MISSION SPECIALIST PRO 5 OPERATOR'S MANUAL

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Language Support

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Arabic	Table of Contents	Internet connection required, results not guaranteed
Chinese	Table of Contents	Internet connection required, results not guaranteed
Deutsch	Table of Contents	Internet-Verbindung erforderlich, ergebnisse nicht garantiert
English	Table of Contents	
Espanol	Tabla de contenidos	Requiere conexion a Internet, los resultados no garantizados
Francaise	Table des matieres	Connexion Internet requise, resultats non garantis
Indonesia	Daftar isi	Koneksi internet diperlukan, hasil tidak dijamin
Italiano	Indice dei contenuti	Richiesta una connessione Internet, I risultati non garantiti
Japanese	Table of Contents	Internet connection required, results not guaranteed
Korean	Table of Contents	Internet connection required, results not guaranteed
Nederlands	Inhoudsopgave	Internetverbinding nodig, resultaten niet gegarandeerd
Norske	Innholdsfortegnelse	Internett-tilkobling kreves, resultater Ikke Garantert
Russian	Table of Contents	Internet connection required, results not guaranteed
Suomalainen	Sisallysluettelo	Vaatii Internet-yhteyden, tulokset ole taattu
Svenska	Inneholl	Internetanslutning kravs, resultat garanteras inte

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About this Document

Document Navigation

You can navigate through the documentation to specific topics using the menu, or step through sequentially using the Next and Previous arrowhead buttons. The Next button will step you from the current topic to the next topic at the same level unless the current topic has a sub-topic. If the current topic has a sub-topic, the Next button will step you into the first sub-topic. The Previous button works similarly, but in reverse sequence. Your current location within the document is shown as a "breadcrumb" trail at the top of each page under the document title. You can click on any level of the breadcrumb hierarchy to go that location. You can also use the following keyboard shortcuts:

ACTION	KEYSTROKE or BUTTON
Previous Page	Alt-p or
Next Page	Alt-n or
Up one level of the breadcrumb hierarchy	Alt-u

Links are shown in brown font.

Finding Information

This document includes a Table of Contents, Glossary / Index and Google search on each page. You must be connected to the Internet in order to be able to use the Google search, and you can select whether to search VideoRay's online document library only (the default) or the Internet.

Document Conventions

Several symbols are used throughout this documentation to add emphasis and to assist in relocating important information. The following table describes these symbols and their uses.

SYMBOL	DESCRIPTION
	The **Danger** icon is used to indicate there is a potential risk of personal injury or death. Extra care should be taken to understand the risks, and all personnel should exercise caution. It may also be appropriate to warn others in the immediate vicinity.
	The **Caution** icon is used to indicate there is a potential risk of damage to the equipment or surrounding property. Personnel should receive training in the appropriate procedures before attempting to operate or maintain the equipment.
	The **Do Not** icon is used to indicate that an action or activity should NOT be performed.
	The **Note** icon is used to highlight a specific detail or point of information.
	The **Tip** icon is used to highlight a suggestion or recommendation.
	The **Manual Cross Reference** icon is used to link to reference material elsewhere in this document or in an external resource. To view the reference, click on the **Manual Cross Reference** icon.

The **Play Video** icon is used to link to a video about the topic. To view the video, click on the **Play Video** icon.

The **Highlight** icon is used to indicate that a section of text can be highlighted. Clicking on the icon will reload the page with the text highlighted. This may be useful for printing a page with highlights or to send someone a link to a page with specific text highlighted when they open the page. Try it here - click on this highlight icon.

The **Hand** icon is used to indicate an interactive element of the page. When you hover your mouse over the **Hand** icon, an image on the page will change to reflect the information in the text immediately prior to the hand icon. Try it here - hover your mouse over the following text and **Hand** icon to turn the **Hand** icon to the left blue: Interactive Text .

Document Customization - My_Notes

This document has been developed to allow local online versions to be customized using the My_Notes feature. Users can add their own notes to each page. See the Customizing this Document page for more information about how to customize this document.

Beyond this Document

There is no substitute for experience and/or training, especially with respect to the real purpose for which you plan to use this equipment. We encourage you to explore options beyond the scope of these materials to expand your knowledge and skills necessary to support your applications. In addition to this documentation, VideoRay offers training and technical support and hosts a general user discussion forum and user image gallery.

We also realize that collectively, users of our products spend considerably more time operating our systems than we do ourselves. Users also encounter more diverse operating environments across an extremely broad range of applications. We highly value this vast experience base, and invite and encourage you to share your experiences and suggestions with us. Please feel free to contact us by any of the methods listed below.

Quality Commitment

VideoRay strives to design, manufacture, deliver and support the highest quality products and services, including this documentation. We have made every effort to ensure that this documentation is accurate and provides you with the most up-to-date information.

If you find any errors in this documentation or have suggestions for improvements, each page contains a "Help us improve this document" feedback link in the left margin (you must be connected to the Internet to use this link).

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Disclaimer

This document is deemed accurate at the time of its writing, however it is not a legal contract and the information contained herein should not be construed to represent any form of commitment. This document as well as the associated products and services are subject to change without notice.

Alternate Formats

Single HTML Page Format
This document is available as a single HTML page that can be viewed and/or printed by the viewer.

Portable / Printable Format
An abbreviated print version of this document is also available in HTML and PDF formats in Letter and A4 sizes for viewing and/or printing. A free PDF Reader is available from Adobe. Printed versions of this document are available from VideoRay.

HTML File Set
This document set is also available for download as a self extracting zip archive for installation on your local device.

