



IDRONAUT PROFILING SYSTEMS

MARINE SCIENCE, LIMNOLOGY, AQUACULTURE, WATER QUALITY MONITORING

- ✓ **BUOY PROFILER 601**

- ✓ **BUOY PROFILER 701**

- ✓ **PROFILER MODULE**



In the last twenty year period, the degraded condition of aquatic environments such as rivers, lakes and coastal marine areas, has drawn the public's attention.

The reclaiming of these environments requires a better understanding of the degradation processes. Furthermore, the efficacy of restoration procedures needs to be checked with the passing of time by means of suitable monitoring systems.

In order to accomplish these purposes, IDRONAUT has developed an automatic *in situ* monitoring system, able to acquire data at high frequency and making it available in real-time. The system, named BUOY 601/701 PROFILERS, has been developed after 15 years of study and experiment in cooperation with the most important Italian and Swiss research institutes of oceanography, marine biology and limnology.

The core of the monitoring system is the Buoy Controller Module which permits, through the availability of advanced digital and analogue interfaces, the creation of a true interdisciplinary monitoring system.

Furthermore, taking advantage of advanced communication systems like phone (GSM/CDMA) cellular networks or like the GLOBASTAR Satellite networks, reliable and powerful real-time communications to and from the BUOY 601/701 PROFILERS can be achieved.

**UP TO NOW MORE THAN 70 BUOY
601/701 PROFILERS HAVE BEEN
INSTALLED ALL OVER THE WORLD**

BUOY 601/701 PROFILERS can be moored in position quickly, without special tools; the buoy can be moved easily by towing with a small vessel.

The BUOY 601/701 PROFILER is equipped with:

- ◆ The OCEAN SEVEN® 316 CTD multiparameter probe which has been designed for oceanographic application and uses very reliable, accurate and drift-free high quality sensors, associated with an advanced and innovative integrated antifouling system.
- ◆ The Buoy Controller Module which contains all the hardware and software to supervise the buoy operations, from the winch movements to the internal diagnostics functions.
- ◆ The computer-driven motorized winch which is located on the top of the buoy hull that contains the Buoy Controller Module too.
- ◆ The cellular phone link modules (or UHF radio modem or satellite relay system).

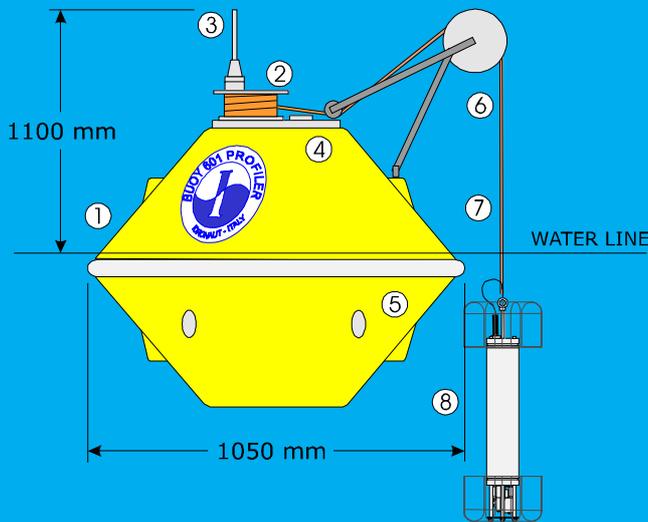
The motorized winch allows to perform automatic vertical profiles with the OCEAN SEVEN 316 multiparameter probe which measures depth, temperature, conductivity, salinity, dissolved oxygen, pH and oxidation-reduction potential and can interface external sensors or data acquisition system (see the OCEAN SEVEN 316 description).

The standard cable length of the winch is 20 meters of 7 mm or 50 meters of 5 mm polyurethane coaxial armored cable.

