
offset = 0.0  
slope = 1.0  
r correlation coefficient = 1.0  
c % of variability = 100%*

The operator can now confirm or modify the offset and slope coefficients.

*Offset = 0.0 Slope = 1.0*

In the end, the list of sensors appears again.

#### 5.6.4 **WETLabs - ECO Triplet Sensor**

WETLabs offers the custom ECO Triplet as a three-sensor instrument that can be configured for a variety of measurements:

- Three scattering measurements.
- Two scattering and one fluorescence measurements.
- Three fluorescence measurements.
- Two fluorescence and one scattering measurements.

Available measurement options:

##### **Scattering**

Blue  
Green  
Red

##### **Fluorescence**

Chlorophyll  
CDOM (limited to one CDOM channel)  
Uranine (fluorescein)  
Phycoerythrin, phycocyanin  
RhodaminePhycoerythrin, phycocyanin  
Rhodamine



The logical codes associated to each parameter are:

<i>Logical code</i>	114 = Fluorometer Chl-(a) 115 = CDOM 116 = Scattering 117 = Phycocyanin 118 = Phycoerithrin 119= Rhodamine 120= Uranine
<i>Description</i>	A seven-character acronym that is used by the probe to identify data acquired from this sensor.
<i>No. of digits to show</i>	6
<i>No. of digits after the dot</i>	2
<i>Do you want to store it ?</i>	Yes
<i>Do you want to show data ?</i>	Yes
<i>Data processing method:</i>	2 = Proprietary&UNESCO
<i>Mux. Channel</i>	246
<i>Mux. Delay</i>	0

**Note**

The parameter configuration must be repeated for each ECO sensor.

The calibration procedure of the ECO sensors implies the introduction of the WETLAB original coefficients found in the “characterization sheet” accompanying the instrument. After selecting the ECO sensor from the list of sensors, then the operator must enter in sequence:

*ECO Sensor dark counts*  
*ECO Sensor scale factor*

**5.6.5 LICOR - PAR Sensor**

The LICOR LI-193SA Underwater Spherical Quantum Sensor gives an added dimension to underwater PAR measurements as it measures photon flux from all directions. This measurement is referred to as Photosynthetic Photon Flux Fluence Rate (PPFFR) or Quantum Scalar Irradiance. This is important, for example, when studying phytoplankton, which utilizes radiation from all directions for photosynthesis. The LI-193SA features a high sensitivity optical design and compact, rugged construction (3400 kPa, 350 meters depth). The LI-193SA analogue interface of the OCEAN SEVEN 310 probe



transforms, by means of a linear current to voltage pre-amplifier, the LI-193SA sensor output (current in  $\mu\text{A}$ ) into ADC counts. Calculation of the calibration coefficients implies a preliminary calculation that is carried out by using the LICOR calibration certificate and the probe calibration certificate. By applying the below calculation, the OCEAN SEVEN 310 transforms the sensor readings into  $\mu\text{mol s}^{-1} \text{m}^{-2}$ .

**Calibration constants**

LI-193SA calibration constant in water	= 4.71 $\mu\text{A}$ per 1000 $\mu\text{mol s}^{-1} \text{m}^{-2}$
OCEAN SEVEN 310 Full Scale current	= 9.83 $\mu\text{A}$ equivalent to = 131072 ADC counts

**Calculation of the full scale PAR sensor**

$$\text{F.S. } (9.83 \mu\text{A} / 4.71) * 1000 = 2087.048832 \mu\text{mol s}^{-1} \text{m}^{-2}$$

Afterwards, the calibration coefficients (a+bx) can be calculated using the value tabled below:

$\mu\text{mol s}^{-1} \text{ m}^{-2}$	ADC counts (bit)
0.0	0.0
2087.048832	131072

From the above table of data, the offset and slope coefficients to be entered during the PAR calibration procedure must be calculated by the operator. This can be done using the “Interpolate” tool distributed with the IDRONAUT ITERM program or by using the probe calibration procedure.

Selecting the PAR sensor from the list of sensors, the following calibration procedure arises:

*Do you already know 'SLOPE & OFFSET' coefficients?: No*

The operator can decide to enter the calibration coefficients received with the probe or to let the probe calculate new coefficients using the table calculated as above described.

By answering <YES>, the following messages appear in sequence:

*Offset = 0.0    Slope = 1.0*

The operator must enter the offset and slope coefficients, while by answering <NO> the following message appears:

*Number of calibration points:0 enter new value< 2*

The operator must answer using the tabled data:

*Sample value (units)*

*Sample reading (bits)*

The above questions about the units and bits are repeated for the number of “Calibration points” entered. Afterwards, the probe shows the result of the linear interpolation:

*PAR = a + bx*  
*offset = 0.0*  
*slope = 1.0*  
*r correlation coefficient = 1.0*  
*c % of variability = 100%*

The operator can now confirm or modify the offset and slope coefficients.

*Offset = 0.0    Slope = 1.0*

In the end, the list of sensors appears again.

### 5.6.6 Single/Three-Channel Fluorimeter

The innovative Single/Three-Channel Fluorimeter makes available to the marine, freshwater, surveying markets a high performance sensor providing the user with increased functionality when compared to other standard fluorimeters. The Single/Three-Channel Fluorimeter can be tailored to measure a wide range of fluorescent parameters (see the below table). Moreover, it is possible to extend the measurement range through the use of dynamic range function. Dynamic range can be adjusted simply by varying the LED intensity, while still maintaining the factory set calibration via the internal referencing of LED output

All versions of the Three-Channel Fluorimeter come with a Chlorophyll *a* channel as standard; two other channels can then be selected from phycoerythrin, phycocyanin or nephelometer (turbidity) options.

The Three-Channel Fluorimeter allows the user to assess the relative contribution to Chlorophyll *a* fluorescence emission from the different light harvesting pigments absorbing light at each of the chosen excitation wavelengths. This information can then be used to make an assessment of the different classes of phytoplankton present in the sample under analysis.



#### Features

- Range of wavelengths available.
- High rejection of ambient daylight.
- Low noise high sensitivity.
- Low turbidity breakthrough.
- Low power consumption.
- Rugged corrosion free "Acetal C" housing.
- Internal referencing of excitation intensity.

#### Applications

- *In Situ* Chlorophyll & Algal class study.
- Environmental monitoring.
- Particulate studies.
- River and Stream monitoring.
- Pollution monitoring.
- Water and Wastewater quality



<u>Fluorescent Parameter</u>	<u>Dynamic Range (*)</u>	<u>Limit of detection</u>
Chlorophyll <i>a</i>	0..100 µg/l	< 0.01 µg/l
Fluorescein	0..100 µg/l	< 0.005 µg/l
Rhodamine WT	0..100 µg/l	< 0.02 µg/l
Phycoerythrin	0..100 µg/l	< 0.02 µg/l
Phycocyanin	0..100 µg/l	< 0.01 µg/l
Nephelometer (Turbidity)	0..100 FTU	< 0.02 FTU

(\*) User configurable up to 500 µg/L or 500 FTU

#### Note

In case the Single/Three-Channel Fluorimeter is installed in an OCEAN SEVEN 310 CTD which carries out monitoring by means of the "TIMED DATA ACQUISITION" cycle, **it is mandatory to set up the "Number of data sets per acquisition" up to 10.**

#### 5.6.6.1 Fluorimeter special calibration procedure

The Single/Three-Channel Fluorimeter can be re-calibrated by the user using the procedure described in the dedicated Fluorimeter Operator's Manual. The calibration is done by using the dedicated interface software. Therefore, before starting the calibration operations, it is mandatory to install the software in a personal computer.

This section describes the step-by-step procedure to run the software on the PC to communicate with the Single/Three-Channel Fluorimeter installed in the OCEAN SEVEN 310 CTD.

- 1) Connect the OS310 to a personal computer with the RS232 laboratory cable.
- 2) Run the ITERM program.
- 3) Switch on the OS310.
- 4) At the end of the start-up messages from the Main Menu, select the "SERVICE Menu".
- 5) From the "Service Menu", select the "DIAGNOSTIC menu".
- 6) From the "Diagnostic Menu", select the "DISI", diagnostic serial interface. The following message appears:

```
Test communication port associated to auxiliary devices
Coms:(0)Quit,(1)Aux1,(2)Aux2,(3)Aux3,(4)Aux4
Aux:1
```

- 7) From the shown list of auxiliary systems to test, select 2 for the auxiliary #2. Once selected, the following message appears on the ITERM screen.

```
COM-Test:<^X>Quit,<^Z>Show CTRL chars,<^Y>Break"
```

Afterwards, any typed character transmitted by the PC is sent to the interfaced Single/Three-Channel Fluorimeter through the selected serial communication port.

- 8) Wait few seconds after the selection; in the meantime, you should see that the real-time measurements from the fluorimeter appears on the ITERM.
- 9) Close the ITERM communication port using the "Port->Close" command.
- 10) Leave the ITERM program running and start the interface software.
- 11) The communication with the fluorimeter may last 1 hour; after that period, the OCEAN SEVEN 310 interrupts the communication and the procedure must be repeated starting from point 4. However, to communicate with the OCEAN SEVEN 310 it is mandatory to close the software and enable the communication port of the ITERM. This last operation can be done by means of the "Port->Open" command.

#### Note

To interrupt the diagnostic communication with the Single/Three-Channel Fluorimeter before the automatic time-out, after the ITERM communication port is re-opened, type CTRL-X on the keyboard. The OCEAN SEVEN 310 immediately terminates the diagnostic test function showing the diagnostic menu.

#### **5.6.6.2 OCEAN SEVEN 310 - Single/Three-Channel predefined calibration coefficients**

After selecting each parameter associated with the Single/Three-Channel Fluorimeter from the calibration list, the following calibration procedure arises:

```
Do you already know 'SLOPE & OFFSET' coefficients?: No
```

The operator must answer "YES" and then answer as follows to the coefficients request. By answering <YES>, the following messages appears in sequence:

```
Offset = 0.0   Slope = 1.0
```

### 5.6.7 TURNER DESIGNS – CYCLOPS-7 calibration coefficients

The CYCLOPS-7® line of submersible sensors is designed for integration into multiparameter platforms requiring high performance and compact sensors at a significantly lower price than traditional submersible sensors. The CYCLOPS-7® combination of price, performance and size makes the sensors very attractive for oceanographic, freshwater and dye tracing applications.



After selecting the CYCLOPS fluorimeter from the calibration list, the following calibration procedure arises:

*Do you already know 'SLOPE & OFFSET' coefficients?: No*

The operator must answer "YES" and then answer as follows to the coefficients request. By answering <YES>, the following messages appear in sequence:

*Offset = 0.0  
Slope = 1.0*

The offset and slope are indicated on a dedicated calibration sheet which accompanies the CYCLOPS sensors and that are prepared by Idronaut.

It is possible to order from Idronaut an advanced interface for the CYCLOPS-7 fluorimeters, which allows the operator to set the CYCLOPS working gain between: x1, x10 and x100.

If available, the following message appears at the end of the calibration procedure:

*Analog interface #1: Optical h/w scale (1)x1, (2)x10, (3)x100  
Hw Scale[1..3] = 1*

The operator can select the most appropriate scale. Please set the coefficients for the selected measuring scale.

### 5.7 CALIBRATING LOGGING

The OS310 probe implements the GLP (Good Laboratory Practice) protocol, which allows the operator to keep trace of up to 1024 calibrations. Once invoked, the following menu appears on screen:

*Cal Log cmd>> Q)uit,(L)ist,(S)howOne,(sH)owAll,(shO)wSensor,(C)lear*

The commands are:

*Quit:* returns to the calibration menu.  
*ShowOne:* shows one of the 1024 calibration logs.  
*ShowAll:* shows, in sequence, all the stored calibration logs.  
*ShowSensor:* allows showing the calibration log of the selected sensor.  
*List:* shows the calibration log list.  
*Clear:* initializes the calibration log.

The logged information about sensor calibration depends on the type of sensor.

## 6 SERVICE, DIAGNOSTICS AND CONFIGURATION

This section describes the probe service functions available under the service menu. Among other commands from the service menu, it is possible to access the probe diagnostics and configuration menus. Most service, diagnostics and configuration functions are available only under “Administrative or Service” probe access rights and are described in a dedicated appendix. Service, diagnostics and configuration available under “user” access rights are here described.

### 6.1 THE SERVICE MENU

The Service menu is selected from the Main Menu.

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 14:29:04.44 2017
<0>[SVUP]-Leave the service menu
<1>[CONF]-Configuration
<2>[DIAG]-Diagnostics
<3>[RAWC]-Raw data acquisition in counts (bit)
<4>[RAWM]-Raw data acquisition in mV
cmd>
```

#### 6.1.1 Raw data acquisition in ADC counts or mV

The RAWC and RAWM commands respectively allow the operator to acquire real-time data from all the installed sensors and represent it in ADC counts or mV. These two representations are very useful to detect problems with the sensor or to collect data that will be then used to carry out the calibration procedure. Both commands allow the operator to store acquired data by typing <S> key. Typing <ESC> key immediately ends the data acquisition and the "Service Menu" is re-displayed. At the end of the data acquisition, if data has been acquired, the data acknowledgement procedure is performed (see the data acquisition section). In case the SEAPOINT Fluorometer and/or Turbidity meter are interfaced by the probe, two more commands allow the operator to cycle through these sensors measuring scales: <T> for the Turbidity meter and <F> for the Fluorometer. While running, the following message appears:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 14:29:04.44 2017
Place the probe on the sampling point - type<any key>to start,<ESC>to leave
```

The operator must type any character to start or <ESC> to exit.

##### ADC Counts

*Raw data acquisition {counts}*

*Keyb.Cmd:<S>Store,<ESC>Quit,<F>Fluorometer-Scales,<T>turbidity-Scales*

*Fluorometer:<0>[150 ug/l]-Turbidity:<0>[750 FTU]*

Press	Temp	Cond	O2Sat%	O2ppm	pHChl(a)	Turb.	PAR	Time&Memory
476.3	107784.1	9.4	30689.1	0.0	-38322.4	7.8	12.3	62.4 10:55:12.77

##### mV

*Raw data acquisition {mV}*

*Keyb.Cmd:<S>Store,<ESC>Quit,<F>Fluorometer-Scales,<T>turbidity-Scales*

*Fluorometer:<0>[150 ug/l]-Turbidity:<0>[750 FTU]*

Press	Temp	Cond	O2Sat%	O2ppm	pHChl(a)	Turb.	PAR	Time&Memory
8.57	1945.06	0.15	553.70	0.0	-679.10	0.13	0.23 1.12	10:56:05.01

#### 6.1.2 Probe diagnostic functions

The OCEAN SEVEN 310 management firmware allows the operator to perform some simple diagnostic

function to verify probe internal devices and/or functions. More powerful and potentially dangerous diagnostic functions are available under the “ADMINISTRATOR” and “SERVICE” access rights.

### 6.1.2.1 The Diagnostics Menu

The Diagnostics Menu is presented by selecting: <2> [DIAG] from the "Service menu".

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.0_10 05/17)Jun 13 14:33:07.88 2017
<0>[DIUP]-Leave Diagnostics menu
<1>[DITT]-Test 16bitADC
<2>[DISR]-Service reading
<3>[DISI]-Serial interface
<4>[DIRT]-Real time clock/calendar
<5>[DITB]-Time base
cmd>
```

Selection of the desired function is performed by typing one of the acronyms in square brackets or the numeric key between the <> brackets. By pressing the <ESC> key or <DIUP> command, the programme returns to the "Service Menu", while pressing the <ENTER> key re-displays the "Diagnostics menu".

### 6.1.2.2 Test 16bit A/D Converter

This command allows the operator to watch the probe analogue inputs. Once invoked, this command shows the following acquisitions in real time on the PC screen until a character is typed on the PC keyboard. Acquired data is shown in ADC Counts or in mV.

```
16bitADConverter test
Show data in mV?:No type [Y]es or [N]o <n
CH-#0 CH-#1 CH-#2 CH-#3 CH-#4 CH-#5 CH-#6 CH-#7
0.0 0.0 0.0 0.0 8930.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 15632.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 20659.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 24427.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 27253.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 29373.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 30963.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 32155.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 33049.0 0.0 0.0 0.0
0.0 1.0 0.0 0.0 35717.0 0.0 0.0 0.0
```

### 6.1.2.3 Service reading

This command shows in real time the acquisition concerning the probe internal temperature, and analogue reference voltage. The following message appears on the PC screen:

```
System working voltages
External Pwr [3.72]V
Battery [3.34]V
uP int Temp [15.96]C
uP VDC [3.27]V
uP Vref [3436.55]mV
Type <any key>To continue
```

#### 6.1.2.4 Serial interface

In case some external equipment (probe, sensor, etc.) is interfaced with the OCEAN SEVEN 310 through the digital interfaces (serial interfaces) present in the probe, this function allows the operator to directly communicate with the interfaced equipment bypassing the OCEAN SEVEN 310 probe interfacing firmware. The following message allows the selection of the probe communication input/output port to be used during the serial interface test.

```
Test communication port associated to auxiliary devices
Aux-coms:(0)Quit,(1)Aux1,(2)Aux2,(3)Aux3
Aux:0
```

If the operator selects a not configured interface, the function is automatically concluded and the diagnostics menu is shown. Otherwise, the following message appears:

```
COM-Test:<^X>Quit,<^Z>Show CTRL chars,<^Y>Break"
```

Any character typed on the PC keyboard is sent to the interfaced instrument through the selected serial communication port; each character received from the interfaced instrument is echoed on the PC screen. The following special characters have dedicated functions:

- <CTRL-X> Terminates the serial interface test.
- <CTRL-Z> Shows the ASCII representation of the typed/received character.
- <CTRL-Y> Sends a break signal to the interfaced instrument.

If not concluded before by means of the <CTRL-X>, the test is automatically concluded after 10'. At the end of the test, the diagnostics menu is shown again.

#### 6.1.2.5 Real-time clock

This function shows the probe date & time in real time as follows.

```
Test Real Time Clock device, type <any key> to leave
Cur time Fri Jan 05 12:08:02.22 2007
```

Typing a character on the PC keyboard causes the probe to conclude the RTC test and show the diagnostics menu.

#### 6.1.3 Probe configuration

This section provides general information about the probe configuration and configuration functions available under the "Configuration Menu". The below configuration is valid once the probe is running under the USER access rights. More configuration commands and configuration parameters are available once the probe is running under the SERVICE or ADMINISTRATOR rights. These "special" configuration parameters are protected because configuring a wrong parameter may cause failures.

##### 6.1.3.1 Configuration memory layout

The configuration information is stored in a section of the non-volatile memory. The configuration integrity is guaranteed by a CRC code 32bit long. In case the configuration integrity is compromised, the "default factory" configuration is automatically restored and used. The configuration contains information pertaining to the probe:

- ❖ Operations.
- ❖ Data acquisition.

- ❖ Serial interfaces.
- ❖ Interfaced sensors.
- ❖ Interfaced external equipment: sensor, probes, Rosette, etc...
- ❖ Interfaced analogue board

For each of the above listed information, a dedicated configuration function is provided.

#### 6.1.3.2 Default configuration

The factory preset configuration is stored in a dedicated and protected section of the SD FLASH memory. If needed, it can be resumed under the operator's control. In case the current configuration is corrupted, the probe automatically resumes by itself the factory configuration at the start-up if it found a configuration corruption.

#### 6.1.3.3 Updating the configuration

Updating of the configuration is immediately undertaken by the probe at the end of a parameter configuration when the Configuration menu appear again.

#### 6.1.3.4 Configuration Menu

Once the Configuration Menu is requested from the Service Menu, the following message appears on the PC screen:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.1_00 06/17)Jun 13 14:47:57.01 2017
<0>[CNUP]-Leave configuration menu
<1>[CNDA]-Data acquisition parameter
<2>[CNOP]-Operating parameter
<3>[CNAP]-Acquired sensor parameters
<4>[CNDT]-Change current Date&Time
<5>[CNES]-External system
cmd>
```

Selection of the desired function is performed by typing one of the acronyms in square brackets or the number in <> brackets. Pressing the <ESC> key or <CNUP> command returns the probe control back to the Main Menu, while pressing the <ENTER> key re-displays the Configuration Menu.

