Operator Manual

VideoRay
AN AV COMPANY



MISSION SPECIALIST

Subsea Batteries

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Subsea Batteries

1 Introduction

The Mission Specialist Subsea Batteries deliver power to the Mission Specialist Defender without the need for a topside power source. When combined with the lightweight Expeditionary Splashproof Controller and Expeditionary Reel, the deployment location of a Mission Specialist Defender is no longer bound by the availability of power outlets. Mission Specialist Subsea Batteries are the perfect accessory for missions that require the smallest topside footprint or where topside power is not available.

2 About This Manual

This manual has been prepared to assist in the installation, operation, charging, and maintenance of the Mission Specialist Subsea Batteries. The operator must thoroughly understand these responsibilities and safety requirements of the batteries as defined in this manual to assure their correct and prudent operation. While the information in this manual are current at the time of issue, this product is continually being updated and improved so the physical product may differ slightly from the descriptions.

3 Safety First

Operating electrical devices in and near the water can be dangerous. There is always a risk of drowning or electrocution in such an environment. Reduce these risks by using common sense and observing safety regulations and recommended safe practices including the following:



_NEVER HANDLE POWER CORDS WHILE IN CONTACT WITH WATER OR ALLOW POWER CORD CONNECTORS OR THE CONTROL PANEL TO ENTER THE WATER. THE ONLY COMPONENTS THAT CAN SAFELY BE PLACED IN WATER ARE THE SUBMERSIBLE, ANY ONBOARD ACCESSORIES, AND TETHER - ONLY AFTER MAKING SURE ALL CONNECTIONS ARE SECURE.



_ALWAYS TEST THE SAFETY COMPONENTS, SUCH AS GFCI SWITCHES AND INTERLOCK DEVICES, BEFORE BEGINNING OPERATIONS. FOLLOW THE PROCEDURES DESCRIBED IN THIS MANUAL FOR PROPER CONNECTIONS.



_HAVE PROPER SAFETY EQUIPMENT, SUCH AS PFDS (PERSONAL FLOTATION DEVICES), ON HAND AND MAKE SURE YOU KNOW HOW TO USE THEM BEFORE YOU NEED THEM.



_DURING PRODUCT OPERATION, HANDS AND LOOSE HANGING OBJECTS SHOULD BE KEPT AWAY FROM MOVING COMPONENTS, AS THEY MAY POSE A PINCHING/CRUSHING HAZARD.

_MONITOR WEATHER AND SEA CONDITIONS AND HEED ANY WARNINGS OR ALERTS.

_BE AWARE OF AND FOLLOW ANY LEGAL ORDINANCES OR REGULATIONS IN YOUR AREA REGARDING OPERATION OF VESSELS AND UNDERWATER EQUIPMENT IN THE WATER.

CAUTION: Avoid lifting or carrying the ROV by grasping a battery; always use the hand carry openings incorporated into both sides of the ROV frame. Do not transport the ROV with the batteries installed; significant lateral rocking, load, or shock may result in damage to the units.

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4 Specifications

NiMH

Chemistry
Nickel Metal Hydride NiMH

Output Voltage
Nominal Regulated: 48VDC

Max Current
21A peak/11A sustained per battery

Nominal Capacity
235 Whr per battery

Depth Rating
300 m or 1000 m (984 ft or 3,280 ft)

SIZE & WEIGHT

Length
561 mm (22.08 in)

Diameter
89 mm (3.50 in)

Dry Weight
300 m – 4.5 kg (9.9 lb) per battery
1,000 m – 5.3 kg (11.7 lb) per battery

Weight in Water
300 m – 1.2 kg (2.6 lb) per battery
1,000 m - 1.8 kg (4.0 lb) per battery

Case
Watertight Transit Case

FEATURES
Pressure safety enabled relief valve (5 psi)
Secondary pressure relief (50 psi)
Toolless mounting
Smart diagnostics and monitoring
External smart charger included

ORDERING*

300 m Battery Set w/ Charger and Case
VideoRay Part Number 72739

1000 m Battery Set w/ Charger and Case
VideoRay Part Number 73501

**Sets above include 2 batteries; sets with 4 also available*

Li-ION

Chemistry
Lithium-ion Li-ION

Output Voltage
Nominal Regulated: 48VDC

Max Current
21 sustained per battery

Nominal Capacity
404 Whr per battery

Depth Rating
300 m or 1000 m (984 ft or 3,280 ft)

SIZE & WEIGHT

Length
561mm (22.08 in)

Diameter
89mm (3.50 in)

Dry Weight
300 m – 4.0 kg (8.8 lb) per battery
1,000 m - 4.8 kg (10.6 lb) per battery

Weight in Water
300 m - 0.6 kg (1.3 lb) per battery
1,000 m - 1.24 kg (2.7 lb) per battery

Case
Watertight Transit Case

FEATURES
Pressure safety enabled relief valve (5 psi)
Secondary pressure relief (50 psi)
Toolless mounting
Smart diagnostics and monitoring
External smart charger included