Customize this Documentation - My_Notes

My_Notes are easy to incorporate directly into the pages of this manual. They can be used to clarify content, add additional information, or document your custom settings, operational tactics or procedures. My_Notes are page specific and display at the bottom of the desired page under the "My_Notes" heading. No programming is required - it is as simple as saving a file with your notes.

Creating My_Notes

My_Notes can be written in HTML or plain text. HTML allows for more flexible formatting and inclusion of images or links to other web pages.

To add a My_Note, create an HTML or text file containing the note and save it in the VideoRay\My_Notes\ folder, which can be found in the computer account user's documents folder (Documents\ for Windows 7, or My Documents\ for Windows XP).

The file should be named the same as the page in which you want the note to appear, with a "my_" prefix (without the quotes). For example, if you want a My_Note to appear at the bottom of this page, the name of the file to create is: my_custom_my_notes.html. The name of the page being viewed can be found in the address bar of the browser being used to display this documentation.

⚠ Even if you are using a text file, the file name must end with the ".html" extension.

⚠ All My_Notes files are processed as HTML, so if you are using a plain text file, you will need to add "<pre>" (without the quotes) at the beginning of the file and "</pre>" (without the quotes) at the end of the file if you want to preserve the layout. The "<pre>" and "</pre>" will not show up in the display.

⚠ When using HTML, the My_Notes folder serves as the root for relative links. An images folder is included for you to store images. You may add other folders or files as desired.

Viewing My_Notes

When you reload the page, your My_Note will appear - there is nothing else to install or configure. A sample My_Note file has been included to display the My_Note below. You can use this file as a model for creating your own My_Notes.

Updating My_Notes

To update a My_Note, simply edit and re-save the My_Note file.

Removing My_Notes

My_Notes can be removed by deleting or renaming the My_Note file.

Sizing My_Notes Display (Optional)

The default vertical size for My_Notes is set to 200 pixels, which is used for the sample My_Note below. Due to browser limitations, My-Notes do not size dynamically. This means that a long My_Note may display a scroll bar in order to view the whole My-Note. You can adjust the size to eliminate the need for the scroll bar. To set the size of a My_Note, you need to edit the file named "my_notes_size_table.js" in the My_Notes\ folder (location defined above). The file contains one line for each page of this document using the following format:

window.*page_name* = *size_in_pixels*;

Find the line for the page that includes the My_Note you want to resize and replace the value of *size_in_pixels* with the desired size in pixels. The page names are listed alphabetically. Example line from the "my_notes_size_table.js" file for this page:

window.custom_my_notes = 200;

⚠ Note that ".html" in not included in the page name, and the line must end with a ";" Also, the optimum size required is dependent upon the size and aspect ratio of the browser window.

How to Get Help

Help for your Mission Specialist Pro 5
is available through several channels.

All Hours Self-Service / Crowd-Source Tools

Operator's Manuals and Standard Operating Procedures	www.videoray.com/support/manuals.html
Software Downloads	www.videoray.com/support/downloads.html
Frequently Asked Questions	www.rovfaq.com
ROV User Forum	www.rovinfo.com

Global Support

Email	support@videoray.com
Phone	+1 610-458-3000 (*select option* 1)
Additional messaging services are available.	Contact us using one of the above methods for options supported.
Remote Sessions	www.videoray.com/support/remote-support.html (*by appointment*)

Regional Support

VideoRay Authorized Dealers and Service Centers	https://videoray.com/contact-us/locate-dealer-or-service-center/

Training

Email	training@videoray.com
Phone	+1 610-458-3000 (*select option* 1)
Training Opportunities	Training Overview

Operational Strategies and Tactics Support

If you need help understanding how to apply your system to a specific project, contact VideoRay or you local VideoRay dealer. We can provide guidance or help you find a certified consultant.

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:

- User 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 unusually about the system or operations

Once you have collected the recommended information, visit the "How to Get Help" page for contact information.

In addition, please review VideoRay's Support website for additional information about:

- Principles of Customer Interactions
- Customer Care Philosophy
- Technical Support Policy
- Third Party Accessory Support Statement
- Use of Non-VideoRay Supplied Computers

Mission Specialist Pro 5
Overview

VideoRay Mission Specialist systems are the world's first ROV to deliver custom purpose-built vehicles using a standard production packaging process. Mission Specialist ROVs are literally built around the payload using core modules instead of figuring out how to adapt an existing vehicle platform in order to mount the payload. The overall system represents the difference between a pickup truck and purpose-built construction vehicles, with equal differences in performance for specific applications.

Based on modular components and standard interfaces, the development a specific Mission Specialist Series ROV is orders of magnitude faster than designing a vehicle form the ground up or customizing an existing monolithic vehicle.

- Modular Primary Components
- Standard Interfaces
- Rapid Prototyping
- Additive Manufacturing
- Sensor Integration

Mission Specialist Vehicle Configurations

Mission Specialist vehicle configurations include:

Defender
Operator's Manual

Pro 5
Operator's Manual

Vehicles are shown approximately to scale.

Quick Start Instructions

These Quick Start Instructions are streamlined to cover just the essentials of operating your Mission Specialist Pro 5
system. They are provided to get you started as quickly as possible, while keeping you and the equipment safe. They cover the equipment set up and basic operation, but are not intended to result in a comprehensive base of knowledge or set of operational and piloting skills. The remaining sections of this documentation should be referenced for a complete understanding of the features, capabilities, operating procedures and maintenance requirements of your Mission Specialist Pro 5
system.

Topics in this Section

- Safety First
- System Components
- Pre-Dive Preparations
- Dive Operations
- Post-Dive Operations

Safety First

DANGER CAUTION 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, and only after making sure the 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.
- 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.
- Keep fingers, hair, loose clothing and other objects away from VideoRay's propellers and other pinch points.
- 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.