#### 6.1.3.5 Data acquisition

Through this command, it is possible to customize some aspects of the probe data acquisition functions.

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.1_00 06/17)Jun 13 14:54:31.65 2017
-- Analog setup ---
Battery      : 3.3 V
Ext.power    : 3.7 V
uP VRef     : 3436.6 mV
uP Core Vdc : 3.3 V
uPTemperature : 16.0 C
I.Temperature : 25.8 C
```

The customizable parameters are in sequence:

The conductivity sensor measuring range.

```
Conductivity range = Fresh water ? : No
```

The probe sampling rate

```
Sampling rate [1..28]Hz:28
```

#### 6.1.3.6 Operating parameters

Through this command, it is possible to customize some aspects of the probe operation. The customizable parameters are:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.1_00 06/17)Oct 01 12:26:28.06 2016
--- Digital setup ---Config[6456]Status[488]
```

```
Warmup timeout [s]:5
```

The operator can customize the time-out used by the probe at the wake-up to wait for the sensor stabilization. The default value is 5. In case unattended profiles or monitoring must be performed and the probe is equipped with chemical sensors, we suggest a warm-up of 10s. If the GO1018 rosette is interfaced by the probe we suggest a timeout of 30s (unattended operations).

```
Realtime data at startup ?:No
```

Is it possible to configure the probe to automatically show at startup data acquired in real time

```
Number of lines between header :22
```

This parameter allows the operator to configure the number of data lines that will be shown between two consecutive data header lines.

```
Max. number of char. per line :160
```

This parameter allows the operator to configure the number of characters per line. The data acquisition functions use this parameter to break data message below this limit.

#### 6.1.3.7 Acquired sensors

Through this command, it is possible to customize the type and number of the interfaced sensors. Once invoked, the list of the acquired sensors appear on the PC screen as follows:

```
OCEAN SEVEN 310 - ID:0317003 {USR}(1.1_00 06/17)Oct 01 12:32:03.01 2016
```

```
Probe parameter list
```

Idx	Parameter	Mux	Type	Code	Cal.Rec
01	Press	240	24bit-Ana	010	000 000
02	Temp	240	24bit-Ana	009	001 001
03	Cond	240	24bit-Ana	008	002 002
04	Sal	255	-----	004	---<<--P{0}T{1}C{2}
05	O2Sat%	240	24bit-Ana	000	006 005<<--T{1}
06	O2ppm	255	-----	005	---<<--T{1}O2{6}S{0}
07	pH	240	24bit-Ana	001	007<<--T{1}
08	Eh	240	24bit-Ana	002	008 004

```
CMD:(A)dd,(D)elete,(M)odify,(Q)uit
```

The list of the acquired sensors ends with the commands available for the customization list.

#### 6.1.3.8 Available commands

##### *Add/ Modify*

The add/modify command allows the operator to add a new sensor or to modify one sensor already configured. When you select the modify function, the following message appears:

*Modify the parameter: 0*

The parameter/sensor to be modified or added must be selected by means of the index indicated in the first column of the above list. The add function will insert a new parameter at the selected position moving the remaining parameters in the list, one position below the insertion point. In both cases, the following answers appear on the PC screen:

```

Logical code           :12
Description           :Tr%
N. of digits to show  :0
N. of digits after the dot :0
Do you want to store it ? :No
Do you want to show data ? :No
Dataprocessing method 0)Counts,1)mV,2)Custom&UNESCO,3)Polynomial,4)a+bx
Data processing method :4
Mux. channel [255=none] :0
Mux. delay [0..255ms ]:0

```

See below for a complete description of the above parameters.

##### *Initialize*

Choosing the “Initialize” command will cause the acquired parameter to be preset to a default condition. Anyhow, please be aware that calibrations are lost if this command is invoked.

##### *Delete*

Choosing the “Delete” command will cause the following message to appear:

*Delete the parameter: 0*

By means of the index, the operator must select the parameter to delete.

##### *Quit*

Terminates the configuration function. When the “Quit” command is selected, the “Configuration Menu” is shown.

Typical parameters that can be configured for each sensor in the above list are:

##### *Logical code*

Assigns a logical code to the sensor, from the list of pre-defined sensors/parameters (see below).

##### *Description*

A seven-character acronym that is used by the probe to identify data acquired from this sensor.

##### *No. of digits to show*

Number of digits used by the probe to numerically show the acquired data for this sensor.

<i>No. of digits after the dot</i>	Number of digits used to show the fractional part of the acquired data for this sensor.
<i>Do you want to store it ?</i>	It is possible to acquire and not show the value or to acquire and show it.
<i>Do you want to show data ?</i>	It is possible to acquire and not store in memory acquired data.
<i>Data processing method:</i>	Kind of algorithm used to convert ADC counts reading from a sensor into engineering values. Predefined values are: (0)Counts, (1)mV, (2)Proprietary&UNESCO, (3)Polynomial interpolation, (4)Linear interpolation.
<i>Mux. Channel</i>	Analogue input can be 0..16. The 255 value is used to identify a derived parameter like salinity, which does not belong to a single sensor.
<i>Mux. Delay</i>	Delay in ms to be spent during acquisition to wait for the stabilization of the sensor pre-amplifier before acquiring.

#### 6.1.3.9 List of the common sensor logical codes

Pressure	0	Temperature	1	Conductivity	2
Salinity	4	Oxygen ppm	5	Oxygen %	6
pH	7	Fluorometer	11	Transmissometer	12
Sound Velocity	16	Density (SigmaT)	22	Turbidity meter	24
PAR	25.				

#### Note

The complete list of the sensor logical codes can be found in the document describing the ocean seven 3xx data transfer protocol.

#### 6.1.3.10 Change date & time

Probe RTC date and time can be configured.

*Enter Date&Time: 05/01/2007 13:47:26 06*

The probe date and time can be modified. At the end of this command, the “Configuration Menu” is shown.

**Note** The day of the week is numbered starting from Sunday (1).

#### 6.1.3.11 External systems

The external equipment interfaced by the probe through digital, analogue or serial interface I/O can be configured.

*OCEAN SEVEN 310 - ID:0617002 {USR}(1.1\_00 06/17)Oct 01 12:47:13.58 2016*  
*--- Auxiliary setup ---*  
*Aux.#1,select:(0)None,(1)Trilux,(2)Wetlab ECO*  
*Aux.#1:0*  
*Aux.#2-Rosette:(0)No,(1)GO1018,(2)SBE32c,(3)MISS*  
*Aux.#2:0*  
*Aux.#3 Select:(0)None,(1)miniSVS,(2)IDRO-DO2*  
*Aux.#3:0*

Auxiliary system/sensor configuration parameter are described in the appendix dedicated to describe the interfaced sensor/system.

## 7 PROBE MAINTENANCE

All the maintenance procedures necessary to keep the probe in its best operating conditions are described in this section. The actions described mainly pertain to the sensors of the probe. In detail, this section includes:

- Oxygen sensor.
- Reference sensor.
- pH sensor.
- Conductivity sensor.
- Redox sensor.
- Temperature sensor.
- Pressure sensor.
- Battery endurance and recharge.
- Routine maintenance schedule.

The following recommendations are to be followed when performing the sensor maintenance; suggestions on maintenance frequency are provided in a dedicated section.

### IMPORTANT NOTE

The following section 7.1 refers to the oxygen sensor – standard versions (150 and 700 bar) only. It is not applicable when the probe is equipped with the MAINTENANCE-FREE DISSOLVED OXYGEN SENSOR (5 bar) or the IDRONAUT BLUE CAP OPTICAL DISSOLVED OXYGEN SENSOR.

### 7.1 OXYGEN SENSOR

To ensure the best performance of the oxygen sensor, frequent full replacement of electrolyte (every month) and membrane (every 6 months) is to be performed.

#### 7.1.1 Important remark on oxygen measurement

Most polarographic oxygen sensors take 5 to 10 minutes after they have been switched on to polarize and become stable. To overcome this limitation, the Idronaut OS310 has been fitted with a small internal rechargeable device, to maintain polarization of the oxygen sensor continuously. However, if the probe is not used for several days, the polarizing device become completely discharged. It is recommended that the probe should be switched ON (and streaming real-time data) for at least a few minutes to completely charge the polarization device before proceeding with the calibration.

#### 7.1.2 Green membrane

IDRONAUT green membrane is ideal for profiling acquisitions. To allow proper sample stirring, the probe must be lowered at a rate of at least 0.2 m/sec. The following table shows the characteristics of the green membrane:

Application	Membrane colour	Time const.(a)	Stirring effect(b)	Membrane material
Profiling	Green	3 sec.	5%(c)	25µ, Teflon®

#### Note

(a) *Time constant* = nitrogen to air.

(b) *Stirring effect* = measuring difference between a sample well stirred and a completely stagnant one.

(c) *Algorithm compensates for this 5% reading decreasing.*

All values of the table are given for a temperature of 25° C. **The probe is delivered with the green membrane installed.**

### 7.1.3 Refilling oxygen sensor cap with electrolyte

- 1) Switch the probe ON and, if possible, achieve oxygen calibration.
- 2) Locate the oxygen sensor on the probe, then unscrew and remove the cap. Pay attention not to damage the glass tip of the sensor.
- 3) Wash the silver and glass assembly with distilled water and dry it with a lint-free paper towel. Do not touch the internal parts of the sensor with the fingers.
- 4) In this condition, with the sensor tip duly dried and cleaned, the sensor should read less than 0.2 ppm (if calibration has been previously achieved). The sensor should not be touched during this check. If the readout is higher, there is most probably a film of moisture still in contact with the sensor tip. Carefully dry the sensor tip.
- 5) Carefully fill the membrane cap with the O<sub>2</sub> electrolyte; do this in such a way that drops are deposited directly into bottom of the membrane in order to prevent the formation of big air bubbles in the cap. To eliminate trapped air bubbles, gently tap the membrane cap.
- 6) Gently screw the membrane cap onto the sensor body, thus allowing the electrolyte in excess to be drained and then securely tighten the membrane cap.
- 7) Dry the sensor, and the membrane in particular, with a lint-free paper towel.

#### Note

*After electrolyte refilling, recalibrate the oxygen channel.*

#### IMPORTANT

- A. Maximum stability of readout is achieved 30 minutes after the membrane cap and/or electrolyte replacement, thus enabling the sensor to reach a good polarization level. Oxygen analysis can, however, be carried out within a few minutes after the membrane cap replacement, provided that a calibration is performed.
- B. While the probe is not used, oxygen sensor polarization remains active since the necessary power is provided by a rechargeable battery placed inside the probe. Battery back-up is performed when the probe is switched ON.
- C. If necessary, the whole electrolyte must be replaced. "Topping-up" with fresh electrolyte must not be carried out since the solution would be contaminated by the old one thus resulting in a reduction of life.
- D. It is recommended that only the IDRONAUT electrolyte be used, since its composition and pH guarantee the best performance and minimize the formation and growing of silver chloride on the anode.

### 7.1.4 Membrane replacement (oxygen membrane cap)

Conditions which could require the membrane and electrolyte replacement are the following:

- 1) Calibration is not systematically achieved (try at least three times) and "OXYGEN SENSOR CALIBRATION ERROR" appears on screen.
- 2) The oxygen sensor responds more slowly than usual or drifts.
- 3) The membrane of the cap is mechanically damaged and shows leakage, holes or scratches.
- 4) Readout of over 0.2 ppm is displayed when carrying out the sensor check in the absence of oxygen.
- 5) The oxygen sensor, filled with electrolyte, has been stored for a long time at temperatures outside those recommended (- 10 to 40° C).

### 7.1.5 Replacement of membrane(s) using the OXYGEN SENSOR MAINTENANCE KIT:

- 1) Locate and pull out the following parts from the maintenance kit:
  - ❖ One oxygen measuring "green" membrane (internal).
  - ❖ One O-ring.
  - ❖ O-ring mounting tool.
- 2) Remove the protection ring from the membrane cap. Remove and discard the black o-ring and the membrane.

- 3) Fit the new o-ring over the mounting tool and roll it down to the widest part of the tool.
- 4) Place the cap on a desktop with its narrow end facing up.
- 5) Position the measuring membrane "green" on top of the cap.
- 6) Place the widest part of the tool against the membrane. Slightly pressing the tool, slide the o-ring carefully into the slot of the cap thus holding the membrane in position.
- 7) Cut away the excessive membrane, with fine scissors, far from the o-ring to avoid damaging the membrane.
- 8) Finally, recap the protective plastic ring.



#### 7.1.6 Oxygen sensor cleaning

During the calibration procedure, the oxygen sensor current is shown:

Checking oxygen sensor:

Current: XXX nA. % of last calibration. XXX.X%

This acceptable range is:

Membrane	Current (nA)
Green	30-90

If, after replacing the membrane cap and cleaning the sensor tip with filter paper, the oxygen sensor current is too low during calibration, it is necessary to polish the sensor tip with the abrasive paper (**which must be wet**) included in the maintenance kit. It is sufficient to slightly rub the tip over the paper two or three times without applying an excessive pressure. Wash the sensor tip with distilled water, or with a few drops of electrolyte, to remove residues. If the silver anode appears completely black or covered with foreign materials, it is necessary to clean it with the abrasive paper. Wrap the paper around the silver body and rotate it to obtain original silver brightness. Wash the sensor under a tap or, if possible, use distilled water to remove residuals. The anode cleaning procedure is required every 2 or 3 years only. After these operations, the oxygen current, during calibration, will be higher than the normal one and will drop during the first few hours to reach the normal stability level of 0.1 to 0.3 ppm/week.

### 7.1.7 Oxygen sensor check in the absence of oxygen

To guarantee maximum accuracy in results, it is a good practice to test the response of the sensor once a month in the absence of oxygen. Nitrogen is recommended for this check; should not Nitrogen be available, an aqueous solution, chemically reduced, can be alternatively used. To carry out this test, it is important that the membrane cap should have been replaced for at least 15 minutes, thus allowing a complete sensor polarization.

#### Procedure

- 1) Connect a cuvette (body of a syringe) to a Nitrogen supply using a flexible tube.
- 2) Purge the line and adjust the gas flow rate at 200 ml/min. approx.
- 3) Calibrate the oxygen channel by exposing the sensor to room air.
- 4) Insert the sensor completely into the cuvette. The reading should rapidly decrease and within a few seconds to one minute, it should be less than 0.2 ppm. If the reading is more than 0.2 ppm, re-expose the sensor to room air and repeat the operation.

Should the inconvenience persist, replace the membrane cap and/or the electrolyte.

**Due to the high-quality construction of this oxygen sensor, which reduces to insignificant the background current, no electronic zero calibration is necessary and possible**

### 7.2 REFERENCE SENSOR

- ❖ During all periods of inactivity, the reference sensor must be always hydrated with the IDRONAUT REFERENCE SENSOR STORAGE SOLUTION or, if not available, even with KCl saturated solution, using the plastic hydrating cap. Fill the cap to about one third with the solution. The cap should be squeezed to allow an easy insertion.
- ❖ Before starting the measurements, the plastic hydrating cap must be removed.
- ❖ If the sensor has been exposed to air without its protective cap or if the solution in the cap is not present, the solid electrolyte of the sensor may have contracted forming internal air bubbles, in particular by the junction hole. In this case, it is necessary to fill the cavity with the IDRONAUT REFERENCE SENSOR STORAGE SOLUTION. Take a small syringe, i.e. 1.5 ml and aspirate a small amount of the IDRONAUT REFERENCE SENSOR STORAGE SOLUTION (supplied with the probe). Place the probe on a table in a horizontal position taking care that it does not rotate. Carefully insert the needle of the syringe in the junction hole of the reference sensor without bending the needle to avoid breaking the glass sensor. Gently press the syringe plunger to inject some drops of solution inside to eliminate the air bubbles. If the cavity is too big and the electrolyte added easily leaks, or should the cavity appear contaminated by foreign material, then the replacement of the reference sensor may become necessary.
- ❖ If the sensor is left immersed in the measuring environment for an indefinite period, there will be a slow progressive loss of the KCl from the solid electrolyte. In such working conditions, the reference sensor needs to be replaced within 6 months ÷ 1 year .

### 7.3 pH SENSOR

The glass membrane of the pH sensor must be always kept hydrated. If the sensor is stored dry for an extended period (more than half a day), the sensor's performance may deteriorate. The electrode sensitivity diminishes, the response times increase, and signals tend to drift during measurements and calibrations.

Before using the sensor after long storage periods, it is advisable to check the electrode performance using pH7 and pH4 buffers. Following calibration of the sensor with pH7 buffer (see the relevant section), wash the sensor and calibration cup with distilled water.

Then perform the following as described:

- 1) Dry the electrode with a soft tissue, making sure not to rub on the pH sensor tip.
- 2) Fill the calibration cup with pH4 buffer and dip the pH and reference electrodes in the cup.

- 3) Gently stir the buffer cup vertically. At an ambient temperature of  $20 \pm 2^\circ \text{C}$ , the pH reading should be  $4.00 \pm 0.10$  pH. If the reading is outside this range, repeat the calibration at pH7 and then re-check reading at pH4. If pH4 reading is still not within tolerance, it is necessary to reactivate the pH sensor using the pH etching solution (supplied with the probe).

Both pH7 and pH4 buffer solutions used in the cup must be thrown away and not placed in the pH7 and pH4 bottles again. The pH7 and pH4 buffer solutions will generally last no longer than one year after opening the bottles, as the ambient  $\text{CO}_2$  and pollutants can deteriorate with them. In case of doubt or of bad results, use fresh pH7 and pH4 buffer solutions as, in many cases, the pH problems are simply due to bad pH solutions.

### 7.3.1 **To etch the sensor, perform the following:**

- ❖ Half-fill the transparent cap with the pH SENSOR ETCHING SOLUTION.

#### **Note**

*Use gloves in order to avoid any direct skin contact with the pH sensor etching solution since the solution contains hydrofluoric acid and ammonium fluoride and is highly corrosive.*

- ❖ Place the cap on the pH sensor, gently squeezing the sides to limit the inclusion of air bubbles during insertion. Take care that the etching solution covers the full round end of the sensor. After no more than 1 minute, remove the cap and carefully rinse both the pH sensor and cap with plenty of water. The electrode should be left in distilled water before use overnight.

#### **IMPORTANT**

- A. The etching solution must not be used improperly, for instance to store the electrode as this will permanently damage its pH glass membrane. The electrodes should always be stored either in distilled water or in the pH7 buffer solution.
- B. The treatment of the pH sensor with the etching solution cannot be performed indefinitely. After performing this step a few times, the treatment ceases to have any positive effect and the sensor should be replaced with a new one.
- C. Do not use the etching solution with the reference sensor. Permanent damage to the reference electrode will result.
- D. When not in use, the pH sensor must be fitted with the protective cap filled with either pH7 buffer or distilled water. (Alternatively, a salt solution - normally 3M KCl - can be used).

### 7.3.2 **Important remark on the pH measurement**

The pH and reference sensors should never be allowed to completely dry out. For short-term storage of up to one day, the probe's sensor head can simply be immersed in clean water. If the probe remains unused for periods longer than one day, always place the hydrating caps on both sensors. The pH sensor cap should be filled with the pH7 Buffer Solution (or simply with clean water). The reference sensor cap should be filled with the Idronaut Reference Sensor Storage Solution (or even with KCl saturated solution).