BUOY 601 PROFILER

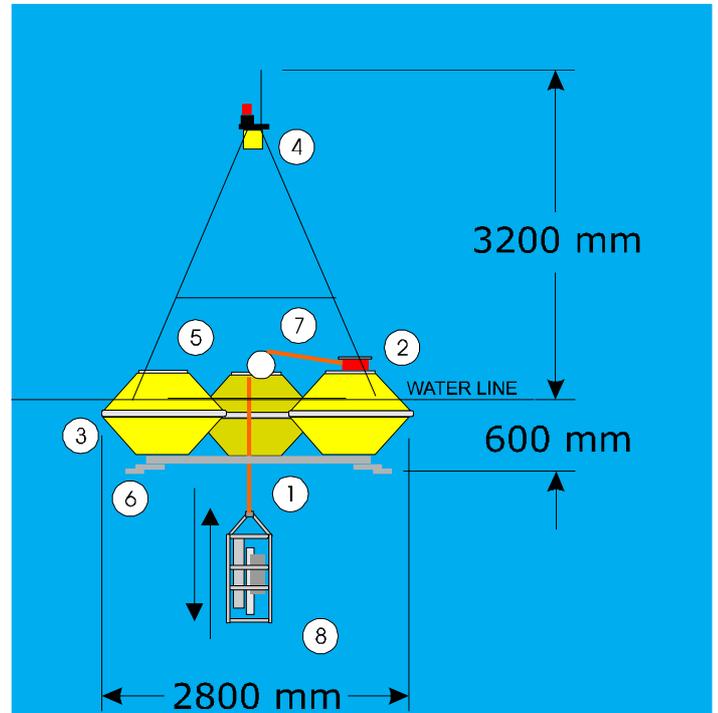
The buoy hull is manufactured from glass reinforced plastic (GRP) with stainless steel (AISI316) inserts and internally filled with polyurethane foam. A rubber bumper is fitted around the buoy at water level. Eyebolts are provided for lifting, lowering into the water and mooring. The size and weight of the buoy (1 meter diameter - 160 kg) allow easy handling and transport. The hull holds 6 rechargeable batteries (12V, 42 A/h each) giving more than 3 kW hours of reserve power, thereby eliminating the need for solar panels which are particularly failure-prone in a marine environment. The system can operate independently for more than three months, depending on the number of profiles programmed.

- ① Hull, contains the Controller, the cellular phone link modules (or the UHF radiomodem), and batteries.
- ② Computer driven winch.
- ③ Marine antenna.
- ④ Connectors.
- ⑤ Mooring eyes.
- ⑥ Wheel and pulley support for cable of the multiparameter probe.
- ⑦ Polyurethane coaxial armored cable.
- ⑧ OCEAN SEVEN 316 multiparameter probe.

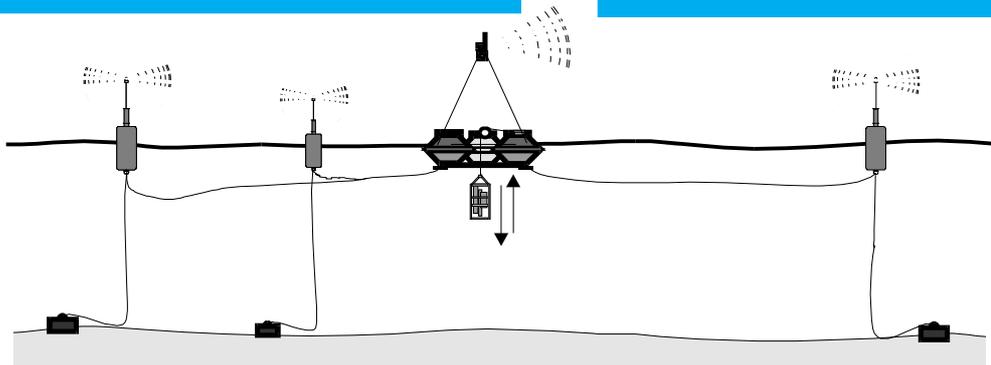


BUOY 701 PROFILER

The BUOY 701 PROFILER is composed of three 601 buoy hulls rigidly mounted on a triangular frame and supported by 6 connecting rods, all of AISI 316 stainless steel. Each of the hulls holds 6 rechargeable batteries (12V, 42 A/h each) giving more than 9 kW hours of reserve power, thereby eliminating the need for solar panels which are particularly failure-prone in a marine environment.



- ① Lower frame, a triangular structure (AISI 316) which forms the base, complete with supports for mooring.
- ② Hull, contains the Controller, the cellular phone link modules, winch and batteries.
- ③ Hull, identical to ② but contains only batteries (six, 12V 42 A/h each).
- ④ Upper base supporting radar reflector, optional antenna and xenon flash lamp with a visible range up to 3 miles, programmable flash intervals, daylight off.
- ⑤ Connecting rods, rafters and supporting trellis.
- ⑥ Mooring supports (3).
- ⑦ Wheel and pulley support for sensor package.
- ⑧ Single OCEAN SEVEN 316 multiparameter probe or sensor package with titanium protection cage supported by the polyurethane coaxial armoured cable.



Example of three-point mooring realized with lightweight marker buoys, fiber ropes, buoy chains and anchors.