Before setting up for or commencing any dive, it is a good practice to make sure there are no hazards to people or the equipment on land or in the water. If there are other people in the water nearby, you should advise them that you are going to be operating the ROV. As the owner/operator, it is your responsibility to ensure the safety of those around you as well as that of the equipment and nearby property.

How Safe Is Safe Enough?

Addressing all aspects of safety while working in a water environment is beyond the scope of this documentation. VideoRay encourages you to participate in safety training appropriate for your industry and applications, including such topics as vessel operations, first aid, survival and other relevant topics.

Introduction to the System Components

Unpack the system and familiarize yourself with the components.

ROV

The ROV, or Remotely Operated Vehicle, carries the cameras, lights and sensors or accessories to the underwater places you want to observe. Thrusters provide mobility and these systems are controlled from the surface using the control panel and hand controller.

See the ROV section of the Equipment Guide for more information.

Operator Control Console

The Operator Control Console includes the system's power and communications modules, computer and hand controller, and serves as the operator's control interface and video display. Open the Operator Control Console and familiarize yourself with the components and primary controls on the hand controller. See the Operator Control Console and Hand Controller sections of the Equipment Guide for a complete description of all of the controls and connections.

See the Control Panel section of the Equipment Guide for more information.

Hand Controller

The hand controller is used to pilot the VideoRay and operate other features like the lights, camera controls and manipulator. The hand controller is pre-programmed, but can be customized to meet specific user or operational needs.

See the Hand Controller section of the Equipment Guide for more information.

Tether

The tether connects the ROV to the control panel. It delivers power and control signals to the ROV, and returns video and sensor data (optional) from the ROV to the surface. Some systems come with a TDS (Tether Deployment System), that makes the work of managing the tether easier. The tether is also often referred to as the umbilical.

See the Tether section of the Equipment Guide for more information.

Additional Items

Additional items may be supplied with your system including tools, spare parts and other items. If included, these items are described in other sections of this documentation.

Some items shown may be optional and not included with your configuration.

Pre-Dive Preparations

Select a safe and preferably level area to set up the Operator Control Console. See the On-site Operations section of the Project Management Guide for more information about site selection and set up.

The pre-dive preparations consist of five parts:

1. Visual inspection before setting up the system
2. Setting up the system including making connections
3. Power on tests of the system's safety circuits
4. Primary functions test of the systems features
5. Adjusting the ballast for the desired buoyancy (to be completed in the next phase)

Conduct a Visual Inspection

Assuming this is your first time using the VideoRay, everything should be in proper working order and ready to go, but it is good practice to perform a pre-dive inspection before every dive, even your first. If any problems are noticed, they should be addressed before continuing.

1. Inspect the ROV and other system components to make sure there are no visible signs of damage or loose or worn parts. Also check for water inside any pressure hull modules, such as the camera.

2. Check the horizontal thrusters to make sure that the shafts are not bent and the propellers are free to spin and are not fouled, loose or binding on the thruster guards.

3. Check the vertical thruster(s) to make sure the shaft is not bent and the propeller is not fouled or loose or binding on the float block.

Make the Connections

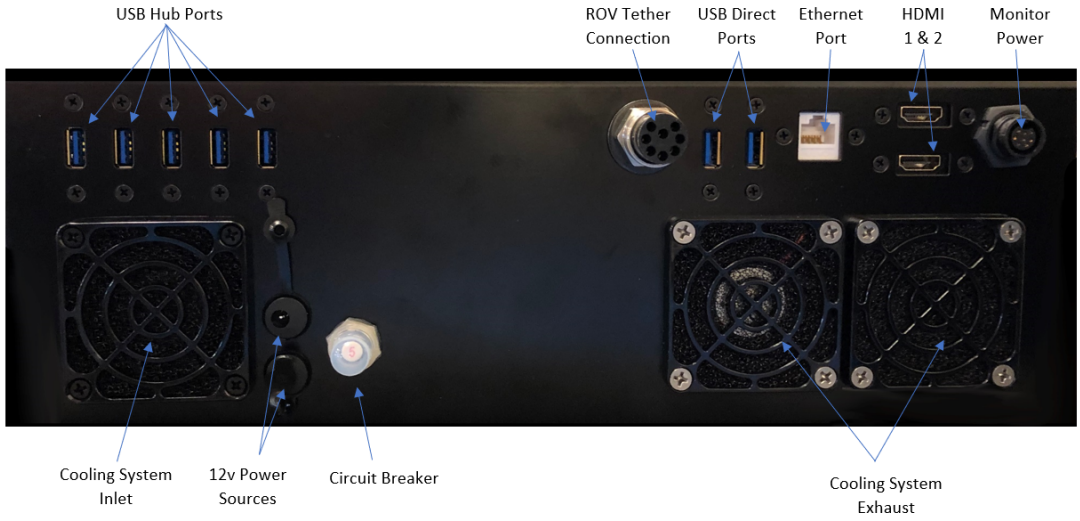
It is best to start making connections at the ROV and working your way to connecting the system to the power source.

CAUTION Connecting or disconnecting cables while the system is powered on is not recommended.

⚠ Make sure the Operator Control Console power switch is set to the Off position and make sure the ROV power switch is set to the off position by pressing it.

Top View

Side View



Some of the cables have been connected at the factory. See the appropriate sections of the Equipment Guide for detailed information about each of the connections.

You will typically need to connect only the ROV, tether, strain relief hand controller, and power cord.

1. Connect the female end of the tether connector to the ROV. The connectors have one pin that is offset towards the center of the connector. Make sure the connectors are clean, align the pins, and push the connectors together - do not twist the connectors. Secure the locking collar by screwing the halves together.

