OPERATOR'S MANUAL

OCEAN SEVEN
304*Plus* CTD PROBE

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OCEAN SEVEN 304Plus CTD
IMPORTANT REMARKS

BATTERY REPLACEMENT/RECHARGING

- To gain access to the internal batteries, loosen the closing screws on the CTD top cover with a proper screwdriver. Remove all water droplets around the top cover to prevent the penetration of moisture inside the housing.
- Install two new 1.5V AA Alkaline cells in the double-battery holder or a new Lithium 3.6V cell in the single-battery holder. **INSTALLING TWO 3.6V LITHIUM BATTERIES IN THE DOUBLE-BATTERY HOLDER AND CONNECTING IT TO THE OS304*Plus* TOP COVER WILL CAUSE A PERMANENT DAMAGE TO THE OS304*Plus* CTD ELECTRONICS.**
- If the CTD is not to be used for long periods (weeks or more),we strongly suggest removing the internal battery from the CTD. This will eliminate the possibility of damaging the electronic circuitry in case of battery leakage.

SELF-RECORDING USE

- The internal Real-Time Clock (RTC) keeper is powered by the CTD main battery. If the battery is fully dead or disconnected, the RTC loses the date & time. **It is mandatory to set up the RTC or check that the RTC date & time are correct before starting a self-recording data acquisition cycle.**
- The CTD is equipped with a rotary magnetic power ON/OFF switch, present on the top cover. The CTD is ON when the switching arm is rotated as indicated on the top cover label. Once the self-recording configuration of the CTD has been set, the CTD can be switched OFF and ON again at the sampling site, when it is ready for deployment.
  VERY IMPORTANT: Allow a 30-second interval between each ON/OFF cycle.

LABORATORY USE

When the CTD is to be used in the laboratory to verify the measurement performance or to perform the CTD sensor calibration, please interface the CTD from a portable computer (battery powered). In fact, using desktop computers may generate ground loops and interferences that can affect the CTD sensor measurements. In case a portable computer is not available, a USB port optical insulator must be placed between the CTD USB cable and the PC USB port. A dedicated data acquisition program "**OceanSevenCalibration"** is provided to properly acquire data from the installed sensors.

CONDUCTIVITY MEASUREMENT

- 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. For fresh water application, the sensor does not require any hydration.
- 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.

PROBE WASHING

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

LIFETIME AND HOW TO REPLACE THE IDRONAUT SENSORS

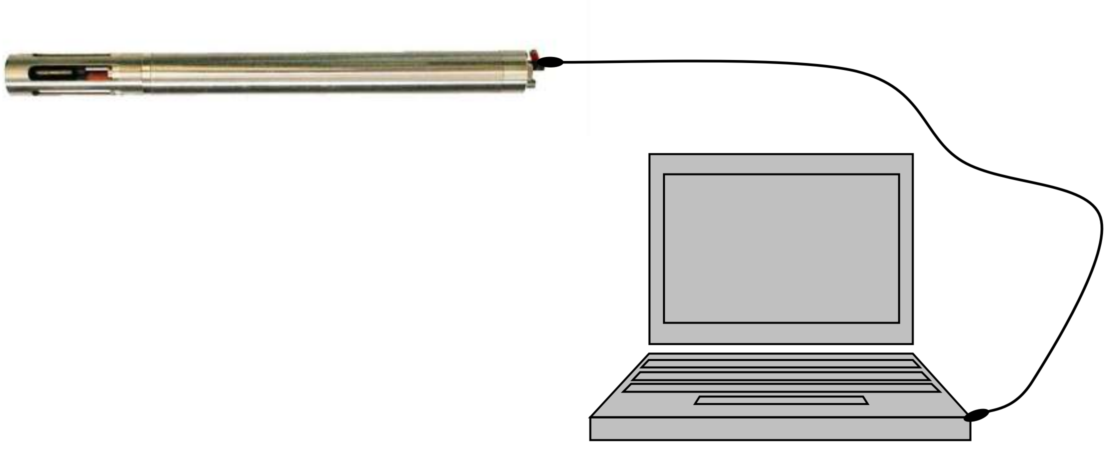
The IDRONAUT sensors are all pressure compensated and, in particular, the physical sensors (pressure, temperature and conductivity) can last many years, if properly used. All sensor heads have a standard 12 mm diameter and are provided with two o-rings (Parker 2-12) for sealing. This means that every sensor can be fitted in any of the four sensor head holes. The pressure sensor is a high-quality transducer, which can last many years if properly used. Its replacement is difficult and requires that the CTD is returned to IDRONAUT.

INTERFACING THE OCEAN SEVEN 304*Plus*

The OCEAN SEVEN 304*Plus* CTD can be interfaced in different ways, depending on the type of action to be performed. The below solutions must be adopted to guarantee that the OCEAN SEVEN 304*Plus* CTD satisfies the stated performance.

CTD configuration and/or stored data uploading

In this case, the CTD can be interfaced using the laboratory (not submersible) cable. The CTD can be powered through the cable or by the internal battery.



Pressure, Conductivity and Temperature sensor performance check

In this case, the CTD must be interfaced using a galvanic or optical insulator between the PC and the laboratory cable.

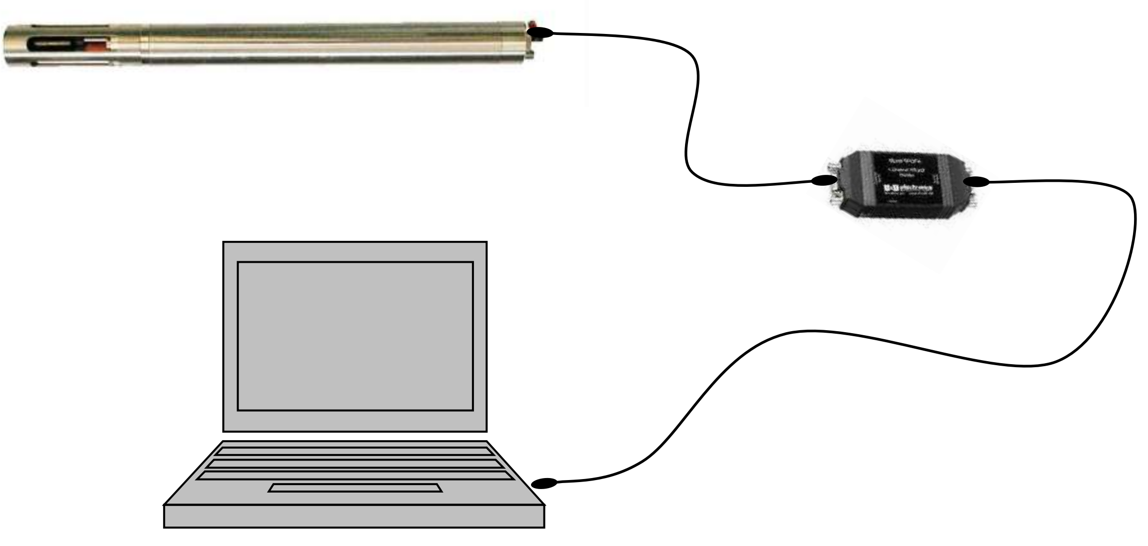


TABLE OF CONTENTS

IDRONAUT Documentation pertaining the OCEAN SEVEN 304Plus

The following documents are available in the "Literature & Manual" folder on the CD-ROM distributed with the OCEAN SEVEN *304Plus* CTD.

- PTP - OCEAN SEVEN CTDs Data Transmission Protocol Description.
- REDAS-5 Condensed Manual.
- uREDAS Operator's Manual.
- OCEAN SEVEN Portable Reader Operator's Manual.

Software updates and technical support

Website download area for software updates and technical support: http://www.idronaut.it/download

Warranty

The OCEAN SEVEN *304Plus* 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 *304Plus*, 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 *304Plus* 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 *304Plus* can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected. Biological contamination is presumed for any instrument, CTD, or other device that has been used with wastewater. Radioactive contamination is presumed for any instrument, CTD or other device that has been used near any radioactive source. If an OCEAN SEVEN *304Plus* 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.

1. PROBE DESCRIPTION

Features:

- Up to 6Hz CTD simultaneous sampling.
- Very low power consumption.
- Expandable: oxygen, turbidity and other sensor interfaces, available upon request.
- Large memory (2GBytes) 60.000.000 data sets.
- High-speed data uploading.

The OCEAN SEVEN 304*Plus* CTD completes the line of high quality and accuracy IDRONAUT OCEAN SEVEN CTDs, fulfilling the demand of a high performance CTD with very small diameter and very low power consumption.
This CTD can be easily integrated/adapted to third-party systems like floating profilers and/or oceanographic moorings, ROVs and AUVs. IDRONAUT prides itself on the design of its full ocean depth, pump-free, low-maintenance sensors. Central to which is their high accuracy seven-platinum-ring quartz conductivity cell (patented) which can be cleaned in the field without the need for re-calibration. This unique quartz cell employs a large diameter (8 mm) and a short length (46mm) to guarantee self-flushing.
The OS304*Plus* does not require pumps or any other external device to flush the sensors, which minimizes its power consumption and allows the use in **Arctic** and **Antarctica**. The OS304*Plus* CTD standard interface is RS232C; other optional interfaces are: TTL, RS485 and **wireless Bluetooth®**. The RS485 interface overcomes the RS232C limitation (max 200m cable). The OS304*Plus* can communicate at speeds up to 115k2 bps, thus minimizing data uploading time. The OS304*Plus* can be manufactured with the following housings: AISI 316 stainless steel/POM (plastic), whole POM, composite titanium/POM or whole titanium and can be deployed to depths of 1000m, 2000m, 4000m or 7000m respectively.

1.1. SAMPLING MODES

User selectable sampling/operating modes include:

Continuous: Data is sampled at configurable sampling rates starting from 0.1 Hz to 6 Hz. Sampling continues until interrupted. Multiple cycles can be possible by switching the CTD ON and OFF.

Pressure: Data is sampled at regular pressure intervals. Multiple profiles can be obtained by switching the CTD ON and OFF.

Timed: CTD 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 between 5s and 1 day. Battery power is conserved while the CTD is in sleep mode. This data acquisition method is ideal for long-term monitoring.

Conditional: Data acquisition is started and continues while the reading from a selected sensor is above a threshold value. Monitoring of the selected sensor threshold value can be configured to occur at intervals: between 5s and 1day.

Burst: 8 Hz measurements can be performed at configured time intervals between 5s and 1 day. Battery power is conserved by switching off the CTD between bursts.

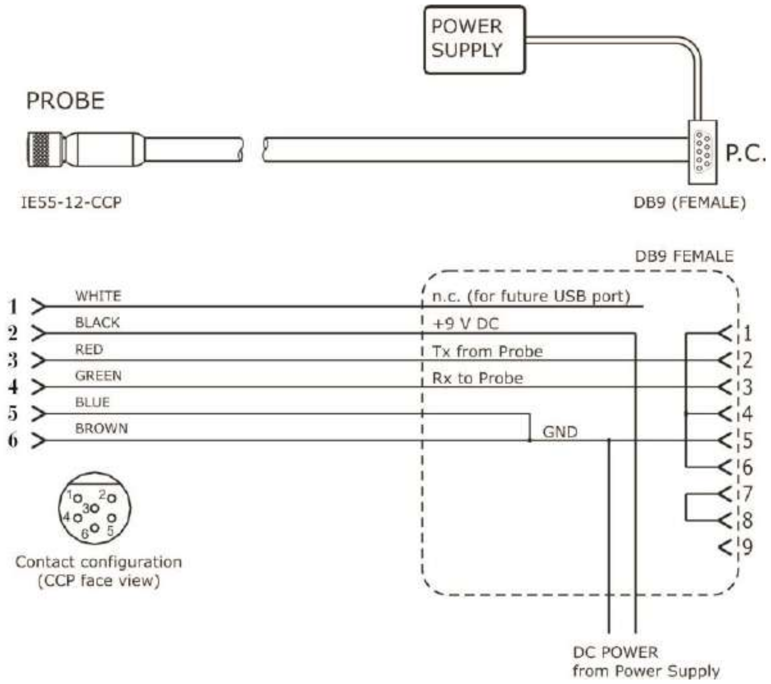
1.2. REAL TIME COMMUNICATION

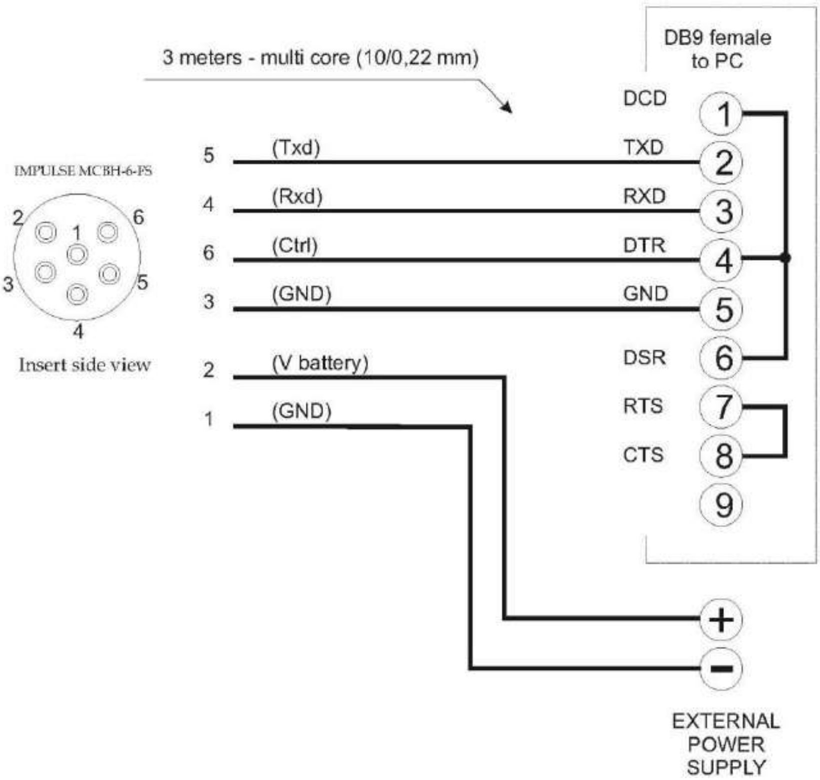
The OCEAN SEVEN *304Plus* CTD communicates with a computer via a standard RS232C interface. Real-time data can be acquired by means of the REDAS-5, µREDAS or ITERM Windows IDRONAUT software. The optional RS485 interface overcomes the limitation of the RS232C cable maximum length (200 m) and allows the CTD to transmit data through distances up to 1000 m. The communication speed is user selectable among: 9600, 19200, 38400, 57600 and 115200 bps. The default speed is 38K4.

Connection type	Max cable length	Max. transfer rate
USB	4 m	115200 bps
RS232C / RS485	10 m	115200 bps
RS232C	200 m	38400 bps
RS485	1000 m	38400 bps

1.3. LABORATORY STANDARD RS232C INTERFACE

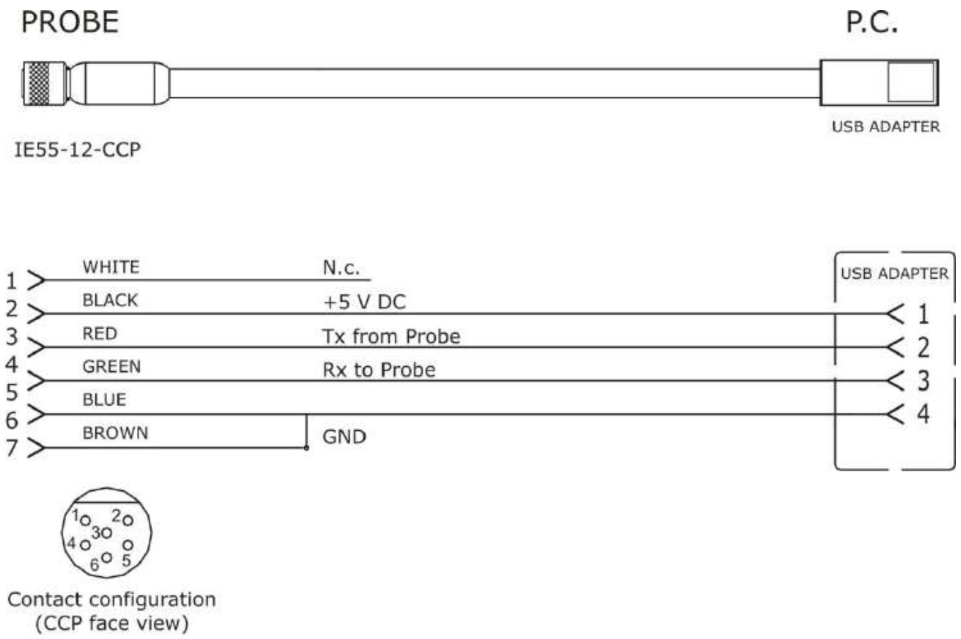
The RS232C interface allows direct connection between the CTD and a personal computer by means of the six-pole male connector located on the top end cap of the CTD. RS232 cable, up to 200m long, can be prepared upon request. Two different connectors, cable combinations are possible depending on the type of the CTD housing. The below pictures and wiring diagrams show both standard laboratory cables.





1.4. OPTIONAL USB COMMUNICATION CABLE

The optional "*USB laboratory*" communication cable overcomes the limitation of the portable PC not provided with the standard RS232C interface. The USB communication cable has the same performance described for the "RS232C" interface.



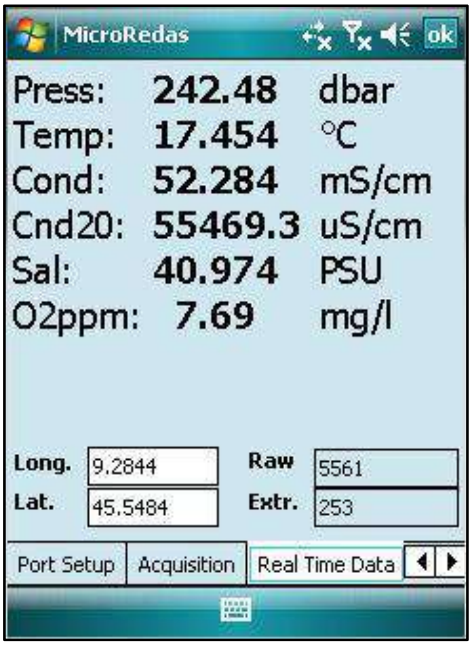
Note
When the USB cable is used to communicate with the OCEAN SEVEN 304Plus, the internal battery status is updated only by powering ON the CTD without the cable connected. Therefore, to update the battery status after the recharging, switch ON the CTD without the USB laboratory cable connected.

1.5. WIRELESS COMMUNICATIONS "BLUETOOTH"

The OCEAN SEVEN 304*Plus* CTD can be optionally equipped with a Bluetooth module which allows full-duplex communications between the CTD and a personal computer (Desktop, Laptop) or PDA devices equipped with a compatible Bluetooth™ device. The wireless adapter is based on the well-known and diffused Bluetooth™ standard 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 CTD, then the range will be limited to 10-20m as foreseen by class-2 devices. The CTD Bluetooth interface allows instant wireless connectivity to any device supporting a compatible Bluetooth™ SPP protocol. The connection with the CTD among the Bluetooth™ devices registered on the network is guaranteed by means of the unique 8-digit PIN code, which identifies each CTD. The installation of the Bluetooth module considerable decreases the lifetime of the CTD internal batteries

1.6. PORTABLE READER

The OCEAN SEVEN 304*Plus* CTD can be interfaced with a portable lightweight and extremely rugged reader based on the Windows Mobile™ software. Through this device, it is possible to perform the operations usually performed 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 CTD through a built-in RS232-C interface and dedicated IDRONAUT programs, specifically developed for the Windows mobile: ZTERM and µREDAS.