## 7.4 **CONDUCTIVITY SENSOR**

For accurate determinations of conductivity, it is important that the seven platinum electrodes of the sensor flow cell be not contaminated with oils, biological growths or other foreign materials, which can cause a reduction in the conductivity reading. During long-term monitoring, the growth of fouling within the cell can cause a decrease of performance

### 7.4.1 **Important remarks on conductivity measurement**

- 1) To obtain the best accuracy, the conductivity sensor and therefore the probe sensor head, must be immersed in clean seawater for at least 15 minutes before measurements.
- 2) When the conductivity sensor is not in use, it is kept dry. Therefore, when the conductivity sensor is

placed in water, very small bubbles may remain attached to the platinum ring electrodes (seven). If such a thing happens, the measured value of conductivity will be lower than the true one. To remove these air bubbles, degrease the inside of the conductivity cell using cotton buds wetted with the Conductivity Sensor Cleaning Solution or with liquid soap. Gently rotate the cotton bud against the whole internal surface of the quartz cell. This will wet the platinum electrodes thus reducing the surface tension of the cell and considerably decreasing the risk of trapped air bubbles.

**This wetting operation must be always carried out before laboratory calibration tests.**

#### 7.4.2 Conductivity sensor cleaning

To clean the conductivity cell, use cotton buds and wet them with the CONDUCTIVITY SENSOR CLEANING SOLUTION gently rotating the cotton bud against the platinum ring surfaces. Replace the cotton bud after each ring cleaning. Repeat the above operation until the cotton buds used come out perfectly cleaned. If the above cleaning solution is not available, use common liquid soap (and cotton buds). If the above cleaning procedure is not enough to completely remove the contamination (for instance carbonate), rotate inside the cell a small swab (10 mm diameter) wetted with 10% concentration of hydrochloric acid. Even a maximum 30 % concentration can be used, if necessary.

#### 7.5 REDOX SENSOR

The redox sensor can be contaminated by fouling or if some mud accidentally covers its sensitive tip. In this case, it is wise to clean the sensor tip before each series of measurements. Use the abrasive paper (**which must be wet**) provided in the OXYGEN SENSOR MAINTENANCE KIT. It is sufficient to slightly rub the glass tip (where, at its centre, the platinum wire is placed) on the abrasive surface of the paper two or three times. Wash the sensor tip with distilled water to remove residues.

#### 7.6 TEMPERATURE SENSOR

The temperature sensor provides, via software, also the automatic temperature compensation for both pH and oxygen channels. The temperature sensor is almost maintenance free; however, we suggest cleaning it once a year with sandpaper (3M, 400 grid), included in the Oxygen Maintenance Kit, to remove carbonate which, if present, will greatly increase its time constant.

#### 7.7 PRESSURE SENSOR

The pressure sensor is almost a maintenance free device meeting the highest reliability standards and thus reducing the chance of possible failure. Replacement of the pressure transducer could however become necessary if an extension of the operating range (depth) is required. In that case, the whole probe must be returned to Idronaut to allow replacement, calibration and performance check of the sensor. The pressure transducer is located at the centre of the probe bottom flange. Protection against fast thermal variation of water sample (thermocline) is obtained by means of a plastic o-ring cap provided with a small hole in the centre. Lack of the protective cap may generate spikes of the signal generated by the transducer when severe thermoclines are encountered.

#### 7.8 INTERNAL BATTERY

The OCEAN SEVEN 310 CTD housing has, in its upper part, enough space to accommodate an internal battery pack. The OS310 is powered by three 1.5V batteries or a single 3.6V battery but different types of battery can be installed in the CTD housing.

- 3 x size "AA" Alkaline 1.5V battery assembled in a single pack 5V
- 1 x size "AA" Lithium non rechargeable battery 3.6V, 2.4Ah
- 1 x size "C" Lithium non rechargeable battery 3.6V, 8.4Ah
- NiMH rechargeable IDRONAUT custom battery pack (3x1.2 AA) 3.6V, 2.6 Ah

➤ *Li-Ion rechargeable IDRONAUT custom battery pack*

3.7, 4.5Ah

When the CTD is not used for long periods (e.g. 2 weeks or more), we suggest disconnecting the internal battery pack connector from the CTD electronics or removing the internal battery pack from the CTD to prevent the internal batteries from damaging the CTD due to battery acid leakage. This is why the OCEAN SEVEN 305*Plus* CTD is shipped without batteries installed.

**INSTALLING THREE 3.6V LITHIUM BATTERIES IN THE TRIPLE BATTERY HOLDER AND CONNECTING IT TO THE OS310 TOP COVER WILL CAUSE A PERMANENT DAMAGE TO THE OS310 CTD ELECTRONICS.**

The status of the internal battery pack can be derived from the battery diagnostic reading of the CTD start-up message. This last is carried out only when the laboratory cable power supply (AC/DC) is not connected to the wall socket. Three different batteries are used to operate the probe:

**7.8.1 Internal battery pack endurance**

The internal probe battery endurance can be easily calculated using the “Os3xxCTDAutonomy” tool, which is distributed with the ITERM program and the REDAS-5 program. This tool, through a simplified user interface (see below), allows the operator to select the probe type, select the sensors interfaced by the probe and then calculate the probe battery autonomy.

**Ocean Seven 3xx CTD Memory and Battery autonomy calculator**

**Probe type**

- OCEAN SEVEN 305
- OCEAN SEVEN 305Plus
- OCEAN SEVEN EA/89
- OCEAN SEVEN 316
- OCEAN SEVEN 316Plus
- OCEAN SEVEN 320
- OCEAN SEVEN 320Plus
- OCEAN SEVEN 310**

**Memory**

512 Memory size (MB)

Standard  Extended

**Battery**

1.200 Ah 9.0 VDC

Battery pack

- 2xPP3 Lithium ( 9V, 2.4 Ah) Int.
- 10xD Alkaline (15V, 18Ah) Ext.
- 12xAA NiMh (14.4V, 4.5Ah) Ext.
- 12xAA NiMh (14.4V, 2.85Ah) Int.
- 1xC Lithium (3.6V, 8.4Ah) Int.
- 3xAA NiMh (3.6V, 4.5Ah) Int.
- 4xAA Lithium (14.4, 2.4Ah) Int.
- 1xAA Lithium (3.6V, 2.4 Ah) Int.
- 2xAA Alkaline (3.0V, 1.0 Ah) Int.
- 3xAA Alkaline (4.5V, 1.0Ah) Int.
- 1xC Li-Ion (3.7V, 4.5Ah) Int.**
- Custom battery pack

**Measurement cycle**

600.00 Measure interval (s)

1 Dataset x measure

6.00 ON time x measure (s)

Switch On/Off between measure

**Power Consumption**

0.023 Running (Ah)

0.000078 Stand-by (Ah)

5.0 Self discharge (%)

**Autonomy**

0 Memory autonomy (day) 0 Max. Dataset

0.00 Battery autonomy (day) 0 DataSet x day

0.00 Battery autonomy (hour) 0 Mea cycle x day

Clear Calculate About Exit

**7.8.2 Oxygen sensor polarization device**

The internal (oxygen sensor) device is automatically charged during the probe ON periods. If the probe is not in use for more than five days, the device must be recharged by keeping the probe ON for at least 10 minutes.

**7.9 ROUTINE MAINTENANCE SCHEDULE**

The most important maintenance actions to be periodically carried out are listed below.

**Monthly maintenance**

- ❖ Replace electrolyte of the oxygen sensor.
- ❖ Check that pH and reference sensors be protected by proper caps and solutions, if not in use.
- ❖ Recharge the oxygen polarization device by keeping the probe ON for few minutes.

**Quarterly maintenance**

- ❖ Replace the oxygen membrane.
- ❖ Check the pH channel and renew the pH sensor, if necessary.
- ❖ Clean the flow cell of the conductivity sensor.

8 **TROUBLESHOOTING**

Most common errors and the suggested solutions are listed below. In case of trouble, contact IDRONAUT at [idronaut@idronaut.it](mailto:idronaut@idronaut.it).

**Please always mention the probe serial number in your request for support.**

DEFECT	SOLUTION
No communication with the probe using ITERM or/and REDAS-5	<ul style="list-style-type: none"> <li>❖ If working with telemetry, try to communicate using the RS232C laboratory cable.</li> <li>❖ Verify that the battery and/or the power supply are correct.</li> <li>❖ Verify that the communication port used by the program corresponds to the hardware interface where the cable is connected.</li> <li>❖ If working with battery or external power supply, switch the probe on by means of the magnetic switch.</li> <li>❖ Close and restart the ITERM program.</li> <li>❖ If working with REDAS, try to communicate using the ITERM program</li> </ul>
The measurement cycle cannot be stopped.	<ul style="list-style-type: none"> <li>❖ In case the measurement cycle was started in non-verbose mode, use the ITERM program "Stop Cast" function to stop the measurement cycle.</li> <li>❖ Run ITERM, switch on the probe and, when acquired data starts to appear on the PC screen, type the &lt;ESC&gt; key. Answer &lt;YES&gt; to the given question to stop the measurement cycle.</li> </ul>
Partial data stored in memory	<ul style="list-style-type: none"> <li>❖ In case the probe is performing unattended acquisition, verify the code indicated in the area code of the stored cast. Most of the times, the reason for the partial data can be understood by analyzing the area code of the stored cast.</li> <li>❖ Verify the battery status.</li> <li>❖ Verify the memory status.</li> </ul>
Data cannot be stored in memory	<ul style="list-style-type: none"> <li>❖ Most of the times, initializing the memory solves the problem.</li> </ul>
REDAS-5 does not detect or initialize the probe	<ul style="list-style-type: none"> <li>❖ The REDAS-5 condensed manual describes a step-by-step configuration which should allow to complete the probe initialization and detect it without problem.</li> <li>❖ If the probe is interfaced through the telemetry, check the suggestions on the deck unit installation and operator's manual.</li> </ul>
Oxygen sensor calibration error	<ul style="list-style-type: none"> <li>❖ Perform the oxygen sensor maintenance procedure described in the maintenance section.</li> </ul>
pH sensor calibration error	<ul style="list-style-type: none"> <li>❖ Perform the pH sensor maintenance procedure described in the maintenance section.</li> </ul>

**RECHARGE THE INTERNAL BATTERIES of the 100 mm HOUSING**

The rechargeable battery pack can be different from probe to probe. The battery pack comes complete with the associated international battery charger. The below instruction are valid for each battery pack

- 1) Dry the probe and lay it down on a table.
- 2) Remove the six screws on the probe cover with the hexagonal wrench included in the CTD accessories.
- 3) When extracting the cover, dry the fissure between the cover and the body of probe with a strip of paper inserted edgewise and dry any trace of water in the proximity of the external side of the o-ring.
- 4) Pull the battery pack off and remove the cable connector.
- 5) After connecting the battery pack, the charger immediately checks the nominal voltage, thus automatically selecting the most appropriate action to carry out.

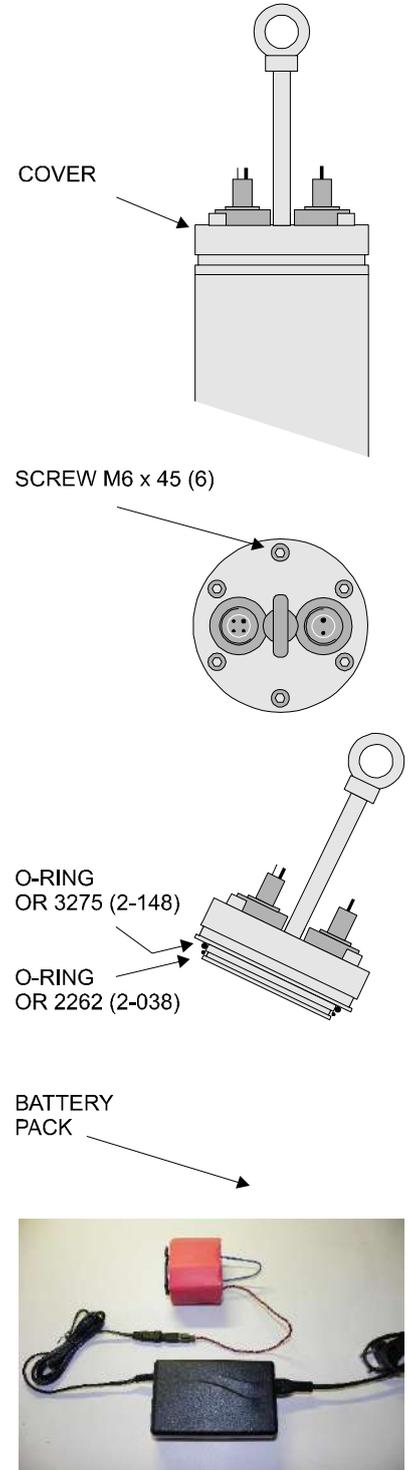
**LED indicators**

Please carefully read the booklet associated to the battery pack for detailed instruction about the indication during the battery charging.

**Note**

*At the end of the quick-charging procedure, the charger undertakes a low-current equilibration charging procedure which lasts 30 m. This procedure is also called tricky-charging procedure. The aim of this procedure is to keep the battery cells in good condition, thus compensating for the auto-discharge.*

- 6) Replace the cover on the probe and lift the probe itself vertically.
- 7) Check the correct position of the o-ring and close again the probe with the six screws. Gradually tighten the six screws in sequence such as to close the cover uniformly



**RECHARGE THE INTERNAL BATTERIES of the 89 mm TITANIUM HOUSING**

The rechargeable battery pack can be different from probe to probe. The battery pack comes complete with the associated international battery charger. The below instruction are valid for each battery pack

- 1) Dry the probe and lay it down on a table.
- 2) Remove the four titanium fixing bolts on the probe cover with the hexagonal wrench included in the probe accessories.
- 3) In case the cover does not come out easily, screw the four bolts (previously removed) into the blind holes in order to extract the probe cover. Gradually screw the bolts alternating between them such as to raise the cover evenly.
- 4) When extracting the cover, dry the fissure between the cover and the body of probe with a strip of paper inserted edgewise and dry any trace of water in the proximity of the external side of the o-ring.
- 5) Pull the battery pack off and remove the cable connector.
- 6) Connecting the battery pack, the charger immediately checks the nominal voltage, thus automatically selecting the most appropriate action to carry out.

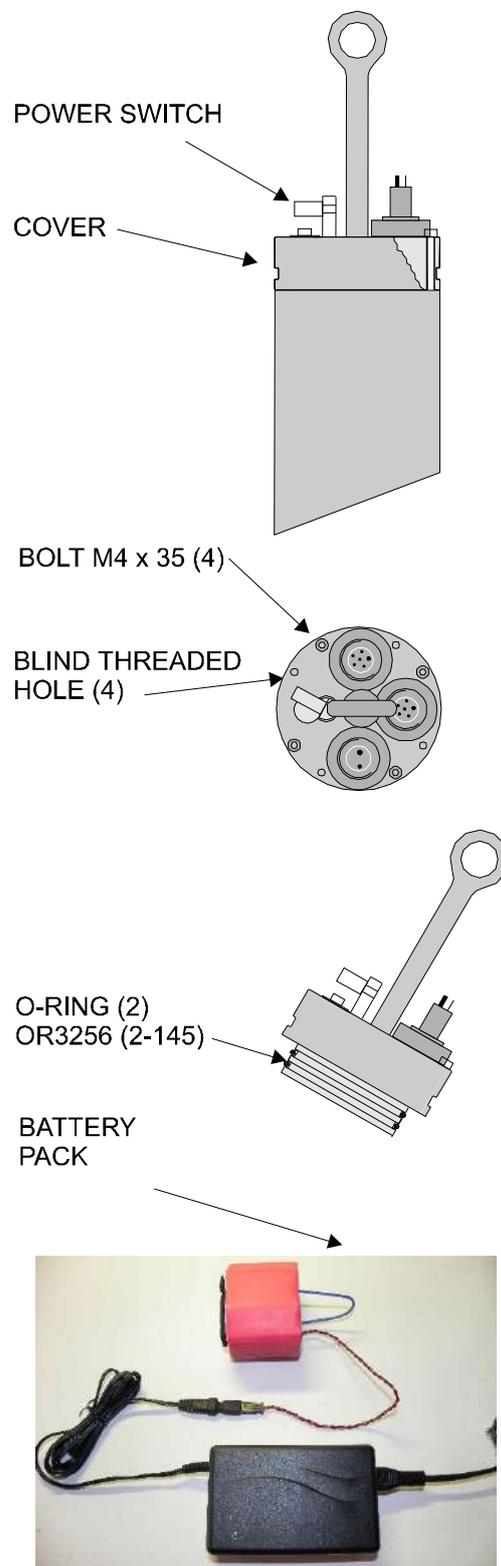
**LED indicators**

Please carefully read the booklet associated to the battery pack for detailed instruction about the indication during the battery charging.

**Note**

*At the end of the quick-charging procedure, the charger undertakes a low-current equilibration charging procedure which lasts 30 m. This procedure is also called tricky-charging procedure. The aim of this procedure is to keep the battery cells in good condition, thus compensating for the auto-discharge.*

- 7) Replace the cover on the probe and lift the probe itself vertically.
- 8) Close again the probe with the four bolts. Gradually tighten the bolts in sequence such as to close the cover uniformly.



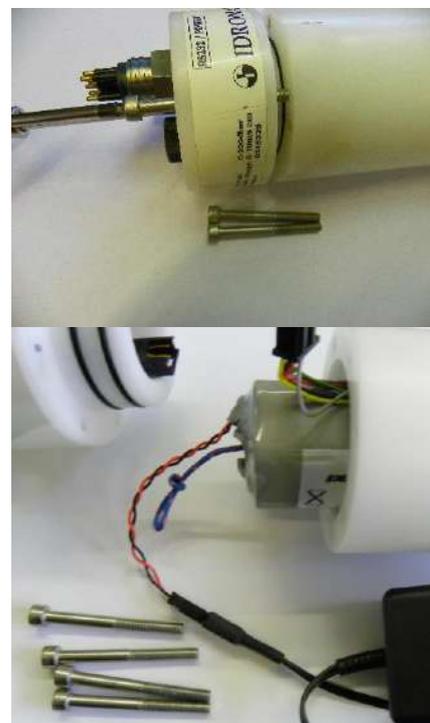
**RECHARGE THE INTERNAL BATTERIES of the 75 mm POM and TITANIUM HOUSING**

To gain access to the internal battery holder, loosen the four hexagonal screws on the CTD top cover. Gently pull out the top cover from the CTD housing. During this operation, remove any water droplets around the top cover to prevent them from seeping into the housing. The battery holder contains 3xAlkaline type AA cell, assembled in series, to create a unique 4.5VDC battery pack.