PROFILER MODULE

In cases where the 601 or 701 buoy supports are not adapted (weight or marine standard requirements) due to the adverse marine conditions expected during intended use, or the customer is already in possession of an alternative, the IDRONAUT PROFILER MODULE provides a suitable profiler for installation on the existing system.

The module can be easily installed, vertically or horizontally, using the four bolt holes present on the lower part.

The container is manufactured from glass reinforced plastic (GRP) with stainless steel AISI316 inserts and internally filled with polyurethane foam. On the top cover are installed the motorized winch and the water proof connections for external systems such as a battery pack, solar panel, antenna, meteorological station, etc.

The PROFILER MODULE contains the Controller Module which manages the winch profiles, and the associated sensor package, data acquisition and storage, communication with a shore station via a cellular phone link. Alternative communications systems can be interfaced through one of the RS232C interfaces.

The PROFILER MODULE is equipped with:

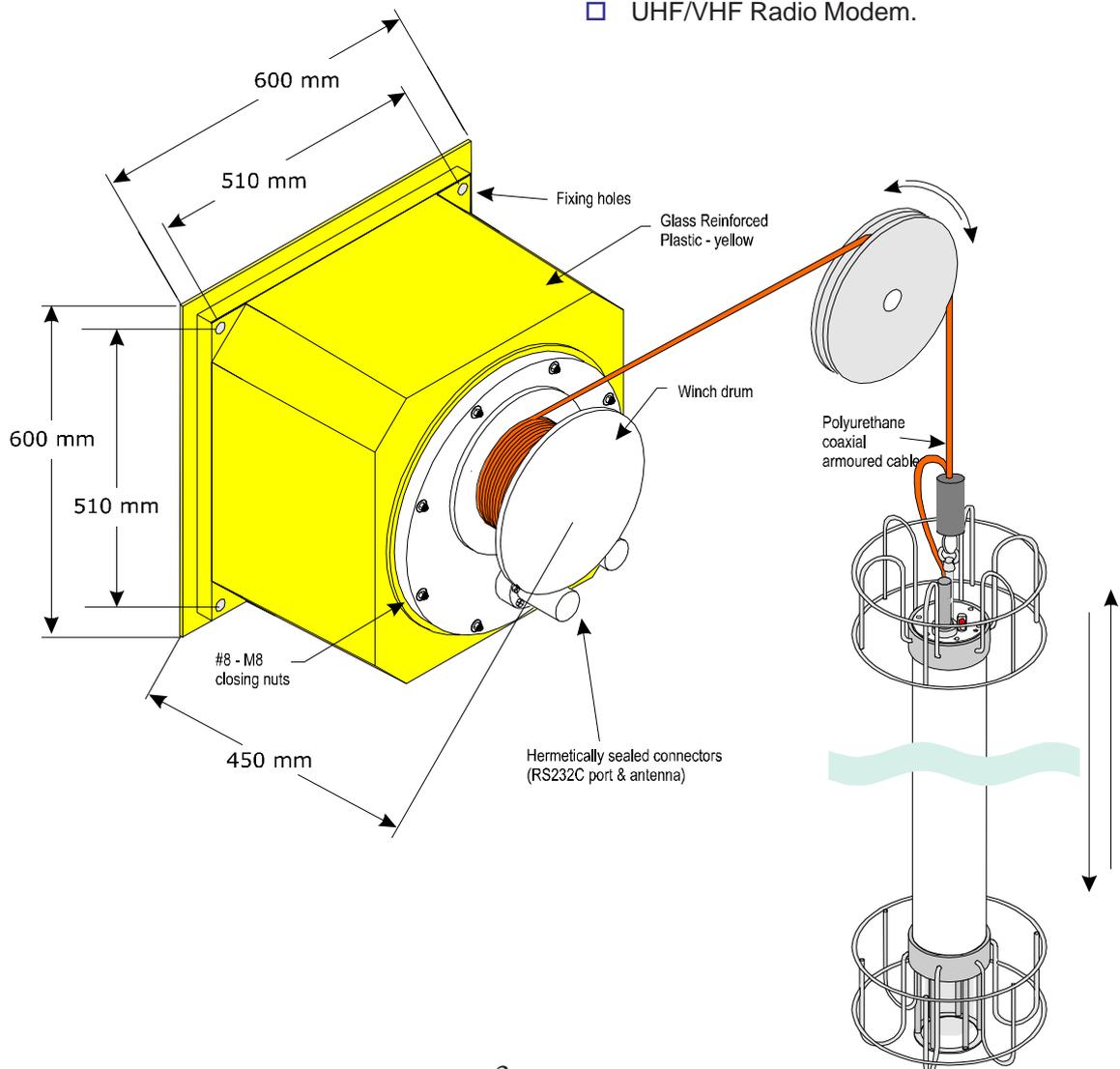
- ◆ The OCEAN SEVEN 316 CTD multiparameter probe which has been designed for oceanographic application and uses very reliable, accurate and drift-free high quality sensors, associated with an advanced and innovative integrated antifouling system.