These programs interfaces the OS304*Plus* CTD and allows the operator to dialogue directly with it thus performing: sensor calibration, real-time data acquisition, CTD configuration, etc.
All these operations are possible thanks to the CTD smartness included in the management firmware.
Furthermore, the "Portable Reader" not only shows data sent by the CTD in real time but also stores it.
Data is stored in files using the "Portable Reader" main or extension "Flash" memory which can be later transferred to a desktop personal computer using the Microsoft ActiveSync program.
Data acquired by means of the "μREDAS" program must be imported using the REDAS-5 program.
Data storage capability of the "Portable Reader" is limited only by the size of the installed "Flash" memory card.
The "Portable Reader" can operate for up to 15 hours continuously. Autonomy of the interfaced CTD is about 40 hours.

1.7. INTERNAL BATTERY PACK

The OCEAN SEVEN 304*Plus* CTD housing has, in its upper part enough space to accommodate an internal battery pack.
The OS304*Plus* is powered by a single 3.6V battery or two Alkaline 1.5V batteries; different types of battery can be installed in the CTD housing. Together with the CTD, IDRONAUT ships two plastic battery holders for the single Lithium or the double Alkaline batteries.
IDRONAUT does not include the batteries in the CTD shipment.

- ***2 x size "AA"Alkaline 1.5V battery assembled in a single pack*** **3.0V**
- *1 x size "AA"Lithium non rechargeable battery* *3.6V, 2.4 Ah*
- *1 x size "C" Lithium non rechargeable battery* *3.6V, 8.4 Ah*
- *1 x size "D" Lithium non rechargeable battery* *3.6V, 19 Ah*
- *NiMH IDRONAUT rechargeable custom battery pack (3x1.2 AA)* *3.6V, 2.6 Ah*

INSTALLING TWO 3.6V LITHIUM BATTERY IN THE DOUBLE ALKALINE BATTERY HOLDER AND CONNECTING IT TO THE OS304*Plus* TOP COVER WILL CAUSE A PERMANENT DAMAGE TO THE OS304*Plus* CTD ELECTRONICS.

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 304*Plus* CTD is shipped without batteries installed. The status of the internal battery pack can be derived from the battery diagnostic reading on the CTD start-up message.

1.7.1. Optional rechargeable battery pack

An NiMH IDRONAUT custom rechargeable battery pack (3.6VDC, 2.6Ah) is available upon request. It comes complete with an international battery charger. Please be aware that it is not possible to recharge the batteries when they are installed inside the CTD. Therefore, the CTD top cover must be opened to recharge the internal NiMH battery pack.

1.8. CTD POWER ON/OFF SWITCH

The OCEAN SEVEN 304*Plus* CTD is equipped with a rotary magnetic switch which acts as an ON/OFF switch. This switch allows the operator to easily deploy a pre-configured CTD which, when it is on the sampling site, will start to acquire data according to the pre-configured cycle. **It is important to wait at least 30 seconds between consecutive ON/OFF cycles.** The below pictures show the top covers according to the AISI, POM and Titanium housings.

Housing Ø 100mm
OS304Plus - MI
Titanium/white POM

Housing Ø 75mm
OS304Plus - STD
White POM

Housing Ø 48mm
OS304Plus - STD
Titanium

Housing Ø 43 mm
OS304Plus – STD
AISI 316/black POM

1.9. INTERFACING WINDOWS PROGRAMMES

IDRONAUT programmes designed for any type of Windows 32bit operating systems allow the operator to communicate with the OCEAN SEVEN *304Plus* CTD to perform attended or unattended data acquisitions. Programmes include functions to upload data from the internal memory when the CTD acts as a logger. The programme packages comprise:

ITERM: Terminal Emulation Programme and CTD management. It simplifies the communications with the OCEAN SEVEN *304Plus* CTD. Diagnostic and CTD dedicated functions are provided under the "PROBE" menu.

ZTERM: Terminal Emulation programme for Windows Mobile operating system. It simplifies the communication with the OCEAN SEVEN *304Plus* CTD.

uREDAS-5: 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 numerically shown on screen.

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

OceanSevenCalibration:
Test program to verify the OS304*Plus* operations in a calibration laboratory. It allows the operator to see in real time and store in a text file data acquired from the OS304*Plus* CTD sensors in engineering unit and in raw data format.

1.10. FIRMWARE OVERVIEW

The OS304*Plus* CTD is provided with a firmware that manages all the CTD operations. The most important management functions are described in the following subsections.

1.10.1. 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 subsections.

1.10.1.1 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 a digit contained in two square brackets followed by an explanatory message. 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 number contained in the square brackets. Once one of the submenus is shown, it is possible to return to the upper layer by means of the [0] key. The <ENTER> key re-displays the shown menu.

1.10.1.2 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.
- ✓ Any key different from <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).

1.10.2. Probe Access Rights

The OCEAN SEVEN 304*Plus* configurations and functions are password protected to avoid unwanted modifications or running of functions that can led to CTD unpredictable behaviours. In the CTD Service Menu, it is present a command <Rights>, which allows the operator to modify the CTD access rights.

Three different access rights are foreseen:

USR	User access to perform daily operations and standard CTD configuration and management. At this level, it is not possible to modify certain sensor configuration or CTD operating parameters. Moreover, some CTD 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 304*Plus*. This access is reserved to IDRONAUT technicians or to trained operators. Upon request and under IDRONAUT supervision, administrative access can be granted to the operator to carry out dedicated functions or configurations.

The CTD access right is indicated on the menu headers with an acronym shown inside {} brackets as above described. At the start-up, the CTD operates in user "USR" mode. Service or Administrator access must be configured using the access rights command. Once the access rights 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:

"SERVICE304"	to grant SERVICE access to the CTD functions and configuration.
"****************"	to grant ADMINISTRATIVE access to the CTD. Administrative password can be obtained from IDRONAUT only.

The modification of the access right remains valid until the CTD is switched off or the access right is modified. Typing an arbitrary password causes the CTD access right to switch to the USR level.

1.10.3. Menu header structure

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

OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 14:21:09.01 11-07-2012

Where:

OCEAN SEVEN 304Plus	Type of CTD and name.
ID:0010101	Serial number.
{USR}	Indicates the access rights to the CTD functions and configuration.
[9.0_00 02/2012]	CTD firmware release number and release date.

1.10.4. Data transmission protocols

Whenever the CTD 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.

1.10.5. Point-to-point protocol

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 CTD and a PC. The CTD, which is always the slave device, does not send any message unless requested by the master PC.

1.10.6. Verbose and non-verbose special characters

Some special characters are used by the OCEAN SEVEN 304*Plus* communication protocol and operator interface which are associated to special functions:

CTRL-C	Interrupts any data acquisition cycle in progress, attended or unattended. Data storing is completed automatically and the CTD operations control returns to the "operator interface" software module.
CTRL-T	Switches the CTD immediately from verbose to non-verbose operating mode.
BACKSPACE	Allows the operator to delete previously entered characters.
CTRL-J	Special character used to terminate the PTP protocol messages.
ENTER	Confirms the modified numerical parameters.

1.10.7. Field upgradeable firmware

Like most up-to-date high technology products, the OS304*Plus* CTD is equipped with "FLASH" memories. A special function of the management firmware allows the user to upgrade the firmware to the last release flawlessly and without opening the CTD. Please contact IDRONAUT to obtain the relevant information and dedicated instructions.

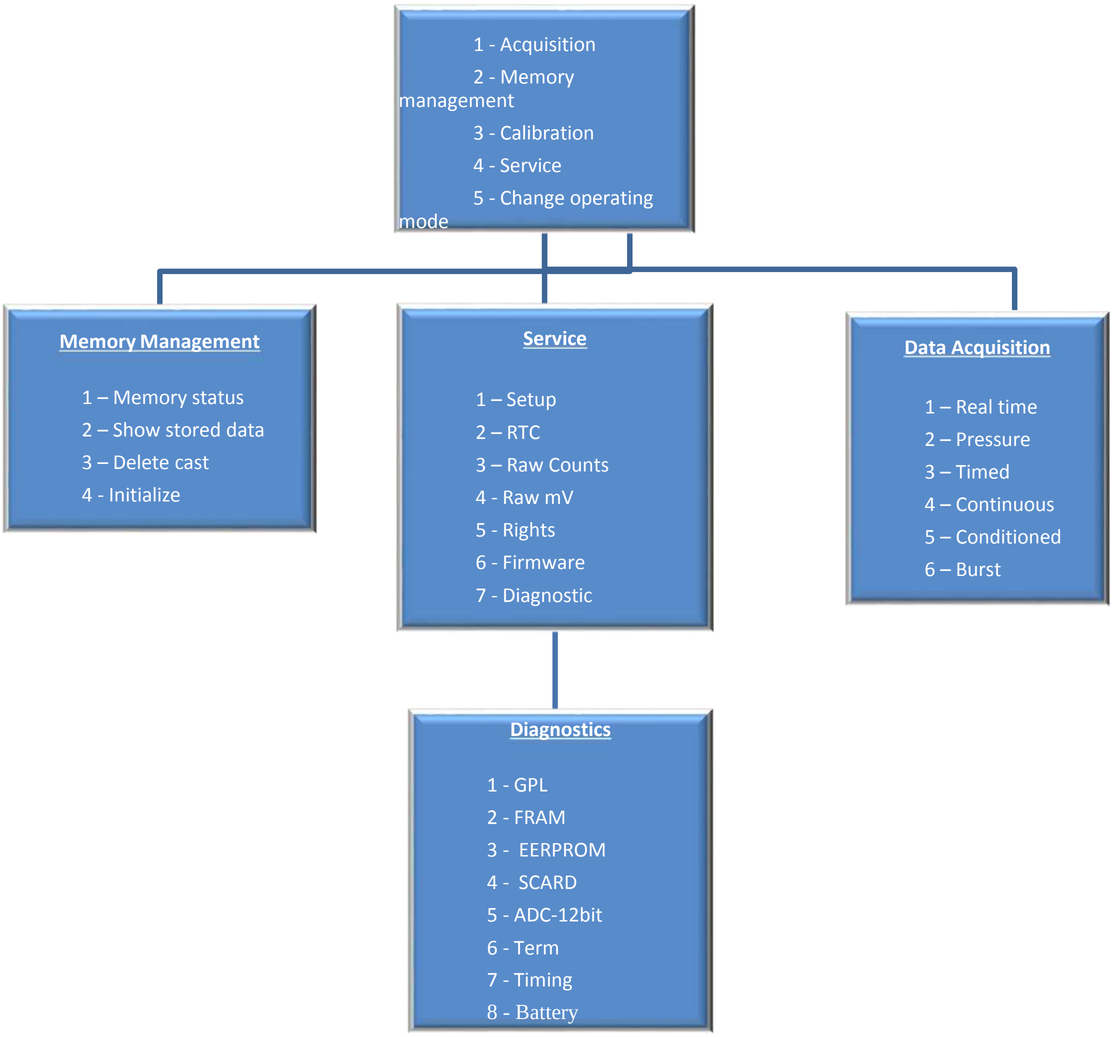
1.10.8. Low power consumption

CTD electronics is accomplished using high integration CMOS devices, low power consumption integrated circuits, and discrete components. The power consumption of the OCEAN SEVEN 304*Plus* CTD is very low if compared to its performance. The low power consumption is further reduced whenever the CTD is not used for more than 1 minute. In fact, the management firmware powers OFF all unused internal hardware resources while waiting for a command from the operator. Furthermore, whenever the CTD remains in this low power condition for more than two minutes, it automatically shuts down by itself thus further reducing the power consumption to less than 8 μAh.

1.10.9. Configuration and Calibration

The OCEAN SEVEN 304*Plus* CTD configuration and calibration parameters are stored in a non-volatile memory which guarantees up to 10.000.000 of write operations and infinite read operations.

1.10.10. Menu & submenu structure



1.11. *CALCULATIONS*

The fundamental properties of seawater, like: **Salinity, Sound Speed, Water Density, Oxygen ppm and pressure to depth conversion** 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". The freshwater properties like: **TDS (Total Dissolved Solids), Fresh Water Conductivity** corrected at 20°C and 25°C are automatically calculated.

1.11.2. Conductivity compensated at 20°C

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

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

$$cond\ 20^{O}\ C = cond \times K$$

Where:

cond = conductivity sensor output a = 1.721183 c = 0.0011484224

temp = temperature sensor output b = 0.05413696 d = 0.00001226563

1.12. SENSOR SPECIFICATION

The OS304*Plus* CTD can be equipped with the following sensors to measure:

Parameter	Range	Accuracy	Resolution	Time Constant
Pressure	0..1000 dbar(1)	0.05 %F.S.	0.0015 % F.S.	50 ms
Temperature	-5.. +35°C	0.002 °C	0.0001 °C	50 ms
	+35.. +45°C	0.01 °C	0.0001 °C	50 ms (4)
Conductivity	0.. 90 mS/cm(*)	0.003 mS/cm	0.0003 mS/cm	50 ms (2)
Analogue	0..5000 mV	1 mV	0.1 mV	50 ms (3)

(1) Other standard pressure transducers available have : 10, 40, 100, 200, 500, 2000, 4000, 7000 dbar ranges.
(2)At 1 m/second flow rate.
(3) Six analogue inputs available for future expansion.
(4) OS304*Plus* – MI version, special extended measurement range.
(*) By reducing the range to 0..70 mS/cm, the resolution becomes 0.0002 mS/cm.

1.13. OPTIONAL SENSOR SPECIFICATIONS

The OCEAN SEVEN *304Plus* CTD can be optionally equipped with the IDRONAUT Highly Accurate Precise (0.01%) pressure transducer, the IDRONAUT OEM Turbidity Meter and the IDRONAUT dissolved oxygen sensor.

Parameter	Range	Accuracy	Resolution	Time Constant
Pressure	0..7000 dbar	0.01% F.S.	0.002 % F.S.	50 ms
Oxygen	0.. 50 pm	0.1 ppm	0.01 ppm	3s (*)
	0.. 500 % sat.	1 % sat.	0.1 %sat.	3s (*)
Turbidity Meter	0.03..750 FTU/NTU	5 FTU/NTU	0.5 FTU/NTU	0.1 s
	0.03..500 FTU/NTU	1 FTU/NTU	0.1 FTU/NTU	0.1 s
	0.03..125 FTU/NTU	0.25 FTU/NTU	0.025 FTU/NTU	0.1 s
	0.03.. 25 FTU/NTU	0.05 FTU/NTU	0.005 FTU/NTU	0.1 s

(*) from nitrogen to air.

A detailed description of the optional sensors can be found in the dedicated appendices.

1.14. THE SENSORS

A short presentation of the standard IDRONAUT OCEAN SEVEN 304*Plus* sensors follows.

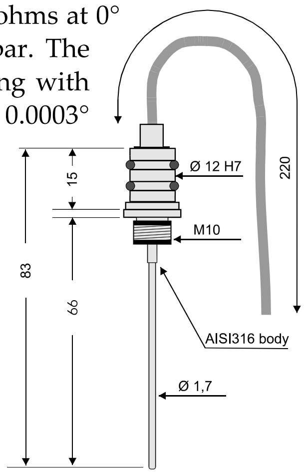
1.14.1. The pressure sensor

The pressure sensor is a high quality strain gauge, centrally mounted on the CTD base, capable of generating a linear signal output thus giving a resolution of 0.03% over the whole measuring range of 0 - 700 bar.

Type:	strain gauge.
Measurement range:	0..700 bar.
Accuracy:	0.05%FS.
Resolution	0.0015%FS.
Response time:	50 ms @1 m/s.
Measurement bridge resistance:	@ 25°C 3500 Ω ± 20%.
Excitation current:	0.6 mA.
Insulation:	@ 50 VCC 100 MΩ
Operating temperature:	-30..100 °C
Sensor body:	AISI 316 L.
Compensation:	Automatic compensation for temperature variations. Not compensated for the barometric pressure variations.
Life:	unlimited.
Calibration:	offset calibration in air.

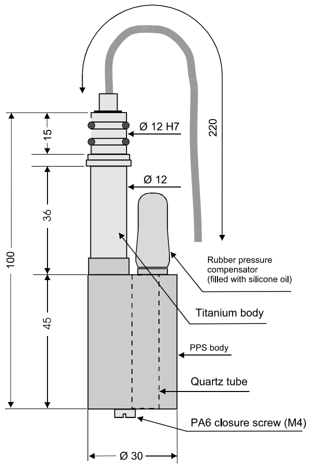
1.14.2. The temperature sensor

The temperature sensor is 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:	-5..+35 °C.
Accuracy:	0.003 °C.
Resolution:	0.0006 °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.

1.14.3. 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 recalibration. 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 45 mm.
Measurement range:	0..90 mS/cm.
Accuracy:	0.009 mS/cm.
Resolution:	0.001 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. *ELECTRONIC SPECIFICATIONS*

Real-time and logging:		6 Hz
Interfaces:		RS232C, TTL (3.3VDC), RS485, wireless Bluetooth®.
Real Time Clock accuracy:		3 ppm/year.
Communication speed:		38k4 bps (up to 115k2 bps).
Data memory:		2 GByte.
Supply voltage:	*Battery:*	2x size "AA"Alkaline 1.5V battery assembled in a single pack. 3.0V; 1x size "AA" Lithium non rechargeable battery 3.6V, 2.4Ah.
	External:	4.5..18VDC.
Supply current:	*Running:*	45 mA @ 3.6V.
	Sleep:	8 µA @ 3.6V.