1. Dry the probe and lay it down on a table.
2. Remove the four screws on the probe cover with the hexagonal wrench included in the CTD accessories.
3. In order to safely remove the top cover use two of the screw to gently pull-out the cover as per the picture.
4. When extracting the cover, dry the fissure between the cover and the body of probe with a strip of paper inserted edgewise and dry any trace of water in proximity of the external side of the o-ring.
5. Pull the battery holder out and remove the dead batteries.
6. Install the new batteries.
7. Insert the battery pack in the CTD housing
8. Lifting the CTD vertically helps to properly insert and mount the top cover.
9. Check the correct position of the o-ring and close the CTD with the four screws. Gradually tighten the four screws in sequence such as to close the cover uniformly

**Rechargeable battery pack**

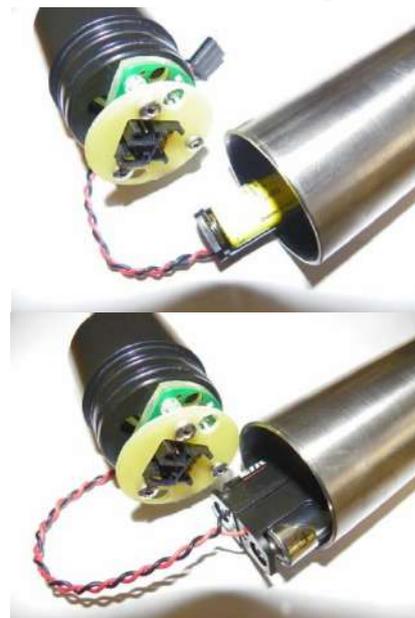
1. Dry the probe and lay it down on a table.
2. Remove the four screws on the probe cover with the hexagonal wrench included in the CTD accessories.
3. In order to safely remove the top cover use two of the screw to gently pull-out the cover as per the picture.
4. When extracting the cover, dry the fissure between the cover and the body of probe with a strip of paper inserted edgewise and dry any trace of water in proximity of the external side of the o-ring.
5. Pull the battery pack off and remove the cable connector. After connecting the battery pack, the charger immediately checks the nominal voltage thus automatically selecting the most appropriate action to carry out. Detailed information is available on the battery charger documentation.
6. At the end of the battery charging, insert the battery pack in the CTD housing, connect the wiring to the top cover and mount it on the CTD. Lifting the CTD vertically helps to properly insert and mount the top cover.
7. Check the correct position of the o-ring and close the CTD with the four screws. Gradually tighten the four screws in sequence such as to close the cover uniformly



**RECHARGE THE INTERNAL BATTERIES of the 48 mm AISI316L and TITANIUM HOUSING**

To gain access to the internal battery holder, loosen the two closing screws on the CTD top cover. Gently pull out the top cover from the CTD housing. During this operation, remove any water droplets around the top cover to prevent them from seeping into the housing. The battery holder contains 3x 1.5V Alkaline type AA cells, assembled in series, to create a unique 4.5VDC battery pack.

1. Dry the probe and lay it down on a table.
2. Loosen the two closing screws on the probe cover with a proper screwdriver.
3. When extracting the cover, dry it and pay attention to any drops of water present on the cover or in the upper part of the probe body. Anyhow, dry any trace of water in proximity of the external side of the o-ring.
4. Extract the battery holder from the CTD housing.
5. Remove the dead batteries and install the new ones.
6. Gently push the wires and connectors to the side of the battery pack and insert the battery holder in the CTD housing.
7. Gently reassemble the CTD top cover. Close the CTD with the two closing screws and gradually tighten them in sequence such as to close the cover uniformly.

**Rechargeable Battery pack**

To gain access to the internal rechargeable battery pack, loosen the two closing screws on the CTD top cover. Gently pull out the top cover from the CTD housing. During this operation, remove any water droplets around the top cover to prevent them from seeping into the housing.

1. Dry the probe and lay it down on a table
2. Loosen the two closing screws on the probe cover with a proper screwdriver.
3. When extracting the cover, dry it and pay attention to any drops of water present on the cover or in the upper part of the probe body. Anyhow, dry any trace of water in proximity of the external side of the o-ring.
4. Disconnect the battery pack connector (4-pin black connector) from the CTD upper cover.
5. Connect the battery charger to the battery pack and wait until the battery is fully charged.
6. Connect the battery to the 4-pin black connector of the CTD top cover.
7. Gently push the wires and connectors to the side of the battery pack.

Gently reassemble the CTD top cover. Close the CTD with the two closing screws and gradually tighten them in sequence such as to close the cover uniformly.



### **EXTERNAL BATTERY PACK**

The OCEAN SEVEN 310 can be optionally equipped with an external 3.6 VDC submersible battery pack. Aim of the external submersible battery pack is to enhance the internal battery capacity thus extending the deployment period. Both, battery pack can be installed at the same time. The probe electronic selects by itself from which battery the energy will be taken.

The external submersible battery pack comes complete with an international battery charger. Recharging of the external battery pack foresees the opening of the battery housing and connection of the battery charger with the battery pack. Detailed instruction about the external submersible battery pack and battery re-charging can be found in the battery pack documentation.

The OS310 probe, if this option is present, is provided with a special Y-style submersible cable that allows the simultaneous connection of the external battery pack and of the RS232C laboratory cable to the "RS232&Power" top-cover bulk-head connector.

The Y-Style cable is mandatory to configure the CTD before deployment and to deploy the CTD.

### **Deployment of CTD with external battery pack**

After the CTD has been configured, switch it OFF using the TOP COVER switch. Afterward remove the RS232 laboratory cable from the Y-Style cable and plug-in the dummy connector to protect the male connector. Now the probe is ready for the deployment.



NEVER disconnect the external battery after the probe has been configured, otherwise the unattended setup will be lost.

**B FOREWORD**

The OCEAN SEVEN 310 CTD multi-parameter probe automatically performs sensor data processing functions needed to guarantee the probe measurement stated accuracy and precision. This section briefly introduces the data processing procedures.

**B.1 CTD MEASUREMENT SYNCHRONIZATION**

Independently from the applied filtering procedure the OS310 data acquisition hardware and firmware guarantee the simultaneous measurement of all sensors.

**B.2 RAW DATA FILTERING**

The aim of the "raw data filtering functions" is to attenuate the noise in the acquired data without affecting the signal content. The OS310 is shipped with pre-set best condition and it should be noted that modifying the raw data processing filtering can led the probe to deviate from the stated measurement accuracy and/or precision. We discourage the modification of the raw data filtering.

**B.2.1 Thermal compensation**

The thermal compensation procedure is applied to the CTD (Conductivity, Temperature and Pressure) sensors only. The thermal compensation algorithm compensates deviation of the electronic preamplifier of the CTD sensors due to the variation of the ambient temperature inside the probe housing. The thermal compensation is performed by continuously monitoring the probe internal temperature and by applying a thermal compensation algorithm based on coefficients obtained in laboratory by means of repeated thermal characterization cycles.

**B.2.3 Temperature sensor self-heating minimizing**

To eliminate the self-heating effect of the temperature sensor, the OCEAN SEVEN 310 probe powers off the temperature sensor excitation when not needed. Without this precaution, the temperature sensor itself is capable of changing the temperature of the small volume of water immediately around it by a fraction of milli-degrees °C in the presence of a modest water flow.

**B.3 CONVERSION INTO ENGINEERING UNITS**

Raw data consists of digitised voltages or ADC counts acquired from the sensors through the electronic sensor conditioning circuits (sensor preamplifiers). Raw data values are converted into physical and chemical units by means of calibration data and data conversion algorithms.

**B.2.1 Dedicated conversion procedure**

Conversion of signals coming from a sensor into engineering units is the result of a processing algorithm, which for some sensors cannot be directly correlated with a standard mathematical method. For such parameters, a dedicated data conversion function is provided. The OCEAN SEVEN 310 has dedicated processing algorithms for the following sensors:

- ❖ Dissolved oxygen sensor saturation.
- ❖ Dissolved oxygen sensor expressed in ppm.
- ❖ pH expressed in pH.
- ❖ REDOX expressed in mV

An overview of the processing algorithms and parameters is described in the introduction section.

**B.2.2 Common conversion procedure**

Sensors which do not require dedicated conversion procedure use polynomial (up to the 2<sup>nd</sup> order) or first order interpolation algorithms to convert the ADC counts into engineering values.

Polynomial interpolation:  $y = a + bx + cx^2 + dx^3$

1st order interpolation:  $y = a + bx$

**B.2.3 DERIVED PARAMETERS**

Derived parameters like: Salinity, Sound Speed, Pressure to Depth Conversion, Theta, Sigma T, etc. are obtained using the algorithms described in the UNESCO technical papers in marine science no. 44 "Algorithms for computation of fundamental properties of sea water".

**B.4 SENSOR LOGICAL CODE TABLE**

The following logical code table shows the most common sensors and derived parameters. A complete list of the sensor logical codes can be found in the "Ocean Seven 3xx Data Transmission Protocol" document.

Description	Logical code
Pressure	0
Temperature	1
Conductivity salt waters	2
Conductivity fresh waters @20°C	3
Salinity (UNESCO FORMULA)	4
Dissolved Oxygen ppm	5
Dissolved Oxygen %	6
pH	7
Redox	8
Dissolved Oxygen ppm (UNESCO FORMULA)	9
Fluorometer	11
Transmissometer CSTAR	12
Sound Velocity (UNESCO FORMULA)	16
Depth (UNESCO FORMULA)	20
Sigma T (Density UNESCO FORMULA)	22
Turbidity Meter	24
PAR – generic	25
Potential Temperature (THETA)	44
Conductivity fresh water @25°	80
Conductivity fresh water	89
PAR – QSP200L	99
Rhodamine	112
Sea bed contact	113
ECO FLRT Chl-a	114
ECO FLRT CDOM	115
ECO FLRT SCATTER	116
ECO FLRT Phycocyanin	117
ECO FLRT PycoErithrin	118
ECO FLRT RHODAMINE	119
ECO FLRT URANIN	120
OBS 3LR	121
OBS 3HR	122
EH –Standard Horiba	124
Cyclops #1	201
Cyclops #2	202
TRILUX/UNILUX PHYCOERITHRIN	212
TRILUX/UNILUX PHYCOCYANIN	213
TRILUX/UNILUX FLUOROSCEIN	214
TRILUX/UNILUX CHL-a	215
TRILUX/UNILUX TURB	216
TRILUX/UNILUX CDOM	217
High Precision pressure transducer	252

**C1 HIGH PRECISION PRESSURE TRANSDUCER**

The pressure transducers cover all pressure ranges from 100 mbar to 1000 bar. They are all delivered with engraved serial number and electrical lead outs. Several millions of these pressure transducers are in use worldwide in a variety of different applications. The main fields of application are level technology, pneumatics, hydraulics, and avionics. A high-sensitivity piezo-resistive silicon chip is used for pressure sensing. The chip is protected against ambient influences by a stainless steel housing sealed with a concentrically corrugated diaphragm. The housing is filled with silicone oil so as to ensure the transfer of the pressure from the diaphragm to the sensing component. All metallic parts in contact with the pressure media are made of stainless steel AISI316L. The fully welded housing is vacuum-tight. Each pressure transducer is subject to comprehensive tests as to its pressure response and temperature characteristic, and is delivered with an individual calibration certificate stating the characteristics as well as the results of all tests that were performed.



Each pressure transducer is subject to comprehensive tests as to its pressure response and temperature characteristic, and is delivered with an individual calibration certificate stating the characteristics as well as the results of all tests that were performed.

**C1.1 TECHNICAL SPECIFICATIONS**

	<u>Standard Pressure Ranges (FS) and Overpressure in Bar</u>						
Available ranges:	08...12	3	10	30	100	300	1000
Overpressure:	2	5	20	60	200	400	1000
Output :	RS 485						
Supply (V):	8...28 Vcc						
Accuracy, Error Band (-10...80 °C):	0,1 % FS						
Precision (10...40 °C):	0,01 %FS ranges <sup>3</sup> 10 bar						
Output Rate:	400 Hz						
Resolution:	0,002 %FS						
Long-term Stability typ.:	Gauges: 1 mbar or 0,05 %FS Absolute: 0,5 mbar or 0,025 %FS (10...40 °C)						
Load Resistance (ohm):	<(U-7V) / 0,02A (2-wire) > 5'000 (3-wire)						
Electrical Connection:	- MIL C-26482-Plug (6 pole) - Binder-Plug 723 (5 pole) - DIN 43650 Plug (4 pole)						
Insulation :	100 Mohm / 50 V						
Storage/Operating T. range:	-40...120 °C						
Pressure Endurance:	10 Million Pressure Cycles 0...100 %FS at 25 °C						
Vibration Endurance:	20 g (5...2000 Hz, max. amplitude ± 3 mm), according to IEC 68 2-6						
Shock Endurance:	20 g (11 ms)						
Protection:	IP65 optional: IP 67 or IP68 (with cable)						
CE-Conformity:	EN 50081-2, EN 50082-2						
Material in Contact with Media:	HASTELLOY						
Weight:	30 g;						
Dead Volume Change:	< 0,1 mm <sup>3</sup>						
Connector:	Molex Milli-Grid 2 mm.						

**C1.2 ACCURACY AND PRECISION**

"Accuracy" is an absolute term, "Precision" a relative term. Deadweight testers are primary standards for pressure, where the pressure is defined by the primary values of mass, length and time. Higher-class

primary standards in national laboratories indicate the uncertainty of their pressure references with 70 to 90 ppM or close to 0.01%. Commercial deadweight testers used to calibrate the transmitters indicate an uncertainty or accuracy of 0.025 %. Below these levels, expression "Precision" is the ability of a pressure transmitter to be at each pressure point within 0.01 %FS relative to these commercial standards.

### C1.3 POLYNOMIAL COMPENSATION

This uses a mathematical model to derive the precise pressure value (P) from the signals measured by the pressure sensor (S) and the temperature sensor (T). The microprocessor in the transmitter calculates P using the following polynomial:

$$P(S,T) = A(T).S_0 + B(T).S_1 + C(T).S_2 + D(T).S_3$$

With the following coefficients A(T)...D(T) depending on the temperature:

$$\begin{aligned} A(T) &= A_0 . T_0 + A_1 . T_1 + A_2 . T_2 + A_3 . T_3 \\ B(T) &= B_0 . T_0 + B_1 . T_1 + B_2 . T_2 + B_3 . T_3 \\ C(T) &= C_0 . T_0 + C_1 . T_1 + C_2 . T_2 + C_3 . T_3 \\ D(T) &= D_0 . T_0 + D_1 . T_1 + D_2 . T_2 + D_3 . T_3 \end{aligned}$$

The transmitter is factory-tested at various levels of pressure and temperature. The corresponding measured values of S, together with the exact pressure and temperature values, allow the coefficients A0...D3 to be calculated. These are written into the EEPROM of the microprocessor. When the pressure transmitter is in service, the microprocessor measures the signals (S) and (T), calculates the coefficients according to the temperature and produces the exact pressure value by solving the P(S,T) equation. Calculations and conversions are performed at least 400 times per second.

### C1.4 CONFIGURATION

Through the probe set-up, it is possible to configure the Highly Precise Sensor by adding or modifying an existing sensor and associating the logical code 0 to this sensor and associating the multiplexer input 252 special code.

### C1.5 SENSOR CALIBRATION

Calibration is carried out as described in the Operator's Manual for the standard pressure sensor. However, the following calibration coefficients must be configured:

$$\begin{aligned} \text{Coefficient (a)} &= 0.0 \\ \text{Coefficient (b)} &= 10.0 \\ \text{Coefficient (c)} &= 0.0 \end{aligned}$$

**C2 SINGLE/THREE CHANNEL FLUOROMETER**

The innovative Single/Three-Channel Fluorometer makes available to the marine, freshwater, surveying markets a high performance sensor providing the user with increased functionality when compared to other standard fluorometers. The Single/Three-Channel Fluorometer can be tailored to measure a wide range of fluorescent parameters (see the below table). Moreover, it is possible to extend the measurement range through the use of dynamic range function. Dynamic range can be adjusted simply by varying the LED intensity, while still maintaining the factory set calibration via the internal referencing of LED output. All versions of the Three-Channel Fluorometer come with a Chlorophyll *a* channel as standard; two other channels can then be selected from phycoerythrin, phycocyanin or nephelometer (turbidity) options. The Three-Channel Fluorometer allows the user to assess the relative contribution to Chlorophyll *a* fluorescence emission from the different light harvesting pigments absorbing light at each of the chosen excitation wavelengths. This information can then be used to make an assessment of the different classes of phytoplankton present in the sample under analysis.

**Features**

- Range of wavelengths available.
- High rejection of ambient daylight.
- Low noise high sensitivity.
- Low turbidity breakthrough.
- Low power consumption.
- Rugged corrosion free “Acetal C” housing.
- Internal referencing of excitation intensity.

**Applications**

- *In Situ* Chlorophyll & Algal class study.
- Environmental monitoring.
- Particulate studies.
- River and Stream monitoring.
- Pollution monitoring.
- Water and Wastewater quality



<b>Fluorescent Parameter</b>	<b>Dynamic Range (*)</b>	<b>Limit of detection</b>
Chlorophyll- <i>a</i>	0..100 µg/L	< 0.01 µg/L
Fluorescein	0..100 µg/L	< 0.005 µg/L
Rhodamine WT	0..100 µg/L	< 0.02 µg/L
Phycoerythrin	0..100 µg/L	< 0.02 µg/L
Phycocyanin	0..100 µg/L	< 0.01 µg/L
Nephelometer (Turbidity)	0..100 FTU	< 0.02 FTU

(\*) User configurable up to 500 µg/L or 500 FTU

**C2.1 CALIBRATION**

The Single/Three-Channel Fluorimeter can be re-calibrated by the user using the procedure described in the dedicated Fluorimeter Operator’s Manual. The calibration is done by using the dedicated interface software. Therefore, before starting the calibration operations, it is mandatory to install the software in a personal computer. This section describes the step-by-step procedure to run the software on the PC to communicate with the Single/Three-Channel Fluorimeter installed in the OCEAN SEVEN 310 probe.

- 1 – Connect the OS310 to a personal computer with the RS232 laboratory cable.
- 2 – Run the ITERM program.

- 3 – Switch on the OS310.
- 4 – At the end of the start-up messages from the Main Menu, select the "SERVICE Menu".
- 5 – From the Service Menu, select the "DIAGNOSTIC menu".
- 6 – From the Diagnostic Menu, select the "DISI", diagnostic serial interface.
- 7 – Select the AUX1.

Afterwards, any character typed transmitted by the PC, is sent to the interfaced Single/Three-Channel Fluorimeter through the selected serial communication port.

- 8 – Wait few seconds after the selection; in the meantime, you should see that on the ITERM window appears the real-time measurements from the fluorimeter.
- 9 – Close the ITERM communication port using the "Port->Close" command.
- 10 – Leave the ITERM program running and start the interface software.
- 11 – Run the CHELSEA calibration program.

**Note**

*To interrupt the diagnostic communication with the Single/Three-Channel Fluorimeter after the ITERM communication port is re-opened, type CTRL-X on the keyboard..*

The OCEAN SEVEN 310 uses a pre-defined not modifiable calibration coefficients:

Offset = 0.0    Slope = 1.0

**C3 SEAPOINT OEM Turbidity Meter**

The SEAPOINT OEM Turbidity Meter is a sensor that measures turbidity by detecting scattered light from suspended particles in water. Its small size, very low power consumption, high sensitivity, wide dynamic range and 6000-meter depth capability allow this sensor to be used in most applications where turbidity or suspended particle concentrations are to be measured. The sensor is also insensitive to ambient light when underwater and has a very low temperature coefficient. The SEAPOINT Turbidity Meter senses scattered light from a small volume within 5 centimetres of the sensor windows. Confining the sensing volume allows the sensor to be calibrated in relatively small water containers without errors from surface and wall reflections. It also allows the sensor to be used in tight spaces such as crowded instrumentation packages, pipes and shallow streams. Each sensor is factory calibrated using formazine Turbidity Standard. The user may also calibrate the sensor with particles of interest to measure their suspended concentrations. The SEAPOINT Turbidity Meter is constructed from rugged, corrosion-free materials and quality surface mount electronic components for durability and high reliability (read more on the SEAPOINT Operator's Manual).