2. Connect the braided strain relief from the tether to the rear of the ROV using the retaining screw. See the strain relief section for more information.

3. Connect the male end of the tether to the Operator Control Console. When not in use, keep the tether connectors clean and protected for the best performance and reliability.

4. Connect the hand controller to one of the USB ports on the Operator Control Console

5. Plug the Operator Control Console power cord into a conventional power source (100-240 Volts AC, 50,60 Hz). Power can be supplied through a land-based power outlet, generator or battery and inverter. See the Operator Control Console section of the Equipment Guide for power source requirements.

Power On Tests

DANGER CAUTION If the system does not pass any of the following tests, it should not be used until the problem is identified and corrected.

The VideoRay MSS includes two circuit safety components.

- GFCI (Ground Fault Circuit Interrupter)
- LIM (Line Insulation Monitor)

Testing the Circuit Safety Components

Connect the power cord to a suitable power source.

The GFCI can be found inline in the power cord.

1. Press the GFCI Reset button to turn on the GFCI. The green LED should illuminate.

2. Press the test switch on the GFCI. The GFCI should interrupt power and the green LED should go out.

3. Press the GFCI Reset button to restore power and continue the pre-dive steps.

⚠ When using a power source that includes a GFCI, the VideoRay supplied GFCI is not needed and can be removed from the power cord.

Power On and LIM Tests

Set the Power switch to the On position. The green Power On indicator light should turn on. If the green Power On indicator light is not on, make sure the system is connected to a working power source and the GFCI switch is turned on.

Twist the ROV Power switch to the On position. The green 400 V Power On indicator light should turn on. If the green 400 V Power On indicator light is not on, make sure the system is connected to a working power source and the GFCI and main power switches are turned on.

Test the LIM. The LIM can be found on the right side of the Operator Control Console. The GFCI switch and the main and 400 V Power switches must both be set to On in order to perform this test.

1. The yellow Alarm light should be off. If the yellow light is on, press and hold the Reset button until the yellow Alarm light turns off.

2. To test the LIM, press and hold the Test button until the yellow Alarm light turns on. This may take up to 10 seconds. Release the button when the yellow Alarm light turns on.

3. Press and hold the Reset button to reset the LIM. The yellow Alarm light should turn off. Release the button when the yellow Alarm light turns off.

Starting the VideoRay Control Software

Make sure the system is connected to a working power source and the GFCI / Circuit Breaker and Power switches are turned on.

1. Turn on the Operator Control Console and wait for the system to complete the boot up process.

2. To start the MSS EOD Workspace control software, double click on the Pro 5 icon

on the desktop.

See the Software Guide for more information about the VideoRay control software.

Testing the System's Functions

The next step is to ensure that the essential features of the ROV are functioning properly. Use the hand controller to perform the following tests. The manipulator functions listed below do not necessarily represent the full capabilities of the system. See the Hand Controller section of the Equipment Guide for the complete list of functions and more information about using the hand controller.

Horizontal Control joystick
Depth Control knob
Camera Tilt Up button
Camera Tilt Down button
Camera Focus In button
Camera Focus Out button
Lights Intensity knob

⚠ Additional features and controls may be available depending on the system configuration. These tests represent the minimum set for all configurations.

Test the thrusters

DANGER CAUTION For the next two steps, make sure no one is near the thrusters and do not operate the thrusters out of water for more than 30 seconds to avoid overheating or premature wear of the seals.

1. Gently move the joystick forward and backward and left and right - the horizontal thruster motors should turn the propellers. Release the joystick - it will return to center on its own, and the propellers will stop turning.

2. Rotate the Depth Control knob - the vertical thruster motor should turn the propeller. Return the Depth Control knob to center to cease the vertical propeller rotation.

Test the lights

CAUTION For the next two steps, do not leave the lights on bright for more than 30 seconds while the ROV is out of water to avoid overheating.

1. Rotate the Lights Intensity knob clockwise to increase the intensity of the lights - the lights should get brighter.

2. Rotate the Lights Intensity knob counter clockwise to dim the lights - the lights should dim.

Test the camera functions

1. Press and hold the Camera Tilt Up button - the camera should tilt up smoothly through its entire range.

2. Press and hold the Camera Tilt Down button - the camera should tilt down smoothly through its entire range.

3. Press and hold the Camera Focus In button - the camera should focus in smoothly through its entire range.

4. Press and hold the Camera Focus Out button - the camera should focus out smoothly through its entire range.

⚠ If a manipulator or other accessories are attached, these items should be checked at this time.

Good Advice

The time to catch small problems before they become big problems is during the pre-dive inspection.

Dive Operations

After the previous four pre-dive checks and tests have been completed successfully, you are almost ready to commence the dive. But, there is one more issue to address that could affect the performance of the ROV. The ROV is designed to be operated in a near neutrally buoyant configuration, so the last step before launching your VideoRay is to check the buoyancy, and adjust the ballast if necessary. For most operations, the buoyancy is optimal when the top of the float block is even with the water surface and the ROV is level. If the ROV is too buoyant or too heavy, the vertical position may be hard to maintain or control.

⚠ Buoyancy will need to be adjusted for use in fresh water versus salt water and depending upon whether accessories are used with the ROV.

Buoyancy Check and Adjustment

To determine if the buoyancy is correct, lower the ROV and at least 3 meters (10 feet) of tether into the water. You can lower the ROV by the tether - it will not hurt the tether because there is Kevlar in it. Observe the ROV in the water - it should not be floating too high or sink. It should also be floating level and not tipped to one side or pitched up or down. If the ROV floats too high, you will need to add some ballast weights. If the ROV sinks, you will need to remove some ballast weights. If the ROV is not floating level, you can change the locations of the weights.