1.16. *PHYSICAL CHARACTERISTICS*

Standard versions:

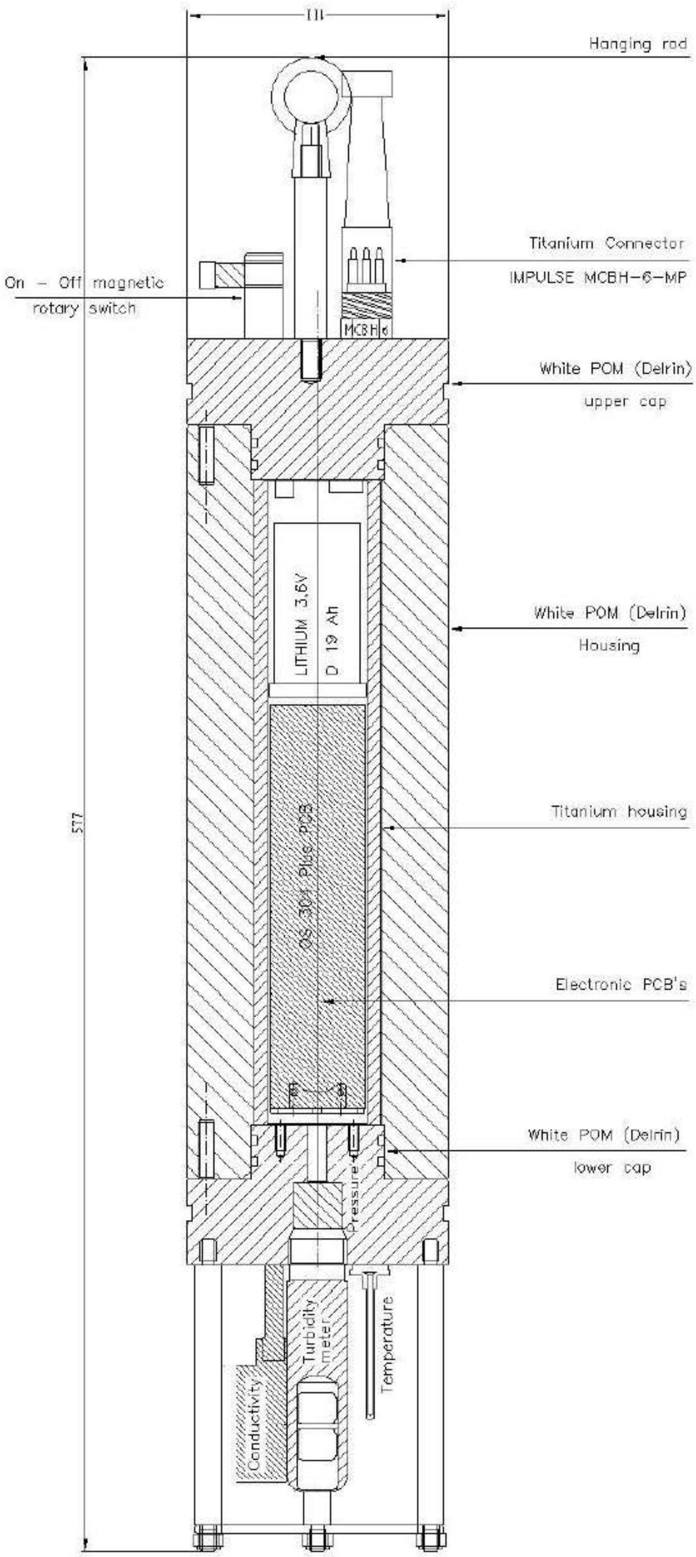
		1000 dbar	2000 dbar	2000 dbar	7000 dbar
Dimensions	*Housing diameter*	43 mm	75 mm	48 mm	48 mm
	Total length (with hanging rod)	562 mm	580 mm	560 mm	595 mm
Weight	*In air*	1.2 kg	2.2 kg	1.5 kg	1.85 kg
	In water	0.65 kg	0.5 kg	0.8 kg	1.15kg
Material		AISI316/POM	POM	Titanium/POM	Titanium

Special AUV versions:

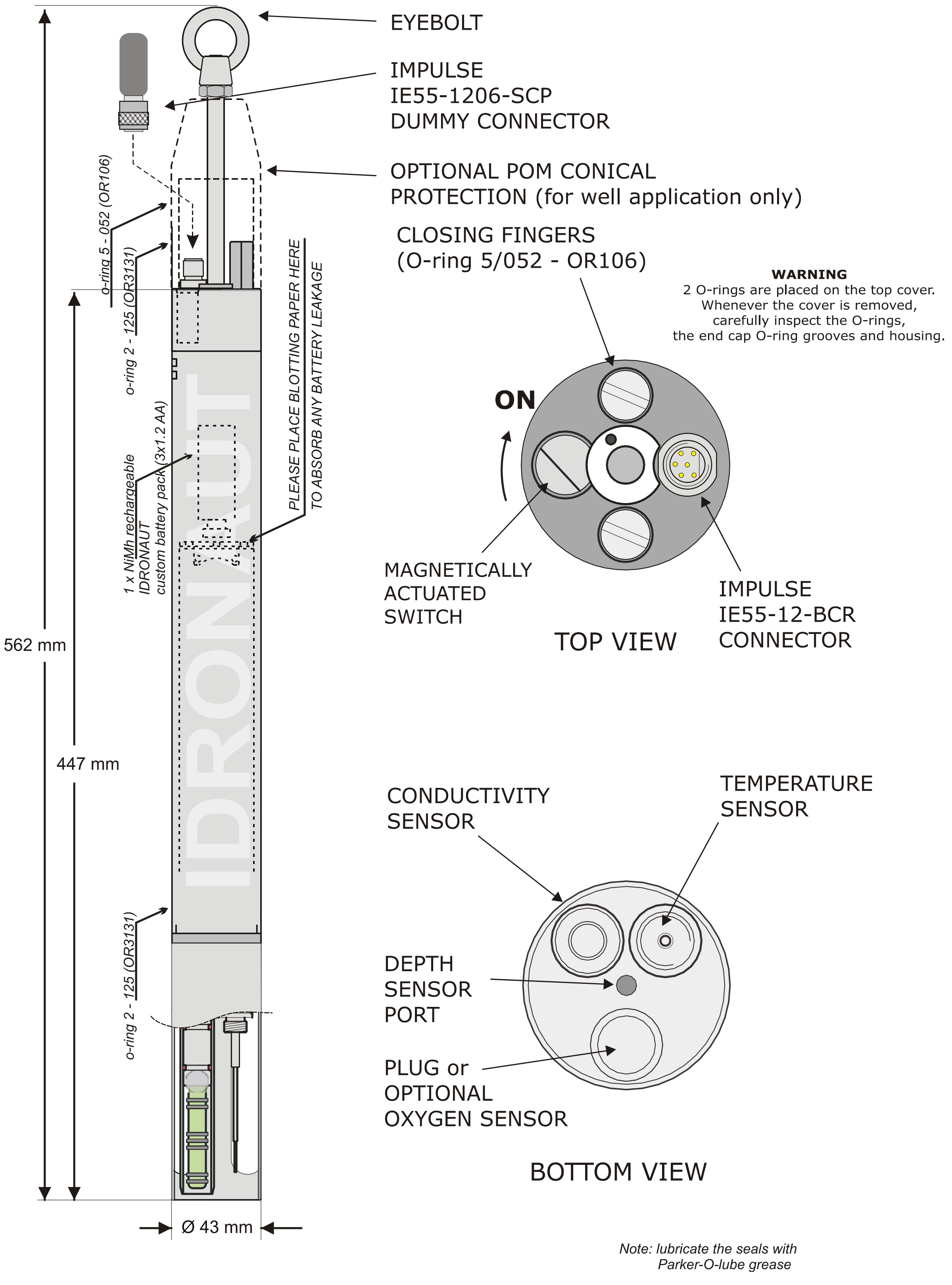
		1000 dbar	7000 dbar
Dimensions	*Housing diameter*	43 mm	48 mm
	Total length	435 mm	435 mm
Weight	*In air*	0.9 kg	1.7 kg
	In water	0.6 kg	1.1 kg
Material		AISI316L/POM	Titanium

Special MI version:

		4000 dbar
Dimensions	*Housing diameter*	100 mm
	Total length(with hanging rod)	560 mm
Weight	*In air (without battery)*	4.6 Kg
	In water (without battery)	1.0 Kg
Material		Titanium/POM

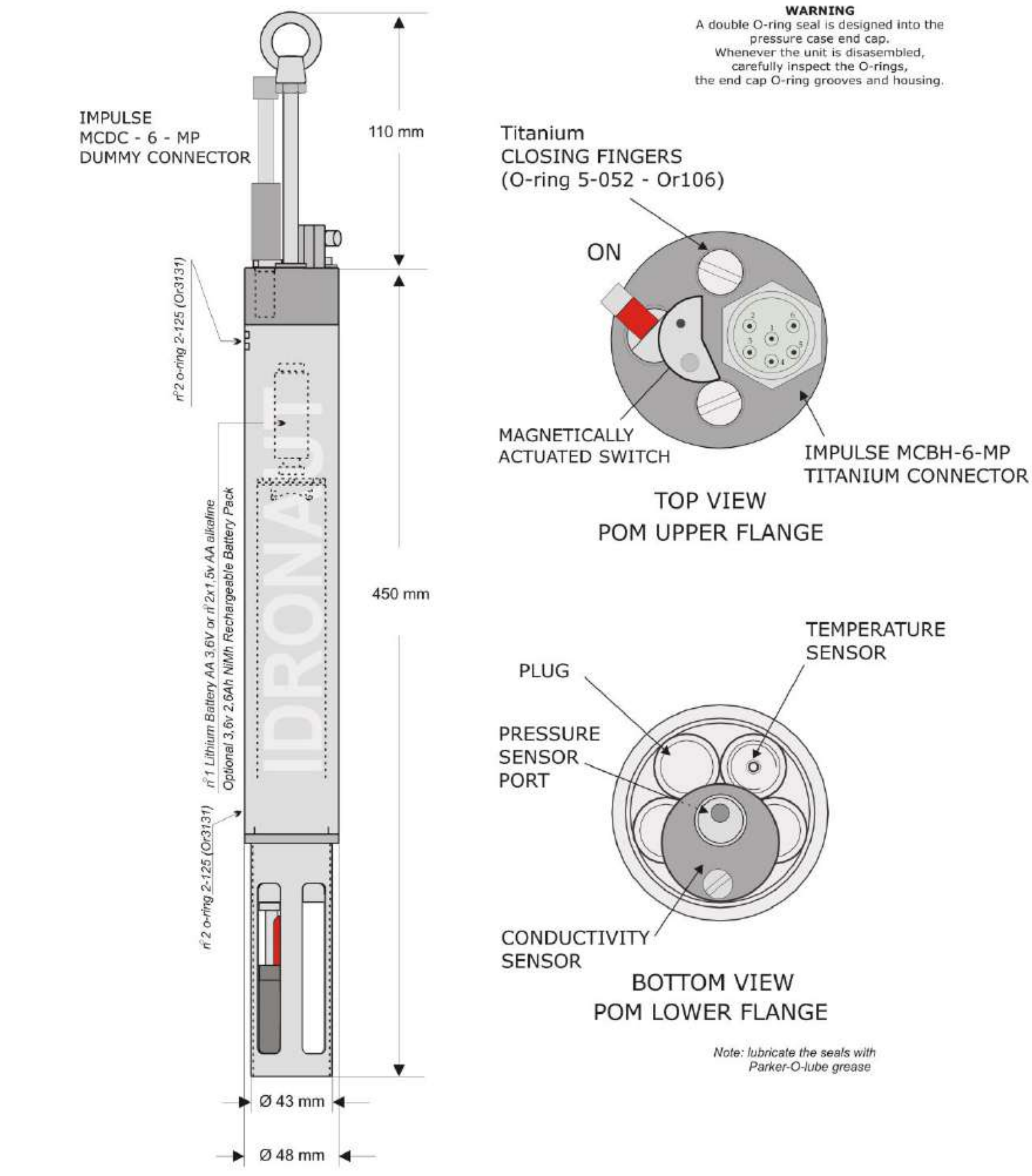


<u>OCEAN SEVEN 304*Plus* MI - 4000 dbar - COMPOSITE TITANIUM/POM HOUSING</u>



OCEAN SEVEN 304*Plus* - 1000 dbar AISI316/POM HOUSING

Note
A Titanium gr 2 housing is also available, rated to 7000 dbar, whose diameter is 48 mm.



OceanSeven 304 48mm 2000 dbar version
titanium housing / POM upper and lower flange

OCEAN SEVEN 304*Plus* - 2000 dbar Titanium/POM HOUSING

2. INSTALLATION AND START-UP

Unpacking, installation and start-up procedures are described in this section.

2.1. SHIPPING LIST

Description	Quantity
- OCEAN SEVEN 304*Plus*	1
- Dummy connector with looking sleeve	1
- Laboratory RS232C communication cable	1x 3 m
- 2x 1.5V Alkaline battery holder	1x
- 1x 3.6V Lithium battery holder	1x
- Sensor maintenance kit, including:	
Conductivity sensor cleaning solution	1x 25 ml
- CD-ROM programs and documentation	1

2.2. INSTALLATION PROCEDURE

Unpack and inspect the shipped parts; check the materials with respect to the above shipping list and be sure that no damages have occurred during the transport. Open the CTD and install the internal batteries (see dedicated section). Remove the underwater dummy cap from the top cover of the CTD and connect it with the connector of the laboratory cable. Connect the other side of the cable to a personal computer USB interface.

2.2.1. Optional USB-cable software driver installation

The first time the USB laboratory communication cable is connected to a personal computer, the operator is requested by the Windows operating system to install the USB driver. The driver can be found on the ITERM or REDAS-5 CD-ROM included in the CTD accessories. The USB driver installation allows the personal computer and the Windows operating system to communicate with the Ocean Seven 304*Plus* through a simulated "communication port". The simulated communication port is used by ITERM and other IDRONAUT programs to communicate with the CTD.

2.3. HOW TO OPERATE THE CTD

The CTD can be operated through the IDRONAUT Terminal Emulation software per Windows (for brevity's sake, hereafter referred to as "ITERM"). The "ITERM" software is described in a dedicated appendix of this Operator's Manual. The communication parameters of the software must be set to meet those of the CTD (see the configuration sheet). The default communication values are: **38400 baud, 8 data bits, 1 stop bit, no parity.**

After the installation, the "ITERM" programme must be configured to meet the default communication set-up. Afterwards, any modification done to the OCEAN SEVEN *304Plus* communication speed must be reflected on the ITERM programme too. ITERM initialization file keeps trace of the modification for the successive start-up of the ITERM programme.

Run the **ITERM** programme, set it up, and then switch on the CTD by positioning the arm of the rotating switch on the red dot. The OS*304Plus* now starts to wake up.

Note

At the start-up, the CTD shows you the command prompt, waiting for the operator's instructions, unless the CTD has been previously configured to perform self-recording data acquisition cycles. In this latter case, a dedicated section of the manual describes how to revert the CTD to normal operations.

2.4. START-UP PROCEDURE

2.4.1. CTD Start-up - Verbose operating mode

Once the CTD is switched on and the verbose operating mode is operative, the following message appears:

OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 14:19:42.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK].WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.59 VDC....CTD..Ok Analogue:.Ok
OperatingMode...Operator
Main menu
[0]ShutDown
[1]Acquisition
[2]Memory
[3]Calibration
[4]Service
[5]Op.mode
cmd>

2.4.2. CTD Start-up Non-verbose operating mode

Once the CTD is switched on, it enters in the non-verbose operating mode.

OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 14:21:09.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK].WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.59 VDC....CTD..Ok Analogue:.Ok
OperatingMode...PTProtocol
PTPProtocol
ER 000

Once the "non-verbose operating mode" is active, type VT <LF> to reactivate the "verbose operating mode". When the CTD is turned on, it keeps the operating mode of the last ON period. So, in case the CTD is turned off in the "non verbose operating mode", no menu will appear on the screen. In that case, the command VT<LF> must be typed in order to return to the "verbose operating mode".

2.5. *THE MAIN MENU*

When the initialization process is completed, the OCEAN SEVEN 304*Plus* Main Menu is shown on the user's screen:

Main menu
[0]ShutDown
[1]Acquisition
[2]Memory
[3]Calibration
[4]Service
[5]Op.mode

The CTD accepts the following keys in input, detailed as follows:
[0] – this key switches off the CTD. Then, the magnetic switch must be rotated to the OFF position.
[1] - this key gives access to the DATA ACQUISITION function.
[2] - this key gives access to the MEMORY MENU.
[3] - this key gives access to the Probe CALIBRATION MENU.
[4] - this key gives access to the SERVICE MENU.
[5] - this key gives access to the Non-Verbose communication protocol.

3. COMMANDS

A detailed description of the OS304*Plus* commands follows. The commands are grouped in order of function. The groups are:

- Shutdown.
- Data Acquisition.
- CTD Sensor Calibration.
- Memory management.
- Service.

3.1. *SHUTDOWN*

This command allows the operator to immediately switch the CTD off. To complete the switching off procedure, rotate the top cover ON/OFF switch
to the OFF position.

3.2. *DATA ACQUISITION*

Data acquisition group of commands allows the operator to see data acquired and store it in the CTD memory by using different techniques. Data acquisition commands are accessed through the "Data Acquisition" sub-menu:

```
OCEAN SEVEN 304Plus - ID:304-0010101 {ADM}[9.0_00-02/2012] 14:35:25.24 11-07-2012
Acquire
[0]MainMenu
[1]RealTime
[2]Linear
[3]Timed
[4]Continuous
[5]Conditional
[6]Burst
cmd>
```

3.2.1. Real Time

This command allows the operator to see data acquired by the CTD in real time. Data acquisition can be interrupted at any time by means of the **<CTRL-C>** character. Once running, the following message appears on the screen:

```
Acquisition: <Type any char>To start, <^C>To leave
Type <any key>To continue
```

Type a key on the keyboard to start the acquisitions

```
Acquisition: <^C>Stop
Press  Temp   Cond   Sal
0.18 25.4583 1.3714 1.2340 15:18:21.51
0.18 25.4586 1.3715  1.2340 15:18:21.78
0.18 25.4584 1.3715 1.2340 15:18:22.05
0.17 25.4588 1.3715  1.2340 15:18:22.32
```

3.2.2. Linear Profile

The CTD starts an automatic unattended data acquisition cycle in function of pressure intervals. Once the command is completed, the CTD switches off by itself and waits for the successive start-up. At the

successive start-up and until the "Stop Acquisition" character is sent (CTRL-C), the CTD always wakes up and starts to acquire data in function of pressure intervals.
Acquired data is automatically stored in the CTD memory. Consecutive acquisitions/profiles can be done by switching ON/OFF the CTD. Each time the CTD is deployed, a new cast and data header is created. A profile is considered completed when more than 5 measurements (i.e. 5 pressure intervals) are stored.
The following message shows the CTD set-up and the "Linear" acquisition cycle.

OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 15:19:28.93 11-07-2012
Pressure acquisitions
Pressure acquisition step [dbar]:0.100000 <
DataSet per acquisition:1 <
Do you confirm the above setup [1(Yes,0(No] ?
Confirm ?:0 < 1
Probe Switch-Off by itself.
The next probe Wake-UP will start the configured acquisitions
OS304Plus Shutdown

Details of the linear configuration parameters can be found in section 4.0. Here is an example of the messages sent by the CTD once it starts an unattended linear cycle:

OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 15:20:44.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK].WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.60 VDC....CTD..Ok Analogue:.Ok
OperatingMode...Pressure
PressureProfile
OpenLOG(1)..oK
Acquisition: <^C>Stop
Press Temp Cond Sal
0.19 25.4894 1.3770 1.2340 15:20:47.35
0.20 25.4902 1.3770 1.2340 15:20:47.61
0.20 25.4903 1.3770 1.2340 15:20:47.88

The CTD waits for the subsequent pressure data acquisition point.

WARNING
Please be aware that the configuration of zero or negative parameters could cause the CTD to behave in an unpredictable way.

3.2.3. Timed Profile

The CTD starts automatic unattended data acquisition in function of time interval. Once the set-up is completed, the CTD switches off by itself and waits for the successive start-up. At the successive start-up and until the "Stop Acquisition" character is sent (CTRL-C), the CTD wakes up and starts an acquisition. Acquired data is automatically stored in the CTD memory. A new cast and data header is created at the first cycle. Successive data is associated to the open cast.
Time between consecutive measurements is spent in OFF condition with a negligible current consumption (less than 8uA). The minimum interval time is 10 seconds.
An example of CTD configuration follows:
Timed Acquisitions

```
Data acquisition step: 00:01:00[hh:mm:ss]<
DataSet per acquisition:5 <
Number of acquisition cycle:0 < 10
First acquisition time: 00:00:00[hh:mm:ss]<
Do you confirm the above setup [1(Yes,0(No] ?
Confirm ?:0 < 1
OpenLOG(3)..oK
TimeAcquisition
Acquisition: <^C>Stop
Press   Temp    Cond    Sal
0.28 25.7098 1.3624  1.2340 15:35:38.37M
0.28 25.7098 1.3624 1.2340  15:35:38.63M
0.28 25.7100 1.3624  1.2340 15:35:38.90M
0.28 25.7105 1.3624  1.2340  15:35:39.19M
0.27 25.7111 1.3624  1.2340  15:35:39.46M
Timed Acquisition cycles left: 9
NextACQTime 15:36:37.48 11-07-2012
OS304Plus Shutdown
```

The timed profile parameters are described in section 4.0.
Here is an example of messages sent by the CTD once it carries out a time cycle.

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 15:37:37.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK]..WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.60 VDC....CTD..Ok Analogue:.Ok
OperatingMode...Timed
TimeAcquisitionAcquisition: <^C>Stop
Press   Temp    Cond    Sal
0.28 25.7565 1.3629  1.2340 15:37:41.02M
0.28 25.7562 1.3629  1.2340 15:37:41.29M
0.28 25.7558 1.3628  1.2340 15:37:41.56M
0.28 25.7555 1.3628  1.2340 15:37:41.83M
0.28 25.7551 1.3628  1.2340 15:37:42.12M
Timed Acquisition cycles left: 7
NextACQTime 15:38:37.14 11-07-2012
OS304Plus Shutdown
```

WARNING
The configuration of zero or negative parameters could cause the CTD to behave in an unpredictable way.

3.2.4. Continuous Sampling

The CTD continuously acquire and store data from the sensors accordingly with the configured data rate. This command is interrupted upon receipt of the "Stop Acquisition" (CTRL-C). More continuous sampling cycles can be performed by acting on the CTD ON/OFF switch.
An example of CTD configuration messages follows:

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:14:51.70 11-07-2012
Continuous acquisitions
Data acquisition scan rate [125ms]:250 <
Probe Switch-Off by itself.
 The next probe Wake-UP will start the configured acquisitions
OS304Plus Shutdown
```

The continuous cycle configuration parameters are described in section 4.0.

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:15:59.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK].WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.59 VDC....CTD..Ok Analogue:.Ok
OperatingMode...Continuous
OpenLOG(4)..oK
Acquisition: <^C>Stop
 Press   Temp    Cond    Sal
 0.24 26.2479 1.3653  1.2340 16:16:02.75M
 0.24 26.2479 1.3653  1.2340 16:16:03.04M
 0.24 26.2483 1.3653  1.2340 16:16:03.31M
```

WARNING
The configuration of zeros or negative parameters could cause the CTD to behave in an unpredictable way.

3.2.5. Conditional Sampling

Output from a chosen sensor is monitored at configured regular time intervals. When it reaches the configured boundary "Trigger", a "continuous sampling cycle" starts as configured. The cycle continues until data from the chosen sensor falls back under the trigger. This data acquisition cycle is interrupted upon receipt of the "Stop Acquisition" (CTRL-C).
Conditional sampling cycles can be performed by acting on the CTD ON/OFF switch. An example of CTD configuration message follows:

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:19:16.45 11-07-2012
Conditional Sampling
Monitoring timeout: 00:00:30[hh:mm:ss]<
Sensor to monitor: 0)Pressure, 1)Temperature, 2)Conductivity
Select sensor:0 < 1
Sensor trigger value:0.100000 < 30
Data acquisition scan rate [125ms]:250 <
Do you confirm the above setup [1(Yes,0(No] ?
Confirm ?:0 < 1
Probe Switch-Off by itself
The next probe Wake-UP will start the configured acquisitions
NextACQTime 16:20:01.86 11-07-2012
OS304Plus Shutdown
```

The conditional profile configuration parameters are described in section 4.

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:21:01.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK].WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.60 VDC....CTD..Ok Analogue:.Ok
OperatingMode...Conditional
NextACQTime 16:21:31.74 11-07-2012
OS304Plus Shutdown
```

WARNING
The configuration of zero or negative parameters could cause the CTD to behave in an unpredictable way.

3.2.6. Burst Sampling

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 CTD switches OFF and ON by itself between bursts. Burst sampling is somehow complementary to "time" acquisitions.

An example of a burst sampling cycle configuration follows:

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:43:44.77 11-07-2012
Burst measurements
Whole number of burst:5 <
Data set per single burst:1 <
Time between consecutive burts: 00:00:30[hh:mm:ss]<
Time between dataset in single burst [250ms..60000ms]:250 <
First acquisition time: 00:00:00[hh:mm:ss]<
Do you confirm the above setup [1(Yes,0(No] ?
Confirm ?:0 < 1
OpenLOG(5)..oK
BurstAcquisition..HF
Acquisition: <^C>Stop
Press   Temp    Cond    Sal
0.34 26.5440 1.3686  1.2340 16:44:06.37M
Burst cycles left: 4
NextACQTime 16:44:35.39 11-07-2012
OS304Plus Shutdown
```

The burst data acquisition configuration parameters are described in section 4.

```
OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:45:35.01 11-07-2012
Work.Mem:Cnf[oK].Calb[oK].Stat[oK].WakeUp[9F]
Data memory...[1 GByte]
WarmUp-
Battery..3.60 VDC....CTD..Ok Analogue:.Ok
OperatingMode...Burst
BurstAcquisition..HF
Acquisition: <^C>Stop
 Press   Temp    Cond    Sal
   0.33 26.5543 1.3686 1.2340 16:45:39.04M
Burst cycles left: 1
NextACQTime 16:46:05.06 11-07-2012
OS304Plus Shutdown
```

WARNING

The configuration of zero or negative parameters could cause the CTD to behave in an unpredictable way.

3.3. *CALIBRATION*

This section provides general information on options available under the CALIBRATION MENU. In details, it includes:

- **Pressure sensor.**
- **Temperature sensor.**
- **Conductivity sensor.**

Note
Calibration procedures of the optional sensors: Oxygen and Turbidity are described in the dedicated sections.

The below message shows the CALIBRATION MENU, as it is presented on the ITERM screen by the CTD.

OCEAN SEVEN 304Plus - ID:304-0010101 {USR}[9.0_00-02/2012] 16:45:35.01 11-07-2012
Calibration
Idx – Sensor
255- Quit
001- Press
002- Temp
003- Cond
Idx:255 <

Exiting from the sensor calibration is done by confirming the default index code (255). When exiting, the new calibrations are stored in the non volatile memory and the main menu appears on the screen.

WARNING
- *Modification of calibration affects both newly acquired data and stored data. Therefore, before recalibrating a CTD sensor, we strongly suggest uploading data from the CTD memory.*
- *IDRONAUT suggests a complete check and CTD sensor re-calibration once per year.*

3.3.1. Pressure sensor calibration

To avoid that a minimum drift occurs in the pressure sensor, it is preferable to immerse the CTD in water, up to about 10 cm from the CTD housing and wait a few seconds before starting the calibration. After the pressure sensor is selected by means of the index code, the CTD displays:

Pressure is calculated by means of a polynomial interpolation against a calibration curve.

Press dbar = $(a + bx + cx^2)$ – sensor offset

Where:

x = pressure sensor reading in ADC counts
sensor offset = automatically acquired at the end of calibration

Pressure
Enter coeff.. x=a+bx+cx2
a = -18.173212
b = 0.018204
c = -12.46533E-12

The operator can confirm or modify the above coefficients. Typing an **<ENTER>** key confirms the shown coefficients, while, typing new values followed by an **<ENTER>** key modifies the previous coefficients.

a = -18.173212
b = 0.018204
c = -12.46533E-12

Once the last coefficient has been entered, the CTD performs the pressure sensor offset,

Pressure sensor offset = 0.017830 dbar

3.3.2. Temperature sensor calibration

The operator enters the calibration values. Temperature is calculated by means of a polynomial interpolation against a calibration curve.

Temp °C = $a + bx + cx^2$

where:

x = temperature sensor reading in ADC counts

Three coefficients "a", "b" and "c" must be entered. After the "temperature sensor" has been selected, typing its index code at the data entry prompt, the CTD shows the following messages:

Temperature sensor calibration
Enter coeff.. x=a+bx+cx2
a = -0.304912
b = 0.0078532
c = -0.1289741e-12

The operator can confirm or modify the above coefficients. Typing an **<ENTER>** key confirms the shown coefficients, while, typing new values followed by an **<ENTER>** key modifies the previous coefficients.

(a)=:-0.304912 <
(b)=:0.0078532 <
(c)=:-0.12897e-12 <

Once the last coefficient has been confirmed or modified, the CTD shows the sensor calibration menu again.

3.3.3. Conductivity sensor calibration

After the "conductivity sensor" has been selected, type its index code at the data entry prompt and the CTD shows the following message.
Conductivity is calculated by means of a polynomial interpolation against a calibration curve.

Cond $mScm^{-1} = a + bx + cx^2$

Where:

X = Conductivity sensor reading in ADC counts

Message from CTD

Conductivity
Enter coeff.. x=a+bx+cx2
a = 0.0000987
b = 0.0011187
c = 1.659832e-13

The operator can confirm or modify the above coefficients. Typing an **<ENTER>** key confirms the shown coefficients, while, typing new values followed by an **<ENTER>** key modifies the previous coefficients.

a = 0.0000987
b = 0.0011187
c = 1.659832e-13

Note
The conductivity sensor is usually very stable and precise. A check of any drift with time or calibration can be performed by using a Standard Solution. A worldwide used Standard Solution for conductivity is the so called "Copenhagen Water" and is supplied by I.A.P.S.O. - Standard Seawater Service. The certified value of Chlorinity is 19.371 ppt, which corresponds to a Practical Salinity of 35.00 ppt. The temperature value is determined in the salinity calculation. 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 CTD must be carefully rinsed with distilled water, in order to remove any salt residue, and dried. These precautions are necessary for not diluting or contaminating the Reference Solution. Transfer some Copenhagen Water into a beaker and immerse the CTD into it. The value for conductivity and temperature can be read from the "Real-time calculated data" mode. The conductivity value is supposed to be coincident or very close to the theoretical one.

3.4. *MEMORY MANAGEMENT*

This group of commands allows the operator to check, query and show data stored in the CTD non-volatile memory. Once invoked, the following message appears on the ITERM screen:

OCEAN SEVEN 304Plus - ID:304-0000000 {USR}[9.0_00-08/2012] 12:43:37.23 11-09-2012
Memory
[0]MainMenu
[1]Status
[2]Show-Stored
[3]Delete Cast
[4]Initialize
cmd>

3.4.1. Memory priming

The non-volatile data memory installed in the OCEAN SEVEN 304*Plus* CTD allows the storing of up to about 60,000,000 data sets, each one being composed of the reading of: Conductivity, Temperature and Pressure sensors plus the acquisition date and time. Data sets are automatically associated with the header "cast" information that allows the operator to successively identify and retrieve portion of the stored data. The CTD can store up to 1600 different casts or headers.

3.4.2. Memory Status

This command allows the operator to know the amount of CTD memory used at the moment of the query.

Memory Status

Stored cast :	*[1600]Max*	*- [*	*0]Used*
Stored dataset:	*[61793120]Max*	*- [*	*0]Used*
Memory sectors:	*[3862528]Max*	*- [*	*202]Used*
Memory bytes :	*[1977614336]Max*	*- [*	*103424]Used*

3.4.3. Show stored data

It allows the operator to see the contents of a single cast. Data is sent to the ITERM screen, data set by data set converted into engineering units. Data showing can be interrupted by means of the **<CTRL-C>** character. Here is an example of the message shown on screen once this command is invoked:

Id DataSet 1stSector N.Sectors Acq.Mode Acq.Step Status Time
001 00000003 00000000-00000001 LINEAR 1.00 002 10:19:15 10-09-2012
Cast to show:0 < 1

From the shown list of casts/headers, it is possible to select the cast to show on the screen.

Press Temp Cond Sal
0.01 20.378 0.007 0.012 10:20:01.30 10-09-2012
0.01 20.378 0.007 0.012 10:20:03.20 10-09-2012
0.01 20.378 0.007 0.012 10:20:15.10 10-09-2012

3.4.4. Delete Cast

A single cast can be "marked" as deleted using this command. Deleted cast will not be uploaded from the PC using the IDRONAUT REDAS-5 and ITERM software.
The cast header and the associated data is not effectively deleted. A deleted cast can be undeleted, if needed, using the same command. Once invoked, the list of stored cast is shown on the ITERM screen.

Id DataSet 1stSector N.Sectors Acq.Mode Acq.Step Status Time
001 00000003 00000000-00000001 LINEAR 1.00 002 10:19:15 10-09-2012
Cast to delete/undelete 0 < 1

3.4.5. Initialize Memory

This command allows the operator to initialize and effectively delete the CTD memory: data and headers. **This command cannot be reversed: the data is permanently deleted.**

Initialize&Delete Memory
Confirm memory initialization ? (1)Yes, (0)No:0 < 1

If the operator answers "1" for YES, the data memory is permanently deleted !

Probe memory has been initialized
Type <any key>To continue

3.5. *SERVICE MENU*

CTD diagnostics and configuration functions are available under the Service Menu. Most of the service functions are password-protected and can be accessed only under the SERVICE or ADMINISTRATIVE rights. Once invoked, the following message appears on the ITERM screen:

OCEAN SEVEN 304Plus - ID:304-0000000 {USR}[9.0_00-08/2012] 12:58:10.45 11-09-2012
Service
[0]MainMenu
[1]Setup
[2]RealTimeClock
[3]RawCounts
[4]RawmV
[5]Rights
[6]Firmware
[7]Diagnostic
cmd>

3.5.1. Set-up

The CTD "USER"configuration procedure allows to set up the following parameters:

OCEAN SEVEN 304Plus - Setup
Warm-up timeout [s]:0 <

Time-out to be spent at the CTD start-up to allow the sensor stabilization. It must be used when the CTD interfaces oxygen and/or turbidity optional sensors (default values: 30s for oxygen and 5s for turbidity).

Number of rows between headers [1..255]:22 <

This parameter defines the number of data rows shown by the CTD between header messages. Default value is 22.

Under the "SERVICE" rights, the following additional parameters can be set.

16bit sensors measure to average:32 <

Optional sensors like: O2 and Turbidity data acquisition. Increasing the "measure to average" decreases the noise and the number of measurements per second. The default value is 32. Below this figure, the CTD performance, in terms of accuracy and resolution, cannot be guaranteed.

Turbidity Meter auto scale set-up [0..65535 ms]:800 <

Whenever the Turbidity meter is installed and the automatic scale management is active, this time-out is spent when the measuring scale is switched to allow the Turbidity sensor stabilization.

Main com. port BPS: 0)9k6,1)19k2,2)38k4,3)57k6,4)115k2:2 <

CTD communication speed. Default value is 38K4. In case this parameter is modified, the ITERM program communication speed must be modified too. The modification is applied at the successive CTD start-up.

Battery low voltage limit [V]: 2.7

This limit represents the minimum battery operating voltage. Below the 2.7V limit, the CTD cannot operate properly and its behaviour is unpredictable.

Under the "ADMINISTRATOR" rights, additional parameters can be set.

Note
Details about these parameters are out of the scope of this Operator's Manual. The improper modification of these parameters could cause malfunction of the CTD. Contact IDRONAUT to obtain detailed information.

Now the CTD shows the list of acquirable sensors and associated derived parameters. This list is used by the CTD to acquire, store and show real-time data. Up to fifteen parameters/sensors can be configured, selecting them from the below list of possible sensors, parameters.

Parameter Set-up
Id Name Code Mux Digits
01   Press 0000 254 0002

02 Temp 0001 254 0003
03 Cond 0002 253 0003
04 Sal 0004 255 0003
05 UNKNW 0255 255 0000
06 UNKNW 0255 255 0000
07 UNKNW 0255 255 0002
08 UNKNW 0255 255 0002
09 UNKNW 0255 255 0002
10 UNKNW 0255 255 0002
11 UNKNW 0255 255 0002
12 UNKNW 0255 255 0002
13 UNKNW 0255 255 0002
14 UNKNW 0255 255 0002
15 UNKNW 0255 255 0002

CMD:I)nitialize,M)odify,D)elete,Q)uit

At the end of the list, commands available to perform the configuration are shown:

Initialize Completely deletes the list.
Modify Allows the operator to enter a new sensor/parameter in the list or modify an existing one. See below for the details about configuration.
Delete Allows the operator to delete a configured sensor/parameter from the list.
Quit Terminates editing and ends the set-up too.

The following parameters can be configured by means of the Modify command:

Sensor code[0..24,255=NU]
Sensor mux.[0..3,255=NU]
Sensor precision [0..6]

The below table reports the value associated to the available sensors/parameters:

Sensor Code	Sensor Description	Sensor Mux.	Sensor Precision
0	Pressure	254	2
1	Temperature	254	3
2	Conductivity	253	3
3	Conductivity @20°C	255	3
4	Salinity	255	3
5	O_2 ppm	255	2
6	O_2 %	1	1
16	Sound-V	255	4
18	Conductivity @25°C	255	3
22	Density	255	6
24	Turbidity	0	1
29	TDS	255	3

Mux channel 255 = Derived parameter does not belong to a single sensor.
Mux channel 254/3 = Special CTD preamplifier.

The present firmware release includes the following processed/derived parameters: SALINITY, SOUND SPEED, DENSITY, CONDUCTIVITY@ 20°C, CONDUCTIVITY@ 25°C and TOTAL

DISSOLVED SOLIDS, according to the UNESCO formulae. Derived parameters must appear in the list after the sensors used in the calculations. For instance, salinity must appear in the list after conductivity, temperature and pressure sensors.

WARNING
The configuration of zeros or negative parameters could cause the CTD to behave in an unpredictable way.

3.5.2. Real-time Clock set-up

This command allows the operator to set up the CTD RTC date and time. Once invoked, a data entry prompt appears and the operator can enter the relevant information. When the battery or the external power supply is removed, the RTC date and time are lost and must be configured again. If the battery is left connected, the RTC date and time are kept indefinitely.

Once this function is invoked, the following message appears on the user's screen.

Date&Time [dd/mm/yyyy hh:mm:ss wday] [1..31/1..12/1970..2069 0..23:0..59:0.59 1..7 <

The operator should enter the current date and time respecting the above rule and concluding the message with an **<ENTER>** key. About the day of the week, it is coded as 1 = Monday to 7=Sunday.

3.5.3. Raw Counts or Raw mV

This command allows the operator to see data acquired from the 16bit ADCoverter (**Optional sensors data acquisition)** in real time expressed in counts or in mV. Data acquisition can be interrupted at any time by means of the **<CTRL-C>** character. Once running, the following message appears on the screen:

Keyb.Cmd:<^C>Quit,<T>urbidity-Scale<1>[500 FTU]

Mux(0)	*Mux(1)*	*Mux(2)*	*Mux(3)*	*Mux(4)*	*Mux(5)*	*Mux(6)*	*Mux(7)*
0.0	*714.4*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
0.0	*714.2*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.1*
0.0	*714.2*	*0.0*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*
0.0	*714.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
0.0	*713.9*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*

3.5.4. Rights

This command allows the operator to set up the access rights to the CTD functions and configuration. The operator's password is "**SERVICE304**", while, the administrator's password which allows the set-up of delicate and privileged configuration parameters can be obtained only by requesting it to IDRONAUT.

3.5.5. Firmware

The OS*304Plus* CTD firmware can be updated in the field without opening the CTD and/or changing any electronic component. This section describes the procedure to follow in order to upgrade the OS*304Plus* firmware.
OS*304Plus* firmware upgrading package contains:

OS*304Plus*ReadMe.txt	Description of the firmware news.
Os*304Plus*_xxxx.txt	OS*304Plus* firmware upgrading file (xxxx indicates the firmware release).
ITERM.exe	The IDRONAUT Terminal Emulation Programme.
ITERM.rtf	Help document of the Terminal Emulation Programme.

Copy the OS304*Plus* firmware upgrading file into the ITERM folder on the computer hard disk.

Windows Personal Computer Preparation

The firmware is shipped together with the ITERM (IDRONAUT Terminal Emulation Programme). The installation of ITERM is simple and does not require running any set-up.

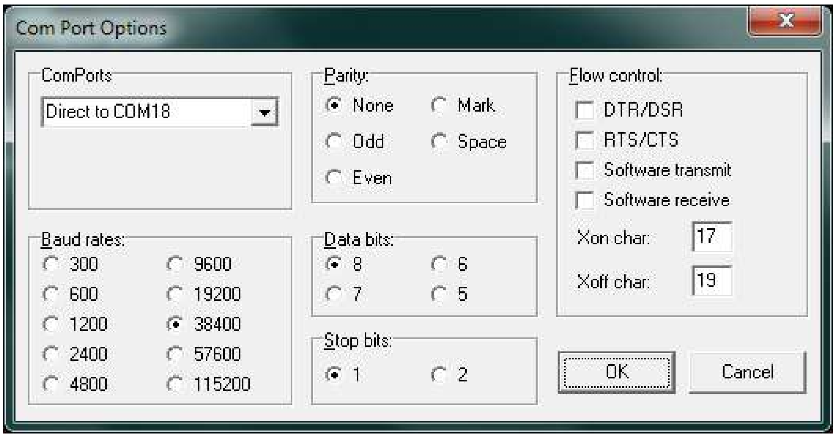
Proceed as follows:

- Copy the OS*304Plus* firmware upgrading package to a dedicated folder on the computer hard disk.
- Unpack it using WINZIP or any other file uncompressing utility.
- From the desktop and using the Windows resources, create a link on the desktop pointing to the ITERM programme.
- Run the ITERM programme. It starts with the correct communication parameters already set.
- You are ready to switch ON the OS*304Plus* device.

Note

☞ *The ITERM port configuration is the following:*

- *Communication speed* *38400 bps*
- *Data bit* *8*
- *Stop bit* *1*
- *Parity* *None*
- *Flow Control* *None*



☞ *The ITERM programme help contains the description of the programme main functions.*

OS*304Plus* preparation

Connect the laboratory cable between the personal computer communication port and the OS*304Plus* and then switch on the OS304*Plus*. As soon as you switch the OS*304Plus* on, the start-up messages must appear on the ITERM window.

Once the OS*304Plus* main menu appears, select the Service Menu and then select command 5. This command allows the operator to access the "SETUP" using administrative rights. Once the command is sent, the following message appears:

Access rights<<

Answer the request by typing "**ROOTACCESS**". If the password is correctly entered and accepted, the menu appears again. From the shown service menu, select command 1 **SETUP**! Go through the parameters using the ENTER key until the request about the MAIN com port speed appears.

OCEAN SEVEN 304Plus - Setup
Configuration[191]-Status[177]-Calibration[309]{F8E5}
Warm-up timeout [s]:0 <
Number of rows between headers [1..255]:22 <
Main com. port BPS: 0)9k6,1)19k2,2)38k4,3)57k6,4)115k2:0 <

Change the speed to the 9.6Kbps !

....
Parameter Setup Id Name Code Mux Digits
01 Press 0000 254 0002
02 Temp 0001 254 0003
03 Cond 0002 253 0003
04 Sal 0004 255 0003
05 SoundV 0016 255 0004
CMD>I)nitialize,M)odify,D)elete,Q)uit
cmd>

When this prompt appears, type Q to exit and then **switch off** the OS304*Plus* CTD and proceed with the next step. The CTD will wake using the new 9600 bps speed !

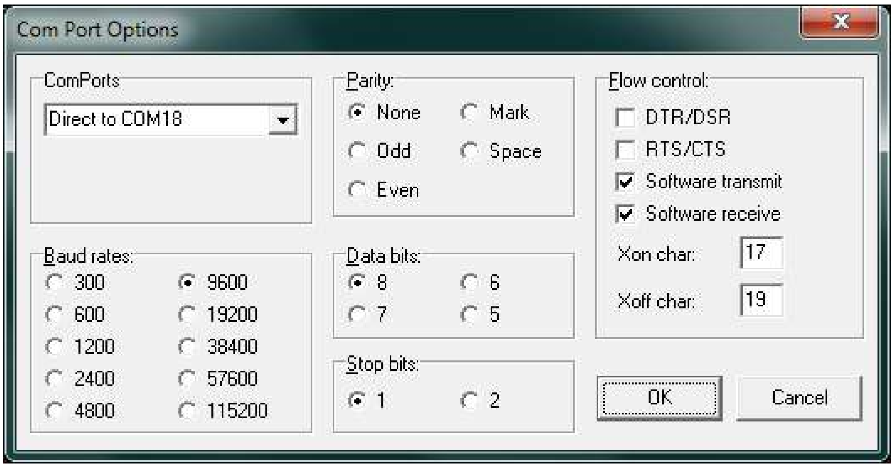
Set up the ITERM to the 9600 bps speed

Now, ITERM must be modified according to the firmware upgrading speed and set-up.

Note

☞ *The ITERM port configuration is the following:*

- *Communication speed* 9600 bps
- *Data bit* 8
- *Stop bit* 1
- *Parity* None
- *Flow Control* Xon/Xoff



☞ *The ITERM programme help contains the description of the programme main functions.*

☞ *At higher baud-rates, even if possible, it* ***cannot be used to upgrade the OS304Plus*** *CTD firmware. Therefore, modify the OS304Plus communication speed and* ***set it to the 9600bps value before continuing/proceeding with the firmware upgrading.***

☞ *During the firmware upgrading, the Xon/Xoff RS232C protocol is used by the CTD to communicate with the ITERM programme.* ***Therefore, before proceeding, the Xon/Xoff must be enabled in the ITERM programme by accessing the serial port set-up and enabling the "Software transmit" and "Software receive".***

Start firmware upgrading

1. Switch on the OS304*Plus*. Once the OS304*Plus* main menu appears, select the Service Menu and then select command **6 FIRMWARE**. This command allows the operator to access the "Firmware upgrading" function. Once the command is sent, the following message appears:

```
Access rights<<
```

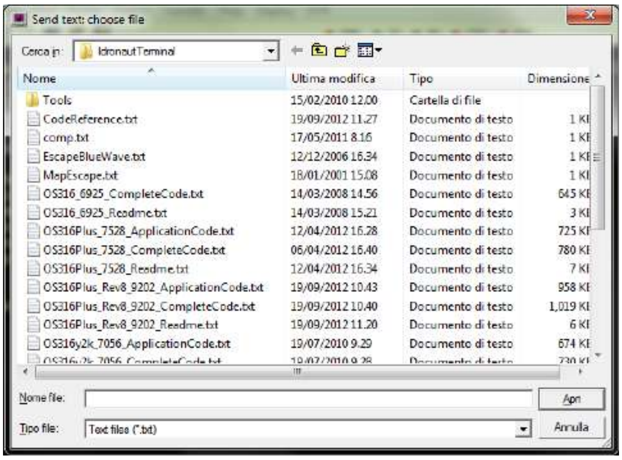
2. Answer the request by typing "ROOTACCESS". If the password is correctly entered and accepted, the following message appears:

```
Firmware upgrading: 07:13:52.39 04-02-2026
OS304Plus-Bootloader[v4 03/2013]<^C-Abort> <SPACE-New Firmware>
```

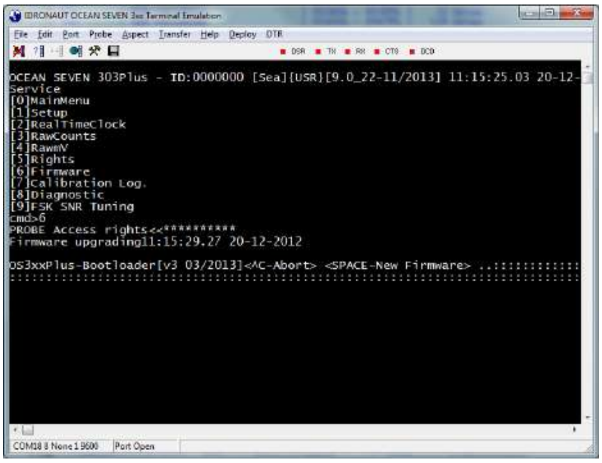
Two commands are available:

CTRL-C Aborts the firmware upgrading procedure and runs the previous firmware again.
SPACE Starts the firmware upgrading procedure.

3. When the SPACE is typed, a dot appears after the ">" bracket immediately. After few seconds, a second dot appears at the same position.
4. When this happens, select the OceanSeven*304Plus*_xxx.txt file using the "TRANSFER->SEND TEXT FILE" function of the ITERM programme and confirm it by means of the OK button.

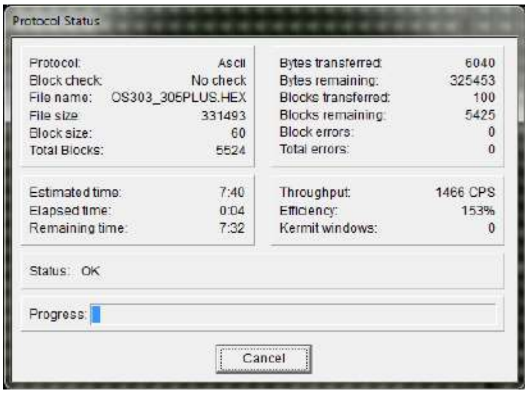


5. The ITERM programme will automatically start to transfer the OceanSeven*304Plus*_xxx.txt file contents to the OS*304Plus* CTD, row by row.



6. In the meantime, a row is sent to the OCEAN SEVEN *304Plus* a **":"** character is shown repeatedly on the ITERM window. This character is transmitted by the OCEAN SEVEN

304Plus CTD to acknowledge receipt of a portion of firmware. This procedure continues until the end of the OceanSeven*304Plus*_xxx.txt file is reached. The end of the firmware transfer is easily acknowledged by the automatic closure of the ITERM "File Transfer" window.



7. When this happens and if everything has gone well, the OS*304Plus* CTD will restart by itself showing the main menu. The OS*304Plus* firmware has been upgraded.
8. Sometimes and independently of the successfully completion of the firmware upgrading procedure, the CTD does not restart by itself immediately. If this happens, please switch it OFF and then ON respecting the 30s delay between the OFF-ON cycles. The CTD will restart and, if the following firmware upgrading message appears again:

```
OS3xxPlus-Bootloader[v3 03/2013]<^C-Abort> <SPACE-New Firmware>
```

type CTRL-C to start with the new firmware. If the CTD Main Menu appears, the procedure is completed. Otherwise, if the above message appears again, repeat the firmware upgrading procedure starting from point 2 above.

Note

- ☞ *This procedure cannot be interrupted or aborted; after you've run it, you must complete it as described, otherwise the OS304Plus device will not operate properly.*
- ☞ *Please be sure that the OS304Plus power source is stable and never interrupted during the firmware upgrading.*
- ☞ *Please be sure that the connected PC is well powered and do not run any other software during the firmware upgrading procedure.*
- ☞ *The firmware upgrading procedure should take about 10 minutes at the maximum.*

In case the firmware upgrading procedure is not well performed and after switching on/off the CTD, the main menu does not appear, nor is the above message in point (2) shown, contact Idronaut to receive the further instructions.

The OCEAN SEVEN 304Plus communication speed can now be returned to the default value of 38400bps reverting the above described procedure!

3.5.6. Diagnostics

Access to the diagnostic functions of the CTD electronic board is protected by ADMINISTRATIVE rights. The description of these functions is out of the scope of this Operator's Manual. Contact IDRONAUT to obtain detailed information.

3.6. CHANGE OPERATING MODE

This command allows the operator to change the OCEAN SEVEN 304*Plus* CTD operating mode from "Verbose" to "Non Verbose".

4. SELF RECORDING

The following section describes, by means of step-by-step procedures, how to configure and perform unattended data acquisitions in function of pressure and/or time intervals, and how to retrieve data stored in the CTD internal memory.

4.1. *UNATTENDED PROFILES IN FUNCTION OF PRESSURE INCREMENTS*

This type of acquisition is used to automatically gather and store data in function of the pressure increments, whenever the CTD is deployed and lowered in water. After establishing the communication with the CTD, proceed as follows.

4.1.1. Preliminary configuration

- Install new batteries or recharge the battery pack (optional NiMH battery pack).
- Run the "ITERM" programme.
- Connect the CTD to the computer using the USB laboratory cable and then switch the CTD ON.
- The CTD main menu appears.
- Check and set up the RTC, if needed
- Using the sensor calibration function, perform the pressure sensor offset zeroing.
- From the Main Menu, select the "DATA ACQUISITION MENU" and then select the "LINEAR".
- Answer the following questions:

Pressure acquisitions
Pressure acquisition step [dbar]:0.100000 < 1.0

Pressure interval that will be used during the acquisition cycles to store data in memory.

Data Set per acquisition:50 < 3

Number of data set to store for each pressure interval.

Confirm: [0)No 1)Yes]

- Now, the CTD switches OFF by itself and is ready to perform the data acquisition.
- Disconnect the USB laboratory cable and rotate the magnetic rotary switch in OFF position.

4.1.2. Field operations

Once you have reached the sampling site, switch ON the CTD by positioning the magnetic switch arm on the red dot; the CTD wakes up and watches the pressure sensor value to start the acquisition. Lowering the CTD in water starts the data acquisition and data storing. When the CTD returns to the surface, wait 20 seconds and then switch it OFF by rotating the magnetic switch arm to the OFF position. Move to the new profiling site, switch ON the CTD and lower it into water.

Notes

1) Each time a data acquisition is performed, a new data header is automatically generated.
2) Data acquisition ends whenever the CTD battery has run down or data memory is full or the operator decides to stop it.

4.1.3. Ending the unattended data acquisitions

- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable.
- The CTD start-up messages appear.
- Type the <CTRL-C> key until the Main menu appear.
- The unattended linear profile is ended and the CTD is working in the default verbose mode, waiting for the operator's commands.

4.2. *UNATTENDED ACQUISITION IN FUNCTION OF TIME INCREMENTS*

Unattended acquisition in function of time is useful once the CTD is used to monitor the environment for long periods of time. Some examples of configuration and CTD behaviours are reported below.

4.2.1. Preliminary configuration

- Install new batteries or recharge the battery pack (optional NiMH battery pack).
- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD main menu must appear.
- Check and set up the RTC, if needed.
- Select the "Data Acquisition" menu and then the "Timed data acquisition" function, answering the following questions:

Data acquisition step: 00:01:00 < 00:00:30

Time interval that is used during the acquisition cycles to acquire and store data in memory. The minimum interval time is 10 s.

Data Set per acquisition:5 < 1

Number of data sets stored for each time interval.

First acquisition time: 00:00:00

Data acquisition starting time. If the default value of 00:00:00 is confirmed, the CTD switches OFF configuring the next acquisition time and adding the "data acquisition step" to the current date and time. Otherwise, the next acquisition time will be the configured first acquisition time.

Next Time 10:00:00 10-09-2005

At the end of configuration, the CTD switches OFF by itself and waits for the next start-up before starting to acquire data.

Confirm: [0)No 1)Yes]

The operator must confirm the configuration before the unattended measurement cycle can begin. In case of a negative answer, the CTD returns to the main menu. Vice versa, a positive answer causes the CTD to switch OFF by itself, ready to perform the configured data acquisition cycle.

Notes

1) Once started, the data acquisition cycle can be interrupted at any time by rotating the magnetic switch arm to the OFF position. The cycle will start again when the CTD is switched ON. The new data acquisition time-out is automatically calculated using the data acquisition interval and the present time.
2) The data acquisition ends whenever: i)The CTD battery has run down. ii) The data memory is full. iii)The operator decides to stop it.

4.2.2. Field operations

Once you have reached the sampling site, switch ON the CTD by positioning the magnetic switch rotating arm over the red dot. When the CTD returns to the surface, you can switch it OFF by rotating back to OFF position the magnetic switch. The timed data acquisition cycle is temporarily suspended.

4.2.3. Ending the unattended data acquisitions

- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD start-up messages appear.
- Type the **<CTRL-C>** key until the main menu has appeared again.
- The unattended timed data acquisition cycle is ended and the CTD is working in the default mode, waiting for the operator's commands.

4.3. *UNATTENDED PROFILES USING THE CONTINUOUS ACQUISITION FUNCTION*

This type of acquisition is used to automatically gather and store data at the maximum possible sampling rate. This data acquisition function can be used to carry out both profiles and timed acquisitions. The advantage to carry out profiles using the continuous data acquisition, with respect to the linear (pressure step), is that the continuous data acquisition implies to acquire downward and upward data.

4.3.1. Preliminary configuration

- Install new batteries or recharge the battery pack (optional NiMH battery pack).
- Run the "ITERM" program.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD main menu must appear.
- Check and set up the RTC, if needed.
- Select the "DATA ACQUISITION MENU" and then select the "CONTINUOUS DATA ACQUISITION".
- Answer the following questions:

Continuous acquisitions
Data acquisition scan rate [125ms]:1 < 125

Data acquisition rate. The parameter is configure in ms. The minimum value is 125 ms and can be incremented in step of by 125 ms. The below table indicate some configuration examples:

Sampling rate	Interval to set up
8 Hz	125 ms
6 Hz	166 ms
4 Hz	250 ms
2 Hz	500 ms
1 Hz	1000 ms
0.1 Hz	10000 ms

The CTD switches OFF by itself and is ready to perform the data acquisition. Disconnect the USB laboratory cable and rotate the magnetic rotary switch to the OFF position.

4.3.2. Field operations

Once you have reached the sampling site, switch ON the CTD by positioning the magnetic switch arm to the red dot; the CTD wakes up and starts to acquire and store data.
When the CTD returns to the surface, switch it OFF by rotating the magnetic switch arm to the OFF position; data acquisition ends.

Notes:
1) Each time a data acquisition is performed, a new data header is automatically generated.
2) The data acquisition ends whenever: i)The battery has run down. ii) The data memory is full. iii)The operator decides to stop it.

4.3.3. Ending the unattended data acquisitions

- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD start-up messages appear.
- Type the **<CTRL-C>** key until the main menu appears.
- The continuous unattended data acquisition cycle is ended and the CTD is working in the standard mode, waiting for the operator's commands.

4.4. UNATTENDED PROFILES USING THE CONDITIONAL ACQUISITION

This type of acquisition is used to automatically gather and store data at the maximum possible speed, conditioned to the overcoming of a trigger value of the selected reference parameter. After establishing the communication with the CTD, proceed as follows.

4.4.1. Preliminary configuration

- Install new batteries or recharge the battery pack (optional NiMH battery pack).
- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD main menu appears.
- Check and set up the RTC, if needed.
- Select the "DATA ACQUISITION MENU" and then select the "CONDITIONAL DATA ACQUISITION".
- Answer the following question:

Conditional Sampling
Monitoring time-out [5s to 1day]: 5

Monitoring time-out used by the CTD to judge the value of the "condition" sensor. The minimum configurable time-out is 5 seconds, the maximum is one day. The CTD waits for the time between consecutive time-outs in OFF condition thus reducing the power consumption. The monitoring timeout affects the CTD power consumption, therefore a careful planning should be considered.

Sensor to monitor: 0)Pressure, 1)Temperature, 2)Conductivity
Select sensor: 0

Select the sensor to monitor in order to judge whether or not to start a sampling cycle.

Sensor trigger value: 10

Trigger value use by the CTD to start a a data acquisition cycle. The trigger value must be configured in engineering units. Obviously, the EE unit depends on the selected sensor: i.e. pressure dbar, temperature °C, conductivity mS/cm.

Data acquisition scan rate [125ms]: < 125

Define the scan rate at which the acquisition will be performed. The parameter is configured in milliseconds. The minimum value is 125 ms and can be increased in step of 125 ms.

Sampling Rate	Set-up parameter
8 Hz	125 ms
6 Hz	166 ms
4 Hz	250 ms
2 Hz	500 ms
1 Hz	1000 ms
0.1 Hz	10000 ms

Once the sampling rate is configured the following message appears on screen;

Confirm: [0)No 1)Yes]

The CTD switches OFF by itself configuring the first time-out at which the selected sensor will be monitored. In case the deployment should be done later on, it is possible to disconnect the USB laboratory cable and rotate the magnetic rotary switch to the OFF position.

4.4.2. Field operations

At the sampling site, switch ON the CTD by positioning the magnetic switch arm to the red dot; the CTD wakes up, monitors the selected sensor and, if needed, starts to acquire and store data.
When the CTD returns to the surface, you can switch it OFF by rotating the magnetic switch arm to the OFF position; data acquisition ends.

Note
The data acquisition ends whenever: i) The CTD battery has run down. ii) The data memory is full. Iii) The operator decides to stop it.

4.4.3. Ending the unattended data acquisitions

- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD starts to wake up and the start-up messages appear.
- Type the **<CTRL-C>** key until the main menu appears.
- The unattended conditional sampling cycle is ended and the CTD is working in the default mode, waiting for the operator's commands.

4.5. *UNATTENDED BURST SAMPLING*

Burst sampling is useful when the CTD is used to monitor the environment for long periods of time. Some examples of configuration and CTD behaviour are reported below.

4.5.1. Preliminary configuration

- Install new batteries or recharge the battery pack (optional NiMH battery pack).
- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The main menu appears.
- Check and set up the RTC, if needed.
- From the Main Menu, select the data acquisition menu and then the "Burst Sampling" function answering the following question:

Total number of bursts: 8 < 10

Number of measurement cycles or "Burst" to be carried out.

Data sets per single burst: 10 < 10

Number of data sets for single measurement cycle or "burst".

Time between consecutive bursts: 00:01:00[hh:mm:ss]<

Time interval between consecutive burst cycles. The minimum interval time is 10 s.

Time between data sets in a single burst [125ms..60000ms]:125 <

Time interval between consecutive dataset acquisitions in a single burst cycle. The minimum interval time is 125 ms; the maximum interval time is 60 s. The minimum value is 125 ms and can be increased by 125 ms as follows:

Sampling Rate	Set-up parameter
8 Hz	125 ms
6 Hz	166 ms
4 Hz	250 ms
2 Hz	500 ms
1 Hz	1000 ms
0.1 Hz	10000 ms

First acquisition 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.

NxTime 10:00:00 10-11-2012

At the end of configuration, the CTD switches OFF by itself and waits for the next start-up time.

Confirm: [0)No 1)Yes]

Before the unattended measurement cycle can begin, the operator must confirm the configuration. In case of a negative answer, the CTD returns to the Main Menu. Vice versa, a positive answer causes the CTD to switch OFF by itself, ready to perform the configured data acquisition cycle.

Note

1) *Once started, the data acquisition cycle can be interrupted at any time by rotating the magnetic switch arm to the OFF position. The cycle will start again when the CTD is switched ON. The new data acquisition time-out is automatically calculated using the time between burst cycle and the present time.*
2) *The burst sampling ends whenever: i)The CTD battery has run down. ii) The data memory is full. iii)The operator decides to stop it. iv) The configured burst cycle has been perfor*med.

4.5.2. Field operations

At the sampling site, switch ON the CTD by positioning the magnetic switch rotating arm over the red dot. 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 temporarily suspended.

4.5.3. Ending the unattended data acquisitions

- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD start-up messages appear.
- Type the **<CTRL-C>** key until the Main Menu appears.
- The unattended burst sampling cycle is ended and the CTD is working in the standard mode, waiting for the operator's commands.

4.6. *UPLOADING THE DATA STORED IN THE PROBE MEMORY*

At the end of any unattended acquisition, data stored in the CTD memory can be retrieved. The following instructions explain how to do that by using the IDRONAUT Windows Terminal and REDAS-5 programs.

4.6.1. WINDOWS "ITERM"

- Run the "ITERM" programme.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- The CTD main menu appears.
- Run the "identify" command available under the "CTD" menu of the ITERM programme.
- After the CTD has been identified, run the CTD upload cast from the ITERM "Probe" menu.
- Select the stored data and leave ITERM upload them for you.

4.6.2. WINDOWS "REDAS-5"

- Run the "REDAS-5" program.
- Connect the CTD to the personal computer using the USB laboratory cable and then switch ON the CTD.
- From the REDAS-5 main menu, select the "REMOTE" sub-menu and then the "UPLOAD CAST" function.
- REDAS-5 interrogates the CTD and retrieves the list of stored casts.
- From the shown list of casts, the operator can select the cast he intends to upload using the mouse and the **<SHIFT>** or **<CNTRL >** keys.
- After the operator clicks on the OK button, the REDAS-5 programme starts to upload all the selected casts automatically.

4.7. *UNATTENDED ACQUISITIONS - IMPORTANT TIPS*

4.7.1. Power consumption reduction

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

4.7.2. ON/OFF cycles

Whenever you switch OFF the CTD, please wait 30 seconds before switching it ON again. This waiting time allows the CTD to perform a correct start-up procedure.

4.7.3. Shipping conditions

The CTD is shipped without the battery pack installed. Recharge and install the battery pack before carrying out any unattended acquisition cycles. Set up the CTD internal RTC date and time before starting an unattended cycle.

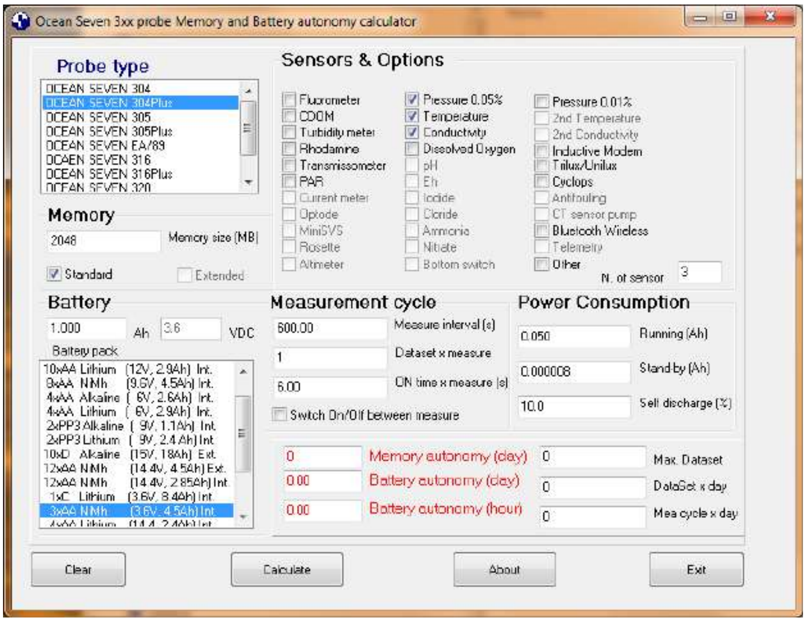
4.7.4. Sensors

Depth sensor Before executing a data acquisition in relation to depth, proceed to calibrate (null) the pressure sensor offset.

Conductivity sensor After using the CTD in seawater, wash the conductivity sensor with fresh water (preferably distilled water) thoroughly.
Do not leave the CTD exposed to direct sun light. Wet the conductivity sensor for one night before starting the measurement campaign.

4.7.5. Probe autonomy

A programme distributed with the ITERM software allows the user to calculate memory and power autonomy.



5. ITERM – WINDOWS TERMINAL EMULATION PROGRAMME

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 3xx CTDss. ITERM does not need any Windows installation procedure.

5.1. DISTRIBUTED FILES

ITERM can be freely uploaded from the IDRONAUT web site download area in a self-extracting package which contains the following files:

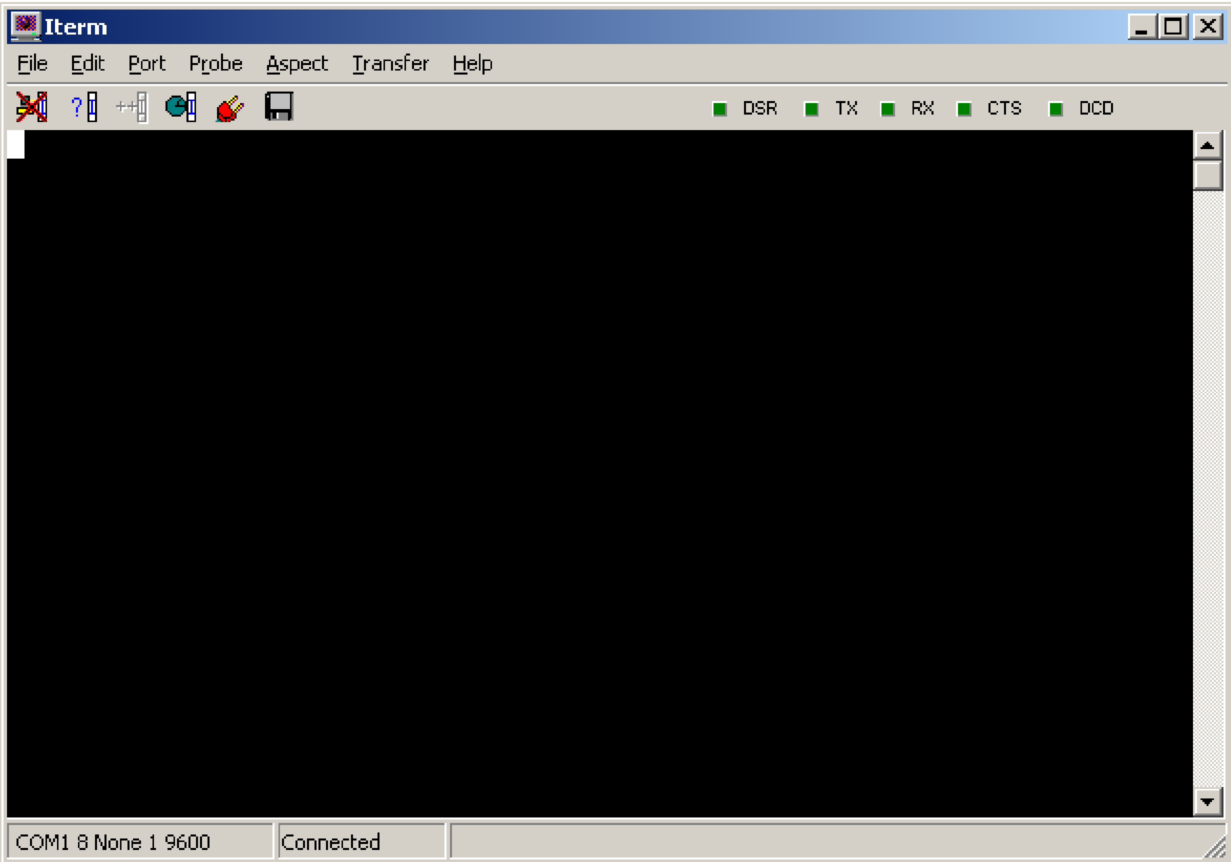
ITERM.EXE	Terminal emulation program.
Iterm.rtf	ITERM programme documentation (Read Only).

5.2. INSTALLATION

Before running the 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.

5.3. PROGRAMME MENUS AND FUNCTIONS

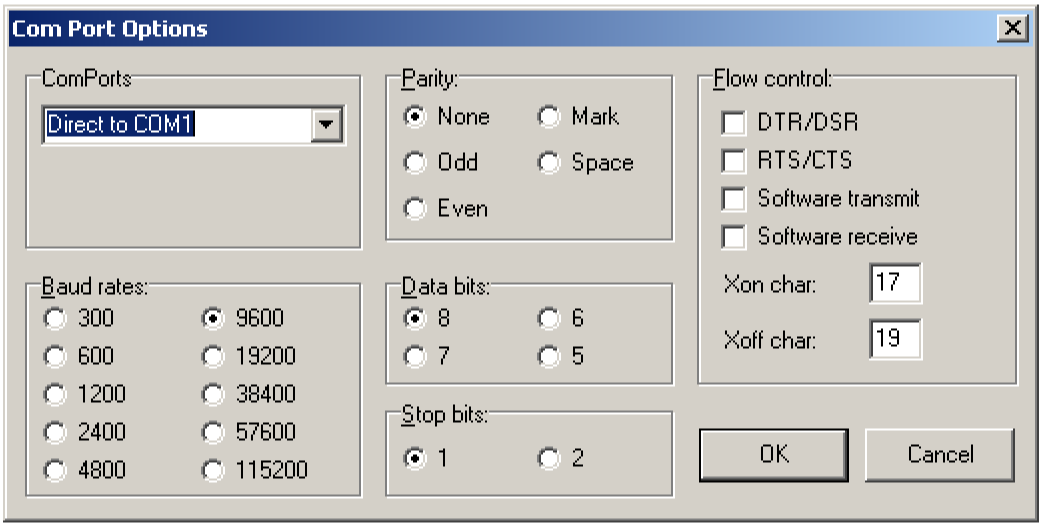
The ITERM main menu has the following items: File, Port, Probe, Transfer, Help. A short description of menus and functions follows.



File->Exit
It exits from the programme closing the communication port and any open files.

Edit->CopySelectionToClipBoard
This function copies the selected text to the Windows operating system clipboard buffer.

Port->Set parameters
This function allows the operator to set and define the communication port parameters. Default values for the OCEAN SEVEN 304*Plus* CTD are: 38k4bps, 8bit data, 1stop bit, No parity, hardware hand-checking (CTS/RTS, DTR/DSR) and software hand-checking (XON/XOFF).

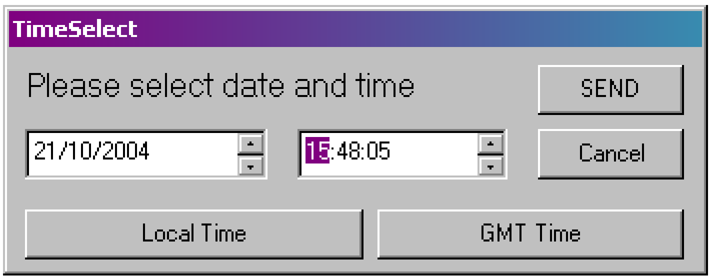


Port->Close
It closes the open communication port.

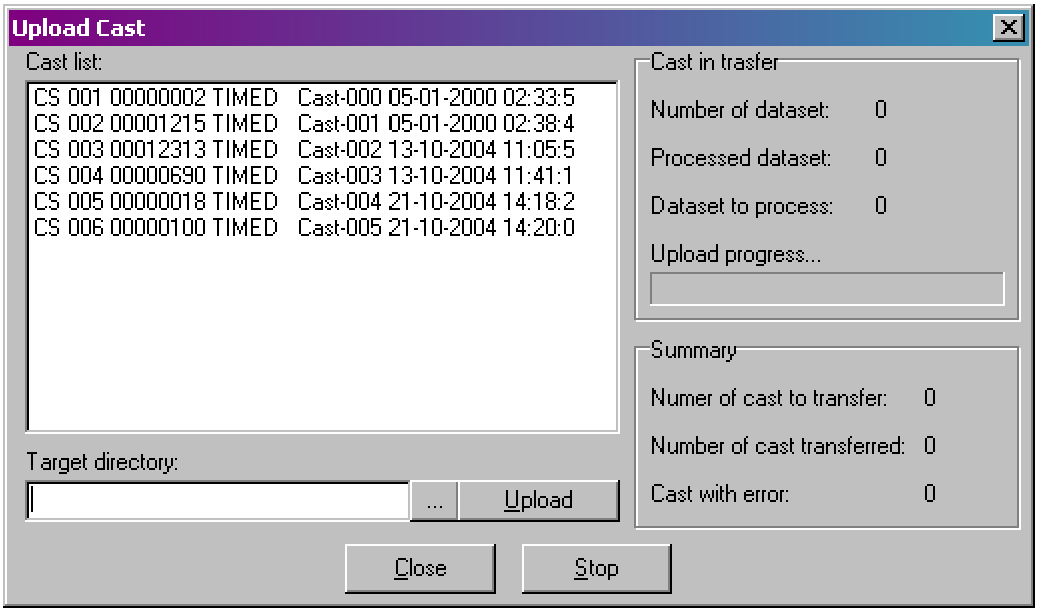
Probe->Identify
It identifies the connected CTD; information like the serial number, the hardware and firmware release are shown on screen.

Probe->Upgrade
This function is not available on the OCEAN SEVEN 304*Plus* CTD.

Probe->Set Time
It sets up CTD time and date. It is possible to select the time among GMT and local time or to customize the date and time.



Probe->UploadCast
This function allows the operator to retrieve data stored in the CTD memory storing it in "Text" files on the PC. The cast uploading is automatically performed by the program. This function is available only after the CTD 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 the 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 CTD 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 CTD connected through the serial port.

Transfer->CaptureToFile
This function captures the characters received and sent thought 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.

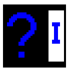
Help->Contents
It shows this help file.

Help->About
It shows notice about the ITERM programme release.

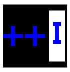
5.4. *TOOLBAR*

On the programme toolbar, there are the shortcuts to the programme functions.

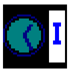
Disconnects the communication port, freeing the port for other programmes or allowing the communication port parameter modifications.



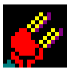
Detects and identifies the connected OCEAN SEVEN CTD type. At the end of the identification on the status and title bar of the programme, the information about the connected CTD appears.



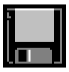
Upgrades the connected and identified CTD firmware.



Sets the connected CTD time and date, according to the PC or custom settings.



Accesses the communication port parameter set-up.



Captures transmissions from the connected CTD and keyboard typing and stores them in the selected text file. A red cross appears over the icon when running. Pressing once stops the capture and closes the text file.

5.5. *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.

5.6. *TROUBLESHOOTING*

The automatically generated files "Detect.log" and "Upgrade.Log" contain the dialog between the programme and the CTD concerning the operations of CTD detection and CTD upgrading. In case of trouble, please send us the above files together with a short description of the problem.

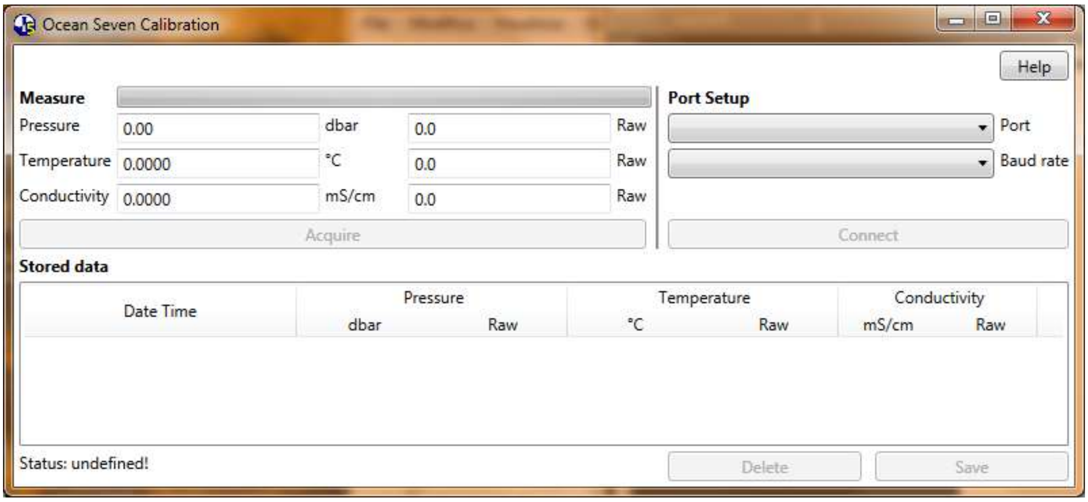
5.6.1. Tools

Together with ITERM, IDRONAUT distributes the following utility programs under the "tools" folder of ITERM:

Swpc	Sea water properties calculator.
UnitConvert	Convert among different units.
Interpolate	Linear/Logarithmic interpolation calculator.
OceanSevenCalibration	Acquire and store data for CTD re-calibration.

5.6.2. OceanSevenCalibration

This programme, distributed with ITERM, allows the operator to properly acquire and store data in a text file during the OS304*Plus* verification in a calibration laboratory.



6. INTERNAL BATTERIES

The OCEAN SEVEN 304*Plus* CTD housing has in its upper part enough space to accommodate an internal battery pack. The OS304*Plus* is powered by a single 3.6V battery; different types of battery can be installed in the CTD housing.

- *2 x size "AA" Alkaline 1.5V battery assembled in single battery pack* *3.0V*
- *1 x size "AA" Lithium non rechargeable battery* *3.6V, 2.4Ah*
- *1 x size "C" Lithium non rechargeable battery* *3.6V, 8.4Ah*
- *1 x size "D" Lithium non rechargeable battery* *3.6V, 19Ah*
- *NiMh rechargeable IDRONAUT custom battery pack (3x1.2 AA)* *3.6V,2.6 Ah*

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 304*Plus* CTD is shipped without batteries installed.

INSTALLING TWO 3.6V LITHIUM BATTERIES IN THE DOUBLE BATTERY HOLDER AND CONNECTING IT TO THE OS304*Plus* TOP COVER WILL CAUSE A PERMANENT DAMAGE OF THE OS304*Plus* CTD ELECTRONICS.

Optional USB Laboratory cable

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 USB laboratory cable is not connected. Therefore, to update the battery status after the recharging, switch on the CTD without the USB laboratory cable connected.

6.1. AISI316L & TITANIUM HOUSING BATTERY REPLACEMENT PROCEDURE

- Dry the CTD and lay it down on a table.
- Loosen the two closing screws on the CTD cover with a proper screwdriver.
- When extracting the cover, dry it and pay attention to any drop of water present on the cover or in the upper part of the CTD body. Anyhow, dry any trace of water in proximity of the external side of the o-ring.
- Extract the plastic battery holder from the CTD housing.
- Replace the battery.
- Re-insert the plastic battery holder in the CTD housing.
- Gently push the wires and connectors to the side of the battery holder.
- 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.

6.2. *POM HOUSING - BATTERY REPLACEMENT PROCEDURE*

To gain access to the internal battery holder, loosen with the ball end Allen screwdriver included in the CTD accessories, 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 2xAlkaline type AA cell, assembled in series, to create a unique 3.0VDC battery pack.

1. Dry the probe and lay it down on a table.
2. Remove the four hexagonal screws on the probe cover with the ball end Allen screwdriver.
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 proximity of the external side of the o-ring.
4. Pull the battery holder out and remove the dead batteries.
5. Install the new batteries.
6. Insert the battery pack in the CTD housing.
7. Lifting the CTD vertically helps to properly insert and mount the top cover.
8. Check the correct position of the o-ring and close the CTD with the four hexagonal screws. Gradually tighten the four screws in sequence so as to close the cover uniformly.

6.3. *OPTIONAL RECHARGEABLE BATTERY PACK*

The internal custom NiMH rechargeable battery pack (3.6VDC, 2.6Ah) comes complete with the international battery charger.

6.3.1. Battery recharging procedure

- Dry the CTD and lay it down on a table.
- Loosen the two closing screws on the CTD cover with a proper screwdriver.
- 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 CTD body. Anyhow, dry any trace of water in proximity of the external side of the o-ring.
- Disconnect the battery pack connector (4-pin black connector) from the CTD upper cover.
- Connect the battery charger to the battery pack and wait until the battery is fully charged.
- Connect the battery to the 4-pin black connector of the CTD top cover.
- 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 so as to close the cover uniformly.

6.4. *OS304Plus-MI - TITANIUM/POM HOUSING – BATTERY REPLACEMENT PROCEDURE*

To gain access to the internal battery holder, loosen with the ball end Allen screwdriver included in the CTD accessories, the three 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.

1. Dry the CTD and lay it down on a table.
2. Remove the three hexagonal screws on the top cover with the ball end Allen screwdriver.
3. When extracting the cover, dry the fissure between the cover and the body of CTD with a strip of paper inserted edgewise and dry any trace of water in proximity of the external side of the o-ring.
4. Disconnect the 4-pin female black connector from the top cover
5. Pull the battery out and remove the dead battery.
6. Install the new battery.
7. Insert the battery 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 three hexagonal screws. Gradually tighten the three hexagonal screws in sequence so as to close the cover uniformly.

6.5. *OPTIONAL RECHARGEABLE BATTERY PACK*

The internal custom NiMH rechargeable battery pack (3.6VDC, 2.6Ah) comes complete with the international battery charger.

6.5.1. Battery recharging procedure

- Dry the CTD and lay it down on a table.
- Loosen the three closing hexagonal screws on the CTD cover with the ball end Allen screwdriver.
- 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 CTD body. Anyhow, dry any trace of water in proximity of the external side of the o-ring.

- Disconnect the battery pack connector (4-pin black connector) from the CTD upper cover.
- Connect the battery charger to the battery pack and wait until the battery is fully charged.
- Connect the battery to the 4-pin black connector of the CTD top cover.
- Gently push the wires and connectors to the side of the battery pack.
- Gently reassemble the CTD top cover. Close the CTD with the three closing hexagonal screws and gradually tighten them in sequence so as to close the cover uniformly.

6.6. BATTERY ENDURANCE

The “OS3xx CTD autonomy” program distributed together with the ITERM program allows the user to calculate memory and power autonomy. The following table reports a forecast about the maximum **CTD ON time** for each type of battery that can be installed in the OS304*Plus.* The forecast assumes that fully charged new batteries are used.

Type of battery	*Autonomy(hours)*
2x1.5 Alkaline “AA” cell	30
1x3.6 Lithium “AA” cell	40
3x1.2 NiMH “AA” cell	48
1x3.6 Lithium “C” cell	160
1x3.6 Lithium “D” cell	330

6.7. RTC AND BATTERY

The internal real-time clock is kept by means of the CTD main battery pack. Therefore, when the battery pack is removed or it is fully flat, the RTC loses the date & time. **At the successive start-up, the CTD date and time must be configured.**

7. PTP COMMUNICATION PROTOCOL

The OCEAN SEVEN 304*Plus* CTD is operated according to a series of rules and message formats commonly indicated with the term ”communication protocol”. The OCEAN SEVEN 304*Plus* supports a very simple communication protocol, with function selections (incoming data) and sensor readings (outgoing data) assembled in ”messages” whose generic structure is the following:

ID[<param list>] <LF> or <CR>

“ID” is a two-character identification for the message; for example “PT” stands for single CTD real-time acquisition. The message identification is optionally followed by a space and a list of parameters, whose number and format strictly depend on the type of message.
Each incoming message must end with an **<LF>**, that is the ASCII character line-feed (0x0A hexadecimal, 10 decimal). Vice versa, the Line Feed character on a PC keyboard can be obtained by pressing the **<CTRL-J>** (press and hold the **<CTRL>** key, press and release the **”J”** key, release the **<CTRL>** key). The CTD operates in ”slave” mode, meaning that it does nothing but waits for user commands to be received. When a complete message is received, its ID field is searched for in a lookup table and, if a match is found, the system dispatches the received message to the appropriate handler. The message handler is responsible for verifying each parameter and carrying out the desired action; the action usually consists in assembling and sending back another message.

The document “*OCEAN SEVEN 3xx Data Transmission Protocol*” describes in detail the communication protocol. It can be found in the download area of the IDRONAUT web site.

A.1 INTRODUCTION

The OCEAN SEVEN 304*Plus* CTD interfaces an IDRONAUT Dissolved Oxygen sensor through dedicated interface and software. This appendix contains all the information needed to operate the CTD in the laboratory and in the field with the Dissolved Oxygen sensor. It should be mentioned that, due to the lack of continuous polarization of the Dissolved Oxygen sensor, the CTD, depending on the measurement and sensor conditions, needs a 30s warm-up before the oxygen measurements are stable and accurate. Therefore, in case of profiling, we suggest waiting on surface for the stabilization time before lowering the CTD into water. Instead, in case of acquisitions in function of time, a dedicated configuration parameter allows the operator to set up a delay time "warm-up time-out" to be used at the start-up before starting the measurements. In this case, it is necessary to consider the time spent during the warm-up time-out in the computation of the CTD battery autonomy.

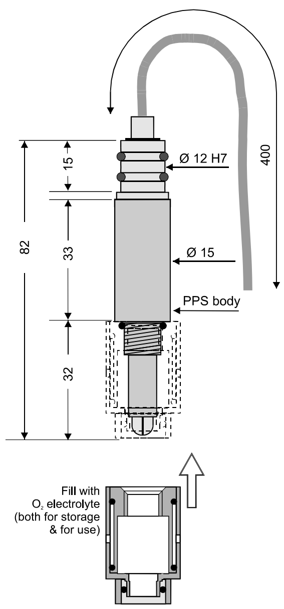
A.2 DISSOLVED OXYGEN SENSOR (standard version)

This section refers to the standard versions (150 and 700 bar) only.

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:

$$O_2 + 2\ H_2O + 4e^- >>>\ 4\ OH^-$$

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



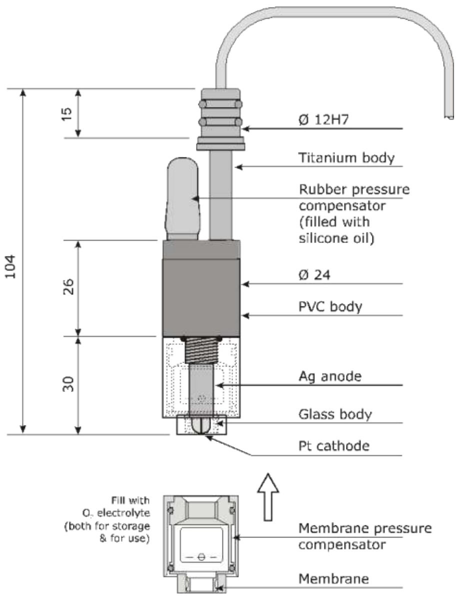
Standard version 150 bar

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 @20°C
Max Pressure:	150 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:	measuring membrane replacement, electrolyte replacement.

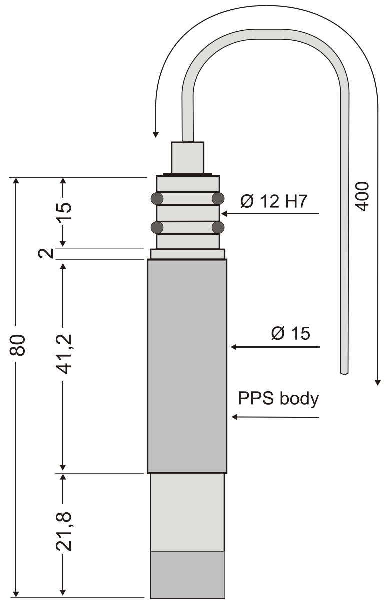
Standard version 700 bar

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.



A.3 DISSOLVED 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.



A.3.1 Oxygen measurement priming

The OCEAN SEVEN 304*Plus* 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:

ppm = Saturation x Solubility / 100

The relevant formulae for the computation of saturation and solubility can be found in the below 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 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 CTD allows the operator to manually enter a correction coefficient during the calibration procedure.

A.3.2 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 CTD has been designed such that, the application of such correction factors by the operator is a relatively straight forward procedure. The oxygen sensor calibration and the correction coefficient calculation are both described at the "Sensors Calibration" section of this manual.

A.4 CALCULATIONS

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

A.4.1 Calculation of solubility

The following constants are required for calculation of solubility:

a1	=	-173.4292	b1	=	-0.033096
a2	=	249.6339	b2	=	0.014259
a3	=	143.3483	b3	=	-0.001700
a4	=	-21.8492	cnv	=	1.428

The following variable is required for the calculation of solubility:

tempK = tempC + 273.15

the formula is:

r1 = a1 + (a2 x (100/temp)) + (a3 x ln (temp/100)) + (a4 x temp/100)

r2 = salinity x (b1 + (b2 x (temp/100)) + (b3 x (temp/100 x temp/100)))

Solubility (mg/l)= cnv x exp (r1 + r2)

A.4.2 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.

C_1 = - 0.029

C_2 = 0.000115

Saturation % = Coeff. x O_2 x SlopeO_2 x exp(Temperature x C_1 + Pressure x C_2)

where:

Coeff.	= Stirring effect and barometric pressure compensation **(*)**
O_2	= Sensor reading in counts
SlopeO_2	= Calibration coefficient = 1/ exp(Temperature * C_1) x 0_2 / 100
Temperature	= Temperature reading in °C
Pressure	= Pressure reading in dbar

A.4.3 Calculation of ppm

The formula is:

ppm = Saturation x Solubility / 100

A.5 CONFIGURATION

Through the CTD set-up, it is possible to configure the oxygen sensor too. The first parameter to configure allows the operator to define the time-out spent by the CTD before starting the measurement. The warm-up time-out is used by the CTD to wait for the dissolved oxygen sensor stabilization. The stabilization is mandatory as the dissolved oxygen sensor must be properly polarized before it can perform reliable and accurate measurements.

Warm-up time-out

The warm-up time-out in seconds must be configured as 30s.

Configuration of the dissolved oxygen sensor in the list of acquired sensors:

```
OCEAN SEVEN 304Plus
Id    Name    Code  Mux   Digits
01    Press   0000  253   0002
02    Temp    0001  253   0003
03    Cond    0002  254   0003
04    Sal     0004  255   0003
05    O2%     0006  001   0001
06    O2pmm   0005  255   0002
CMD:I)nitialize,M)odify,D)elete,Q)uit
```

At the end of the list, commands available to perform the configuration are shown below:

Initialize: completely deletes the list.

Modify: allows the operator to enter a new sensor/parameter in the list or modify an existing one. See below for the details about configuration.

Delete: allows the operator to delete a configured sensor/parameter from the list.

Quit: terminates the data acquisition parameter editing and ends the configuration command too. The new configuration is stored in a non-volatile memory.

The following parameters can be configured by means of the "Modify" command:

```
Sensor code[0..24,255=NU] 6
Sensor mux.[0..3,255=NU]  1
Sensor precision [0..6]   1
```

A.6 CALIBRATION

The oxygen sensor is the sensor which requires most attention of all the OCEAN SEVEN 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.

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 seldom used because of the difficulties of obtaining a solution homogeneous in temperature and at saturation, particularly in the field. **For this reason, the calibration is usually carried out in air.**

A.6.1 Oxygen sensor calibration in air

After the"Oxygen Sensor" has been selected, typing its index code at the sensor selection prompt, the CTD displays:

Wipe O_2 membrane and Temp. sensor

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 or direct sun rays, for at least one minute before proceeding with calibration. When ready, press any key to continue; the following message appears:

Sensor Current	%Last cal.	Drift	Temp.
42.59 nA	98.9 %	0.0 Count	18.216 C

"% of last calibration" is given by (new cal/old cal) x 100 and gives a measurement of aging of the membrane and the electrode. If excessive drift is detected (>2%) the message:

Oxygen error

appears for three seconds, then the display returns to the sensor list and the calibration must be repeated. If this last message does not appear, it means that calibration has been achieved and the oxygen calibration continues with the question concerning the atmospheric pressure/stirring effect compensation coefficient:

Correction coeff. for Barometric pressure and Stirring effect
Coeff. : 1.05 >

The operator must confirm the default coefficient 1.05 or enter a different value (see the below note); the calibration continues with the confirmation of the Oxygen sensor DC-OFFSET value. This value is indicated in the document accompanying the CTD and should not be modified unless the sensor is changed.

DC-OFFSET: -56 >

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

The correction coefficient different from the nominal one 1.05 is needed for the following reasons:

1)To enter barometric pressure values differing from the 760-mm Hg 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 meters 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 read-out will be multiplied by a factor of 10. 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. $\frac{760}{625}$ = Barometric correction coefficient = 1.216

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

1.05 x 1.216 = 1.2768 total coefficient to be applied.

A.7 MAINTENANCE (required for the standard oxygen sensor only)

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.

A.7.1 Available membrane

The performance of the oxygen sensor depends on the type of membrane being used.
IDRONAUT uses a proprietary 25μ,Teflon® membrane.

A.7.2 Refilling oxygen sensor cap with electrolyte

- Switch the CTD ON and, if possible, achieve oxygen calibration.
- Locate the oxygen sensor on the CTD; then unscrew and remove the cap. Pay attention not to damage the glass tip of the sensor.
- 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.
- 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 read-out is higher, there is most probably a film of moisture still in contact with the sensor tip. Carefully dry the sensor tip.
- Carefully fill the membrane cap with the O_2 electrolyte; do this in such a way that drops are deposited directly into the 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.
- Gently screw the membrane cap onto the sensor body, thus allowing the electrolyte in excess to be drained, then securely tighten the membrane cap.
- Dry the sensor, and the membrane in particular, with a lint-free paper towel.

Note

After electrolyte refilling, recalibrate the oxygen channel.

IMPORTANT

- Maximum stability of read-out 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.
- While the CTD is not used, the oxygen sensor polarization remains active since the necessary power is provided by a rechargeable battery placed inside the CTD. Battery back-up is performed when the CTD is switched ON.
- 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 sensor life.
- 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.

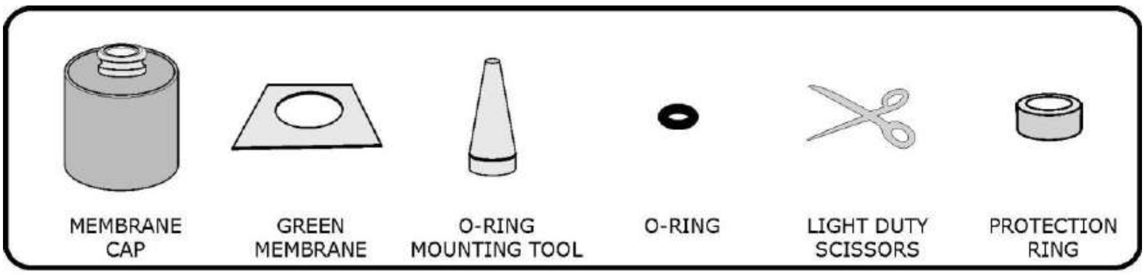
A.7.3 Membrane replacement (oxygen membrane cap)

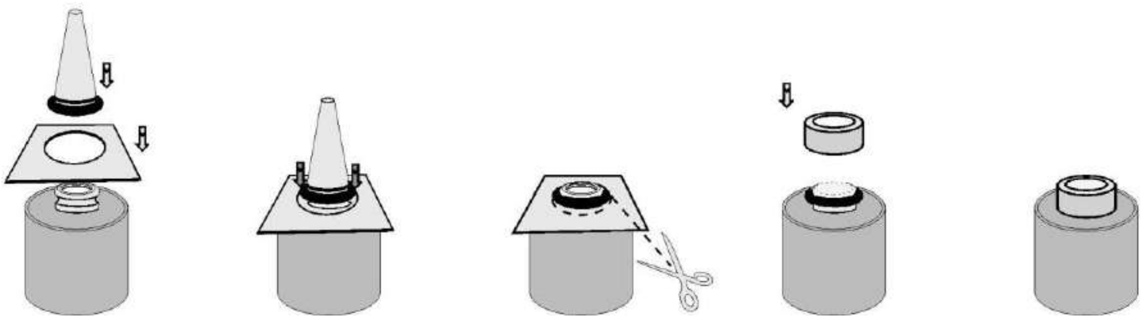
Conditions which could require the membrane and electrolyte replacement are the following:

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

A.7.4 Replacement of membrane can be done using the OXYGEN SENSOR MAINTENANCE KIT:

- Locate and pull out the following parts from the maintenance kit:
  - one oxygen measuring "green" membrane;
  - one o-ring;
  - o-ring mounting tool.
- Remove the protection ring from the membrane cap. Remove and discard the black o-ring and the membrane(s).
- Fit the new o-ring over the mounting tool and roll it down to the widest part of the tool.
- Place the cap on a desk top with its narrow end facing up.
- Position the measuring membrane "green" on top of the cap.
- 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.
- Cut away excessive membrane, with fine scissors, far from the o-ring to avoid damaging the membrane.
- Finally, recap the protective plastic ring.





A.7.5 Oxygen sensor cleaning

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

```
Checking oxygen sensor:
Current: XXX nA. % of last calibration. XXX.X%
```

The acceptable current is 30-90 nA.

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 with tap water 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 normal and will drop during the first few hours to reach the normal stability level of 0.1 to 0.3 ppm/week.

A.7.6 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 Nitrogen not 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

- Connect a cuvette (body of a syringe) to a Nitrogen supply using a flexible tube.
- Purge the line and adjust the gas flow rate at 200 ml/min. approx.
- Calibrate the oxygen channel by exposing the sensor to room air.
- 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.**

B.1 INTRODUCTION

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 and during the time spent during the measurements, according to the following rules.

The UV-LED sterilization is automatically switched off at the end of the sterilization time-out if:

- the CTD is interrogated through the operating menus or the communication protocol functions;
- the CTD enters stand-by mode;
- the CTD carries out a measurement cycle in function of pressure interval, real-time acquisitions or continuous acquisitions;
- the CTD carries out an autonomous cycle: LINEAR, CONTINUOUS, CONDITIONAL.

B.2 SET-UP OF THE UV-LED ANTIFOULING STERILIZATION TIME

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:

OCEAN SEVEN 304Plus

Id	*Name*	*Code*	*Mux*	*Digits*
01	*Press*	*0000*	*253*	*0002*
02	*Temp*	*0001*	*253*	*0003*
03	*Cond*	*0002*	*254*	*0003*
04	*Sal*	*0004*	*255*	*0003*

CMD:I)nitialize,M)odify,D)elete,Q)uit

At the end of the list, commands available to perform the configuration are shown below:

Initialize: completely deletes the list.
Modify: allows the operator to enter a new sensor/parameter in the list or modify an existing one. See below for the details about configuration.
Delete: allows the operator to delete a configured sensor/parameter from the list.
Quit: terminates the parameter editing and ends the configuration command too. The new configuration is stored in a non-volatile memory.

The following parameters can be configured by means of the “Modify” command by selecting the CONDUCTIVITY sensor from the above list:

Sensor code[0..24,255=NU]< 2
Sensor mux.[0..3,255=NU]< 1
Sensor precision [0..6]< 3
UV disinfection time [0.255]< 5

B.3 POWER CONSUMPTION AND BATTERY ENDURANCE

The presence of the UV-LED antifouling system increases the power consumption of the OCEAN SEVEN 304*Plus*. The power consumption can be resumed as follows:

CTD at wake-up, sterilization,	UV ON	55 mAh @ 3.0V
CTD running, measurement,	UV ON	78 mAh @ 3.0V

Considering a typical cycle of 5 seconds dedicated to the UV sterilization only, 4 seconds to carry out the measurement and sterilization and 2 seconds spent during the wake-up and shutdown functions, it is possible to calculate the following battery endurance with a 3.6V “C” type, 8.4 Ah battery:

Measurement interval	Endurance in days
15′	421
30′	830
60′	1615

C.1 INTRODUCTION

The OCEAN SEVEN 304*Plus* CTD CTD can interface the Highly Precise Pressure Transducer through a dedicated hardware and software interface. The below section contains all the information needed to operate an OS304*Plus* CTD which interfaces the Highly Precise Pressure Transducer.

C.2 HIGHLY PRECISE PRESSURE TRANSDUCER

This high-precision 0,01 %FS pressure transmitter is based on the stable, floating piezoresisitive transducer and the newly developed XEMICS microprocessor with an integrated 16-bit A/D converter. Temperature dependency and non-linearity of the sensor are mathematically compensated by the interfacing electronics. The output rate is 400 Hz.

C.2.1 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.

C.2.2 Technical specifications

	Standard Pressure Ranges (FS) and Overpressure in Bar						
Available ranges:	0,8…1,2	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 ^{3} 10 bar
Output Rate:	400 Hz
Resolution:	0,002 %FS
Long-term stability typycal.:	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 mm3
Connector:	Molex Milli-Grid 2 mm.

C.2.3 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:

$$A(T) = A_0 . T^0 + A_1 . T^1 + A_2 . T^2 + A_3 . T^3$$
$$B(T) = B_0 . T^0 + B_1 . T^1 + B_2 . T^2 + B_3 . T^3$$
$$C(T) = C_0 . T^0 + C_1 . T^1 + C_2 . T^2 + C_3 . T^3$$
$$D(T) = D_0 . T^0 + D_1 . T^1 + D_2 . T^2 + D_3 . T^3$$

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.

C.3 CONFIGURATION

Through the CTD 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.

C.4 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:

Coefficient (a) = 0.0
Coefficient (b) = 10.0
Coefficient (c) = 0.0

D.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-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.

D.1.1 Characteristics

Range setting: 25, 125, 500, >750 FTU
Output Time Constant: 0.1 sec
Sensing Distance (from windows): < 5 cm (approx.)
Linearity: < 2% deviation 0-750 FTU/NTU.

Gain	Sensitivity (mV/FTU/NTU)	Range (FTU/NTU)	Accuracy (FTU/NTU)	Resolution (FTU/NTU)
100x	200	0.03 ... 25	0.05	0.005
20x	40	0.03 ...125	0.25	0.025
5x	10	0.03 ...500	1	0.1
1x	2	0.03 ...<750 **	5	0.5
1x	2	0.03…<4000 ***	5	0.5

** output is non-linear above 750 FTU/NTU
*** output is non-linear above 1250 FTU/NTU
Please contact Idronaut to get the correct range.

Temperature Coefficient: < 0.05% / °C.
Operating Temperature: 0°C to 65°C (32° F to 149° F).
Power Requirements: 7-20 VDC, 3.5 mA avg, 6 mA pk.
Weight (dry): 86 g (3.0 oz).

D.2 CONFIGURATION

Through the CTD set-up, it is possible to configure the Turbidity Meter.

```
OCEAN SEVEN 304Plus
Id  Name   Code  Mux  Digits
01  Press  0000  253  0002
02  Temp   0001  253  0003
03  Cond   0002  254  0003
04  Sal    0004  255  0003
05  Turb   0024  000  0001
CMD:I)nitialize,M)odify,D)elete,Q)uit
```

At the end of the list, commands available to perform the configuration are shown:

Initialize: completely deletes the list.
Modify: allows the operator to enter a new sensor/parameter in the list or modify an existing one. See below for any details about configuration.
Delete: allows the operator to delete a configured sensor/parameter from the list.
Quit: terminates the data acquisition parameter editing and ends the configuration command too. The new configuration is stored in a non-volatile memory.

The following parameters can be configured by means of the "Modify" command:

Sensor code [0...24,255=NU] *24*
Sensor mux. [0...3,255=NU] *0*
Sensor precision [0...6] *1*

The below table reports the values associated to the available sensors/parameters. Following the introduction of the above parameters, the CTD continues the set-up of the turbidity meter as follows:

Turbidity sensor with multiple measuring scales? [1=Yes,0=No]"

Define if the interfaced turbidity meter has more than one measuring scale. Answer 1 for yes in this case.

Do you want the automatic range? [1=Yes, 0=No]

In case the turbidity meter has multiple measuring scales, it is possible to leave the CTD the responsibility to select the most appropriate measuring scale according to the sample under measurement. Answering 1 for "yes" enables the automatic measuring range adaptation, whereas, answering 0 for "no" causes the following question to appear.

Turbidity meter scale:(1)>750 FTU,(2)500 FTU,(3)125 FTU,(4)25 FTU
Select one [1..4]

In case there is no need to have the automatic range adaptation, it is possible to select the most appropriate measuring scale.

Under the service access rights, it is needed to set up the auto-scale set-up time as follows.

Optical Sensor autoscale set-up [0..65535 ms]:0 < 800

D.3 CALIBRATION

Two different calibration procedures are automatically selected by the CTD firmware.

A. *Automatic scale management disabled*

The STM sensor is calibrated by entering an offset and slope for the selected measuring range

TURBIDITY METER- y=a+bx
(a)=0.000000
(b)=0.000000

B. *Automatic scale management enabled*

The STM sensor is calibrated by entering an offset and slope for each measuring range. The introduction starts from the >750 FTU.

TURBIDITY METER
Meas. scale 1, F.S.[>750 FTU] y=a+bx
(a)=0.000000
(b)=0.000000

and continues with the next scale

Meas. scale 2, F.S.[500 FTU] y=a+bx
(a)=0.000000
(b)=0.000000

and continues with the next scale

Meas. scale 3, F.S.[125 FTU] y=a+bx
(a)=0.000000
(b)=0.000000

and continues with the next scale

Meas. scale 4, F.S.[25 FTU] y=a+bx
(a)=0.000000
(b)=0.000000

D.3.1 Calibration solution preparation

Calibration of a turbidity instrument by using Formazin or another primary standard is usually done in the laboratory. Turbidity standards for various ranges are available commercially, for instance Formazin based standards can be diluted by using a dilution formula to create a set of calibration standards of different concentrations. A technique for the preparation of such turbidity standards is discussed by Wilde and Gibs 1998 (see note 1).
Thus, preparation of the calibration standards is a customer's responsibility. From a technical point of view, we suggest that at least a blank and two calibration standard solutions should be prepared for each measuring range: 25,125,500 and greater than 750 FTU. Furthermore, we suggest that the calibration solutions should be equally spaced through the Turbidity Meter measuring scales (i.e. 0.0, 60.0, 120 for the 125 scale).
Before immersing the Turbidity Meter sensor in a standard solution, the sensor must be cleaned, rinsed at least three times with turbidity-free water, and carefully dried. Turbidity-free water is prepared as described by Wilde and Gibs (1998).

Note
Wilde, R.F., and Gibs, Jacob, 1998, Turbidity, in Wilde, F.D., and Radtke, D.B., eds., 1998, Field measurements, in National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6.7, 30 p.

E.1 BLUETOOTH® MODULE

The IDRONAUT Wireless Module allows bidirectional full duplex communications between the OCEAN SEVEN 304*Plus* CTD and a PC (Desktop, Laptop) or PDA devices equipped with a Bluetooth® device. The IDRONAUT Wireless Module is formed by a Bluethoot® OEM module mounted inside the OCEAN SEVEN 304*Plus* CTD housing and is designed to provide an interface conforming to the Bluethoot® 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 304*Plus* CTD 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 304*Plus CTD*.

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 CTD.

IDRONAUT Windows programs like REDAS-5 and ITERM flawlessly operate the OCEAN SEVEN 304*Plus* through the Wireless Module as if it were connected through a USB cable.

E.1.1 How it works

The OCEAN SEVEN 304*Plus* Wireless Module is always powered (low power stand-by) and is ready to accept wireless connections once the CTD is in ON condition and in AIR. Communications through the OCEAN SEVEN 304*Plus* Bluetooth® Wireless Module can be only achieved after a valid Bluetooth session is established. Whenever the communication session is established, the CTD automatically and autonomously switches the communications from the wired interface: RS232C/RS485 to the Wireless Module. Afterwards, communication continues using the wireless module until the communication session drops or the OCEAN SEVEN 304*Plus* CTD is switched off. The only limitation is that the CTD cannot be used with both interfaces (wire and wireless) at the same time.

F.1 FORWARD

A special version of the OS304*Plus* is available for the installation on AUVs/ROVs. The OS304*Plus* special AUV version can be configured to automatically acquire and transmit data immediately by following the start-up procedure. Data can be transmitted according to the configured sampling rate and the chosen data transmission format. The OS304*Plus* AUV housing version is shorter than the standard one, as it not equipped with the: hanging road, ON/OFF switch and has not the space for the installation of the internal battery.
The below section contains the information on how to set up the OS304*Plus* and about the data format transmitted when the CTD operates in AUV mode.

F.2 Set-up of AUV mode

The OS304*Plus* set-up allows modifying the following parameter:

Tx data at start-up? [0)No,1)Yes]:1 <

The OS304*Plus* automatically acquires and transmits data after the start-up.

Tx data:AUV format: 0)BLUEFIN-21,1)OEX-C:1 <

Select the format of transmission, see below.

Tx data Rate [0.1..8Hz]:8.000000 <

Select the sampling rate or/and data transmission rate.

F.3 BLUEFIN data format

The OS304*Plus* acquires and transmits in real time: Conductivity (mS/cm), Temperature (°C IPTS-68), Depth (dbar).

```
OCEAN SEVEN 304Plus - ID:304-0513514 {IDR}[9.0_10-04/2014] 07:58:42.06 06-05-2014
Work.Mem:Cnf[oK].Calb[oK].Stat[oK]
BlueTooth..[Not-installed]
Data memory...[2.0 GByte]
Analogue....CTD!.Ok.ADC..Ok
Battery..3.05 VDC
+46.2185 ,+19.7701 ,+000.212
+46.2189 ,+19.7698 ,+000.212
```

F.4 OEX-C data format

The OS304*Plus* acquires and transmits in real time: Temperature (°C ITS-90), Conductivity (S/m), Depth (dbar).

```
OCEAN SEVEN 304Plus - ID:304-0513514 {ADM}[9.0_10-04/2014] 07:59:31.06 06-05-2014
Work.Mem:Cnf[oK].Calb[oK].Stat[oK]
BlueTooth..[Not-installed]
Data memory...[2.0 GByte]
Analogue....CTD!.Ok.ADC..Ok
Battery..3.05 VDC
019.7758,04.62230,000.211
019.7769,04.62215,000.211
```

G.1 FOREWORD

This appendix describes the proper care of submersible connectors and cables installed in the IDRONAUT OCEAN SEVEN 3xx series CTDs. The text refers to the IE55-12-CCP and to the MCBH/MCIL one (detailed characteristics of these connectors can be found on www.impulse-ent.com).

G.2 BULKHEAD CONNECTORS

Bulkhead connectors must be carefully inspected and cleaned: i) before every cruise, ii) during the cruise; iii) as part of the yearly CTD 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 that may affect the connector integrity, contact IDRONAUT to receive assistance.

G.3 SUBMERSIBLE CABLES

Cable end connectors must be inspected and cleaned: i) before every cruise, ii) during the cruise; iii) as part of the yearly CTD 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 brash 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 CTD.

G.4 DUMMY PLUGS

The purpose of the dummy plug is to protect the connector contacts from being in contact with water during the CTD 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 CTD 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 CTD. Always use the locking sleeve with dummy plug.

G.5 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 results in the unthread of the bulkhead connector from the CTD top cover. A slack connector will lead to a flooded CTD. After immersing in seawater, always rinse the mated connection with fresh water.

G.6 IEE55-12-CCP CONNECTOR TYPE ONLY

Guidelines:

- Female and male can trap water (suggest flush with alcohol and blow dry).
- Avoid contact with noxious solvent.

Connector insertion

Always align the male female connectors. 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.

G.7 MCBH/MCIL CONNECTOR TYPE ONLY

These kinds of connector are easy to mate and require less force to be 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. 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.

H.1 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 they 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 appendix 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 CTDs. Most of the recommendations below reported are taken from the OCEAN SEVEN 3xx Operator's Manuals.

This appendix is divided into two sections:
- OCEAN SEVEN 3xx CTDs general cleaning.
- Sensor dedicated cleaning and care.

H.2 GENERAL CLEANING

After use, the OCEAN SEVEN 3xx CTD 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 CTD is not contaminated even by any small quantity of oil. In this case, do not use this water.
In case the CTD body or the sensors have any visible deposits of marine growths, we recommend cleaning the CTD 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 CTDs is used in wastewater, it may be disinfected with 5% Lysol if this is more convenient to the user.

H.3 SENSOR DEDICATED CLEANING AND CARE

H.3.1 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 CTD 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.

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H.3.2 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.

H.3.3 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.

H.3.4 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 green measuring membrane too.