**C3.1 CONFIGURATION**

The following parameters are requested to properly set up the SEAPOINT STM Turbidity Meter. The sensor setup sequence can be run using the CNAP command available under the CONF menu

```

Logical code      [0..255]:24
Description       :Turb
Significant digits [1..13]:6
Digits after the dot [0..9]:2
Do you want to store it   ?:Yes
Do you want to show data   ?:Yes
Data processing method
0)Counts,1)mV,2)Custom&UNESCO,3)Polynomial,4)a+bx
Method            [0..4]:2
Mux[0..7,240=A.Board,255=NU]:0
Compensate thermal drift  ?:No
Turbidity with multiple measuring scales ?:Yes
STM scales:1)>750,2)500,3)125,4)25 [FTU]
Startup scale [1..4]:1
Enable automatic scale selection ?:Yes

```

**C3.2 CALIBRATION**

The STM sensor is calibrated by entering an offset and slope for each measuring range. The procedure can be run starting from the CASE command available under the CALB menu.

- Measuring scale 1, Full scale [>750 FTU or 1500FTU]
- Measuring scale 2, Full scale [500 FTU]
- Measuring scale 3, Full scale [125FTU]
- Measuring scale 4, Full scale [25 FTU]

```

measuring scale 1, Full scale [>750 FTU]
Do you already know 'SLOPE & OFFSET' coefficients ?:No type [Y]es or [N]o < y
Offset:0
Slope:0 enter new value< 1

```

---

Measuring scale 2, Full scale [ 500 FTU]  
Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y  
Offset:0  
Slope:0 enter new value< 1

Measuring scale 3, Full scale [ 125 FTU]  
Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y  
Offset:0  
Slope:0 enter new value< 1

Measuring scale 4, Full scale [ 25 FTU]  
Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y  
Offset:0  
Slope:0 enter new value< 1

Update calibration parameters  
Turbidity meter full scale:(1)>750 FTU,(2)500 FTU,(3)125 FTU,(4)25 FTU  
Measuring range [1..4]:1

The STM sensor calibration is complete and the CTD shows the list of sensors. The procedure foresees that the slope and offset coefficients for each measuring scale is known. It is possible to calculate offset and slope starting from a table of values by answering NO at the question about the offset and slope. Contact IDRONAUT to receive detailed instructions.

**C4 SEAPOINT OEM FLUOROMETER**

The SEAPOINT Fluorometer allows the user to monitor chlorophyll concentration by directly measuring the amount of fluorescence emission from a given sample of water. The sample media is pumped through a quartz tube mounted through the long axis of the instrument. Chlorophyll, when excited by the presence of an external light source, absorbs light in certain regions of the visible spectrum and re-emits a small portion of this light as fluorescence at longer wavelengths. SEAPOINT uses two bright blue LEDs (centred at 455 nm and modulated at 1 kHz) to provide the excitation. Blue interference filters are used to reject the small amount of red light emitted by the LEDs. A detector, positioned at 90° to the axis of the LED mounts, measures the emitted light from the sample volume. The approximately 0.25 cm<sup>3</sup> sample volume is defined by the intersection of the excitation light with the field of view of the detector, within the quartz flow tube. A red interference filter is used to discriminate against the scattered blue excitation light. The red fluorescence emitted at 90° is synchronously detected at 1 kHz by a silicon photodiode. The amplified and demodulated voltage output of the photodiode is provided to the user for connection to a digital voltmeter or an a-d converter. The calibration procedure is the same described for the turbidity meter. The only differences are the measuring scales, which in the case of the fluorometer are: 5, 15, 50 and 150 µg/l.

**C4.1 CONFIGURATION**

The following parameters are requested to properly set up the SEAPOINT STF Fluorometer. The sensor setup sequence can be run using the CNAP command available under the CONF menu

```
Logical code      [0..255]:11
Description       :Chl-a
Significant digits [1..13]:6
Digits after the dot [0..9]:2
Do you want to store it   ?:Yes
Do you want to show data   ?:Yes
Data processing method
0)Counts,1)mV,2)Custom&UNESCO,3)Polynomial,4)a+bx
Method            [0..4]:2
Mux[0..7,240=A.Board,255=NU]:1
Compensate thermal drift  ?:No
Fluorometer with multiple measuring scales ?:Yes
STF scales:1)>150,2)50,3)15,4)5
Startup scale [1..4]:1
Enable automatic scale selection ?:Yes
```

**C4.2 CALIBRATION**

The STF sensor is calibrated by entering an offset and slope for each measuring range. The procedure can be run starting from the CASE command available under the CALB menu.

- Measuring scale 1, Full scale [150 ug/l]
- Measuring scale 2, Full scale [50 ug/l]
- Measuring scale 3, Full scale [15 ug/l]
- Measuring scale 4, Full scale [5 ug/l]

```
Measuring scale 1, Full scale [150]
```

```
Do you already know 'SLOPE & OFFSET' coefficients ?:No type [Y]es or [N]o < y
```

Offset:0

Slope:0 enter new value< 1

Measuring scale 2, Full scale [ 50]

Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y

Offset:0

Slope:0 enter new value< 1

Measuring scale 3, Full scale [ 15]

Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y

Offset:0

Slope:0 enter new value< 1

Measuring scale 4, Full scale [ 5]

Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y

Offset:0

Slope:0 enter new value< 1

Update calibration parameters

Fluorometer full scale:(1)>150,(2)50,(3)15,(4)5

Measuring range [1..4]:1

The STF sensor calibration is complete and the CTD shows the list of sensors. The procedure foresees that the slope and offset coefficients for each measuring scale is known. It is possible to calculate offset and slope starting from a table of values by answering NO at the question about the offset and slope. Contact IDRONAUT to receive detailed instructions.

**C5 PAR SENSOR**

The LICOR LI-193SA Underwater Spherical Quantum Sensor gives an added dimension to underwater PAR measurements as it measures photon flux from all directions. This measurement is referred to as Photosynthetic Photon Flux Flounce Rate (PPFFR) or Quantum Scalar Irradiance. This is important, for example, when studying phytoplankton, which utilizes radiation from all directions for photosynthesis. The LI-193SA features a high sensitivity optical design and compact, rugged construction (3400 kPa, 350 meters



depth). The OCEAN SEVEN 310 probe LI-193SA analogue interface transforms, by means of a linear current to voltage pre-amplifier, the LI-193SA sensor output (current in  $\mu\text{A}$ ) in ADC counts. Calculation of the calibration coefficients implies a preliminary calculation that is carried out by using the LICOR calibration certificate and the probe calibration certificate. By applying the below calculation, the OCEAN SEVEN 310 transforms the sensor readings in  $\mu\text{mol s}^{-1} \text{m}^{-2}$ .

Calibration constants

LI-193SA calibration constant in water = 4.71  $\mu\text{A}$  per 1000  $\mu\text{mol s}^{-1} \text{m}^{-2}$   
 OCEAN SEVEN 310 Full Scale current = 9.83  $\mu\text{A}$  equivalent to = 65536 ADC counts

Calculation of the full scale PAR sensor

F.S.  $(9.83 \mu\text{A} / 4.71) * 1000 = 2087.048832 \mu\text{mol s}^{-1} \text{m}^{-2}$

Afterwards, the calibration coefficients (a+bx) can be calculated using the value tabled herewith.

$\mu\text{mol s}^{-1} \text{m}^{-2}$	ADC counts (bit)
0.0	0.0
2087.048832	65536

From the above table of data, the offset and slope coefficients to be entered during the PAR calibration procedure must be calculated by the operator. This can be done using the “Interpolate” tool distributed with the IDRONAUT ITERM program.

**C5.1 CONFIGURATION**

The following parameters are requested to properly set up the PAR. The sensor setup sequence can be run using the CNAP command available under the CONF menu

```

Logical code      [0..255]:25
Description       :PAR
Significant digits [1..13]:10
Digits after the dot [0..9]:6
Do you want to store it   ?:Yes
Do you want to show data  ?:Yes
Data processing method
0)Counts,1)mV,2)Custom&UNESCO,3)Polynomial,4)a+bx
Method           [0..4]:4
Mux[0..7,240=A.Board,255=NU]:2
Compensate thermal drift  ?:No
    
```

**C5.2 CALIBRATION**

---

The PAR sensor is calibrated by entering an offset and slope for each measuring range. The procedure can be run starting from the CASE command available under the CALB menu.

PAR SENSOR

Do you already know 'SLOPE & OFFSET' coefficients?:No type [Y]es or [N]o < y

Offset:0

Slope:0 enter new value< 1

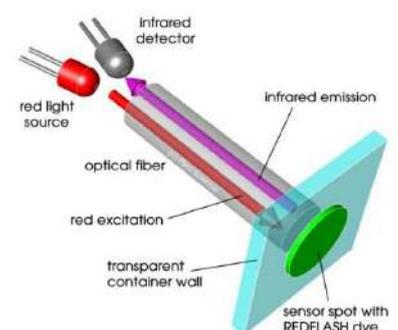
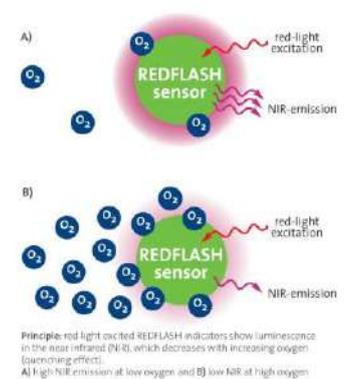
The STF sensor calibration is complete and the CTD shows the list of sensors

## C6 BLUE CAP OPTICAL DISSOLVED OXYGEN

Oxygen optical sensors work according to the principle of dynamic fluorescence quenching. The sensor contains fluorescent dye that is excited by light of a certain wavelength. Depending on the amount of oxygen molecules present, the luminescence response of the optical sensor varies. A polymer fiber transmits the excitation light of the sensor and at the same time also transmits the fluorescence response of the sensor to the measurement device. The oxygen sensitive dye is immobilized in a polymer matrix. This polymer can be applied to carrier material and used as sensor spots or sensor foil. It can also be coated directly onto the optical fiber. Oxygen quenching luminophores have been studied from at least 1939 when Kautsky described quenching of luminescence by oxygen. More recently, as optical sources, detectors, and data processing have become more advanced, the application of luminophores to the measurement of oxygen concentrations in liquids has resulted in bench-top instruments and optodes., with significant advances since 1990,s. Recent advances in blue light –emitting diodes and low-powers high-speed electronics have enabled the miniaturization of oxygen sensitive optodes to the point of field-deployable units. The sensors do not consume oxygen and are stable over long deployment period.

The new REDFLASH technology is based on the unique oxygen-sensitive REDFLASH dyes. In contrast to common techniques using blue-light excitation, the REDFLASH dyes are excitable with orange-red light and show an oxygen-dependent luminescence in the near infrared (NIR). The REDFLASH technology impresses by its high precision, high reliability, low power consumption, low cross-sensitivity, and fast response time. The orange-red light excitation significantly reduces interferences caused by auto-fluorescence samples. Further, the NIR detection technology significantly reduces interference with ambient light, known from the old-blue-light techniques. The new REDFLASH technology is based on the unique oxygen-sensitive REDFLASH indicator showing excellent brightness. The measuring principle is based on the quenching of the REDFLASH indicator luminescence caused by collision between oxygen molecules and the REDFLASH indicator immobilized on the sensor tip or surface. The REDFLASH indicators are excitable with the red light (More precisely orange-red at a wavelength of 610-630nm) and show an oxygen-dependent luminescence in the near infrared (NIR 760-790 nm).

*Principle:* Red light excited the REDFLASH indicators show luminescence in the near infrared, which decreases with the increasing of oxygen (quenching effect). A) High NIR emission at low oxygen and B) low NIR at high oxygen. The measuring principle is based on a sinusoidal modulated red excitation light. This results in a phase-shifted sinusoidal modulated emission in the NIR. The measurement device measures this phase shift (termed dphi in the software) The phase shift is then converted into oxygen units based on the Stem-Vollmer-Theory. The red-light excitation significantly reduces interferences caused by auto-fluorescence and reduces stress in the biological systems. The REDFLASH indicators show much higher luminescence brightness than other optical sensor working with blue light excitation. Further due to the excellent luminescence brightness of the REDFLASH indicator, the actual sensor matrix can be now prepared much thinner, leading to fast response times of the oxygen sensors.



**C6.1 BLUE CAP DESCRIPTION**

The external part of the Blue Cap Oxygen Optical Sensor is a titanium support with a 11,7mm diameter, where at its centre is placed a 3mm fiber optics well sealed to guarantee 700 bar operations. The length of the support is about 44mm (without the Blue replaceable membrane cap installed); two 2-12 Parker O-rings seal the support onto the probe housing. The measuring membrane cap is simply fitted inside the titanium support till it stops and is provided with a friction system (groovers) to prevent unwanted removal or accidental loss. The membrane cap is made of blue plastic to better shield the external light and is very similar to the Idronaut pH watering cap. The only difference is that a hole at its bottom allows the factory installation of the glass window on its inside. The black sensor spot which allow the oxygen measurement is centrally placed on the outside of the glass window. The other side of the optical fiber remains inside the CTD housing and is fitted in a unique miniaturized transducer whose optics and electronics transform the optical signal into RS485 output.

**C6.2 SPECIFICATIONS**

<i>Measuring range:</i>	0-250% O <sub>2</sub> (0-45 mg/l)
<i>Detection limit:</i>	0.02% O <sub>2</sub> (0.01 mg/l)
<i>Resolution:</i>	0.01% O <sub>2</sub> (0.005 mg/l) at 1% O <sub>2</sub> 0.05% O <sub>2</sub> (0.025 mg/l) at 100% O <sub>2</sub>
<i>Accuracy:</i>	+0.02% O <sub>2</sub> (0.01 mg/l) at 1% O <sub>2</sub> +0.2% O <sub>2</sub> (0.1 mg/l) at 100% O <sub>2</sub>
<i>Temperature range:</i>	0 to 50°C
<i>Response time (t<sub>90</sub>) gas/water:</i>	sensor spot down to 5 s
<i>No cross-sensitivity:</i>	pH 1-14, CH <sub>4</sub> ; CO <sub>2</sub> , H <sub>2</sub> S, any ionic species
<i>Cleaning procedures:</i>	3 % H <sub>2</sub> O <sub>2</sub> , ethanol, soap solution
<i>Storage time:</i>	>3 years in darkness at room temperature. A black cap is provided to dark the blue cap membrane installed on the CTD. Please remove it before deploying the CTD in water and before carrying out the calibration.
<i>Calibration:</i>	single point
<i>Optical Isolation:</i>	the sensor spots are covered with a final black layer in order to minimize influence of strong external illumination

**C6.3 CONFIGURATION**

Through the CTD configuration menu and the external sensor setup (CNES, command from the CONFIGURATION MENU) it is possible to configure the optical dissolved oxygen sensor as below described. The CTD propose by itself the correct parameters, they must be only confirmed using the enter key.

Aux.#3 Select:(0)None,(1)miniSVS,(2)BlueCap-DO2  
Aux.#3:0 enter new value< 2

After selecting the IDRONAUT Optical Dissolved Oxygen the working parameter are automatically proposed. Please do not change them ! accept them using the ENTER key.

```

ComPort:(2)Aux#1,(3)Aux#3,(4)Rosette
Com. [2..4]:3
Speed(BPS):(3)2k4,(4)4k8,(5)7k2,(6)9k6,(7)19k2,(8)38k4,(9)57k6,(10)115k2
Baud Rate :7
Data bit:(0)7 bit, (1)8 bit
Data bit :1
Parity:(0)None,(1)Even,(2)Odd
Parity type:0
Stop bit:(0)1 bit, (1)2 bit
Stop bit :0
Flow Control:(0)None,(1)CTS/RTS,(2)DelayTx
Flow cnt :0
Wait data timeout [ms]:1000
Sample rate [ms]:2000

```

At the end of the configuration of external sensors the configuration procedure is completed. To make the new configuration effective, it is mandatory to switching off and then on the OCEAN SEVEN 310.

#### C6.4 CALIBRATION

Calibration is carried out by using the CASE command available under the CALIBRATION MENU. Two calibrations must be carried out: Saturation and ppm. When the list of sensors appear on the ITERM window select in sequence first the Saturation Optical dissolved oxygen sensor **OPT\_O2%** and then the PPM optical dissolved oxygen sensor **OPT\_O2**.

Once selected the OPT\_O2% sensor from the list the below message appears on the ITERM window:

```

OPT_O2% sensor calibration
Gently wipe O2 membrane and Temperature sensor
Type <any key>To continue, <ESC>To leave

```

Using a soft paper gently wipe and well dry the O2 membrane and the temperature sensor as suggested. Afterward the calibration procedure is carried out automatically. The below message appear:

```

Calibration completed:
Phase shift 0%=53000, 100%=20550
Signal Intensity (300 - 500): 358.162000
Ambient light intensity : 49.550000

```

Signal intensity should be, for optimal sensor operation between 300 and 500. Afterward the correction coefficient can be introduced

```

Enter Altitude above sea level [m]:0

```

If the altitude is 0 (sea level) no correction is required, leave the shown value (0); Otherwise enter the altitude. The CTD calculates by themselves the relative atmospheric pressure.

```

Oxygen correction coefficient
Correction coefficient:1

```

**NOTE REGARDING THE CORRECTION COEFFICIENT**

The correction coefficient different from the nominal one 1.0 is needed for the following reasons:

- To expand the scale of the oxygen sensor readings. For example, on entering a correction coefficient of 10, the readout will be multiplied by a factor of 10.
- In case of moored applications, where the CTD remains steady measuring for long periods, a coefficient different from 1 can be entered to compensate for the stirring effect on the surface membrane.

At the end of the calibration procedure the below message appear and the calibration is concluded.

**C6.5 O2 PPM CALIBRATION**

Once selected the OPT\_O2 sensor from the list the below message appear on the ITERM window:

OPT\_O2 sensor calibration  
OPTICAL OXYGEN - Calibration  
Scale factor from uMol/l to ppm:0.032

The optical dissolved oxygen sensor measuring unit calculates the dissolved oxygen concentration in  $\mu\text{mol/L}$  and in % of saturation. The concentration in  $\mu\text{mol/L}$  can be converted customizing the coefficients as follows:

<u>Dissolved O2 concentration</u> $\text{mg/L} = \text{ppm}$	Scale factor: $[\text{mg/L}] = [\mu\text{mol/L}] \times 0.032$
<u>Dissolved O2 concentration</u> $\text{mL/L} = \text{ppm}$	Scale factor: $[\text{mL/L}] = [\mu\text{mol/L}] \times 0.02241$

**C6.6 BLUE CAP MEMBRANE STORAGE**

A black cap is provided to protect the membrane from light. When the CTD is not used protect the membrane by installing the black cap.

**C6.7 BLUE CAP DEPLOYMENT**

A black cap is provided to protect the membrane from light. PLEASE remove the black cap before calibration and before deploying the CTD in water.

**C.6.8 BLUE CAP CLEANING**

At the end of the OCEAN SEVEN 3xx general cleaning, remove the blue cap and clean the membrane using a 3 % H<sub>2</sub>O<sub>2</sub>, ethanol or a soap solution. Gently wash the membrane using a soft brush

**C7 CONDUCTIVITY SENSOR WITH INTEGRATED UV-LED ANTIFOULING**

A UV-LED (Ultraviolet 250 ÷ 300 nm @ 500 µW, Light-Emitting Diode) is integrated into the conductivity sensor quartz cell (patent pending). The UV-LED sterilizes the early growth of biofouling, thus eliminating environmental drift in the conductivity sensor. This innovative solution does not break the European rules, which do not permit the use of Tributyltin (TBT), a very toxic and poisoning (carcinogenic) substance which has been banned by the international government agencies, mandatory to protect any recessed conductivity cell, which present a very small diameter and may get contaminated or even clogged. The UV-LED is excited, for a configurable amount of seconds, when the CTD wakes up.