The buoyancy can be adjusted by adding or removing the supplied ballast weights to the vehicle. The weights can be added to or removed from the slots by hand. For most operations, the weights should be evenly distributed to provide a balanced attitude of the ROV in water.

Commence the Dive

Once the buoyancy has been adjusted the ROV is ready to launch. Lower it into the water and operate the controls to maneuver it. The ROV can be lowered using the tether.

- Start with the ROV on the surface and push the joystick forward slightly to make the ROV move forward. Move the joystick to the left or right to make it turn left or right. Get a feel for how agile the ROV is.
- Observe the video display as well as the ROV to become acquainted with the camera's wide angle lens and its affect on depth perception underwater.
- Once you feel comfortable with the horizontal maneuverability of the ROV, rotate the depth control knob to dive the ROV. Tilt the camera down as you dive so you can see towards the bottom. Rotate the depth control knob to bring the ROV back to the surface. Tilt the camera up as you surface so you can see towards the surface.
- Change the lights settings, and adjust the camera focus. If you have a manipulator, tilt the camera down so you can see it and open and close the jaws.
- As you get familiar with maneuvering the ROV, you can start to observe some of the on-screen displays including the depth, heading, camera settings and other data.

For your first dives, practice until you are comfortable operating the controls without looking at them and you are able to control the ROV with some precision.

See the Hand Controller section of the Equipment Guide for complete information about using the hand controller and see the Piloting section of the Operations Guide for more advanced tips on piloting the MSS.

Automated Flight Operations

Automated flight operations require additional configuration and tuning to ensure accurate flight dynamics and control. See the Automated Flight Operations section for more details.

Practice Makes Perfect

Developing the skills to operate your Mission Specialist Pro 5
like an expert may take some time. Practicing on a regular basis is highly recommended.

Post-Dive Operations

At the conclusion of your dive, retrieve the VideoRay and power down the system by closing VideoRay Balefire software, turning off the ROV power switch, shutting down the computer and then turning off the main power switch.. Make sure the ROV is secure before disconnecting the tether. After disconnecting the tether, keep the tether connectors clean and do not let them drag on the ground.

Proper maintenance of your VideoRay system ensures a long service life and that it will be ready to operate when you are. After each dive, you should visually inspect the system for damage that might have occurred during your operation.

Keeping the ROV clean is one of the most important aspects of good preventative maintenance practices, especially after using it in salt water. If you use your ROV in salt water, or water with

contaminants, you should first rinse it, and then soak it in clean fresh water for at least one-half hour. After cleaning the ROV and tether, they should be allowed to air dry before being put away for storage.

CAUTION Failure to properly maintain the ROV by thoroughly cleaning it after use may dramatically reduce its service life.

Debriefing

Congratulations! You are well on your way to becoming an accomplished micro-ROV operator, but there are still many things to learn and skills to master. Continue learning about the system by reviewing the additional sections of this documentation and, most importantly, practice, practice, practice.

If you encountered any difficulties or have any questions, review these Quick Start Instructions and the other documentation that came with your system, including the Equipment Guide. If you still have difficulty or questions, contact VideoRay. Your success is our success, and we are here to help you get the most out of your VideoRay.

VideoRay contact information is available on the About this Documentation page.

Ready to Learn More?

To accelerate your learning and receive recognition for your knowledge and skills, VideoRay offers in-person classes and online training as well as the Micro-ROV User Certificate program. Training can be delivered at your site and customized to your needs. To learn more about these opportunities, click on the training link above to visit the VideoRay Educational Resources website.

Mission Specialist Pro 5
Glossary / Index

After each entry, there is a list of pages where the entry can be found in this manual.

Accelerometer - A device used to measure acceleration - used to determine pitch and roll of the ROV

Accessory - An optional device that can be used with the VideoRay system to augment its features and capabilities

> Before Contacting Support, ROV Accessories Specifications, ROV Connections, Switches and Connections, Tether, Accessories, On-site Operations, Auto Altitude, Low Visibility

Accessory Port - ROV connection for ROV mounted accessories that provides access to power and data circuits

> Accessories

Acoustic - Using sound as a method of communicating underwater - often used to measure distance

Altitude - The height of the ROV off of the bottom

> Piloting Tools, Auto Altitude

Artificial Horizon - See Attitude Indicator

Attitude Indicator - Instrument that provides an indication of the pitch and roll of the ROV

ATW - (Automatic White Balance) color corrects an image - See also White Balance

Auto Altitude - Control Feature that maintains the altitude of the ROV at a constant value

> Piloting Tools, Auto Altitude

Auto Depth - Control Feature that maintains the depth of the ROV at a constant value

> Piloting Tools, Auto Depth, Auto Altitude

Auto Heading - Control Feature that maintains the heading (compass direction) of the ROV at a constant value

> Piloting Tools, Auto Heading

Auto Pitch - Control Feature that maintains the pitch of the ROV at a constant value

> Piloting Tools

Auto Roll - Control Feature that maintains the roll of the ROV at a constant value

Ballast - Weights used to decrease buoyancy of the ROV to achieve desired buoyancy

> Pro 5 Ballast, Included Accessories, Confined Spaces

Buoyancy - The tendency to float, sink or remain at a constant depth

Tether Specifications, Pro 5 Buoyancy, Tether Specifications, Tether Management

Camera - The camera provides a video image from the ROV

Camera Module, ROV Submersible, Camera Module, Camera Tilt Up, Camera Tilt Down, Camera Focus In, Camera Focus Out, Snapshot, Video Record, Camera Tilt Up, Camera Tilt Down, Camera Focus In, Camera Focus Out, Snapshot, Video Record, VideoRay Interface Overview, Updating Firmware, Command: vr_enum, Command: vr_setid, Command: vr_debug_putty, Command: vr_create_virtport, General Logistics, Video / Sensor Recording, Image and Video Production, Still Images, Snagged Tether / ROV, Piloting Tactics, Low Visibility, Camera Module

Camera Focus - Method to control image focus or the current state of image focus

Camera Focus In, Camera Focus Out, Camera Focus In, Camera Focus Out

Camera Tilt - Method to control the vertical angle of the camera or the current state of camera tilt

Camera Tilt Up, Camera Tilt Down, Camera Tilt Up, Camera Tilt Down

Celsius - Unit of measure of temperature

Checklist - Method to ensure all operations are completed as planned or functions perform as expected

Mission Planning, Piloting Tools

Close - The Close button exits ROV Control Software

Manipulator Close, Manipulator Close, VideoRay Interface Overview, Software Updates, Deployment Platforms, Confined Spaces, Communications Module, Thruster Module, LED Light Module

Compass - Instrument that provides an indication of the heading of the ROV

AHRS Module, AHRS Module, Auto Heading

Compatibility - The state or being able to work together

System Voltage Advisory, Hand Controller, System Voltage Advisory, Environmental Compatibility, ROV Materials List, Potable Water, Contaminated Water

Computer - Primary topside component required to run the ROV control software

Customize this Document, Before Contacting Support, Operator Control Console, Switches and Connections, Computer, HD Monitor, VideoRay Industrial Controller, VideoRay IP65 Controller, Accessories, Included Accessories, General Logistics, Video / Sensor Recording, Project Completion, Still Images, Cold Weather Operations, Hot Weather Operations

Operator Control Console - The surface component that provides power and communications with the ROV

Operator Control Console, Safety Circuits, Switches and Connections, Computer, Connections Summary, Software Guide

Current - The flow of water or electricity

Communications Module, Thruster Module, LED Light Module, Safety Circuits, Video / Sensor Recording, Image and Video Production, Still Images, Tether Management, Potable Water, Auto

Heading, Auto Depth, Auto Altitude, Piloting Tactics, Swift Current, Power Module, Communications Module, AHRS Module, Camera Module

Customization - The ability to change the operation or behavior of the system to make it more suitable for specific applications

Accessories

Cutter - An optional ROV mounted device for cutting objects

Accessories

Data Export - Allows data from the ROV to be exported to external applications

Data Import - Allows data from external applications or sensors to be displayed on the video as overlay text

Date - Calendar Date

Customize this Document, Product FAQ, Specifications, Snapshot, Video Record, Snapshot, Video Record, Accessories, Software Updates, Command: vr_refresh, Updating Firmware, Video / Sensor Recording, Still Images

Depth - Vertical location of the ROV within the water measured from the surface

Power Module, Communications Module, AHRS Module, Thruster Module, Camera Module, LED Light Module, ROV Nomenclature, AHRS Module, Depth Control, Depth Control, Acceptable Use, Piloting Tools, Auto Modes , Auto Depth, Auto Altitude, Low Visibility, Swift Current, Deep Water

Depth Control Knob - Method of controlling the depth of the ROV

Depth Control, Depth Control, Auto Depth, Auto Altitude

Depth Gauge - Display that indicates the current depth of the ROV

Auto Depth, Auto Altitude

Depth Rating - Maximum depth for operation of the ROV

Power Module, Communications Module, AHRS Module, Thruster Module, Camera Module, LED Light Module, Acceptable Use

Diagnostics - Method for identifying the cause of a problem

Command: vr_refresh, Command: vr_enum, Loss of ROV Function(s), Piloting Tools

Edit - The process of modifying data

Customize this Document, Computer, Image and Video Production

Ethernet - Data Protocol and connector style

Communications Module, AHRS Module, Camera Module, Switches and Connections, Computer, Command: vr_create_virtport

Export - Method to communicate data from the ROV to other systems

Factory Default - Initial state of a variety of parameters

Fahrenheit - Unit of measure of temperature

Fault - Indication of a problem

> Customize this Document, Operator Control Console, Safety Circuits, Command: vr_refresh, Updating Firmware, Command: vr_enum, Command: vr_setid, Command: vr_debug_putty, Communications Module

Feet - Unit of measure of length or distance

> Power Module, Communications Module, AHRS Module, Thruster Module, Camera Module, LED Light Module, Tether Specifications, Tether Specifications, Tether Management

Firmware - Software that resides on the ROV modules

> Software Guide, Folder Structure, Module Configuration, Configuration Commands, Command: vr_refresh, Updating Firmware

Float Block - Required ROV component used to increase buoyancy of the ROV - counteracted by ballast to achieve desired buoyancy

> Power Module, Communications Module, AHRS Module, Thruster Module, Camera Module, LED Light Module

Gain - Setting to control the level of some parameter

> Video Record, Video Record, ROV Materials List, Contaminated Water, Piloting Tools, Auto Heading, Auto Depth, Auto Altitude, Low Visibility, Swift Current, Communications Module, Thruster Module, LED Light Module

Generator - AC power source that typically runs on gasoline or diesel fuel

> System Voltage Advisory, Operator Control Console, Accessories, Mission Support Accessories, System Voltage Advisory, General Logistics, Deployment Platforms

GFCI - (Ground Fault Circuit Interrupter) A safety circuit

> Safety First, Operator Control Console, Safety Circuits, Computer, Loss of ROV Function(s)

GPS - (Geographic Positioning System) Device that provides location

> ROV Materials List, Piloting Tools

Hand Controller - Input device to control the ROV's operation

> Hand Controller, VideoRay Industrial Controller, VideoRay IP65 Controller, Connections Summary, Rotating Manipulator, Video / Sensor Recording, Still Images

Heading - The compass direction the ROV is facing

> Customize this Document, AHRS Module, Piloting Tools, Auto Modes , Auto Heading

Help - Information intended to provide assistance

> Before Contacting Support, System Voltage Advisory, Cycle Display Mode, Cycle Display Mode, Mission Support Accessories, Command: vr_refresh, Command: vr_enum, Command: vr_setid, Command: vr_debug_putty, Acceptable Use, System Voltage Advisory, ROV Project Management, General Logistics, On-site Operations, Emergency Situations, Snagged Tether / ROV, Piloting, Piloting Tactics, Low Visibility

Humidity - Qualitative measure of the amount of moisture in the air

Camera Module

IEC - (International Electrotechnical Commission) Power cord connector standard

Operator Control Console, Switches and Connections, Computer

Import - Method to receive and process data from other systems

Flooded ROV / Component, Snagged Tether / ROV, Deployment Platforms, Piloting Tools

Instrument - User Control Software interface feature to display information or control features

Auto Heading, Auto Depth, Auto Altitude

Inverter - AC power source that runs on battery

Operator Control Console, Mission Support Accessories, General Logistics, Deployment Platforms

Joystick - Input device for controlling the surge and yaw of the ROV

Hand Controller, Forward / Reverse Control, Yaw Control, Forward / Reverse Control, Yaw Control, Auto Modes , Auto Heading, Auto Depth, Auto Altitude

Lens - Camera element used to capture and focus light to create an image

Lights - ROV component that provides lights for scene illumination in dark areas

ROV Submersible, Power/Communications Module, Thruster Module, Light Module, ROV Connections, Lights Intensity, Lights Intensity, Module Configuration, General Logistics, Image and Video Production

LIM - (Line Insulation Monitor) A safety circuit

System Voltage Advisory, Operator Control Console, Safety Circuits, Switches and Connections, System Voltage Advisory, Loss of ROV Function(s)

Main Dome - Protective covering over the camera

Contaminated Water

Manipulator - An optional ROV mounted device for grabbing objects

Manipulator Open, Manipulator Close, Manipulator Rotate, Manipulator Open, Manipulator Close, Manipulator Rotate, Accessories, Rotating Manipulator, VideoRay Interface Overview, Snagged Tether / ROV, Deep Water, Communications Module

Meter - Unit of measure of length or distance

Power Module, Communications Module, AHRS Module, Thruster Module, Camera Module, LED Light Module, Tether Specifications, ROV Submersible, Tether, Tether Specifications, Module Configuration, Tether Management, Auto Altitude, Swift Current, Deep Water, Communications Module, Thruster Module, LED Light Module

Mission Planning - A method to prepare for a successful ROV operation

ROV Project Management, Mission Planning

Monitor - Device used for the display of the video or computer image

Safety First, Communications Module, System Voltage Advisory, Operator Control Console, Safety Circuits, Switches and Connections, Computer, HD Monitor, Included Accessories, System Voltage Advisory, General Logistics, On-site Operations, Cold Weather Operations, Auto Modes

My_Note - Feature of the documentation that allows users to add personal notes to the online pages

Customize this Document

Negative - A state of buoyancy in which the ROV will sink and a type of tether

Tether Specifications, System Voltage Advisory, Tether, Tether Specifications, System Voltage Advisory, Tether Management, Swift Current, Deep Water

Neutral - A state of buoyancy in which the ROV will maintain it's vertical location and a type of tether

Tether Specifications, System Voltage Advisory, Tether, Tether Specifications, System Voltage Advisory, Tether Management, Auto Modes , Deep Water, Confined Spaces

O-Ring - Sealing device

Opaque - Unable to see through

Auto Heading, Auto Depth, Auto Altitude

Overlay - Text or logo superimposed on the video

Video / Sensor Recording, Still Images, Piloting Tools, Auto Heading, Auto Depth, Auto Altitude

Pitch - The nose-up or nose-down attitude or motion of the ROV

AHRS Module, ROV Nomenclature, Thruster Module, Module Configuration, Piloting Tools, Deep Water

Positive - A state of buoyancy in which the ROV will float and a type of tether

ROV Nomenclature

PPT - (Professional Performance Tether) A type of tether

System Voltage Advisory, Tether, System Voltage Advisory, Tether Management

Pressure Sensor - A device to measure pressure - used to calculate ROV depth

AHRS Module, Auto Depth

Propeller - ROV component with pitched blades that generate thrust when rotated

Safety First, Thruster Module, Thruster Module, Included Accessories, On-site Operations, Tether Management, Thruster Module

Record - Command to initiate video capture to a storage media

ROV Submersible, Snapshot, Video Record, Snapshot, Video Record, VideoRay Interface Overview, Folder Structure, On-site Operations, Video / Sensor Recording, Image and Video Production, Still Images

Remotely Operated Vehicle - The underwater vehicle

RJ-45 - A connector Style with 8 contacts commonly used for Ethernet connections

Switches and Connections, Computer

Roll - The left or right leaning attitude or motion of the ROV

Customize this Document, Thruster Module, Module Configuration

ROV - See Remotely Operated Vehicle

Safety First, Post-Dive Operations, ROV System Specifications, ROV Modules Specifications, ROV Accessories Specifications, Tether Specifications, System Voltage Advisory, ROV Submersible, ROV Nomenclature, ROV Connections, Operator Control Console, Safety Circuits, Switches and Connections, Computer, Hand Controller, Forward / Reverse Control, Yaw Control, Depth Control, Forward / Reverse Control, Yaw Control, Depth Control, Tether, Tether Specifications, Strain Relief, ROV to Tether, Tether to Tether, Connections Summary, Accessories, Software Guide, Operations Guide, Acceptable Use, System Voltage Advisory, ROV Materials List, ROV Project Management, Mission Planning, General Logistics, On-site Operations, Emergency Situations, Flooded ROV / Component, Snagged Tether / ROV, Cut Tether, Loss of ROV Function(s), Universal Practices, Deployment Platforms, Tether Management, Hot Weather Operations, Potable Water, Contaminated Water, Piloting, Piloting Tools, Auto Heading, Auto Depth, Auto Altitude, Piloting Tactics, Low Visibility, Swift Current, Deep Water, Confined Spaces

RS-485 - Data Protocol

Communications Module, AHRS Module, Thruster Module, LED Light Module, Tether Specifications, Power/Communications Module, AHRS Module, Thruster Module, Camera Module, Light Module, ROV Connections, Tether Specifications, Configuration Commands, Command: vr_create_virtport

Safety - State of, or application of, safe practices

Safety First, Operator Control Console, Safety Circuits, Mission Planning, General Logistics

SDK - (Software Developer's Kit) A program and a set of software libraries and utilities to aid custom program development

Sensitivity - The amount of output based on a specific level of input, particularly for the joystick

Sensor - An instrument for measuring a specific property of an object or the environment

Communications Module, AHRS Module, Thruster Module, Camera Module, LED Light Module, ROV Submersible, Power/Communications Module, AHRS Module, Accessories, Included Accessories, Updating Firmware, Piloting, Piloting Tools, Auto Depth

Settings - The values of specific controls or parameters, or the ability to manage these

Customize this Document, System Voltage Advisory, System Voltage Advisory, Data Management, Auto Heading, Thruster Module, LED Light Module

Skid - The base of the ROV and often used to mount accessories

Snagged Tether / ROV

Software Developer's Kit - See SDK

Snapshot - A still image captured from the video image

Snapshot, Video Record, Snapshot, Video Record, Video / Sensor Recording, Image and Video Production, Still Images

Strain Relief - An ROV and tether component that reduces the load on tether connections

Tether Specifications, Tether, Tether Specifications, Strain Relief, ROV to Tether, Tether to Tether, Connections Summary

Sun Shade - Device used to shade the display for better visibility in direct sunlight

Included Accessories

Surge - The forward and backward motion of the ROV

ROV Nomenclature

TDS - (Tether Deployment System) A reel for storing tether

System Voltage Advisory, System Voltage Advisory, Tether Management

Temperature - Qualitative measure of hot or cold

Thruster Module, Camera Module, LED Light Module, Computer, Module Configuration, Environmental Compatibility, Special Situations, Cold Weather Operations, Hot Weather Operations

Tether - The cable that connects the ROV to the Operator Control Console

Safety First, Power Module, Tether Specifications, System Voltage Advisory, Power/Communications Module, ROV Connections, Operator Control Console, Safety Circuits, Switches and Connections, Tether, Tether Specifications, Strain Relief, ROV to Tether, Tether to Tether, Connections Summary, Accessories, Mission Support Accessories, System Voltage Advisory, ROV Materials List, Mission Planning, On-site Operations, Snagged Tether / ROV, Cut Tether, Loss of ROV Function(s), Deployment Platforms, Tether Management, Potable Water, Contaminated Water, Piloting Tactics, Swift Current, Deep Water, Confined Spaces

Tether Deployment System - See TDS

Text Overlay - Ability to superimpose text over a video image

Video / Sensor Recording, Still Images, Piloting Tools, Auto Heading, Auto Depth, Auto Altitude

Third Axis - Rotational motion of the joystick - can be used as an alternate control method of the joystick

Thruster - ROV propulsion system including a motor and propeller

Power Module, Thruster Module, ROV Submersible, Power/Communications Module, Thruster Module, Light Module, ROV Connections, Forward / Reverse Control, Yaw Control, Depth Control, Forward / Reverse Control, Yaw Control, Depth Control, VideoRay Interface Overview, Module Configuration, Updating Firmware, Command: vr_enum, Command: vr_setid, Command: vr_debug_putty, Potable Water, Piloting Tools, Auto Heading, Auto Depth, Auto Altitude, Deep Water, Power Module, Thruster Module, LED Light Module

Thruster Nozzle - Shroud around the propeller

Tilt Arm - Operator Control Console component to adjust the angle of the optional second monitor

Operator Control Console

Transparent - Ability to see through

ROV Connections, Hand Controller, VideoRay Industrial Controller, Forward / Reverse Control, Yaw Control, Depth Control, Lights Intensity, Camera Tilt Up, Camera Tilt Down, Camera Focus In, Camera Focus Out, Snapshot, Video Record, Cycle Display Mode, Manipulator Open, Manipulator Close, Manipulator Rotate, VideoRay IP65 Controller, Forward / Reverse Control, Yaw Control, Depth Control, Lights Intensity, Camera Tilt Up, Camera Tilt Down, Camera Focus In, Camera Focus

Out, Snapshot, Video Record, Cycle Display Mode, Manipulator Open, Manipulator Close, Manipulator Rotate, Auto Heading, Auto Depth, Auto Altitude

Turns Indicator - An instrument that keeps track of the number of rotations of the ROV about its vertical axis and provides information on which direction to turn to unwind the tether

Umbilical - See also Tether

Potable Water

Upgrade - A newer version or the process of installing a newer version

USB - (Universal Serial Bus) Data protocol and connector style

Switches and Connections, Computer, VideoRay Industrial Controller, VideoRay IP65 Controller, