OCEAN MODULES SWEDEN AB

# Ocean Modules ROV Systems

## ROV V8 M500/L3000

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# Contact Information

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# Contents

# 1 INTRODUCTION

## 1.1 OCEAN MODULES

Ocean Modules has designed and produced ROV systems with manoeuvrability, flexibility and versatility that is unique in the ROV industry for almost 20 years. To date, Ocean Modules has sold over 100 ROV systems, many of which have been custom-built to fulfil specific customer needs.

Science and research customers include the Australian Antarctic Division, the Alfred Wegener Institute, the Swedish National Maritime Museums. Commercial customers include Sakhalin Energy Investment Company and Alcatel-Lucent Submarine Networks.

Military and law enforcement customers include the German Water Police, the Swedish Coast Guard, the Finnish Border Guard, the Australian Customs Service, the US Navy, the Royal Australian Navy, the Republic of Korea Navy, the Finnish Navy and the Chinese Navy, many with signed framework agreements.


*Figure 1. A custom built V8 M500 during operations in the Arctic.*

Although Ocean Modules has produced many “off-the-shelf” ROV systems, many of our customers have chosen Ocean Modules based on the ability to design and build custom systems to fulfil specific needs.

Solutions to problems that have been considered “too difficult” or “impossible” elsewhere, have been implemented successfully by Ocean Modules many times.

Custom-built Ocean Modules ROV systems include designs for scientific data collection, use in extreme environments such as nuclear storage facilities and extremely long tunnel inspections.

## 1.2 THE OCEAN MODULES V8 CONCEPT

In the Ocean Modules V8 ROV range the centre of gravity and centre of buoyancy are placed in the centre of the vehicle. Stability is created artificially, using eight vectored thrusters, an advanced

control system and feedback from precise sensors, whereas traditional ROV design places the buoyancy material at the top of the vehicle and ballast at the bottom.

The Ocean Modules approach allows the ROV to hold any position, with unlimited pitch and roll, indefinitely. Changes in depth, heading, pitch and roll due to external forces such as tether drag, swell, current or payload are automatically corrected. This contributes to ease of operation in difficult environments, and access to spaces which would be difficult or impossible to work in with a traditional ROV.

The unique capability of the V8 range of ROV systems to rotate 360° around any axis means that they can be operated at any angle, and in any direction. This allows operation in tricky spaces and the capability to conduct sonar and video inspections that follow the profile of sea floor, ship hull or subsea structure.

Since sonar, cameras, lights and mounted tools such as a manipulators or samplers are always aligned, there is often no need for separate pan and tilt controls, reducing the cognitive stress on the operator, and thereby the risk of losing sight of the object being tracked.

The choice of several operating modes makes piloting even more intuitive. Vehicle movement can be controlled relative to the surface, ideal for following a subsea structure, or relative to the body of the vehicle, ideal for tracking a moving object with a camera or sonar. In reverse mode, controls are swapped around so that the ROV can be controlled naturally using an aft camera.

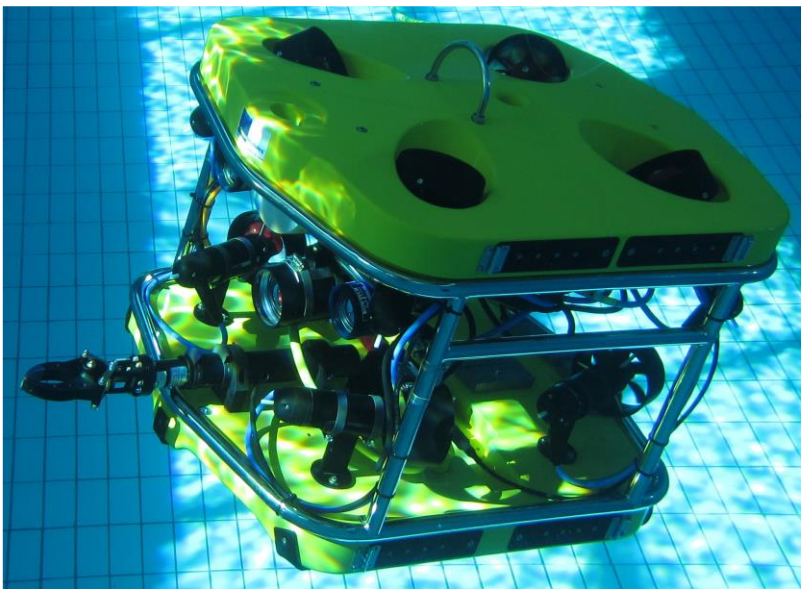


*Figure 2. Ocean Modules ROV M500 with mobility in 6 degrees of freedom.*

## 1.3 Ocean Modules Survey Management Software

SPOT.ON is a patented survey management software which allows operators to supervise, manage and collect synchronized geographic position, video, sonar and serial data in virtually any type of survey environment. Although SPOT.ON was originally designed for underwater use, it is ideal for recording any type of georeferenced data.

Collected data is connected to a track overlay on a drawing, map or chart. Any part of the recorded data is instantly viewable and playable by simply clicking the track. Points of interest are automatically presented in an automated report. The full survey, including all video and other collected data, can be shared and played back in the freely available SPOT.ON Viewer. SPOT.ON has support for practically every type of data input imaginable, such as instrument serial input, telemetry data, video, still photos, live screen capture (such as sonar imagery) and manually entered data.

A real-time tracking system is highly recommended for any ROV operation. On large vessels and in poor visibility ROV operators often become disoriented as to their present location and as well as to where exactly they have already searched. Additionally, it is very difficult to know with a high level of confidence that the entire area has been covered.

SPOT.ON allows the operator to interactively see the sonar, video, and position relative to the search object in real-time. When identifying an object of interest, the operator can mark this object with an attention point. SPOT.ON provides an important quality control improvement as both the operator and customer can instantly see what the ROV has inspected and what areas remain to be inspected.