**C7.1 CONFIGURATION**

Through the CTD set-up, it is possible to configure the UV-LED antifouling sterilization time in seconds. This time is spent by the probe during the wake-up to sterilize the conductivity sensor. The sterilization continues (as it does not affect the conductivity measurements) until the CTD switches off by itself and configures the next data acquisition time according to the above rules. Configuration of the UV-LED sterilization time-out in seconds is done by modifying the conductivity sensor configuration:

The following parameters can be configured by means of the "Modify" command by selecting the CONDUCTIVITY sensor from the above list:

UV-Led installed ? : No type [Y]es or [N]o < y  
UV-Led time [ms]: 0 enter new value < 1000

**C8 C/T FORCED FLOW PUMP**

The OCEAN SEVEN 310 Conductivity and Temperature sensor pair can be optionally pumped to guarantee a constant sample flow through the CT sensors.

The pump rotation speed is factory adjusted to 1000 RPM which allows 10 ml/s flow ratio. This setting guarantees that the sample is renewed every 200ms independently of the OS310 probe deployment speed (profiling speed). If required, the pump rotation speed can be factory adjusted up to 2000 RPM.

**C8.1 MAINTENANCE**

At the end of each profile, carefully wash with fresh or possibly distilled water the CT sensor pair and the pump by flushing from the pump output port through the pipe until the water leaks out of the CT sensor pair upper hole. In case the OCEAN SEVEN 310 is not used for long periods of time, the water remaining inside the CT sensor pair can be removed by simply reverting the probe up and down. In order to clean the conductivity quartz cell, dismount the sensor protection ring and remove the black pipe adapter (see below instructions).

**C8.2 INSTRUCTIONS ON HOW TO REMOVE THE CT SENSOR PUMP PIPE ADAPTER**

To dismount the CT sensor pump pipe adapter, remove the four titanium nuts and washers and the plastic screw which keeps the black pipe adapter in position.



Remove the lower protection ring.

Remove the Tygon tubing from the pump side.

Remove the CT sensor pump pipe adapter.

To reassemble the CT sensor pump pipe adapter, simply reverse the above described dismounting procedure.



## C9

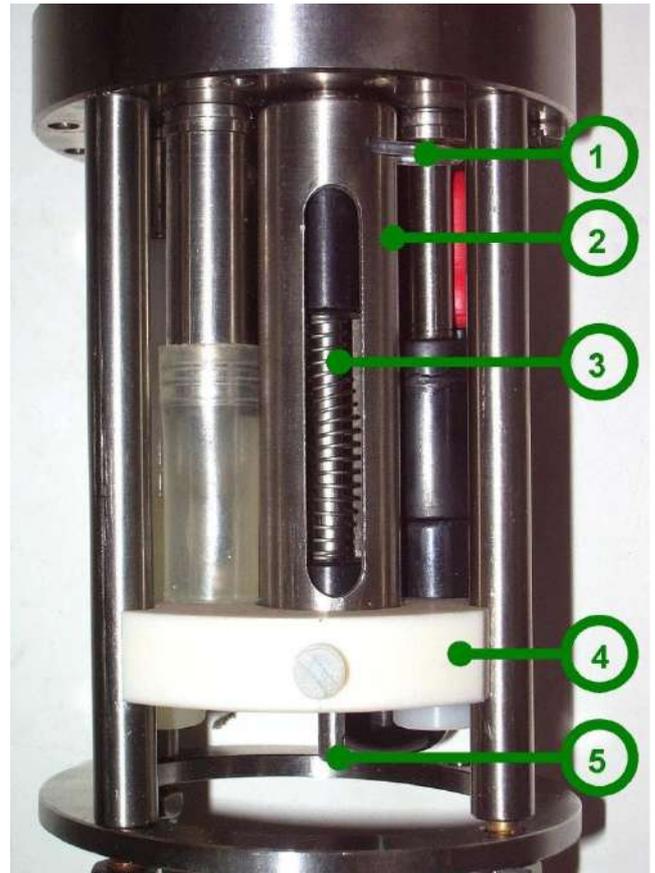
**BOTTOM SWITCH**

The aim of the bottom switch is to give the alarm when the probe is approaching the ocean floor. The bottom switch is an alternative to the acoustic altimeters.

The bottom switch is activated when it is released because the weight attached with a string (rope) to the switch hits the ocean floor. The rope length sustaining the weight should not exceed 10m and the weight should not be more than **3 kg**.

Through the REDAS-5 software, it is possible to associate an audible alarm to the bottom switch thus providing an early warning that the probe is approaching the ocean floor.

- (1) Plastic string which holds the bottom switch body to the probe body.
- (2) Bottom switch body.
- (3) Spring which keeps the bottom switch closed when the weight is released.
- (4) Plastic holder which keeps the bottom contact switch body in position.
- (5) Bottom contact switch piston. It attaches the weight using a robust rope. **The weight must not exceed 3 kg**



**C10**     *CYCLOPS Fluorometer*

The TURNER DESIGNS Cyclops submersible sensor is an accurate single-channel detector that can be used for many different applications. It is designed for integration into multi-parameter systems from which it receives the power and delivers a voltage output proportional to the concentration of the fluorophore, particle or compound of interest.

The Cyclops voltage output can be correlated to concentration values by calibrating with a standard of known concentration.

The Cyclops output can be scaled x1, x10, x100.

**C10.1**    **CONFIGURATION**

The following parameters are requested to properly set up the Cyclops 7 Fluorometer. The sensor setup sequence can be run using the CNAP command available under the CONF menu

```

Logical code      [0..255]:201 or 202
Description       :Chl-a
Significant digits [1..13]:6
Digits after the dot [0..9]:2
Do you want to store it   ?:Yes
Do you want to show data  ?:Yes
Data processing method
0)Counts,1)mV,2)Custom&UNESCO,3)Polynomial,4)a+bx
Method            [0..4]:3
Mux[0..7,240=A.Board,255=NU]:1
Compensate thermal drift  ?:No
Cyclops7F gain 1)x1,2)x10,3)x100

```

**C10.2**    **CALIBRATION**

The Cyclops sensor is calibrated by entering the calibration coefficients for the selected measuring scale. The procedure can be run starting from the CASE command available under the CALB menu.

```

TURNERDESIGN CYCLOPS 7 - Calibration
Select CYCLOPS7 gain 1)x1,2)x10,3)x100

```

Select the working measuring scale

```

Number of coefficients: 2

```

Enter the number of calibration coefficients and then the value for each ones.

```

Coeff. a:
Coeff b:

```

**D ADVANCED CONFIGURATION**

Most of the OS310 configuration parameters are protected avoiding that for a mistake an essential parameter is wrongly modified by the operator causing probe ill-behaviours. This section briefly introduces the configuration parameters which can be configured when the probe access rights are configured as SERVICE or ADMINISTRATOR. We suggest contacting IDRONAUT before modifying any of these parameters.

**D.1 OPERATING PARAMETERS**

By means of the <CNOP> configuration command, available under the Configuration Menu, it is possible to modify the below listed parameters:

```

Warm up timeout    [s]:    5
Realttime data at startup ?:    No
Identification code    :    2
Serial number        :    0000000
Standby between commands ?:    Yes
Wake up from RS232    ?:    Yes
Wait before shutdown [s]:    120
Wait valid command   [s]:    60
Wait valid parameter [s]:    60
ER xxx messages      ?:    Yes
HEADER message       :    OCEAN SEVEN 310 -
Log Calibration      ?:    Yes
USB interface installed ?:    No
BlueTooth installed  ?:    No
WIFI installed       ?:    No
Telemetry:(0)No,(1)QAM,(2)FSK: 0
ComPort:(1)MAIN,(2)Aux#1,(3)Aux#3,(4)Rosette
Com. [1..4]:1
Speed(BPS):(3)2k4,(4)4k8,(5)7k2,(6)9k6,(7)19k2,(8)38k4,(9)57k6,(10)115k2
Baud Rate :10
Data bit:(0)7 bit, (1)8 bit
Data bit :1
Parity:(0)None,(1)Even,(2)Odd
Parity type:0
Stop bit:(0)1 bit, (1)2 bit
Stop bit :0
Flow Control:(0)None,(1)CTS/RTS,(2)DelayTx
Flow cnt :0
Emulate Digital VT100  ?:    Yes
Com.protocol: 1)PTP    :    1
N.data line between header: 24
N. of char per line    :    132

```

**D.2 DATA ACQUISITION PARAMETERS**

By means of the <CNDA> configuration command, available under the Configuration Menu, it is possible to modify the below listed parameters:

```

Conductivity range = Fresh water ? :No
Sampling rate [1..28]Hz: 28
Test battery      ?:    Yes

```

```

Battery monitoring timeout :      00:05:00
Next Battery monitoring  :
Battery coefficient      :      9.37e-05
Battery working limit [V]:      3.2
Test external power    ?:      Yes
Ext power coefficient (OFS):      3.7153001
Ext power coefficient (SLP):      0.00041919999
Ext power working limit [V]:      9
Optical sensors auto-scale settling time [ms]:800
Unattended cycles,PRESSURE auto-zero ?:No
Ana.board filtering [0..5]:      2
16bit ADC reading method:0,1,2:    1
16bit ADC filter:0)None,1)Average,2)LowPass: 2
Lowpass factor x^2:      2
24bit ADC filter:0)None,1)Average,2)LowPass,3)IIRFilter: 2
Smoothing factor:      0.8
Activate the EXTERNAL sensor power  ?:No
ZebraTech HydroWiper installed    ?:No
Wait EXTERNAL power stabilization [ms]:300
Wait EXTERNAL sensor startup [ms]:100
Wait ANALOG Board replay [ms]:1200

```

## D.2 AUXILIARY SENSOR PARAMETERS

By means of the <CNES> configuration command, available under the Configuration Menu, it is possible to modify the below listed parameters:

```

--- Auxiliary setup ---
Aux.#1,select:(0)None,(1)Trilux,(2)Wetlab ECO
Aux.#1:0
Aux.#2-Rosette:(0)No,(1)GO1018,(2)SBE32c,(3)MISS
Aux.#2:0
WARNING
Please,manually delete unused sensors from the sensor configuration
Aux.#3 Select:(0)None,(1)miniSVS,(2)BlueCap-DO2
Aux.#3:0
Please,manually delete unused sensors from the sensor configuration

```

**E FOREWORD**

The aim of this section is the description of operations needed by OCEAN SEVEN probe customers to perform unattended sampling of bottles using an intelligent GENERAL OCEANICS or a MISS Rosette joined to an OCEAN SEVEN 310 probe. Bottles can be sampled in function of pressure, time step or according a configure sensor trigger. Please find below a step-by-step procedure to be followed during the set-up of the unattended cycles and the suggestions on how to successfully accomplish the bottle sampling. Obviously, the OCEAN SEVEN 310 probe must be equipped with the software and hardware interface for the 1018 GO or MISS IDRONAUT Rosette.

**E.1 BOTTLE SAMPLING IN FUNCTION OF TIME**

Bottles can be sampled in function of time only when the probe is configured to perform a timed data acquisition cycle. The interval used to take bottle sampling must be a multiple of the configured data acquisition interval. A bottle is closed when the data acquisition interval coincides with the bottle-sampling interval. Bottles are closed starting from the first configured bottle to the last configured one. During the time between acquisitions, the Rosette and the OCEAN SEVEN 310 probe are in OFF condition and do not consume battery energy. The following message is shown by the probe once the timed data acquisition function is invoked and a Rosette is connected to the probe.

```

ROSETTE
Number of bottle positions:      12
Number of bottles to fire:      12
Bottle step:                    1
First bottle to fire:           1
Reverse depth value:            1500.00
Bottle firing depth step:       100.00
Bottle firing time step:        00:00:00
Bottle firing depth profile:    1
Bottle firing method:           TIME STEP
Do you want to fire bottles?    Y(es, N(o)

```

If the operator answers <NO>, the bottle will not be sampled. If the operator answers <YES>, the set-up continues as follows:

```
Bottles to fire [1..36]
```

The operator must enter the number of bottles installed on the Rosette. It must be any value between 1 and the number of Rosette positions. The bottles are sampled consecutively starting from the first bottle and ending with the last bottle, increasing the bottle number after each bottle sampling.

```
First bottle to fire [1..36]
```

The operator must enter the first bottle to fire. It must be any value between 1 and the number of Rosette positions.

```
Step between bottle [1..36]
```

This allows the operator to define the number of bottles position between two installed bottles. The step value is used to advance the number of bottle in preparation of the next bottle to fire. The default value is 1.

```
Firing bottle time step [hh:mm:ss]
```

The operator must enter the bottle time step taking into account that it must be a multiple of the interval used to acquire data. The probe automatically checks that the operator's set-up meets these criteria and, in case it doesn't, the following message appears:

*Warning: the Firing step must be a multiple of the acquisition step*

And the operator must enter again the time interval. This procedure ends only whenever a valid bottle time step is entered. After the bottle time step is correctly entered, the probe automatically shuts down by itself and configures the first data acquisition cycle time. Bottle sampling interval evaluation starts once the first acquisition in function of time is performed by the probe.

**Note**

*The probe warm-up time-out must be increased from the standard 5 seconds to the more appropriate 30 seconds. This quite long time-out is needed to cover the home positioning procedure taken by the Rosette once it awakes. In fact, the CTD must wait the ROSETTE home positioning procedure before carrying out the bottle firing procedure.*

**E.2 BOTTLE SAMPLING IN FUNCTION OF PRESSURE**

Two different methods can be selected by the operator to close the bottles once the probe is performing an unattended acquisition cycle in function of pressure step. Bottles can be closed using during the downcast or during the upcast. In both cases, bottles are closed when the probe detect that the configured bottle pressure step is overpassed.

**UPCAST**

The bottle firing start when during the downcast, the probe overpasses the configured maximum reverse depth and the difference between the maximum downcast pressure and the pressure during the upcast is greater than the configured bottle sampling step.

**DOWNCAST**

The bottle firing start immediately whenever the bottle pressure step is overpassed. Moreover if the "Bottom bottle closure" is enabled all the bottles not already closed will be automatically closed by the bottom bottle closing procedure.

When a bottle is closed, a complete data set is acquired and stored. Stored data also reports the number of the bottle closed. Therefore, at the end of the data acquisition and bottle sampling, two different casts are stored in memory: the first one describing the profile data and the second one describing the acquisition done during the bottle sampling. The following Rosette set-up message is shown by the probe once the unattended acquisition in function of the pressure interval is invoked.

```

ROSETTE
Number of bottle positions: 12
Number of bottles to fire: 12
Bottle step: 1
First bottle to fire: 1
Reverse depth value: 1500.00
Bottle firing depth step: 100.01
Bottle firing time step: 01:00:00
Bottle firing depth profile: 1
Bottle firing method: DEPTH STEP

Do you want to fire bottles? Y(es, N(o

```

If the operator answers <NO>, the bottle will not be sampled. If the operator answers <YES>, the set-up continues as follows:

```

Close on UPCAST ? Y(es, N(o

```

If the operator answers <NO>, the bottle will not closed during the downcast and on the bottom. If the operator answers <YES>, the bottle will be closed on upcast. The setup continues as follows:

*Bottles to fire [1..36]*

The operator must enter the number of bottles installed on the Rosette. It must be any value between 1 and the number of Rosette positions. The bottles are sampled consecutively starting from the first bottle and ending with the last bottle, increasing the bottle number after each bottle sampling.

*First bottle to fire [1..36]*

The operator must enter the first bottle to fire. It must be any value between 1 and the number of Rosette positions.

*Step between bottles [1..36]*

This allows the operator to define the number of bottles position between two installed bottles. The step value is used to advance the number of bottle in preparation of the next bottle to fire. The default value is 1.

*Bottle firing depth step [dbar]*

The operator must enter the pressure or depth step used to close consecutive bottles.

If the “CLOSE ON UPCAST” has been selected the setup procedure is concluded with the request about the reverse depth then the unattended cycle starts. Viceversa configuration about the parameters of the special closing on downcast starts.

*Reverse depth value [dbar]*

The operator must enter the pressure value used to judge the starting of the bottle closing procedure. When this pressure value is exceeded, the bottle sampling procedure starts.

Special Bottom closure setup.

*Bottom bottle closure enabled ? :No type [Y]es or [N]o*

This allows the operator to specify whether the bottles not closed during the downcast will be closed when the deepest depth is reached.

*Pressure to enable bottom bottle [dbar]:0*

Define the deepest pressure to reach before the bottom procedure starts.

*Speed limit to enable bottom bottle [m/s]:0*

Define the downcast speed limit. The probe monitors the speed to start the bottom procedure.

*Stationary time on bottom [1..720 s]:0*

Define the time to wait before starting closing the bottles.

**E.3 BOTTLE SAMPLING IN FUNCTION OF THE SENSOR CONDITION**

Bottles can be sampled in function of the sensor condition, when the probe is carrying out unattended "Conditional" cycles. When the foreseen condition is met, the bottles are fired according to a configurable time delay. Bottles are closed starting from the first configured bottle to the last configured one. The following message is shown by the probe once the conditional data acquisition function is invoked and a Rosette is connected to the probe.

```

ROSETTE
Number of bottle positions: 12
Number of bottles to fire: 12
Bottle step: 1
First bottle to fire: 1
Reverse depth value: 1500.00
Bottle firing depth step: 100.00
Bottle firing time step: 00:00:00
Bottle firing depth profile: 1
Bottle firing method: CONDITIONAL TIME STEP
Do you want to fire bottles? Y(es, N(o

```

If the operator answers <NO>, the bottle will not be sampled. If the operator answers <YES>, the set-up continues as follows:

```
Bottles position [1..36]
```

The operator must enter the maximum number of positions available on the interfaced Rosette.

```
Bottles to fire [1..36]
```

The operator must enter the number of bottles installed in the Rosette. It must be any value between 1 and the number of Rosette positions. The bottles are sampled consecutively starting from the first bottle and ending with the last bottle, increasing the bottle number after each bottle sampling.

```
First bottle to fire [1..36]
```

The operator must enter the first bottle to fire. It must be any value between 1 and the number of Rosette positions.

```
Step between bottle [1..36]
```

This allows the operator to define the number of bottle positions between two installed bottles. The step value is used to advance the number of bottles in preparation of the next bottle to fire. The default value is 1.

```
Bottle Trigger SENSOR logical code
```

A list of parameters that can be used to start the bottle firing is shown and the operator must select the most appropriate one.

```
SENSOR trigger value
```

The trigger value which will be then used by the probe to start the firing bottle must be configured. The value will be compared with the real-time reading taken by the probe. If the real-time reading is less than the configured trigger value, the bottle firing process is activated. This will go on until the trigger condition is met. Please be aware that the condition is evaluated only if the probe is acquiring data in real time according to the "Unattended Conditional" measurement cycle set-up.

*Firing bottle time step (MAX 600s)*

The operator can select the time step between the firing of two consecutive bottles.

**Note**

*The probe warm-up time-out must be increased from the standard 5 seconds to the more appropriate 30 seconds. This quite long time-out is needed to cover the home positioning procedure taken by the Rosette once it awakes. In fact, during the home positioning procedure, the Rosette does not answer the probe bottle firing request.*

**E.4 CONFIGURING THE ROSETTE**

External equipment interfaced by the probe through digital, analogue or serial interface I/O can be configured by means of the CNES command available under the Configuration Menu.

*OCEAN SEVEN 310 - ID:0000000 {USR}(1.1\_00 06/17)Oct 01 13:06:15.13 2016*

*--- Auxiliary setup ---*

*Aux.#1,select:(0)None,(1)Trilux,(2)Wetlab ECO*

*Aux.#1:0*

*Aux.#2-Rosette:(0)No,(1)GO1018,(2)SBE32c,(3)MISS*

*Aux.#2:1*

After selecting the Rosette type, the following question must be answered depending on the chosen Rosette type:

*Number of bottles [1..24]*

Enter the number of positions of your Rosette:

*Home positioning timeout (s):120*

Time spent waiting the rosette home positioning

*Delay between commands (ms):2000*

Time between consecutive rosette commands

*ComPort:(2)Aux#1,(3)Aux#3,(4)Rosette*

*Com. [2..4]:4*

*Speed(BPS):(0)300,(1)600,(2)1k2,(3)2k4,(4)4k8,(5)7k2,(6)9k6*

*Baud Rate :0*

*Data bit:(0)7 bit, (1)8 bit*

*Data bit :1*

*Parity:(0)None,(1)Even,(2)Odd*

*Parity type:0*

*Stop bit:(0)1 bit, (1)2 bit*

*Stop bit :0*

*Flow Control:(0)None,(1)CTS/RTS,(2)DelayTx*

*Flow cnt :0*

The communication port parameters are automatically proposed by the CTD accordingly with the selected rosette. **Do not change it!**

---

**E.5 TEST ROSETTE INTERFACING**

Once configured, it is possible to test the Rosette interfacing and Rosette operations by means of two functions which are automatically added to the Service Menu. Therefore, after the Rosette configuration, the service menu appears as:

```
OCEAN SEVEN 310 - ID:0000000 {USR}(1.1_00 06/17)Oct 01 13:06:15.13 2016
Service menu
<0>[SVUP]-Leave the service menu
<1>[CONF]-Configuration
<2>[DIAG]-Diagnostics
<3>[RAWC]-Raw data acquisition in counts (bit)
<4>[RAWM]-Raw data acquisition in mV
<5>[FIRE]-Bottle fire
<6>[HOME]-Rosette to home position
cmd>
```

The two new commands: FIRE and HOME allow the operator to respectively fire a bottle (close a bottle) and return the bottle closing arm to the resting position.

**F** **INTRODUCTION**

The aim of the ITERM programme is to provide a simple and reliable tool that IDRONAUT customers can freely use to communicate with their products, like the OCEAN SEVEN probes. ITERM does not need any special Windows installation procedure.

**F.1** **DISTRIBUTED FILES**

ITERM can be freely uploaded from the IDRONAUT web site download area in a self-extracting package, which contains the following files:

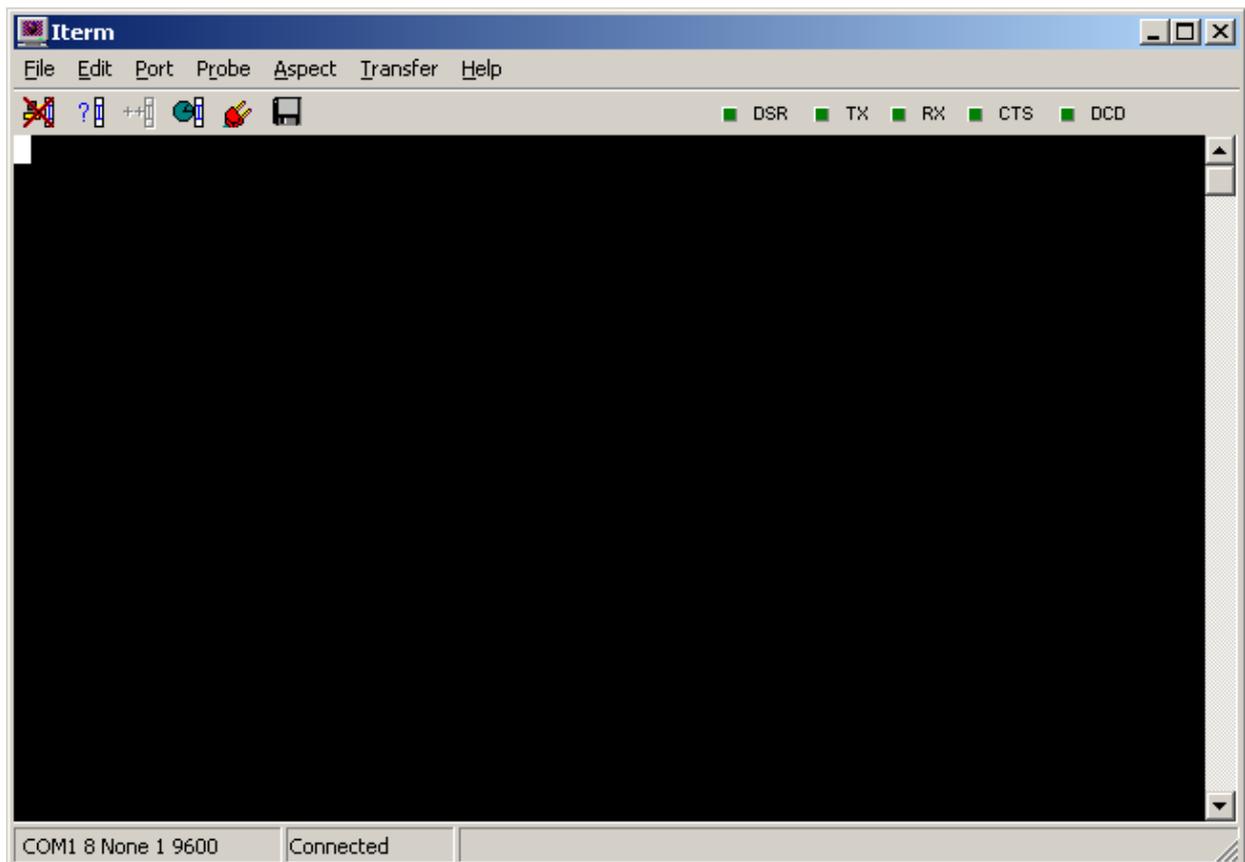
ITERM.EXE	Terminal emulation and probe upgrading programme.
Iterm.rtf	ITERM programme documentation (Read Only).

**F.2** **INSTALLATION**

Before running the ITERM programme, please create a new folder and name it as you like. Then, copy the ITERM.EXE, and the ITERM.RTF programme in that new folder. A shortcut on the desktop can be created using the Windows operating system resources.

**F.3** **PROGRAMME MENUS AND FUNCTIONS**

The ITERM Main Menu has the following items: File, Edit, Port, Probe, Transfer, Help. A short description of menus and functions follows.

**File->Exit**

It exits from the programme and closes the communication port and any open file.

**Edit->CopySelectionToClipboard**

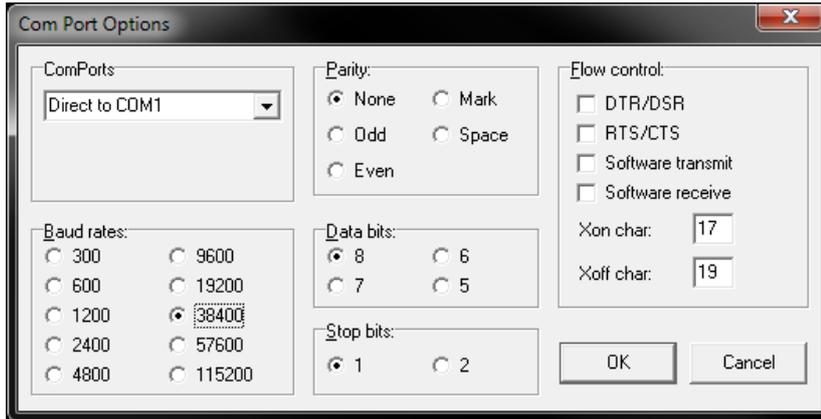
This function copies the selected text to the Windows Operating system clipboard buffer.

**Edit->Clear window**

This function clears the ITERM window.

**Port->Set parameters**

This function allows the operator to set and define the communication port parameters. Default values for the OCEAN SEVEN 310 probe are: 38400bps, 8bit data, 1stop bit, No parity, Hardware hand checking: CTS/RTS.



**Port->Close**

It closes the communication port thus allowing the port configuration. When the port is closed, this command becomes "Open".

**Probe->Identify**

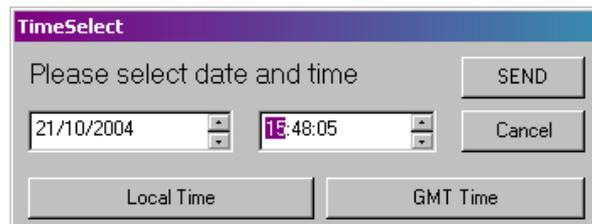
It identifies the connected probe; information like the serial number, the hardware and firmware release is shown on screen in the ITERM program status and title bar. This function must be performed before running any function in the probe menu and is particularly useful to also switch the probe from "non verbose" mode to "verbose" mode. At the end of the probe identification, the probe Main Menu is shown on the PC screen.

**Probe->Upgrade**

This function cannot be used with the OCEAN SEVEN 310 probe.

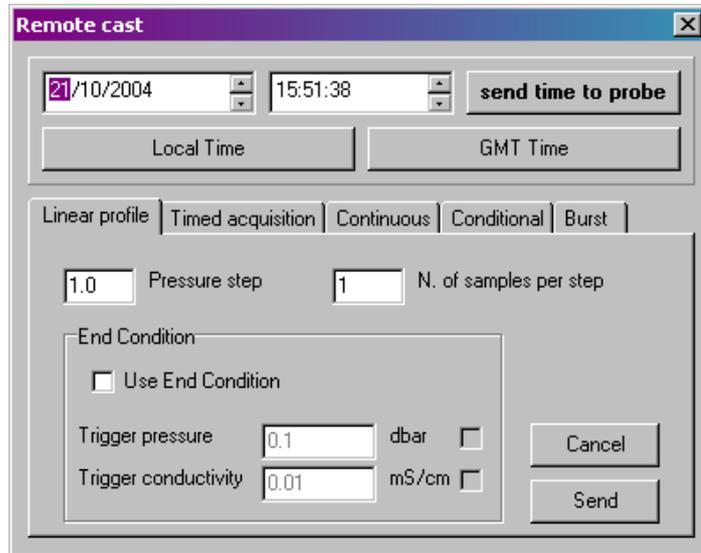
**Probe->Set Time**

This function sets up probe time and date. It is possible to select the new probe time among: GMT, local time or customized date and time.



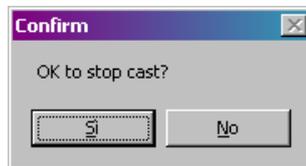
**Probe->Unattended cast**

This command allows the operator to configure the probe unattended data acquisition functions like: Linear profile, Timed data acquisition, Continuous data acquisition, Conditional data acquisition and Burst data acquisition. Through a dialog box, the operator can set the unattended data acquisition parameters and then send them to the Ocean Seven 310 probe, effectively starting the unattended data acquisition cycle. This function is available only after the probe has been identified using the probe Identify function. Different unattended cycles can be configured by selecting the different dialog windows embedded in the "Remote Cast" window.



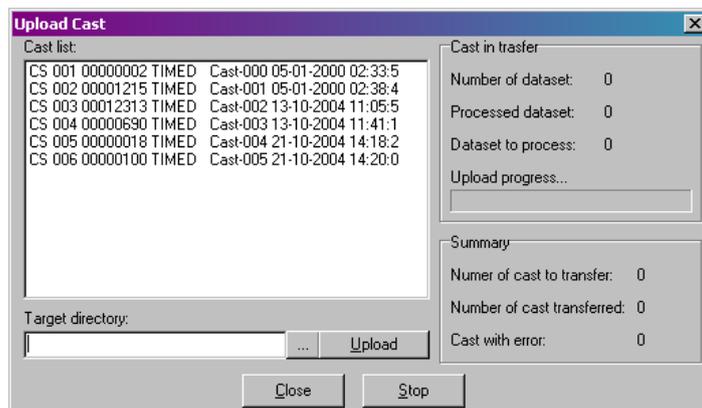
**Probe->StopCast**

This command concludes an "unattended" data acquisition cycle, which was previously started using the "Probe->Unattended Cast" command.



**Probe->UploadCast**

This function allows the operator to retrieve data stored in the probe memory and store it in "Text" files on the PC. The cast uploading is automatically performed by the program. This function is available only after the probe has been identified using the probe Identify function. More than one cast can be selected by using the mouse and the <CTRL> or <SHIFT> keyboard key. "Target directory" must be configured before starting to upload. After the target directory has been configured and the desired cast has been selected from the cast list window, the upload button can be pressed. The programme uploads



the probe memory cast by cast. Uploaded data is stored in text files, a file for each cast.

#### *Aspect->Font*

This function allows the operator to decide the type of font to use to show messages on the terminal window.

#### *Aspect->Colour*

This function allows the operator to select the foreground and background colours among a list of possible choices.

#### *Transfer->SendTextFile*

It allows the operator to transfer a text file to the probe connected through the serial port.

#### *Transfer->CaptureToFile*

This function captures the characters received and sent through the serial port to a text file. The operator can select the file name and folder. Invoking this function, once ITERM is capturing, the character stops capturing and returns to the standard operations.

#### *Help->Contents*

It shows this help file.

#### *Help->About*

It shows notice about ITERM programme release.

### F.4 TOOLBAR

On the programme toolbar, there are the shortcuts to the programme functions.



Disconnects the communication port and frees the port for other programmes or allows the communication port parameter modifications.



Detects and identifies the connected OCEAN SEVEN 3xx probe type. At the end of the identification on the status and title bar of the programme, the information about the connected probe appears.



Not available for the OCEAN SEVEN 310.



Sets the connected probe time and date, according to the PC or customized settings.



Accesses the communication port parameter set-up.



Captures transmissions from the connected probe and keyboard and types and stores them in the selected text file. A red cross appears over the icon when running. Pressing it once stops the capture and closes the text file.

### F.5 START-UP SWITCHES

It is possible to customize the programme at the start-up by adding the following switches to the programme properties:

- p x Where "x" represents the communication port number 1..8.
- b bps Where "bps" represents the communication speed and can be 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200.

### F.6 TROUBLESHOOTING

The automatically generated files "Detect.log" and "Upgrade.Log" contain the dialog between the programme and the probe concerning the operations of probe detection and probe upgrading. In case of trouble, please send us the above files together with a short description of the problem.

### F.7 PROGRAMMES DISTRIBUTED WITH THE ITERM SOFTWARE

The following programmes are distributed with the ITERM software:

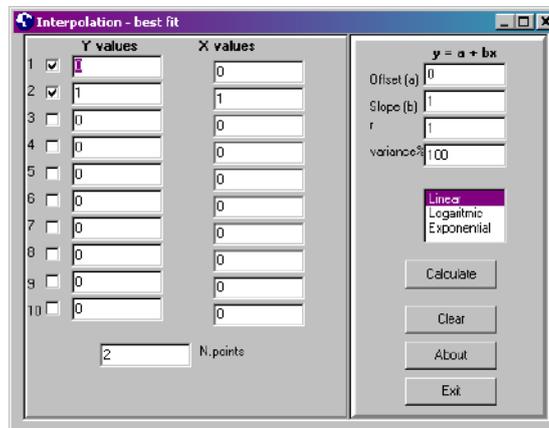
- ❖ Interpolate.
- ❖ OS3xx Probe Memory & Battery Autonomy.
- ❖ Water Properties calculator.
- ❖ Ocean Seven 3xx calibration.

#### Note

The Ocean Seven Probe Memory & Battery Autonomy calculator is described in the maintenance section.

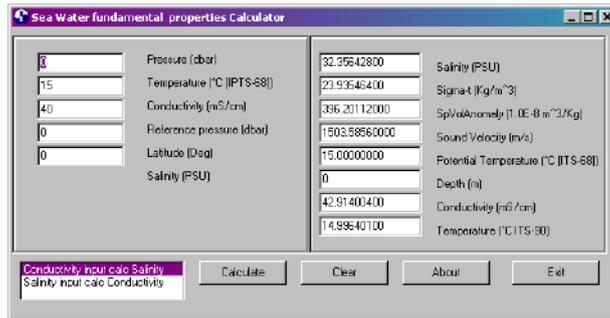
#### F.7.1 Interpolate

This program allows calculating the "a" and "b" coefficients (slope and offset) to interpolate a set of 10 tabbed data (see picture) using: linear, logarithmic or exponential interpolation technique.



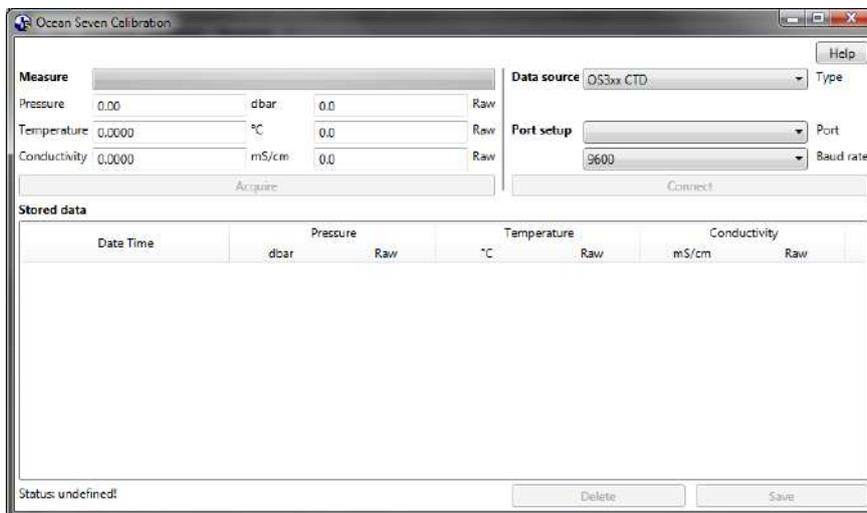
#### F.7.2 Sea Water Fundamental property calculation

This tool allows the probe to calculate the most important fundamental properties of seawater. Through a very simple interface, the operator can enter the Temperature, Conductivity and Pressure sensor values and calculate the derived parameters instantaneously. Calculation is performed using the UNESCO formulae and recommendations.



**F.7.3 Ocean Seven Calibration**

Once the Ocean SEVEN 3xx probe has to be re-calibrated this program allow the operator to correctly acquire data from the interfaced OS3xx probe. A text file containing the collected data can be generated by using the "Save" push button.



## G FOREWORD

The aim of this section is the description of operations needed to operate the OCEAN SEVEN 310 probes equipped with the IDRONAUT innovative not harmful antifouling device (patent pending).

The antifouling is available only if the OS310 probe has the 100 mm POM housing.

### G.1 THE ANTIFOULING DEVICE

The antifouling kit, installed by the measuring sensors of the Ocean Seven 3xx probes, is composed of a central titanium electrode which supplies an electrical current towards six external titanium electrodes on which a copper foil (replaceable) surrounding the sensors, can be wrapped. In addition to chloride formation, there is copper dissolution in an ionic form by the sensors. The copper foil has a typical endurance of more than one year. The sensors are washed when the probe starts profiling.



### G.2 HOW IT WORKS

The fouling probably represents the major difficulty during continuous monitoring of waters and, although many efforts in research at worldwide level have been dedicated to this problem during the past decades, a definitive solution is not yet available. Therefore, a compromise must be found each time according to the specific difficulty met with.

Since our monitoring equipment (Buoy Profiler, OCEAN SEVEN 310) operates to study the environmental conditions where fishes grow, we have not taken into consideration the antifouling system based on the slow release of Tributyltin (TBT) oxide or other heavily poisoning chemical substances. We have then decided to simply use metallic copper to act as an antifouling protection by the measuring sensors. The picture shows an OCEAN SEVEN 310 probe during the antifouling device development test with the antifouling device not active after a monitoring of two months.

A foil of copper (1 mm thickness) has been placed around the sensor cage in such a way that it can be easily replaced with a new one without damaging the measuring sensors and to also avoid reducing the flow of water to be measured. The presence of this simple device has, on average, increased the time between each cleaning from 1 to 2 weeks only.

This is because the metallic surface of the copper easily becomes oxidised in a few days and, after that, it loses most of its activity. In fact, copper is not able any more to dissolve in an ionic form in the water surrounding the sensors and the inside of the copper protection.

Therefore, to avoid the copper passivation, we have installed in the centre of the probe, where the measuring sensors are placed, a titanium electrode, which "impresses" an electrical current versus the copper foil. In this way the copper foil, which acts as a flow-measuring chamber, is always clean and so this allows the copper dissolution in an ionic form. This effect has drastically decreased the formation of fouling by the measuring sensors.

The current between the titanium and the copper electrodes is applied when the probe is not carrying out measurements. Vice versa, when the probe starts descending, the current is not applied any more and the water to be measured flows between the sensors and washes them of the ionic copper previously dissolved. This improvement considerably increases the "time between cleanings" up to three/four weeks, depending on the water quality.

To the best of our knowledge, this kind of antifouling system does not appear in the scientific literature and



not even an industrial company has ever used it until now. Therefore, we are applying for a patent on it.

### **G.3 OCEAN SEVEN 310 POWER SUPPLY AND POWER CONSUMPTION**

The OCEAN SEVEN 310 probe equipped with the antifouling device requires that a continuous power supply 9...18 VDC be present for the whole monitoring period. The power supply shall be present during the measurements and during the periods between consecutive measurements.

The electronics driving circuit of the OCEAN SEVEN 310 probe antifouling device uses the power supply to generate the low AC voltage which is imposed to the antifouling electrodes. During the measuring periods, the OCEAN SEVEN 310 probe power consumption depends on the sensors equipping the probe.

Vice versa, during the periods between the measurements, the probe power consumption is 30mA@12V. The antifouling driving circuit to generate the low AC voltage, which is continuously applied to the antifouling device electrodes, uses this energy.

### **G.4 OCEAN SEVEN 310 PROBE OPERATIONS IN THE FIELD**

Whenever the probe is performing unattended acquisitions in function of time (monitoring), the probe itself automatically manages the antifouling device. The operator must provide the energy to power the probe through the internal or external battery pack or through an external power source: 9...18 VDC.

### **G.5 OCEAN SEVEN 310 INTERFACING FROM NON IDRONAUT MONITORING EQUIPMENT**

When the probe is interfaced from some monitoring equipment, in order to correctly use the antifouling device, it is necessary to:

- power the probe continuously;
- switch the probe on/off by means of the PTP communication protocol commands (see below).

### **G.6 PROBE SWITCHING ON**

Sending a character through the probe serial interface causes the probe to wake up immediately. At the conclusion of the warm-up period (usually 30s), the probe is ready to accept commands from the monitoring equipment. In case the probe is not interrogated for more than 5 minutes, it shuts down by itself.

### **G.7 PROBE SWITCHING OFF**

The PTP protocol "KP" command allows the monitoring equipment to switch off the probe. Alternatively, if the probe is not interrogated for more than 5 minutes, it switches off by itself.

### **G.8 PTP PROTOCOL**

A detailed description of the OCEAN SEVEN PTP communication protocol can be freely obtained from the download area on the Idronaut web site "<http://www.idronaut.it>".



## H BLUETOOTH® MODULE

The IDRONAUT Wireless Module allows bidirectional full duplex communications between the OCEAN SEVEN 310 probes and a personal computer (Desktop, Laptop) or PDA devices equipped with a Bluetooth® device. The IDRONAUT Wireless Module is formed by a Bluetooth® OEM module mounted inside the OCEAN SEVEN 310 probe housing and is designed to provide an interface conforming to the Bluetooth® v1.1 class 1.

The operating range of the adapter is specified in 100m although line of sight ranges of 300m can be achieved. However, if a class-2 Bluetooth® device is used to communicate with the IDRONAUT Wireless Module, then the range will be limited to 10-20m as foreseen by class-2 devices.

The IDRONAUT Wireless Module allows instant wireless connectivity to any device supporting a compatible Bluetooth® SPP protocol. The connection with the OCEAN SEVEN 310s probe among the Bluetooth® devices registered on the network is guaranteed by means of the unique 8-digit PIN code which identifies each IDRONAUT OCEAN SEVEN 310 probe.

### Features:

- ❖ Fully Bluetooth® Class 1 v1.1, SPP compliant.
- ❖ Wireless range of over 100m (330ft).
- ❖ Platform independent.
- ❖ Access security guaranteed by means of a unique 8-digit PIN code.
- ❖ Low power sleep mode when not in use.
- ❖ Integrated antenna.
- ❖ Power supply: powered by the probe.



IDRONAUT Windows programs like REDAS-5 and ITERM flawlessly operate the OCEAN SEVEN 310 through the Wireless Module as if it were connected through an RS232 cable.

### H.1 HOW IT WORKS

The OCEAN SEVEN 310 Wireless Module is always powered (low power stand-by) and is ready to accept wireless connections once the probe is in ON condition. Communications through the OCEAN SEVEN 310 Bluetooth® Wireless Module can be only achieved after a valid Bluetooth session is established. Whenever the communication session is established, the probe automatically and autonomously switches the communications from the wired interface: RS232C/RS422 or Telemetry to the Wireless Module. Afterwards, communication continues using the wireless module until the communication session drops or the OCEAN SEVEN 310 probe is switched off.

The only limitation is that the probe cannot be used with both interfaces (wire and wireless) at the same time.

#### Automatic switch-off during deployment

Once the Ocean Seven 310 is deployed with the Bluetooth module active an automatic probe function take control of the Bluetooth module. As consequence the Bluetooth module is automatically switched-off when the probe is immersed in water.

The conductivity and pressure sensors are used to detect the condition. Two pre-configured thresholds are checked during the data acquisition and if both of them are overpassed the Bluetooth module is disabled saving probe battery energy.

## **I FOREWORD**

This appendix describes the proper care of submersible connectors and cables installed in the IDRONAUT OCEAN SEVEN 3xx series probes. The text refers to the XSG/RMG connector and to the standard MCBH/MCIL one (detailed characteristics of these connectors can be found on [www.impulse-ent.com](http://www.impulse-ent.com)).

### **I.1 BULKHEAD CONNECTORS**

Bulkhead connectors must be carefully inspected and cleaned: i) before every cruise, ii) during the cruise; iii) as part of the yearly probe maintenance procedure.

Inspect connector pins for any possible sign of corrosion. The pins must be shiny and bright. In case of any sign of corrosion on the pins, immediately check the associated dummy plug or the submersible cable end. It may be possible that the corrosion is present in the cable end too.

Check the integrity of the connector plastic body for cracks or other flaws that may compromise the seal. Clean the bulkhead connectors by removing all grease, dirtiness and any other contamination. It is possible to use a soft tool or soft brush and alcohol.

In case of corrosion or damages to the pins or to the connector plastic body (see pictures) that may affect the connector integrity, contact IDRONAUT to get assistance.

### **I.2 SUBMERSIBLE CABLES**

Cable end connectors must be inspected and cleaned: i) before every cruise, ii) during the cruise; iii) as part of the yearly probe maintenance procedure. Check that the cable end does not have any problems that may compromise the seal when plugged on the bulkhead connector.

Clean cable end connectors by removing all grease, dirtiness, and any other contamination. It is possible to use a soft tool or soft brush and alcohol. Cable end connectors may be greased before installing them in the bulkhead connector (please see the dedicated section).

A slack, not well inserted or damaged cable end connector may cause the damaging of the bulkhead connector and malfunctioning of the OCEAN SEVEN 3xx probe.

### **I.3 DUMMY PLUGS**

The purpose of the dummy plug is to protect the connector contacts from being in contact with water during the probe immersion. The dummy plug connector integrity is as important as the submersible cable end connector. Always clean and inspect the dummy plug integrity: i) before every cruise, ii) during the cruise; iii) as part of the yearly probe maintenance procedure.

Check that the dummy plug does not have any problems that may compromise the seal when plugged on the bulkhead connector.

Clean dummy plug by removing all grease, dirtiness, and any other contamination. It is possible to use a soft tool or soft brush and alcohol. Dummy plugs like connectors may be greased before installing them in the bulkhead connector (please see the dedicated section).

A slack, not well inserted or damaged dummy plug may cause the damaging of the bulkhead connector and malfunctioning of the OCEAN SEVEN 3xx probe. Always use the locking sleeve with dummy plug.

### **I.4 LOCKING SLEEVE**

The purpose of the locking sleeve is to secure the cable end or dummy plug to the bulkhead connector, thus preventing it from being accidentally disconnected. Locking sleeve does not help in any way to improve the water tightness of connection.

When installing the locking sleeve, it is important to tighten it by hand (do not use a wrench tool). Over-tightening the locking sleeve may break the threads. Furthermore, removing an over-tightened locking sleeve may result in the unthread of the bulkhead connector from the probe top cover. A slack connector will lead to a flooded probe. After immersing in seawater, always rinse the mated connection with fresh water.

### I.5.1 XSG/RMG connector type only

#### Guidelines

- ☞ Female can trap water (suggest flush with alcohol and blow dry).
- ☞ Lubricate male mating side with 3M Silicon Spray or DOW Corning #111 valve lubricant or equivalent.
- ☞ Avoid contact with noxious solvent.
- ☞ Connector must be lubricated on a regular basis.
- ☞ Elastomers can be seriously degraded if exposed to direct sunlight or high ozone levels for extended periods of time.

#### Bulkhead connector greasing

Squeeze the silicone grease onto the end of your finger and apply a light film, even coating of grease, to the plastic body of the connector.

#### Dummy plug/cable end greasing

Squeeze the silicone grease onto the end of your finger. Apply a light film, even coating of grease, to the inside of the cable end or dummy plug.

After cleaning and inspecting and before inserting the dummy plug or the cable end onto a bulkhead connector, proceed to properly grease using 100% silicone grease (Dow DC-4 or equivalent). Do not use petroleum-based lubricants, as they will damage the connectors.

*In alternative to grease, we suggest using a 100% silicon spray.*

### I.5.2 Connector insertion

Always align the bump on the cable end or dummy plug with the big pin on the bulkhead connector. Push the cable end or the dummy plug straight onto the bulkhead connector; do not twist the cable end or dummy plug during the insertion. Twisting can cause bent pins on the bulkhead connector.

#### Air trapped

It may be possible that some air remains trapped between the bulkhead connector plastic body and the plug-in connector. It happens more often with newer cables or dummy plugs or in cold waters (see the below dedicated session).

Therefore, after the cable or dummy plug is mated, pass your fingers along the cable end or dummy plug toward the bulkhead connector, thus making any trapped air leak out. Please be aware that failure to eject the trapped air will result in the connector leakage, with some consequent problems during deployment like OCEAN SEVEN 3xx probe malfunctions and bulkhead connector pin and cable end corrosions.

#### Cold Environments

In cold environments or when retrieving the probe from cold water, the cable or dummy plug may be hard to install and remove. In such cases, wrap some cloth round the dummy plug or connector end and pour hot water on the cloth. Let it for some minutes and then try again. The warmed plastic should become flexible enough to facilitate the removing.

Whenever possible, always install the dummy plug and cable end in warm environments.

### I.5.3 MCBH/MCIL connector type only

OCEAN SEVEN 3xx with titanium housing may use wet-pluggable MCBH/MCIL connectors instead of the standard XSG/RMG ones. These kinds of connector are easy to mate and require less force to be

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removed or installed even in cold environments. Wet-pluggable connectors may be installed in wet conditions as their pins do not need to be dried before. Anyhow, they must not be mated while submerged. Like the XSG/RMG connectors, the MCBH/MCIL ones may be lubricated and require care and cleanliness as above described. Installation of cable end or dummy plug is simpler. Proceed to align the female and male connectors looking at the connector's shape and insert them in a straight way.

#### Guidelines

- ☞ Lubricate mating surface with 3M Silicon Spray or equivalent, DO NOT grease !
- ☞ Connector must be lubricated on a regular basis.
- ☞ Elastomers can be seriously degraded if exposed to direct sunlight or high ozone levels for extended periods of time.
- ☞ Grip main body of connector during mating and un-mating. Do not pull on cable to disconnect.
- ☞ Avoid sharp bends at cable entry to connector.

## L FOREWORD

The IDRONAUT sensors are all pressure compensated and, in particular, the physical sensors (conductivity, temperature and pressure) can last several years, if properly used. They are high-quality sensors and are well known by oceanographers to measure salinity with great accuracy. Even the chemical sensors: pH, dissolved oxygen and redox, if thoroughly maintained with their respective hydrating caps and solutions, can last some years.

The aim of this application note is to make recommendations, based on our experience, on cleaning, care and storage of the IDRONAUT chemical and physical sensors installed in the OCEAN SEVEN 3xx probes. Most of the recommendations below reported are taken from the OCEAN SEVEN 3xx Operator's Manuals.

This application note is divided into three sections:

- OCEAN SEVEN 3xx probes general cleaning.
- Sensor dedicated care and cleaning.
- Special cleaning for the OCEAN SEVEN 3xx probes used to carry out long-term monitoring in salt and fresh water



### L.1 GENERAL CLEANING

After use, the OCEAN SEVEN 3xx probe must be always washed to remove any salt water residual or dirtiness. Deionized water, distilled water or fresh, tap water can be used. Verify that fresh water used to clean the probe is not contaminated even by any small quantity of oil. In this case, do not use this water.

In case the probe body or the sensors have any visible deposits of marine growths, we recommend cleaning the probe body with some liquid soap and a small "soft" brush to clean the sensor bulkheads between the sensors. In case the OCEAN SEVEN 3xx sensors had been exposed to oil, we suggest using the Triton X-100 (solution at 1-2 %) in place of the liquid soap.

Alternatively to the "Liquid soap" or the Triton X-100, it is possible to use a solution of 70% isopropyl alcohol or a solution of 1/4 cup of bleach in 4 litres of tap water.

In case the OCEAN SEVEN 3xx probe is used in wastewater, it may be disinfected with 5% Lysol if this is more convenient to the user.

### L.2 SENSOR DEDICATED CLEANING AND CARE

#### L.2.1 Pressure sensor

The pressure sensor is an almost maintenance-free device, which meets the highest reliability standards thus reducing the chance of possible failures. The pressure transducer is located in the middle of the probe bottom flange, protected by a plastic black cap. Every five years, ask IDRONAUT to remove the pressure sensor plastic o-ring cap and brush any sediment using a soft-haired brush. Remove excess grease using a tissue or cotton bud. Take care not to damage the very thin pressure sensor diaphragm. Gently apply a thin layer of grease on the sensor surface to minimize any device corrosion. Ensure that the holes in the pressure sensor cover are not blocked with sediment.





### L.2.2 Temperature Sensor

The temperature sensor is almost maintenance free; however, we suggest cleaning it once a year with sandpaper (3M, 400 grid) - which is included in the Oxygen Maintenance Kit - to remove carbonate which, if present, will greatly increase its time constant.

### L.2.3 Conductivity Cell.

The IDRONAUT conductivity cell has the advantage that it can be used both in clean and unclean water without fear of contamination. When the conductivity cell is not in use, it is kept dry.

Should cell contamination occur, it can be easily cleaned (even with up to 30% hydrochloric acid) without affecting the conductivity cell performance or requiring re-calibration. To clean the conductivity cell, use common cotton buds. The cleaning can be done using the Idronaut "Conductivity Sensor Cleaning Solution" or a non-ionic detergent like Triton X-100. At the end of cleaning, rinse very well the conductivity cell with tap, deionized or distilled water.

### L.2.4 Polarographic Oxygen Sensor

At the end of the OCEAN SEVEN 3xx general cleaning, remove the oxygen sensor cap, clean and wash it again if needed, then refill the cap with oxygen electrolyte. If mechanically damaged or stressed, replace the measuring membrane too, usually the green one.

### L.2.5 Optical Oxygen Sensor

At the end of the OCEAN SEVEN 3xx general cleaning, remove the blue cap and clean the membrane using a 3 % H<sub>2</sub>O<sub>2</sub>, ethanol or a soap solution. Gently wash the membrane using a soft brush.

### L.2.6 Reference Sensor

At the end of the OCEAN SEVEN 3xx general cleaning, install the hydration cap to keep the reference sensor hydrated. Fill the hydration cap by about 1/3 with the Idronaut "Reference Sensor Storage Solution". During insertion, the cap should be squeezed in order to limit the formation of air bubbles.



*If the sensor has been exposed to air for a long time (days) without its protective cap or if the solution in the cap has in the meantime evaporated, the solid electrolyte of the sensor may have contracted thus forming an internal air bubble by the junction hole. In that case, the sensor must be replaced if pH calibration is not achievable any more (open circuit).*

### L.2.7 pH sensor

At the end of the OCEAN SEVEN 3xx general cleaning, install the hydration cap to keep the pH sensor hydrated. Fill the hydration cap by about 1/3 with the pH7 Buffer Solution or distilled water. During insertion, the cap should be squeezed in order to limit the formation of air bubbles.



*The glass membrane of the pH sensor should be always hydrated prior to use. If the sensor is stored dry for an extended period (more than a couple of days), the sensor performance may deteriorate.*

**L.3 SPECIAL CLEANING FOR OCEAN SEVEN 3xx PROBES USED TO CARRY OUT LONG-TERM MONITORING IN SALT WATER**

OCEAN SEVEN 3xx probes used to carry out long-term monitoring are equipped with the IDRONAUT antifouling device (patent pending). The IDRONAUT antifouling device helps to keep the confined area surrounding the measuring sensors (see the picture ) clean.

When the probe is left for long periods to carry out monitoring in warm, polluted and highly productive waters, the marine organisms may attack the probe body and sensors even if protected by the antifouling device.

Under these circumstances, we suggest a strong and special cleaning procedure to revert the OCEAN SEVEN 3xx and sensors to their original state.

Prepare a solution with 10% hydrochloric acid diluted in clean fresh water. Leave the probe immersed in the solution for 1 hour. This procedure should dissolve carbonate that may be deposited and should remove any marine growths from the probe body and sensors. Afterwards, carry out the cleaning procedure described in the above paragraph "Generic Cleaning".



**M FOREWORD**

The OS310 can be optionally purchased in AUV version. The AUV version foresees a reduced length housing and special data transmission formats.

The housing length is reduced by removing the space dedicated to the internal battery pack. Therefore, the OS310 AUV version can be powered from an external power supply only.

**M.1 CONFIGURATION**

It is possible to configure the OS310 to automatically transmit after the wake-up data acquired in real time.

The sampling rate depends on the chosen rate, while data transmission format can be selected among three different options:

- a) Ocean Seven 310 custom
- b) BLUEFIN-21
- c) OEX-C

*Ocean Seven 310 custom*

Data acquired is transmitted according with the probe configuration

*BLUEFIN-21*

The OS310 transmit conductivity (mS/cm), temperature (°C IPTS68), pressure (dbar)

*+0055.5454,+0022.3451,+0100.126*

*OEX-C*

The OS310 transmit temperature (°C ITS90), conductivity (S/m), pressure (dbar)

*0022.3451,05.55454,0022.3451,+0100.126*

**M.2 DATA TRANSMISSION**

Data transmission can be stopped by typing <ESC> while the probe is transmitting data or SO^J if the probe is working in NON-VERBOSE mode.