ORDERING*

300 m Battery Set w/ Charger and Case
VideoRay Part Number 73133

1000 m Battery Set w/ Charger and Case
VideoRay Part Number 73502

**Sets above include 2 batteries; sets with 4 also available*

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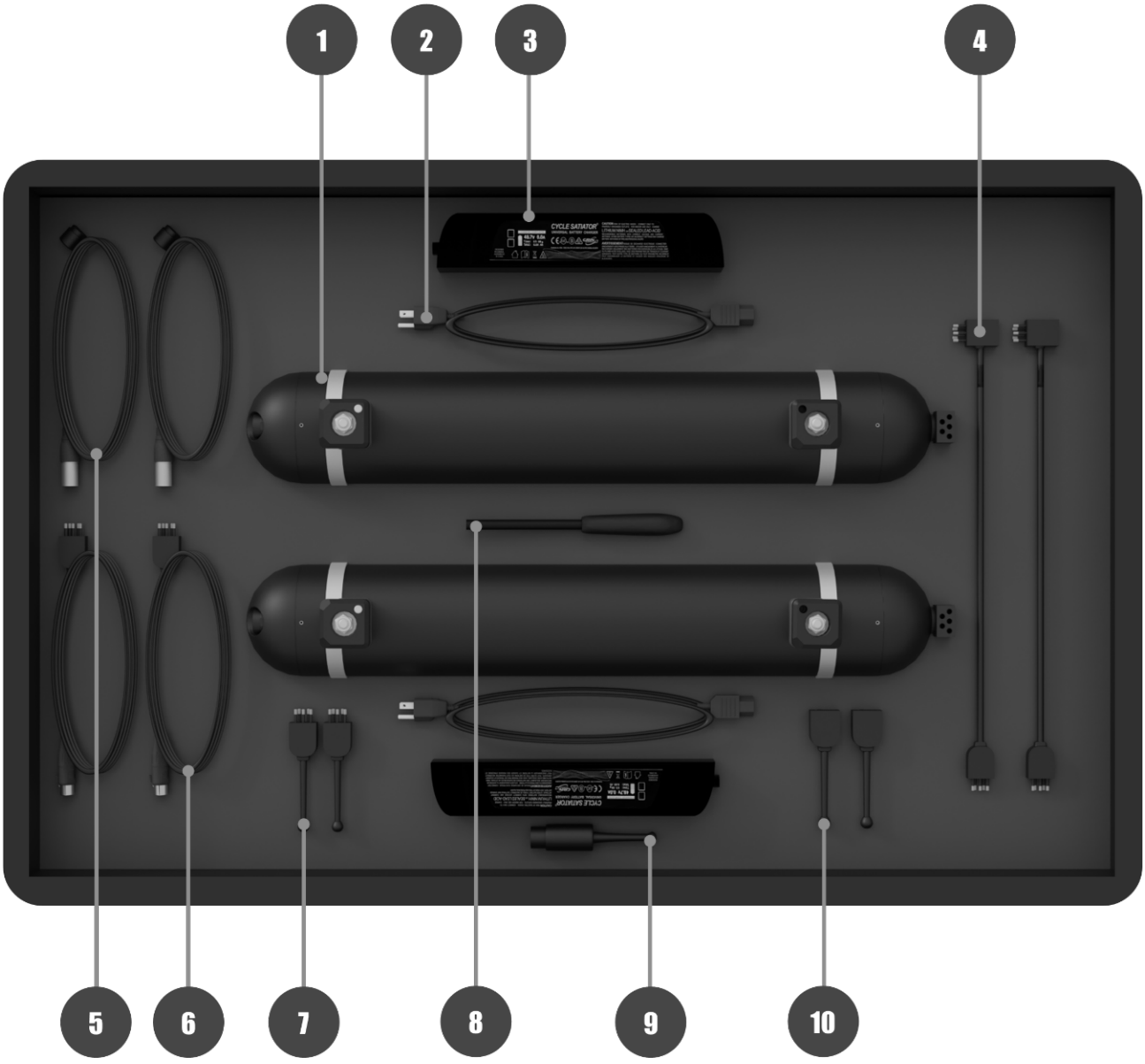
5 Subsea Battery Set Contents

1. Subsea Battery Li-ion 1,000m (2) PN 73181
2. Charger A/C Power Cord (2) PN 72400
3. Battery Charger (2) PN 73507
4. 5-Pin F/M to 5-Pin Male Power Cable (2) PN 72864
5. Charger Port to XLR Charging Cable (2) PN 72400
6. XLR to 5-Pin Male Charging Cable (2) PN 73964
7. 5-Pin Male Dummy Plug (2) PN 70168
8. Power Wand PN 74013
9. 8-Pin Tether Dummy Plug w/ Cap PN 73761
10. 5-Pin Female Dummy Plug (2) PN 70169



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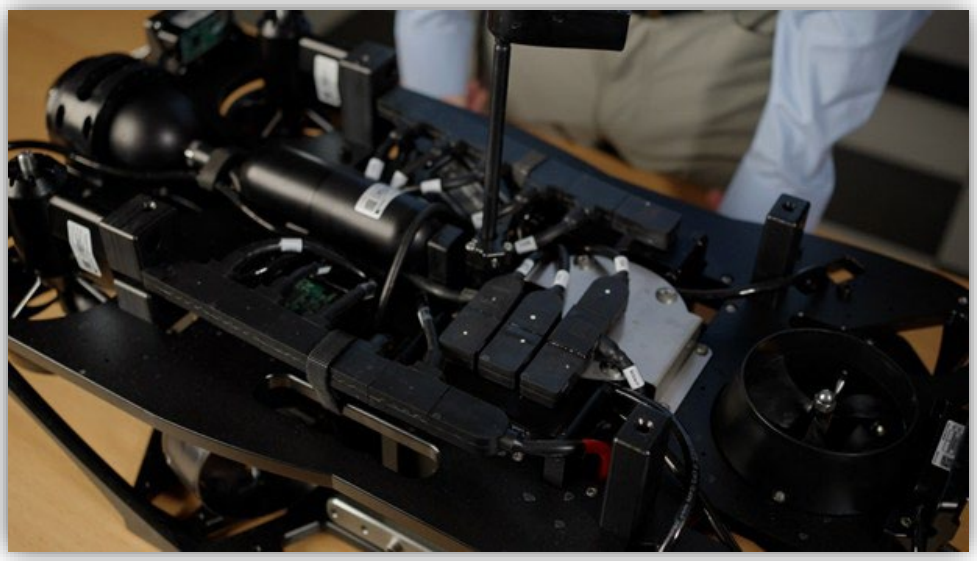
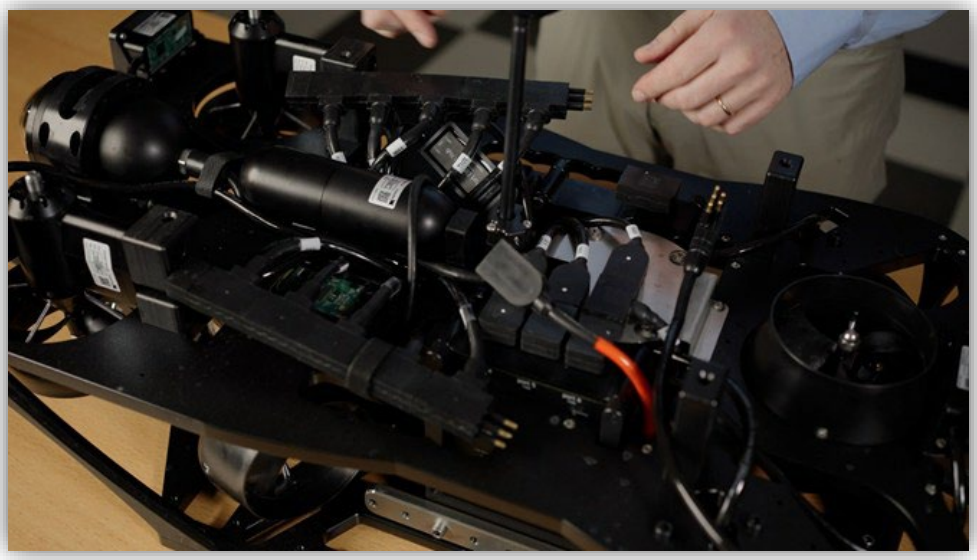
6 Installation

_APPLY A SILICONE-BASED LUBRICANT TO ALL SUBSEA CONNECTORS PRIOR TO MAKING CONNECTIONS

Remove the float block from the ROV and set aside.

Disconnect both port and starboard 5-pin connector chains from the power module and 5-pin extension whip (orange cable on the port side of the ROV).





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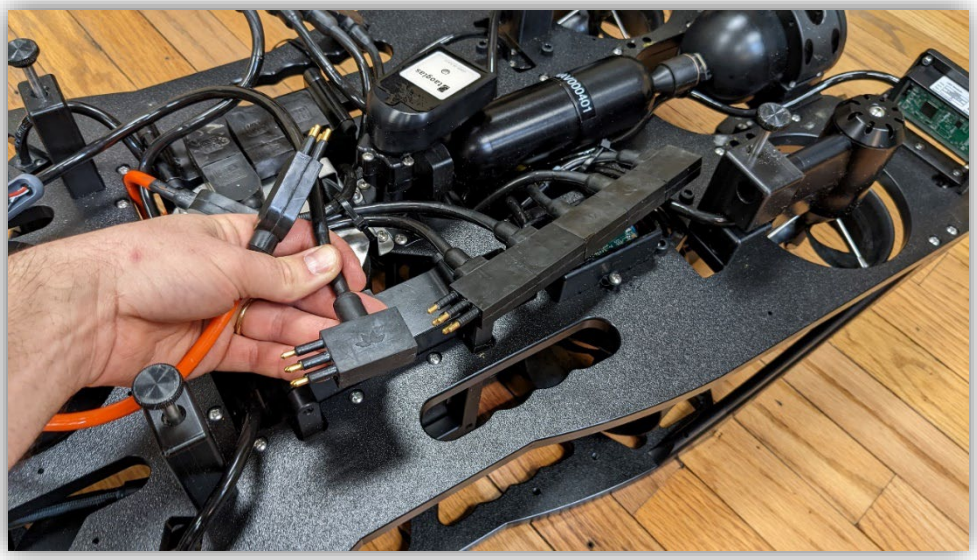
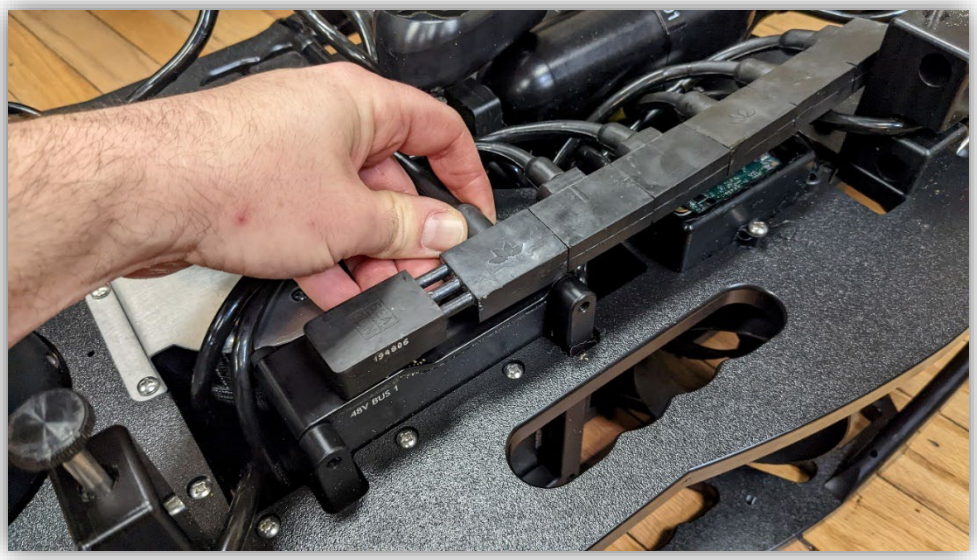
Add the 5-pin battery connector to the chain of connections.





Repeat this process for both 5-pin chains.

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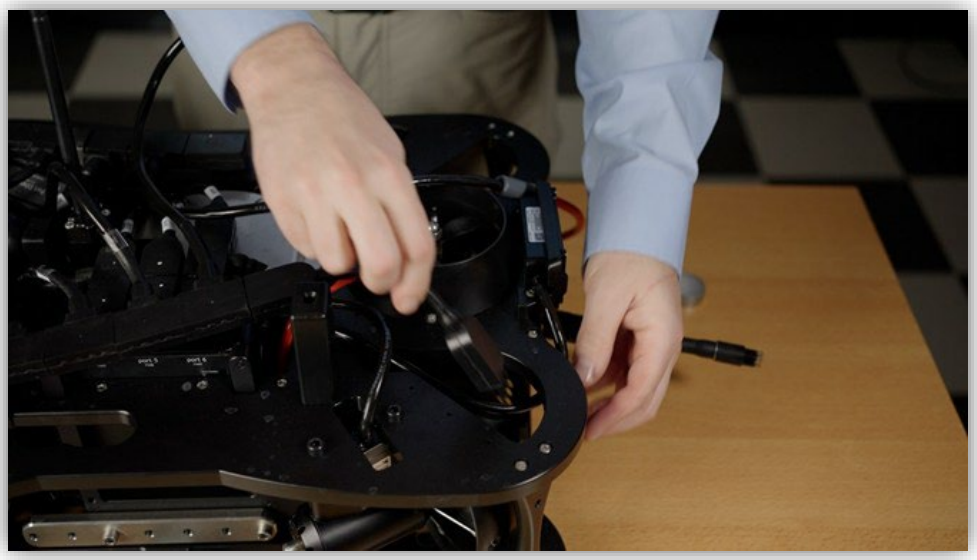
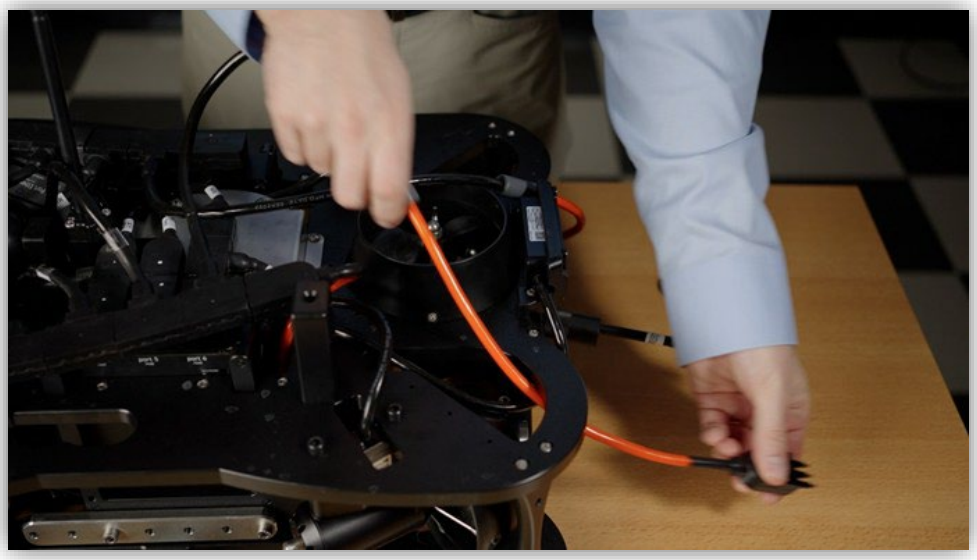
Insert the other end of the battery's 5-pin whip through the opening of the frame above both the horizontal aft thrusters.





Repeat this process for both 5-pin cables.

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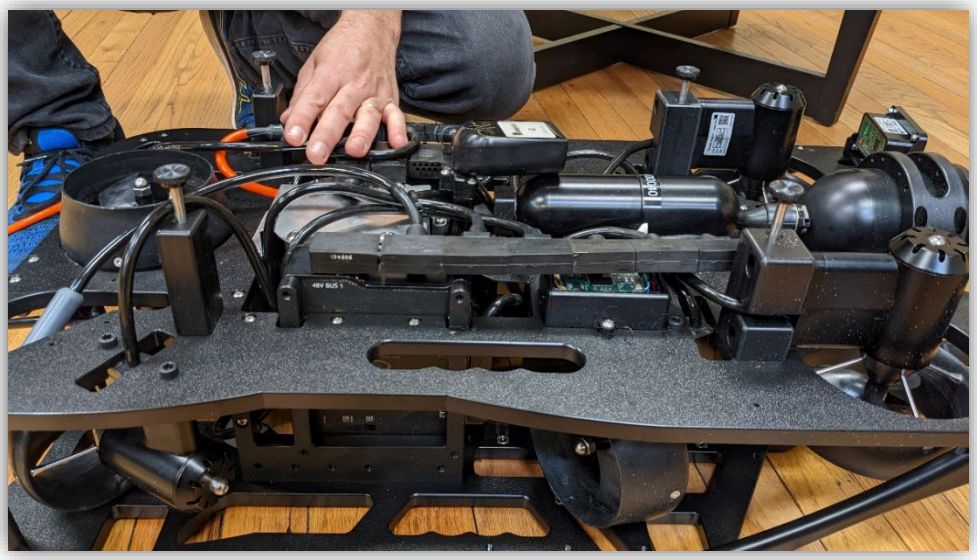
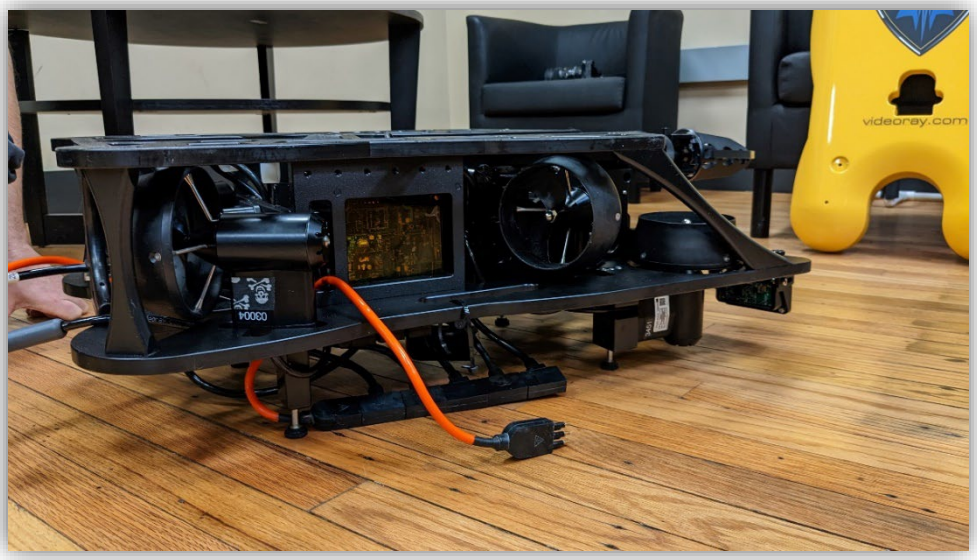
Subsea Batteries

Insert the 4 float block screws into their mounts.



Flip the ROV over onto the heads of the float block screws.



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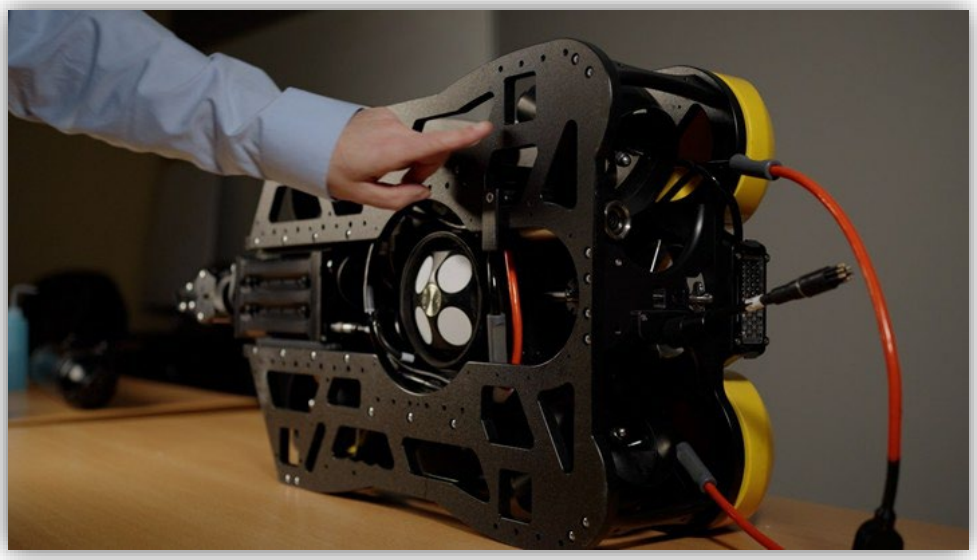
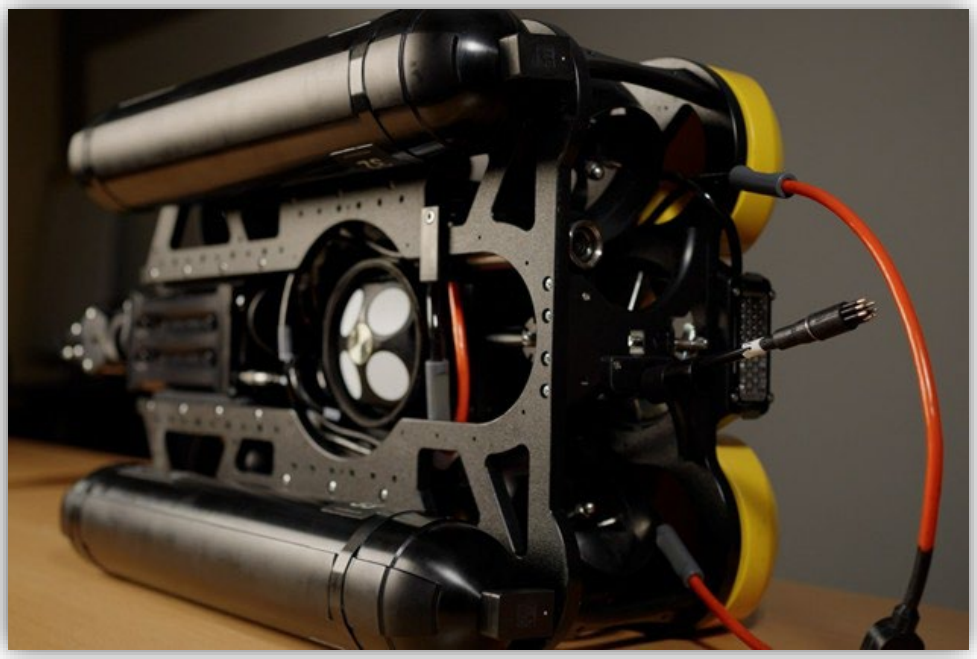
Subsea Batteries

Line up the battery camlocks with the corresponding openings on the bottom of the skid, ensuring the 5-pin port on the battery is toward the aft end of the ROV. Insert the battery camlocks into the square openings on the ROV frame.





Repeat this process for each battery.

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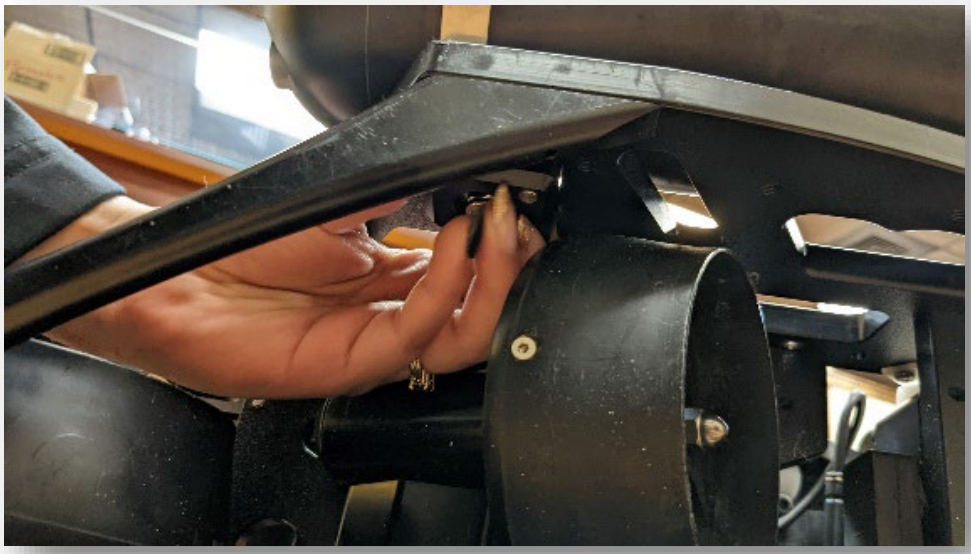
Subsea Batteries

Twist all camlocks on both batteries clockwise 45° to secure the batteries to the ROV frame.





Once the batteries are secured to the frame, lift and flip the ROV right-side up.

AVOID CARRYING OR SUSPENDING THE WEIGHT OF THE ROV BY GRASPING ONE OR BOTH BATTERIES. MISHANDLING MAY CAUSE DAMAGE TO THE CAMLOCK MOUNTS AND HINDER OPERATIONAL ABILITY.

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Subsea Batteries

Connect the male end of the battery's 5-pin cable to the female battery port located on the same side.





Repeat this process for both batteries.

If using standard VideoRay tether or Expeditionary tether, follow standard tether connection procedures and skip the next step.

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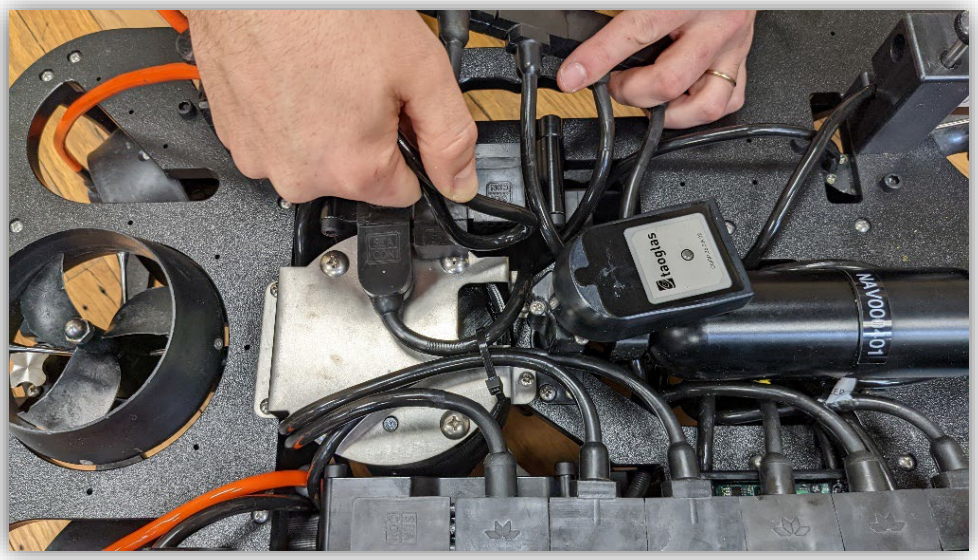
If using VideoRay Fiber Optic tether, ensure to lubricate and mate the dummy plug and threaded cap (provided with the battery kit) to the 8-pin tether whip.





Tuck any cable slack into the ROV frame.



Remove the float block screws from the frame and replace the float block.

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7 Turning On Batteries

_WHEN TURNING ON THE BATTERIES, POWERING UP ONE BATTERY WILL AUTOMATICALLY POWER UP THE OTHER BATTERY.

Power up the batteries by using the included power wand as shown below. Fully insert the wand for approximately one second into the forward circular opening in the center of one of the batteries and remove. Two audible tones should be heard from the battery, followed shortly after by two audible tones from the other battery. Wait several seconds to confirm ROV power by observing illuminated LEDs on the ROV's Power and Communications Modules. Both batteries are now turned on and providing power to the ROV.





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8 Operating the ROV

_SINCE PILOTING THE ROV WILL HAVE MINOR DEVIATIONS ONCE THE SUBSEA BATTERIES ARE INSTALLED, REVIEW THE FOLLOWING RECOMMENDED OPERATIONS.

Once the ROV is launched, immediately check and adjust ballast so that the top of the float block hovers just at the waterline. It is likely that weights will need to be removed for proper ROV ballast, refer to VideoRay's recommended procedures.

With the batteries mounted below the frame, be cognizant of the ROV's deeper draft. Increase your minimum altitude from the bottom when navigating to avoid inadvertent grounding.

When using Nickel Metal Hydride (NiMH) batteries, it is recommended to reduce the ROV power limit to 700 watts, either via the Home tab in the *Flight View* menu or the 'Vehicle' tab in the *User Preferences* menu. This power setting will extend the flight time of the robot with little effect on navigation and accessories.

Lithium (Li-ion) batteries can operate at the default power setting of 1,000 watts or to the maximum power setting if more power is needed or desired.

During extended periods of use, the batteries may experience excessive power drain resulting in insufficient power for continued normal use. In addition to on-screen battery meters indicating low levels, signs and symptoms of insufficient power will become apparent on the monitor of the console or tablet screen, to include freezing of the video feed, the ribbon compass going dark, or the video feed going dark. If this occurs, safe recovery of the ROV should now be the priority of the pilot. Recommended actions are as follows:

- Disable Auto controls to reset ROV attitude and reduce power consumption
- Turn off ROV lights
- Reduce ROV power setting to 500 watts via the Home menu
- Navigate the ROV back to the deployment site (or surface for tether-pull recovery) and recover the ROV using proper procedures

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9 Turning Off Batteries

_UNLIKE TURNING ON THE BATTERIES, TURNING THEM OFF REQUIRES EACH BATTERY TO BE INDEPENDENTLY POWERED DOWN.

Insert and hold the power wand into the center opening of each battery for approximately one second to turn power off. A single audible tone should be heard from each battery when powering down. To confirm power to the ROV is now off, check that the LED lights on the ROV's Power and Communications Modules are no longer illuminating.



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10 Charging Batteries

_BATTERIES MUST BE TURNED OFF PRIOR TO CHARGING. BATTERIES MAY BE CHARGED WHILE ATTACHED TO THE ROV OR WHILE IN THE BATTERY CASE.

_THE RECOMMENDED CHARGING TEMPERATURE IS 15-25°C (59-77°F), REPEATED CHARGE CYCLES OUTSIDE OF THIS RANGE WILL ACCELERATE NORMAL CAPACITY LOSS. CHARGING OUTSIDE OF 0-55°C (32-131°F), IS BLOCKED BY THE BATTERY MANAGEMENT SYSTEM ELECTRONICS.

_IN TEMPERATURES LOWER THAN 25°C (77°F), BATTERIES CAN BE CHARGED IN THE SHIPPING CASES. IF TEMPERATURES ARE ABOVE 25°C, THEY SHOULD BE REMOVED FROM THE CASE AND CHARGED ON A NONFLAMMABLE SURFACE, E.G. METAL TABLE, CONCRETE FLOOR.

_AVOID FLAMMABLE MATERIALS IN THE IMMEDIATE VICINITY OF THE BATTERIES. CHARGING BATTERIES UNATTENDED IS NOT RECOMMENDED.

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Connect the XLR end of the XLR adapter cable to the XLR cable on the battery charger.





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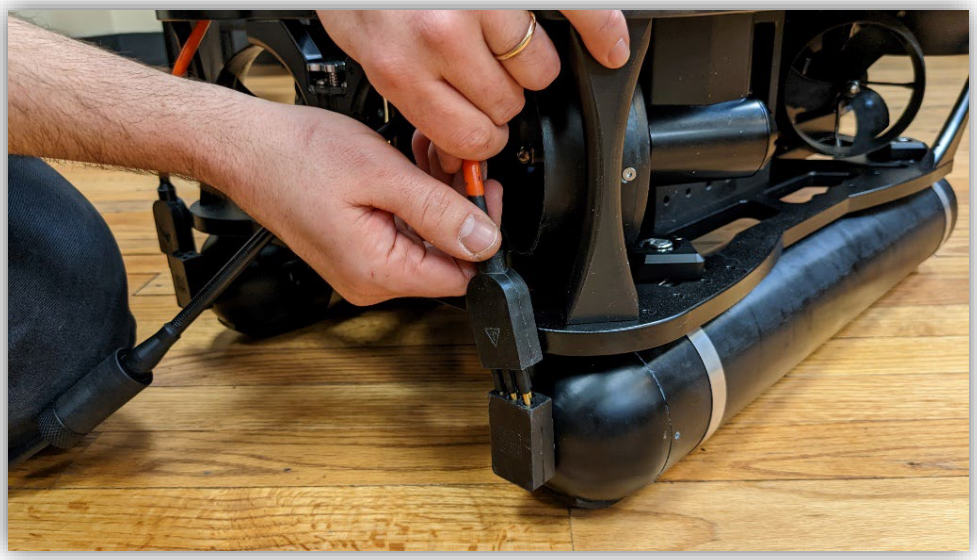
Plug XLR adapter's 5-pin connector to the 5-pin socket on the battery.



Plug the battery charger's power cable into a power source (the charger can remain in the case).



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Subsea Batteries

Once plugged in, the charger will power on. Use the two buttons to cycle through the charging profiles until the desired profile is displayed. There are only two profiles compatible for the Subsea Batteries – "NiMH sub" or "Lithium sub" (*make sure "sub" is next to the desired profile*).





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Subsea Batteries

When the desired profile is displayed, press and hold the bottom button and release when *OKAY* is displayed.



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Subsea Batteries

If “connect battery” is displayed after pressing and releasing the bottom button, press and hold the bottom button again and then release when Force Start appears.





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It will take a few seconds for the battery to begin charging. The battery icon on the left side of the display will then indicate charging status.

The batteries will turn on while charging and automatically shut off after 5 minutes once charging is complete.



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11 Storage

_BATTERIES SHOULD NEVER BE STORED NEAR FLAMMABLE MATERIALS.

Temperature

Mission Specialist Li-ion Subsea Batteries should be stored in their factory cases when not in use. These cases meet the UN38.3 transport requirements and will protect the battery packs from physical damage, e.g. accidental drops, impacts, while reducing the risk of cascading battery failures and/or damage to the surrounding area in the event a battery should fail catastrophically.

Batteries should be stored at a nominal 15 to 25°C for optimal battery life. Higher and lower temperatures (especially higher temperatures) will over time reduce the maximum capacity of the batteries and their overall lifespan. The maximum short-term storage temperature range is -40°C to +60°C. See the table below for approximate loss of capacity under different storage conditions after one year.

Lithium-ion Battery Capacity Retention After One Year of Storage

Storage Temp (°C)	SoC: 20%	SoC: 40%	SoC: 60%	SoC: 100%
0	98%	97%	96%	94%
15	99%	98%	97%	95%
20	99%	98%	97%	96%
25	98%	97%	96%	94%
35	95%	93%	92%	88%
40	92%	90%	88%	40%

Batteries should also be stored at low relative humidity (02-40%). The batteries are in sealed housings so there are not immediate effects from submerged or high humidity environments; however over long periods of time, water vapor can permeate through the O-ring seals and gradually raise the internal humidity of the batteries.

State of Charge (SoC)

Batteries should be stored at 40% SoC. This balances the degradation with risks of deep discharge. The battery management system (BMS) has a small idle power draw which will continually discharge the cells.

If the cells are stored at states of charge lower than 40%, they may become deeply discharged causing dramatic loss of capacity. Batteries should be recharged to 40% at least every 3 months to protect against deep discharge and the resulting capacity loss. Batteries are shipped at 30% SoC because of shipping restrictions, after shipment batteries should be charged to 40% before putting them into storage.

These degradations occur slowly over time, so short duration exposures have minimal effect and are expected as part of the normal use of the batteries but are not recommended for storage of substantive duration. Some examples: if deployments are up to a week apart, discharging/recharging the batteries is not required, particularly if the temperatures are moderate. If the submersible needs to be ready to deploy quickly, the battery could be stored at 60% SoC or higher to minimize top off charge time. Store at moderate temperatures to mitigate capacity loss.

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12 Safety Features

The battery pod's internal electronic stack consists of a VideoRay battery control electronic module, sensors, and in the case of Li-ion chemistries, a Battery Management System board.

NiMH and Li-ion variants share many safety features. The battery management system in the Li-ion variants adds additional protections outlined in the next section.

Features Common to NiMH and Li-ion

VideoRay Board Shutdown

The VideoRay battery control electronics will shut off the battery output under several conditions. The triggers for some of these conditions are configuration parameters accessible via diagnostic mode.

VIdeoRay Battery Control Electronics Temperature

The system monitors the temperature of the electronic board. If the temperature exceeds thresholds the battery output will be shut off. These parameters are available in diagnostic mode. The default is:

Maximum board temperature: *80° C*

Note that the DC/DC converters will also shut down at 125 °C

Battery Pack Temperature

The system monitors the temperature of the battery pack as well. If the temperature exceeds thresholds the battery output will be shut off. These parameters are available in diagnostic mode. The defaults are:

Minimum battery pack temperature: *-5° C*

Maximum board temperature cutoff: *55° C*

Over Current

The output of the battery is regulated by a DC/DC converter to provide a stiff output. These DC/DC converters have several protections, including over current protection.

This hardware is controlled and cannot be modified via diagnostic mode. The default is:

Maximum DC/DC converter current: *37.5A*

The VideoRay Battery control electronics can also detect and shutdown on overcurrent events, but this feature is not currently used.

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Over Voltage

The DC/DC converters have several protections, including over voltage protection.

This hardware is controlled and cannot be modified via diagnostic mode. The default is:

Maximum DC/DC Converter voltage: *58.3 V*

The VideoRay battery control electronics will also shut off the battery output under a high voltage condition. The trigger for this is configurable via diagnostic mode. The defaults are:

NiMH Overvoltage shutoff voltage: *64 V*

Li-ion Overvoltage shutoff voltage: *56 V*

Under Voltage and Low Voltage Cutoff

The DC/DC converters have several protections, including over voltage protection.

This hardware is controlled and cannot be modified via diagnostic mode. The default is:

Maximum DC/DC Converter Voltage: *58.3 V*

The VideoRay battery control electronics will also shut off the battery output under a low voltage condition. The trigger for this is configurable via diagnostic mode. Currently this setting is non-chemistry specific. The default is:

Low voltage cutoff: *36 V*

Overpressure

The Mission Specialist batteries have several layers of protection to react to internal over-pressure events.

Internal Cell Vent

The individual battery cells have vents that prevent the cells from experiencing an individual overpressure event.

Housing Pressure Relief Valve

The battery module has a pressure relief valve on the end cap. This is the primary safety mechanism for battery over pressure events.

PRV Cracking pressure: *10psi +/- 20% (8-12psi)*

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Housing Endcap Shear Pin Release

A secondary pressure relief mechanism is the shear pins that secure the endcaps to the main bottle. The housing cap shear pin releases are:

300m housing:	*22-45 psi*
1000m Housing:	*23-48 psi*

End Cap Restraints

In the event of a housing endcap release the endcaps are retained by the battery skid as well as internal Kevlar leash to retain the endcaps and dissipate the kinetic energy.

End cap release Kevlar leash rating:	*400 lbf breaking strength*

Features Specific to Li-ion

Batteries of Li-ion Chemistry have UN 38.3 certified Battery Management System installed in addition to the VideoRay electronics module. The BMS is only configurable at the factory.

BMS Board Over Temperature

The BMS will shut down the battery output on a board over temperature condition both during charging and discharging states. The defaults are:

Board Over Temperature Discharge:	*68 °C*
Board Over Temperature Charge:	*62 °C*

Battery Cell Over Temperature

The BMS will shut down the battery output on a cell over temperature condition both during charging and discharging states. The defaults are:

Board Over Temperature Discharge:	*60 °C*
Board Over Temperature Charge:	*55 °C*

Over Current

The BMS will shut down the battery output on a pack over current condition both during charging and discharging states. The defaults are:

Over current Discharge:	*32 A*
Over current Charge:	*24 A*

Cell Over Voltage

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The BMS monitors each cell in the pack and will shut down the battery output on a cell over voltage condition. The default is:

Cell over voltage cutoff: *4250 mV*

Undervoltage

The BMS monitors each cell in the pack and will shut down the battery output on a cell under voltage condition. The default is:

Cell under voltage cutoff: *2500 mV*

Short Circuit

The BMS monitors the output current and will shut down on a short circuit condition. The default is:

BMS short circuit cutoff: *120A*

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13 Support

Before Contacting Support

Please make sure to consider the following information before contacting VideoRay's Technical Support to report a problem. The following information should available:

- Name and contact information
- Name of the owner if not the same as the user
- System model
- Serial Number of the affected component(s)
- Accessories in use
- Detailed information about the issue:
    - Symptoms
    - Operating conditions that create the symptoms
    - Anything new or unusual about the system or operations

Customer Care Policy

As a global company, VideoRay operates according to the highest standards of ethical conduct and behavior. These standards guide our decisions in our daily work and help us demonstrate that we take our commitments seriously.

VideoRay believes that our success is driven by our customers' success. To achieve this mutual goal, our products must be capable, easy to learn, easy to use and reliable. To resolve problems when they arise, VideoRay Customer Care is organized into the following three groups:

- Customer Service – Resolves administrative issues
- Technical Support – Resolves technical problems remotely
- Repair – Resolves hardware problems that cannot be resolved remotely

Leveraging the latest technological advances, Customer Care relies on industry standard methods of communication as well as offering our best effort to conform to customers' specific communications protocol requirements. When possible, VideoRay technicians can remotely access users' systems to conduct real-time diagnosis and implement corrective actions.

VideoRay asserts that educated users make the best users and are more likely to operate their equipment in ways that optimize the use of its capabilities and maintain it properly to extend its longevity. We encourage and empower users to participate in the maintenance of their systems. Certified Training opportunities exist for customers that want to increase their operational and maintenance expertise.

Technical Support Policy

For remote support, the following hours of operations and communications methods are established:

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Business hours are from 8:00 AM to 5:00 PM Eastern Standard Time on Monday through Friday (excluding holidays).

You may contact us via:

Email: support@videoray.com

Phone: +1 610-458-3000, Option 1

Your support technician may recommend a video conference call/screen sharing session via Skype, or a remote login session via TeamViewer to operate directly on your system.

For Phone Calls:

Immediate responses for any phone call, while a technician is available.

If a technician is unavailable your call will be answered by a receptionist, or you may leave a voicemail.

A technician will attempt to return your call within 30 minutes for a phone call that is answered by a receptionist or for a voicemail received during business hours.

Unanswered calls and voicemails that are received outside of business hours will be responded to within one hour on the next business day.

For Emails:

An immediate automated response indicating your message has reached our server.

A technician will reply to your email within 30 minutes for an email received during business hours.

Emails received outside of business hours will be responded to within two business hours on the next business day.

For Skype Video Calls or TeamViewer Remote Login Support:

The technician who is currently working on your issue will coordinate with you to arrange this.

Equipment Loaner

VideoRay is the most experienced and reliable vendor of observation class vehicles in the world. We achieved this by assuring the success of our customers with both an extensive and proactive support team, and back-up equipment in our loaner pool available for emergency use.

Our customers with frequent time-critical projects can add an extra level of assurance through our Comprehensive Support and Maintenance program, which allows priority access to our equipment loaner pool should a maintenance issue prevent them from using a VideoRay ROV.

Other customers may occasionally have access to rent a system if they are available. If a system is available, our support representative will advise you.

VideoRay Authorized Service Center

In addition to using its own employee resources to provide support services, VideoRay has developed the VideoRay Authorized Service Center program. Working with strategic partners around the world, together we offer time-convenient regional support and hardware repair services. VideoRay Authorized Service Centers

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must meet business and technical requirements to be qualified and participate in periodic update training to maintain their credentials.

VideoRay has strategically placed fully Authorized Service Centers (ASCs) throughout the world to accommodate our global clientele. Please contact us or visit our website to find an Authorized Service Center in your area.

Warranty

This warranty applies to the original purchaser only and is non-transferrable. Contact VideoRay for information regarding warranty extension and warranty availability for transferred ownership.

Subject to the limitations and/or exclusions specified herein, VideoRay will repair or replace, at its expense and at its option, any system or component, which in normal use has proven to be defective in material or workmanship within two (2) years of the date of purchase.

For claims that are authorized under the provisions of this warranty during the first year of the warranty period, VideoRay will pay for the shipping of affected product(s) from the owner to VideoRay, or its authorized Dealers, and return shipment of the repaired product(s) or their replacement(s) to the owner. In order to take advantage of this, the customer must contact VideoRay for an RMA number and shipping instructions.

Warranty Limitations / Exclusions

Any separate product purchased from, but not manufactured by, VideoRay is sold with only such warranties as are made by the manufacturer thereof. VideoRay only warrants that it has title thereto, free of all liens or encumbrances.

This warranty does not apply to systems or components that are damaged or fail as a result of normal wear, such as, but not limited to, tethers, view ports, light domes and other systems or components subject to wear.

This warranty does not apply to systems or components that are damaged or fail as a result of failure of the user to read and observe instructions for proper operation and maintenance as contained in the User Instruction Manual furnished with the equipment

This warranty does not apply to systems or components that are damaged or fail by connection to improper or improperly wired sources of power, or by inadequate packing, accident in transit or elsewhere, fire, theft or other similar calamity.

VideoRay will not be responsible for any asserted defect which has resulted from Acts of God, normal wear, misuse, abuse, improper configuration, repair, or alteration made, or specifically authorized by, anyone other than an authorized representative of VideoRay. The giving of, or failure to give, any advice or recommendation by VideoRay shall not constitute any warranty by or impose any liability on VideoRay.

The foregoing constitutes the sole and exclusive remedy of the purchaser and the exclusive liability of VideoRay and is in lieu of any and all other warranties, express, implied or statutory as to merchantability, fitness for purpose sold, description, quality productiveness, or any other matter. Under no circumstances shall VideoRay be liable for special, incidental or consequential damages, or for delay in performance of this warranty.

For more information or to submit a warranty claim, contact VideoRay at 610-458-3000 or support@videoray.com.

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