- ◆ The Buoy Controller Module which contains all the hardware and software to supervise the buoy operations, from the winch movements to the internal diagnostics functions.
- ◆ The computer-driven motorized winch which is located on the top of the buoy hull that contains the Buoy Controller Module too.
- ◆ The cellular phone link modules (or UHF radio modem or satellite relay system).

In addition the Controller Module can interface three additional instruments (e.g. a current meter, a small meteorological station, an RDI WORKHORSE ADCP or a GPS) by means of three RS232C ports. The Controller Module collects, stores and forwards to the shore station all the measured parameters.

PROFILER OPTIONS

- Solar panel to extend battery endurance.
- Software and hardware to interface a YOUNG® meteorological station (Wind speed and direction (compass compensated), Barometric pressure, Relative Humidity, Temperature).
- Software and Hardware to interface an RDI WORKHORSE ADCP.
- Software and Hardware to interface a GPS positioning device.
- UHF/VHF Radio Modem.



OCEAN SEVEN® 316 CTD BUOY CONTROLLER MODULE

The OCEAN SEVEN 316 multiparameter CTD probe offers a combination of 16bit high resolution data accuracy, with long term sensor stability, making this probe the ideal choice for both real-time on-line profiling and moored buoy profiling. Idronaut prides itself on the design of its pressure balanced full ocean depth, pump free, low maintenance sensors. Central to which, is the well known high accuracy seven-platinum-ring conductivity sensor, which can be cleaned in the field without need of re-calibration. Furthermore, the OCEAN SEVEN 316 multiparameter probe non-verbose operating mode has been specifically designed for system integration on buoys and ROVs. Data is output by means of the on-board telemetry interface. The telemetry interface remedies the limitations of other interfaces like RS232, RS485 (number of conductors, cable length); the telemetry signals flow superimposed on the probe power supply along the armoured single conductor coaxial probe support cable. Therefore, interfacing of the OCEAN SEVEN 316 multiparameter probe with the Buoy Profiler motorized winch is simplified.

All the measurement sensors installed in the OCEAN SEVEN 316 multiparameter probe are manufactured by IDRONAUT and are exported all over the world. They are used by several other multiparameter probe manufacturers. They have extremely low time constants: 50 milliseconds for physical parameters (CTD) at 1 m/s profiling speed and 3 seconds for chemical parameters.

Antifouling

The OCEAN SEVEN 316 probe is equipped with an electrochemical innovative antifouling system which enables the probe to be operated for periods usually longer than 1 month, thus maintaining the measuring sensor accuracy within specifications. The antifouling system does not interfere with measurements and is not harmful to the environment where monitoring occurs: vice versa, it prevents the formation of mineral and biological fouling in correspondence of the measuring sensors.

The antifouling system, installed in correspondence with the measuring sensors of the OCEAN SEVEN probe, is composed of a central titanium electrode which supplies an electrical current towards six external titanium electrodes on which a copper foil (replaceable), surrounding the sensors, is wrapped. In addition to chloride formation, there is copper dissolution in an ionic form in correspondence of the sensors. The copper foil has a typical endurance of 6 months.

OCEAN SEVEN 316 MULTIPARAMETER PROBE SPECIFICATIONS

Parameter	Range	Accuracy	Resolution	TimeConstant
Pressure	0.. 200 dbar	0.05 % f.s.	0.03 % f.s.	50 ms
Temperature	-3.. +50 °C	0.003° C	0.0007°C	50 ms
Conductivity	0.. 64 mS/cm	0.003 mS/cm	0.001 mS/cm	50 ms
Oxygen	0.. 25 ppm	0.1 ppm	0.01 ppm	3 s
	0.. 250 % sat.	1% sat.	0.1% sat.	3 s
pH	0.. 14 pH	0.01 pH	0.001 pH	3 s
Redox	+/-1000 mV	1 mV	0.1 mV	3 s
Aux. inputs(6)	0..5000 mV	0.5 mV	0.076 mV	50 ms

The OCEAN SEVEN 316 multiparameter probe can also be equipped with additional probes, see the list below. All the probes are located in a compact submersible package which is protected by a light and rugged titanium cage. The total weight of the probe package can reach 20 kg.

- ❑ **WET Labs™** - WETStar Transmissometer and Miniature Fluorometer.
- ❑ **SEAPOINT™** - Fluorometer and Turbidity Meter.
- ❑ **D & A INSTRUMENT COMPANY™** - OBS-3B Sensor.
- ❑ **CHELSEA™** - Minitracka Fluorometer.
- ❑ **LICOR** - 192 SA Underwater and 193 SA Spherical Quantum Sensor.
- ❑ **BIOSPHERICAL INSTRUMENTS™** - PAR sensor QSP-2300.
- ❑ **NE SENSORTEC™** - UCM 60 DL - Current Meter.
- ❑ **NOBSKA™** - MAVS3 Current meter.
- ❑ **VALEPORT™** - MiniSVS Sound Velocity Sensor.
- ❑ **DATASONIC™** - PSA916D Sonar Altimeter, 6000 m.
- ❑ **SATLANTIC™** - Ocean Colour Radiometer System.



BUOY CONTROLLER MODULE

The main performance characteristics are:

- ◆ Low power consumption when operative, negligible consumption during waiting periods.
- ◆ Automatic wake-up on programmed timeouts or measuring system service requests.
- ◆ Communication with a management station through the GSM cellular or Satellite network.
- ◆ Local and remote configuration through a friendly user interface.
- ◆ Built-in diagnostic and power consumption monitoring capabilities allow the BUOY CONTROLLER MODULE to diagnose and report local failures or failures of the connected measuring systems.
- ◆ Field upgrading of the management software, allowing debugging and system improvements in field without interruption of the monitoring activities.
- ◆ Innovative profiling capabilities like: micro-profiling and automatic stop and go on the data acquisition point.
- ◆ Built-in antifouling device which if used with the IDRONAUT OCEAN SEVEN probes greatly extends the probe working period.

Technical description

Two units constitute the BUOY CONTROLLER MODULE: the CPU module and the peripheral interface module. They are placed inside an IP 56 protected metallic box. The processor and the memories together with an expansion bus are allocated on the CPU Module while the peripheral module has on board devices which interface with analogue and/or digital measuring sensors and/or probes. The main characteristics of the BUOY CONTROLLER are:

<i>Processing unit</i>	32 bit 20MHz
<i>Program memory</i>	512KByte FLASH memory.
<i>Data memory</i>	1 MByte CMOS RAM with its lithium backup battery (minimum data retention 10 years), extendable to 64Mbyte using a MULTIMEDIA CARD module.
<i>Interfaces</i>	4x RS232C serial interfaces. 1x telemetry used by the OCEAN SEVEN 316 multiparameter probe. 1x PWM motor control used to manage a 20 A motorised winch. The winch speed can be regulated from 0.5 to 15 cm/sec. 1x Wake up circuitry allowing automatic make-up from RTC or from one of the 4 serial interfaces
<i>Power supply unit</i>	1x Power supply for the OCEAN SEVEN probes 200mA adjustable from 12 to 36 V. 4x Auxiliary power output 12V 1A controlled through 4 singularly addressable relays
<i>Power supply input</i>	8 to 18VDC, operating 180 mA; standby 0.01 mA
<i>Diagnostic</i>	8x analogue inputs, are used to monitor the external measuring system and the motorised winch power supply voltages and current consumption.
<i>Other</i>	1x Built-in antifouling system to be used with the OCEAN SEVEN 316 probes.



Theory of Operation

The BUOY CONTROLLER MODULE supervises the monitoring activities, it collects and stores data from all the attached measuring probes/sensors at pre-set time intervals, forwarding them to the control node land based station once it has been called or automatically at the end of data acquisition cycles.

During the monitoring cycle, the BUOY CONTROLLER MODULE waits for the pre-set data acquisition time in a low power consumption mode. In fact, to save energy, the BUOY CONTROLLER MODULE internal circuits are normally switched OFF, with the exception of the very low power consumption real-time clock calendar and the wake-up circuitry. This ensures a low average power consumption of the whole system which permits long monitoring periods.

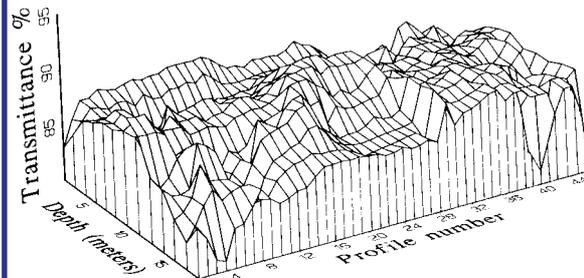
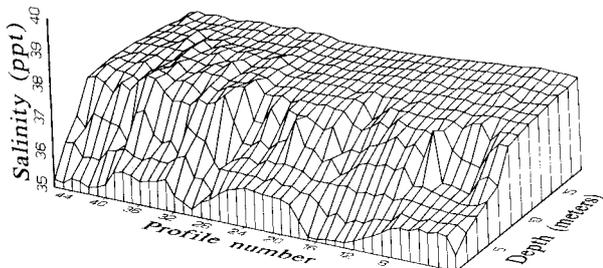
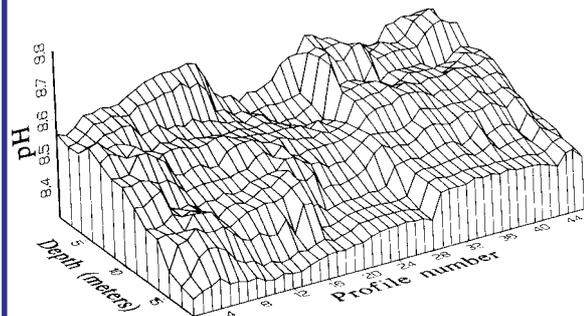
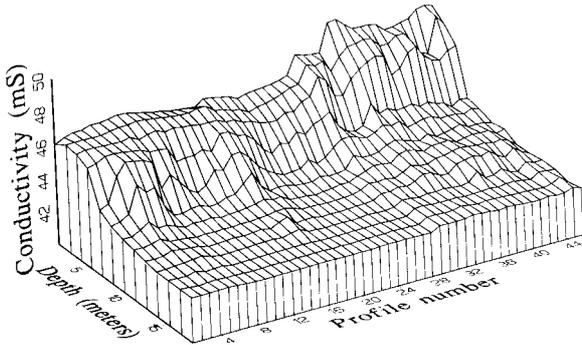
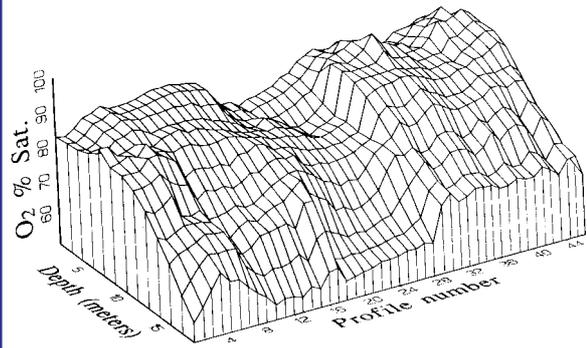
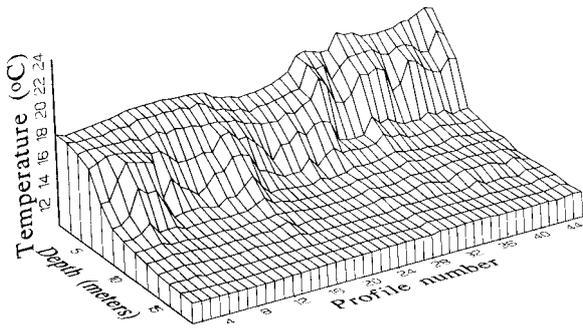
When the BUOY CONTROLLER is switched ON, it instructs the attached measuring probes/sensors to acquire data. For instance, if the winch profiling system is present, the BUOY CONTROLLER manages the motorized winch operation performing profile so that data can be gathered from the OCEAN SEVEN 316 multiparameter probe at pre-set depth intervals.

Data acquisition can also be obtained from non profiling systems like: Meteorological stations; RDI WORKHORE ADCP profilers and GPS systems. Acquisition from these systems can be synchronized with the profiling operations or operate asynchronously.

To guarantee battery integrity, different level of security and management actions can be configured and are automatically taken by the Buoy Controller Module management firmware.

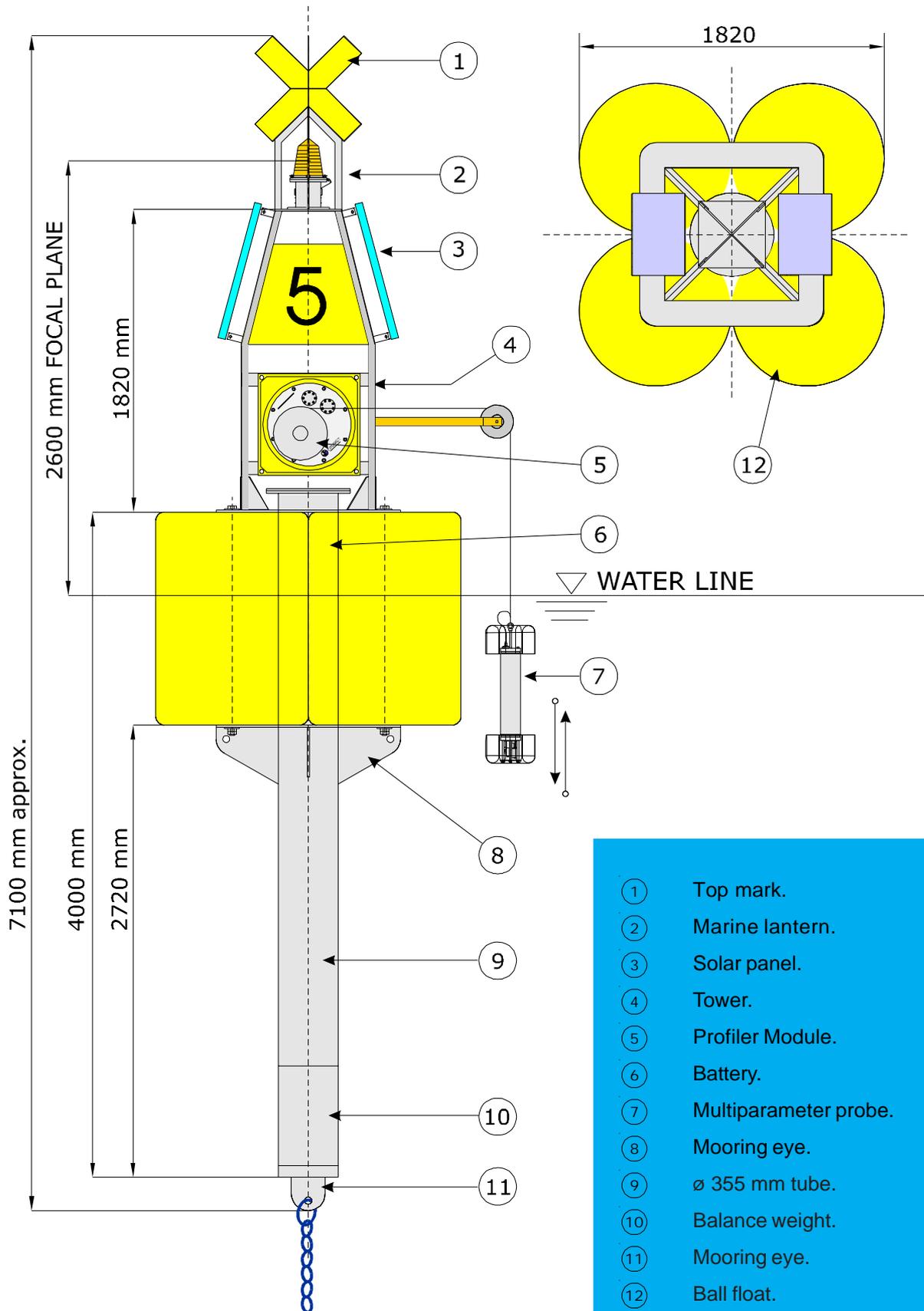
Collected data is maintained in a non volatile memory waiting to be sent to the Control node station. Once the communication with the Control node station is established, the stored data flows in CRC controlled messages, while from the Control Node Station, it is also possible to modify the Buoy operating parameters (profile type, data acquisition interval, etc.). Access to the collected data and to the Buoy 601/701 Profiler configuration is protected by means of user defined passwords.

EXAMPLES OF 3D OUTPUT PLOTS



Adriatic Sea, 10 miles from Po river delta - from May 7th to May 17th, 1990

EXAMPLE OF INSTALLATION OF THE IDRONAUT PROFILING MODULE ON A FLOATEX® MARINE BUOY



- ① Top mark.
- ② Marine lantern.
- ③ Solar panel.
- ④ Tower.
- ⑤ Profiler Module.
- ⑥ Battery.
- ⑦ Multiparameter probe.
- ⑧ Mooring eye.
- ⑨ \varnothing 355 mm tube.
- ⑩ Balance weight.
- ⑪ Mooring eye.
- ⑫ Ball float.

REBUS[®] - REMOTE BUOY MANAGEMENT SOFTWARE

The core of the land based Control/node station is the **REBUS - Remote BUOY Management Software** which allows the user to carry out remote BUOY PROFILER 601/701 control, diagnostics, configuration and data retrieval operations, in an attended or unattended way.

The Control/Communications node can control a high number of Buoy 601/701 profilers; this makes it possible to organize and manage a geographically dispersed monitoring system from a single Control Station. Furthermore, secondary "Slave" stations can exist, and can communicate with the Buoy 601/701 profilers retrieving the collected data. First aim of these secondary "slave" stations is to have access to the Buoy 601/701 profiler remotely collected data from scientific stations, laboratories or administrative offices.

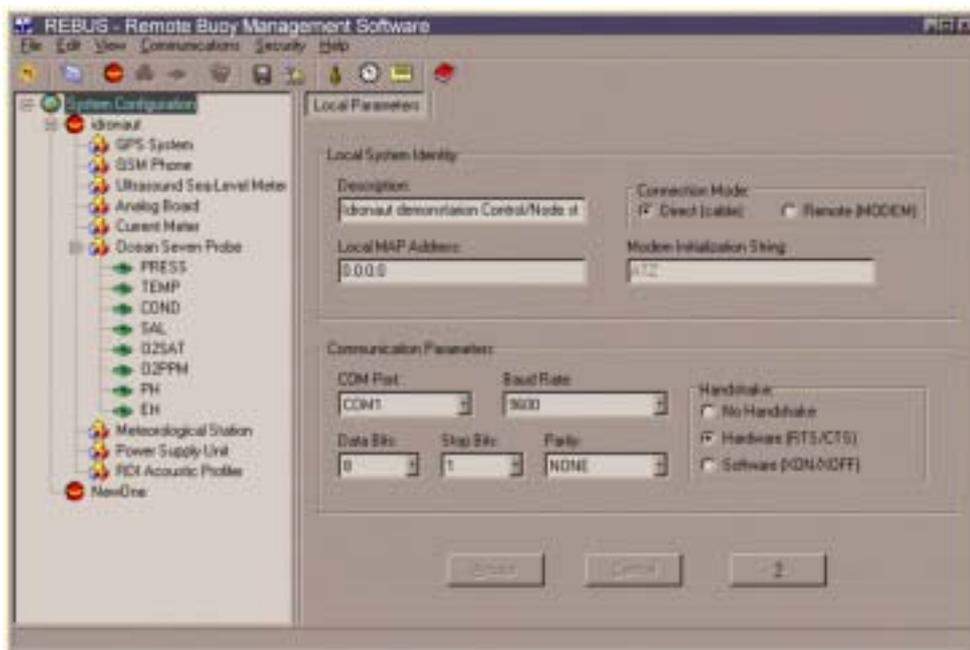
REBUS is a very powerful and flexible software which has been designed for the Windows[®] 32bit Operating systems, Win98/Win2000/WinNT, it permits to more than one customer to share the Buoy 601/701 Profilers resources and to collected data interactively and iteratively. Ultimately, this allows gathering of data and management of the acquisition systems directly in the places where data processing and analyses are performed, whether they are scientific stations, laboratories or administrative offices.

One of the most important features of this programme, resides in the possibility to modify the Buoy 601/701 profiler operating parameters and to obtain information on the Buoy 601/701 profiler status, thus avoiding the need to physically reach the Buoy 601/701 profiler to obtain the same information or to verify its operating conditions.

Moreover, by means of the REBUS programme there is the possibility to follow, in near to real-time, the physical processes operating in the water column and the chemical reactions occurring in marine waters due to a natural phenomenon or to an anthropic impact.

As a consequence, it is possible to intervene by directly modifying the Buoy 601/701 profiler operating parameters at the right moment and in the right way, for example by varying the data acquisition frequency or the maximum, minimum depth. Some of the main features of the programme are listed as follows:

- ◆ Simplified operator's interface taking advantage of the Windows operating system resources.
- ◆ Configuration and remote management of the Buoy 601/701 profiler.
- ◆ Retrieving and numerical representation of the data collected by the Buoy 601/701 profilers.
- ◆ Automatic communication, in the absence of an operator at four daily times or at repetitive time intervals.
- ◆ Retrieving and storing in text files of the Buoy 601/701 profilers status information.
- ◆ On-line contextual help system.
- ◆ Different levels of system security by means of customisable Buoy 601/701 profiler access password and configuration access password.



Via Monte Amiata, 10 - ITALY
20047 Brugherio (MILANO)
Tel. (39) 039 879656 - Fax (39) 039 883382
E-mail: idronaut@idronaut.it
<http://www.idronaut.it>

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