At the completion of each mission the complete SPOT.ON mission is transferred to digital media, such as a USB drive. This media can be freely shared and replayed at any time in the future on any PC using the free viewer software. Additionally, SPOT.ON automatically generates a fully annotated report (with images) that can be provided immediately on completion of the inspection.

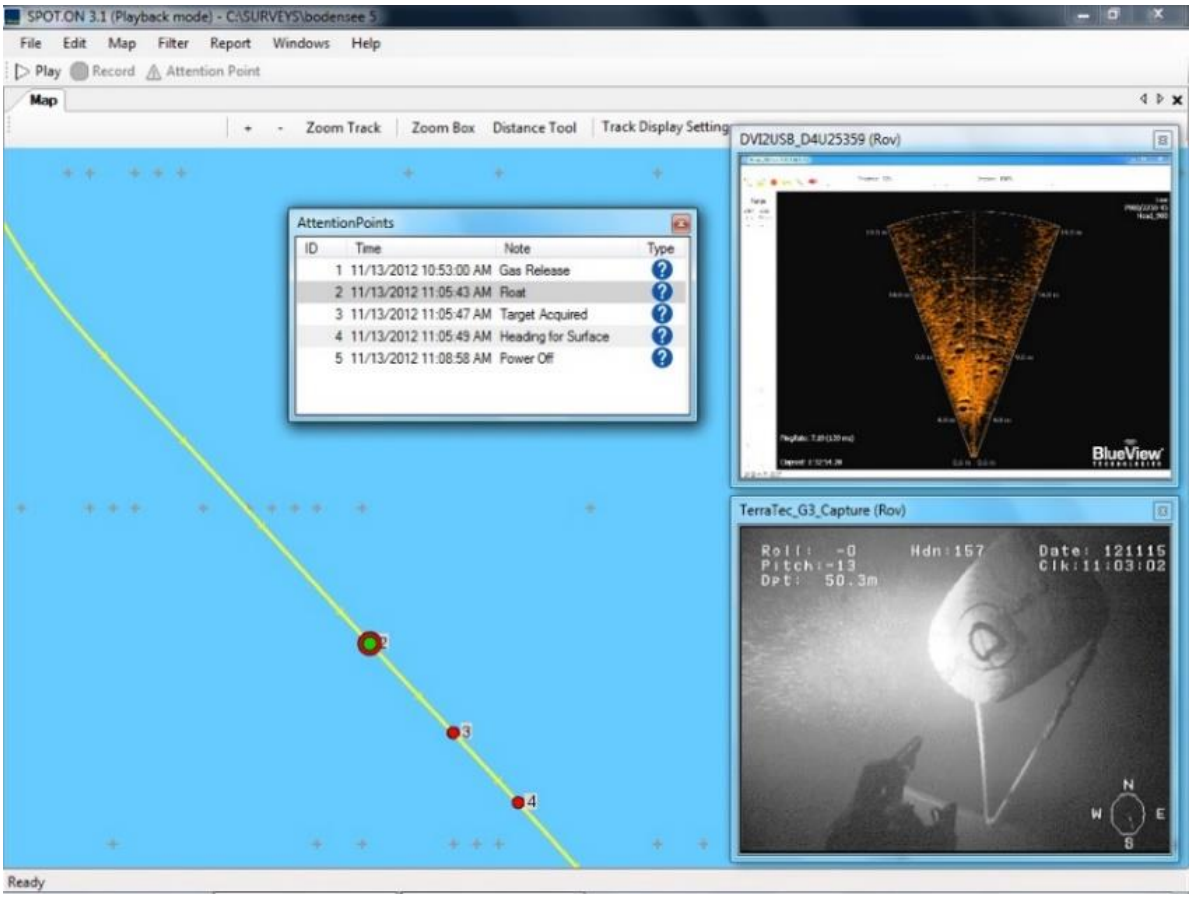



*Figure 3. A snapshot from a SPOT.ON recording. The image captures what has been recorded at Attention point 2: the position of the ROV on a sea chart, and the sonar and video image at that same position.*

# 2 ROV SYSTEMS

V8 ROV systems of various size classes have been used for such diverse application as scientific research underneath the Antarctic ice, ship hull inspections, EOD removal, extremely long inspections in the tunnels for cooling water in nuclear power plants, penetrating shipwrecks, underwater equipment repair, laying of undersea cables and accurate pipeline inspection.

The V8 ROV provides perfect stability at any attitude, making it possible to mount sensors at various angles for different types of research without reconfiguration. Furthermore, the control system allows the user to switch the ROV into “reverse mode”, which flips the controls around so that the ROV can be driven backwards as if it was forwards.

The ROV can be supervised through the control and diagnostics software, Ocean Modules ROV Analyzer, provides instant access to diagnostics such as temperature, voltage, current and leak detection on each individual circuit board as well as feedback from each individual thruster. Electronic fuses can be reset, and software updates can be applied at any time during operation.

## 2.1 V8 M500

The V8 M500 is a small and nimble inspection class ROV with the unique capability to manoeuvre with six degrees of freedom. The small size and significant power of the V8 M500 make it ideal for use in a wide range of tasks, and the capability to rotate 360 degrees in any dimension without losing stability is tremendously advantageous for sonar and video inspections as it allows the profile of sea floor, ship hull or subsea structure to be followed regardless of angle.

The system is able to maintain delicate attitude and position control without contacting the sea floor and with minimal thruster use to maintain its attitude. It is able deploy and retrieve instruments on the sea floor and collect both small and large objects from the sea floor including in areas with powerful currents.

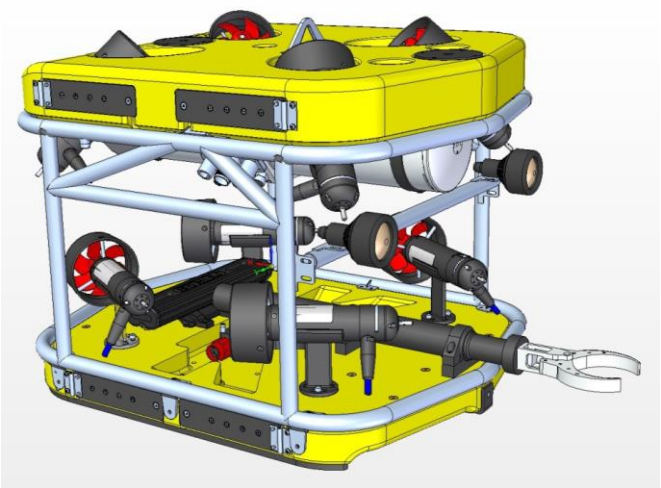


*Figure 4. The ROV V8 M500 in standard configuration.*

| | |
|---|---|
| **Frame** | Stainless steel and Divinycell floatation blocks |
| **Size** | Standard size: 840 x 655 x 670 mm |
| **Weight in air** | Approx. 70 kg |
| **Bollard pull** | >20 kg |
| **Payload (without skid)** | Standard approximately 12 kg but this can be customised. |
| **Thrusters** | 8 x 750W Brushless thrusters |
| **Control system** | 6 degrees of freedom |
| **Speed (Fwd/Bwd)** | > 3 knots |
| **Depth rating** | 500 m |
| **Operating temperature range** | -5° to 40°C |
| **Storage temperature range** | -25° to 50°C |

### 2.1.1 ROV V8 M500plus interfaces

The ROV V8 M500 is equipped with numerous electrical and data interfaces. Data transfer between the ROV and Surface Unit is over a fibre optic link. The ROV is equipped with interfaces for configurable serial data ports RS 232/485, Ethernet, HD-video and analogue data. Virtual serial ports make it simple to route data between subsystems and sensors on the ROV to processing software on the surface.

| Interface on ROV | Qty |
|---|---|
| 4x LED Interfaces | 4 |
| Analog Video Interfaces (simultaneous) with zoom/focus | 2 |
| Analog Video Interfaces (simultaneous) | 1 |
| Gigabit Ethernet Interfaces (24V/2A, Gigabit Ethernet) | 1 |
| Sonar Interface (24V/2A, RS-232/RS-485) | 1 |
| 1-function Manipulator Interface (0 to ±24 V) | 1 |
| AUX Interfaces (24V/5A, RS-232/RS-485) | 2 |

### 2.1.2 Optional extras

| Interface on ROV | Qty (Max) |
|---|---|
| Altimeter Interface (with auto altitude software) | 1 (1) |
| Analog Video Interfaces (simultaneous) | 1 (4) |
| HD Video Interface | 2 (2) |
| Gigabit Ethernet Interfaces | 1 (2) |
| RS-232/RS-485 Interfaces | 2 (4) |
| Analog Input Interfaces 0 to ±24 V | 2 (2) |
| Analog Input Interfaces 0 to 5 V | 1 (1) |
| Analog Input Interfaces 4 to 20 mA | 1 (1) |
| Analog Output Interfaces 0 to ±12 V | 4 (4) |
| Fixed 24 V External Power Interfaces (4x2A, 4x4A) | 4 (8) |
| Adjustable 5 to 16 V External Power Interfaces | 2 (2) |
| 400 Watt External Power | 1 (1) |

### 2.1.3 Auto altitude function

Ocean Modules can provide a control system software that includes an auto altitude function. With this software installed on the ROV, together with an altimeter, it is possible to operate the ROV using a fixed altitude over the sea floor. The ROV will then automatically ascend and descend following the natural topography. The fixed altitude is set and released by pressing a switch on the Pilot Control Unit.

## 2.2 SKIDS AND TOOLS

Ocean Modules ROV systems provide modularity and the possibility to mount a large number of sensors and tools. The V8 M500 can be equipped with custom-made skids that can be mounted and dismounted within 10 minutes. The manoeuvrability and stability of the ROV is not affected by the addition of a well-balanced skid. Skids provide space for extra payload and have the added benefit letting the user quickly reconfigure the ROV for specific purposes.

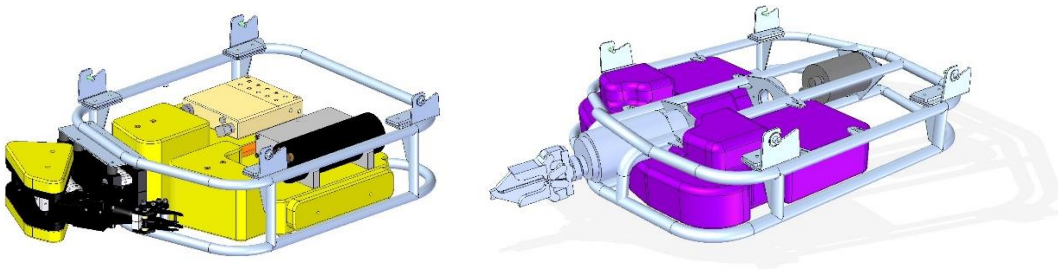


*Figure 5. Examples of custom designed M500 skids. To the left a skid for a hydraulic 5-Function manipulator and to the right a skid with 2-function manipulator for use in nuclear waste storage pools*

## 2.3 FIVE-FUNCTION MANIPULATOR.

Ocean Modules can be equipped with the Bravo-5 manipulator from Blueprint Lab. This is an electrical 5-function manipulator that can be mounted directly on the ROV without the requiring a skid.

Figure 6. The 5-funtion manipulator from Blueprint Lab, Bravo 5.

In cases with particularly high demands, Ocean Modules has developed fully customized systems, for example: advanced protection and maintenance capabilities for use in nuclear storage facilities or the especially well-equipped scientific research system pictured below.

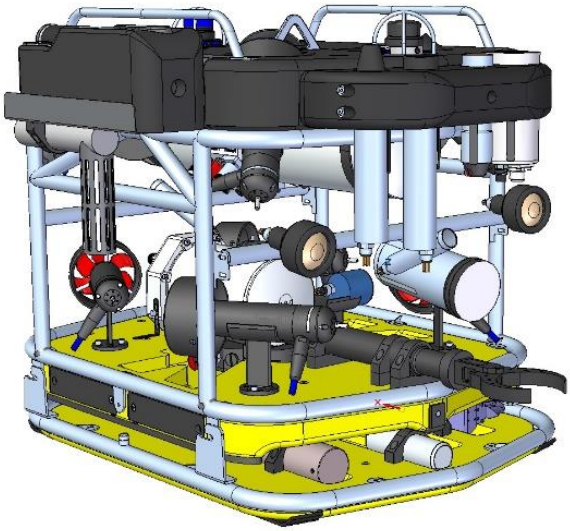


*Figure 7. A custom-built V8 M500 ROV with sensors mounted on all sides.*

The vehicle pictured above was delivered with the following equipment:

- DT101 imaging and bathymetric multibeam sonar
- Glider Payload CTD
- LED Lights
- MicronNav USBL Positioning system
- Navigation Camera 2 (aft looking)
- PA500 High Precision Altimeter
- Hyperspectral Radiance Radiometer
- SUNA V2 Nitrate Sensor
- Viper hyperspectral Transmissometer
- ECO-Triplet Fluorometer
- HD Zoom Camera (Main Camera)
- Micron Scanning Sonar
- Navigation Camera 1 (forward looking)
- One Function Manipulator
- Hyperspectral Irradiance Radiometer
- SBE 18 pH (pH sensor)
- Tiger Shark Still camera

The Surface Unit is a collective designation for several units that make up the top-side of the ROV system. The Surface Unit contains units for the management of the power supply, interfaces, pilot control and data collection. Every V8 M500 ROV system contains at least a Power Unit and a Surface Interface Unit, but may also contain an industrial-grade PC, additional interfaces, additional video recording units, data manipulation units, video switches, UPS equipment or broadcasting hardware.

## 2.4 ROV M500 SURFACE UNIT


*Figure 8. Surface Unit consisting of: Surface Expansion Unit, Computer, Surface Interface Unit and the Power Unit.*

All Surface Units are 19" rack-mountable and can be delivered in a variety of housings depending on customer requirements, from rack cabinets for permanent ship installation to rugged and waterproof mobile cases.

The specification for the Surface Unit, pictured in Figure 8, which is housed in a portable ruggedized case with a 7U standard 19" rack containing a Power Supply Unit (ACDC converter), Surface Interface Unit, industrial computer and an expansion unit (interface panel) is as follows:

| | |
|---|---|
| **Power supply input** | 230 VAC, 50/60 Hz, Min 16 A, single phase |
| **Power supply output** | Setting 300 VDC, Max 11.5 A, (Lambda 3,3 kW) |
| **Power supply computer, screens, etc** | 230 VAC, 50/60 Hz, Min 10 A, single phase |
| **ROV data communication I/O** | Single mode optical fiber |
| **Digital port** | 2x Ethernet, 3x RS-232 |
| **Video** | 4x Analog (2 simultaneous video streams) |
| **HD-Video** | 2x HDMI, 2x HD-SDI |
| **Overlay input** | 1x Serial RS-232 (input 2 rows, 26 characters each) |
| **Overlay output** | 1 x Serial RS 232 (NMEA: Roll, pitch, heading, compass, time, date) |
| **Size (L x W x H)** | 100 x 61 x 46 cm (7U 19" Standard rack) |
| **Weight** | 50 kg |
| **Analog video overlay (video monitor)** | Roll, pitch, heading, compass, time, date, cable turns, text |

### 2.4.1 Pilot Control Unit

The PCU is the main user interface for controlling the ROV. Manoeuvring is primarily managed through two three-function joysticks and a pitch wheel. Different controls may be engaged simultaneously, so that the vehicle may be manoeuvered freely in six degrees of freedom. Four continuous dimmers are used to individually control the intensity of up to four lights.


*Figure 9. The handheld Pilot Control Unit*

| | |
|---|---|
| **Size (L x W x H)** | 24 x 18 x 13 cm |
| **Weight** | 2 kg |

### 2.4.2 ROV M500 standard tether

| | |
|---|---|
| **Diameter** | Max 16 mm |
| **Buoyancy** | Neutral |
| **Minimum bend radius when loaded** | 300 mm |
| **Breaking load** | 700 kg (static load), 150 kg (dynamic load) |
| **Tether power leads (300 VDC)** | 4x 1,2 $mm^2$ copper + 2x 0.2 $mm^2$ |
| **Data communication** | Single mode optical fibre |

The maximum recommended tether length for the ROV M500 is approximately 500 meters. If extended tether lengths are required, the ROV system can be equipped with a long tether power supply which will allow tether lengths over 1000 meters.

## 2.5 VIDEO OVERLAY

The standard overlay displays: Roll, Pitch, Depth, Heading, Date, Clock, and a visual representation of the heading (compass rose). It is also possible to include altimeter data in the overlay.

The video overlay can be turned on or off using the PCU menu. It is also possible to have multiple video outputs on the SIU front panel, some with, and some without, video overlay.

## 2.6 V8 L3000 OFFSHORE

For customers who require an inspection class ROV that dives deeper and carries a greater payload Ocean Modules offers the V8 L3000. The V8 L3000 uses the same control system as the M500 and therefore has same manoeuvrability and stability. The V8 L3000 has a maximum diving depth of 3000 meters and numerous electrical and data interfaces. With fibre optic communications and configurable communications ports that enable interfaces for Ethernet, Serial ports RS 232/485, HD-video and analogue data.

Virtual serial ports make it simple to route data between subsystems and sensors on the ROV and processing software on the surface.

*Figure 10. The ROV V8 L3000 in standard configuration and with a manipulator skid*

| | |
|---|---|
| **Frame** | Stainless steel and Divinycell floatation blocks |
| **Size** | 1190 x 840 x 890 mm |
| **Weight in air** | Approx. 270 kg |
| **Bollard pull** | >50 kg |
| **Payload (without skid)** | Approx. 30 kg |
| **Thrusters** | 8 x 1500W Brushless thrusters |
| **Control system** | 6 degrees of freedom |
| **Speed (Fwd/Bwd)** | > 2.5 knots |
| **Depth rating** | 3000 m |

### 2.6.1 Standard Interfaces for the V8L3000plus

| **Interface on ROV** | **Qty** |
|---|---|
| 4x LED Interfaces | 4 |
| Analog Video Interfaces (simultaneous) with zoom/focus | 2 |
| Analog Video Interfaces (simultaneous) | 2 |
| Gigabit Ehernet Interface (24V, Gigabit Ethernet) | 1 |

| | |
|---|---|
| Sonar Interface (24V, RS-232/RS-485) | 1 |
| 1-function Manipulator Interface (0 to ±24 V) | 1 |
| AUX Interfaces (24V, RS-232/RS-485) | 2 |

### 2.6.2 Optional extras

| **Interface on ROV** | **Qty (max)** |
|---|---|
| Altimeter Interface (with auto altitude) | 1 (1) |
| HD Video Interface | 2 (2) |
| LED Interfaces | 4 (8) |
| Analog Video interfaces (simultaneous) with zoom/focus | 2 (4) |
| Analog Video interfaces (simultaneous) | 2 (4) |
| Gigabit Ethernet Interfaces | 2 (3) |
| RS-232/RS-485 Interfaces | 10 (12) |
| Analog Input Interfaces 0 to ±24 V | 6 (6) |
| Analog Input Interfaces 0 to 5 V | 3 (3) |
| Analog Input Interfaces 4 to 20 mA | 3 (3) |
| Analog Output Interfaces 0 to ±12 V | 16 (16) |
| Fixed 24 V External Power Interfaces | 2 (14) |
| Adjustable 5 to 16 V External Power Interfaces | 2 (2) |
| 400 Watt External Power | 2 (2) |

## 2.7 SKIDS AND TOOLS

The L3000 is designed with a skid system can be equipped with a wide range of customer specific equipment such as 5 function manipulators, shear cutters, cable trackers, dredgers and, custom so that specialized tasks can be set up in minutes.

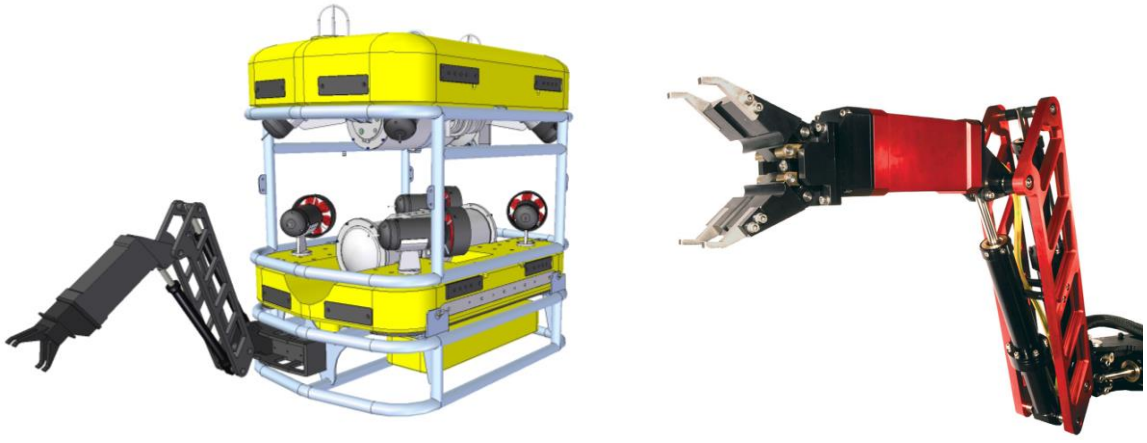
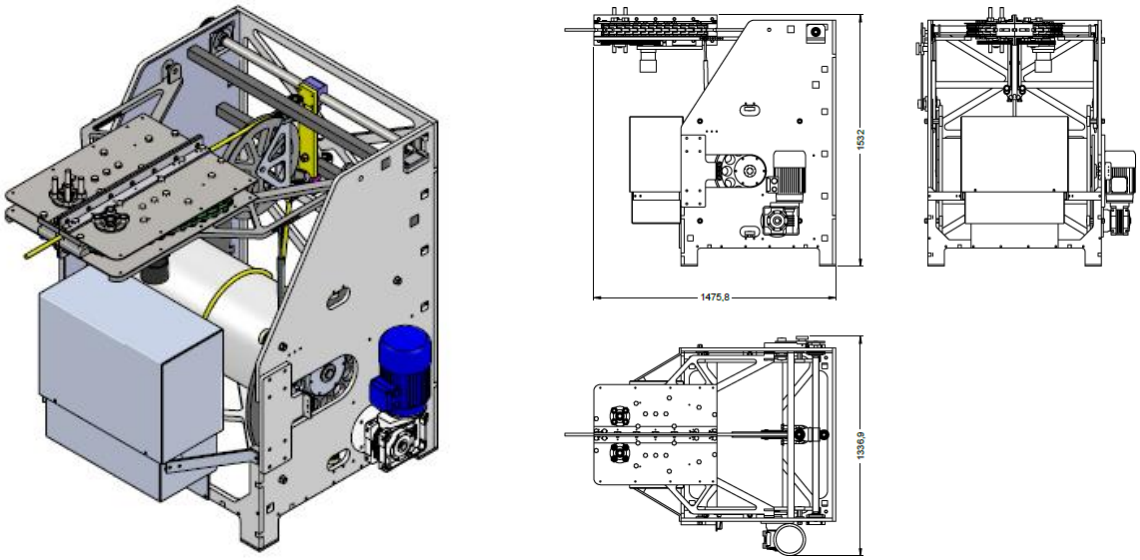


*Figure 11. V8 ROV L3000 with skid mounted manipulator. The 5-function manipulator is an electric manipulator by ECA.*

# 3 OCEAN MODULES WINCHES

## 3.1 DRY TMS WINCH

The Dry TMS Winch is a constant tension winch, which means that it keeps a constant tension on the tether as it is guided and spooled up on the winch drum. This offers easy handling and efficient spooling of the ROV tether. The winch has been developed for under-water tether management systems (TMS), but as the name implies, has been adapted for use on deck.




The standard winch has a capacity of 600 meters tether (ROV M500), but it can also be customised up to a maximum capacity of 1000 meters.

| **Capacity** | **600 meters** | **1000 meters** |
|---|---|---|
| **Height** | 1532 mm | 1570 mm* |
| **Width** | 1337 mm | 1370 mm* |
| **Depth** | 1476 mm | 1510 mm* |
| **Weight (without tether)** | 400 kg | >400 kg* |
| **Tether weight** | 210 kg | 350 kg |
| **Speed** | continuously adjustable with hand or foot control up to 50 meters per minute. | |
| **Lifting capacity** | 150 kg | 150 kg* |
| **Power requirement** | 5 kW | 5 kW* |

Important note: Since the TMS Winch requires a perfect fit between the drum and the tether, the winch drum must be specifically made for every batch of tether. A consequence of this is that we recommend that the user orders 2 reserve lengths of tether from the same batch to avoid buying a new drum for each new order of tether.

## 3.2 MOTOR WINCH (S)

The motor winch (S) is a robust motor winch with an automatic cable guide to assist with efficient spooling. The winch drum can be run at variable speeds, but since it does not have a cable tensioner, will require manual assistance to keep the correct tension on the tether. The winch cannot be used to wind in heavy loads. The dimensions below are for a winch with the capacity for 600 m of tether.

*Figure 12. Motor winch (S)*

| | |
|---|---|
| **Capacity** | 600 meters with 15 mm diameter tether |
| **Height** | 991 mm |
| **Width** | 914 mm |
| **Depth** | 1009 mm |
| **Weight (without tether)** | 136 kg |
| **Tether weight (15 mm)** | 0.167 kg/m |
| **Lifting capacity** | 50 kg |

# 4 THE CONTAINERISED LAUNCH AND RECOVERY SYSTEM

The Containerised Launch and Recovery System is based on a 20 Foot offshore container. Facing the water, the container opens with two doors to the Launch and Recovery System (LARS). The LARS consists of a telescoping boom, a launch winch, and a cable winch with a level wind. The telescoping boom can extend 6.1 meters from the container opening.

A launch winch is used to lower the TMS cage into the water. Well in the water TMS cage will be lowered by the cable winch with the capacity to lower the TMS to 2500 meters depth.

The ROV will be housed in its deployment garage/cage, the Tether Management System (TMS), until it reaches the desired working depth. From this point the ROV can exit the cage and manoeuvre freely up to 600m from the TMS cage.

The back of the container opens to the control room. The control room will be a climate-controlled workspace for three seated persons

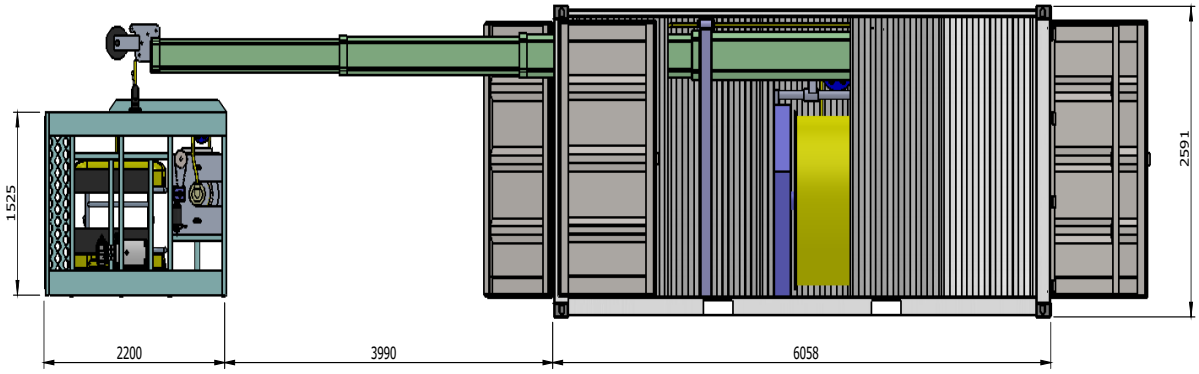



*Figure 13. The containerized launch and recovery system container with extended boom and TMS cage.*

## 4.1 DEPLOYMENT CAGE AND TETHER MANAGEMENT SYSTEM

Where deployment cages normally are designed to work as a clump weight, the Ocean Modules TMS system is built around an innovative light weight deployment cage that is stabilised and kept in place with the help of a positioning system, Ocean Modules 360 control system and four thrusters. The deployment cage practically becomes an ROV with station keeping. This innovation makes the TMS lighter which in turn takes weight of the launch boom and removes the need for a heave compensator on the winch. The deployment cage is therefore made in aluminium and POM plastics to minimise the weight. Components that need protection from corrosion are treated with ceramic coatings.

The cage will be designed and constructed to accommodate the OM ROV L3000 with mounted tool skids. To avoid having to reconfigure the TMS cage after the varying height of the ROV with or without tool skids, system utilising inflatable air bags is used. These air bags are mounted on the inside roof of the cage and are inflated to secure the ROV in place.

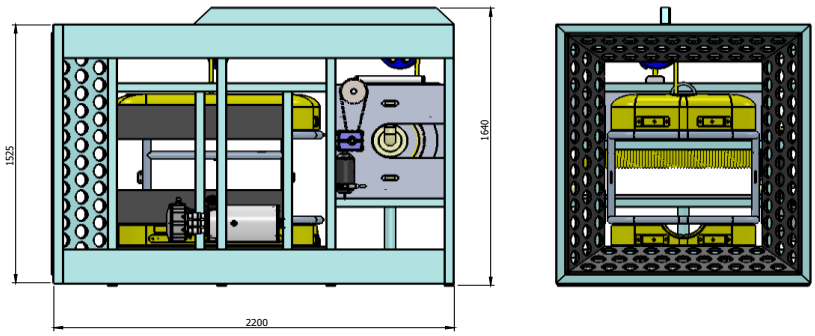



*Figure 14. Side and front view of the deployment cage.*

In the back of the deployment cage is the TMS. The TMS winch has a capacity for 600 meters of tether. To ensure smooth operation the winch is equipped with a pre-tension and even wind system.

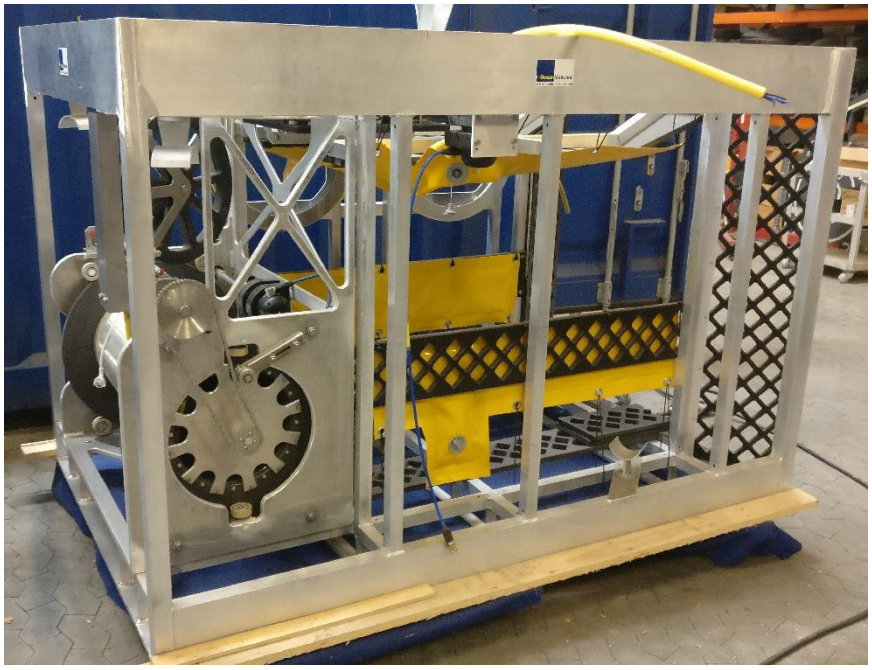


*Figure 15. TMS deployment cage.*

## 4.2 THE CONTROL ROOM

The control room is an acoustically insulated and climate-controlled compartment which is accesses through the back of the container. The room is large enough for three seated persons, a floor to roof 19" equipment rack, a desk and a wall with 6 to 9 video and computer monitors.

## 4.3 DUAL CONTAINER SOLUTION

To accommodate for extra equipment and a larger control room and workshop, Ocean Modules proposes a Dual container solution with one container working as the Containerised Launch and Recovery System and one container housing the workshop and control room. The Containerised Launch and Recovery System can be placed on top of the work shop so that the deployment garage

can be placed outside the workshop with the LARS for the exchange of skids or service. If required the complete system can be powered by an integrated electrical generator which enables the two containers to function as a self sufficient standalone system.

The Control and Workshop container (CWC), would house a generous workshop area with workbenches, tool cabinets and skid storage area. The control room would be a climate controlled workspace for three seated persons.

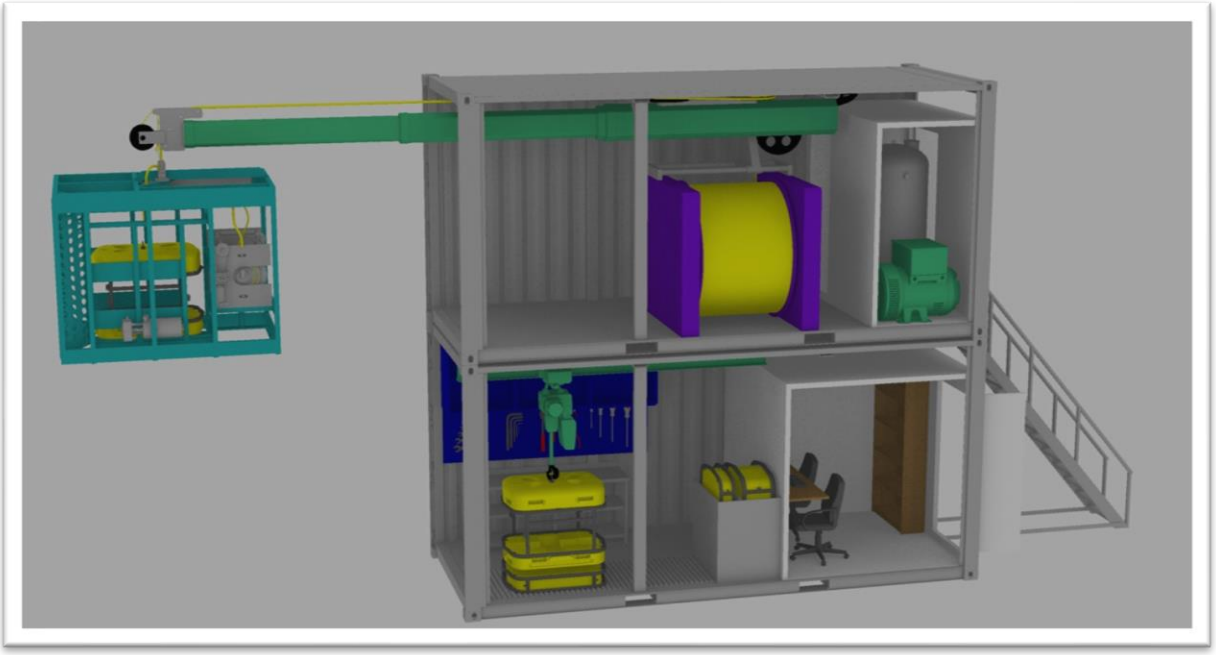


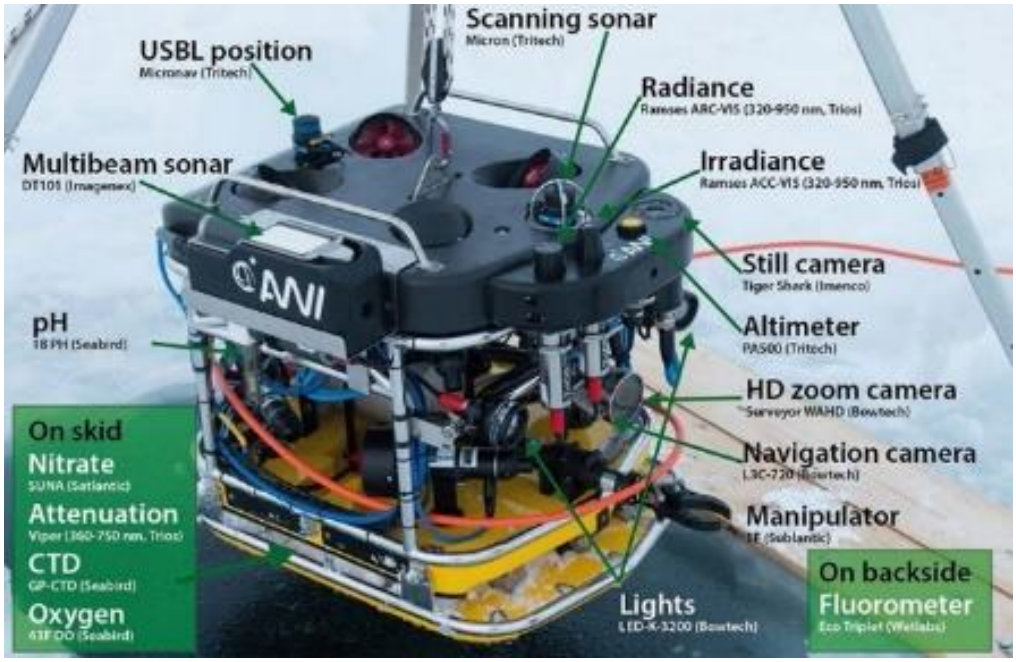
*Figure 16. The dual combination of two 20 foot containers in operational status.*

# 5 FROM THE WEB

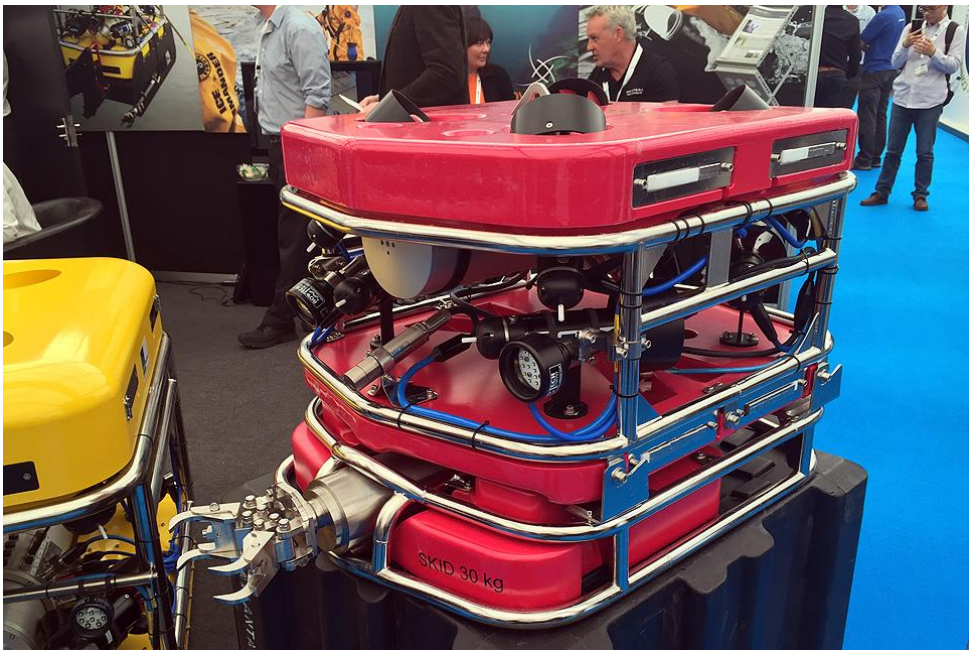
Watch the Ocean Modules V8 500 demonstration of the 6 degrees of freedom

Watch the custom designed and well equipped V8Sii with skid demonstrat the capabilities of the Ocean Modules control system

Read about the Alfred Wegner Institutes New Remotely Operated Sensor Platform for Interdisciplinary Observations under Sea Ice




See ECS Special Projects test the MCM system Cobra and the Bx30i -RF mounted on a ROV M500




The V8 M500N has a lower frame, a new toolskid design for a purpose-built set of tools, extended safety features provided by new software modes of operation and an ingenious skid adapter for existing cleaning and lifting devices. The ROV system also fulfills the strict safety and security requirements set by the nuclear industry, including radiation testing and CE conformity marking.

See how the V8M500N improved safety and efficiency att Sellafield nuclear waste facility.

Read aboaut Seaterra and their Offshore UXO survey operations using Ocean Modules ROVs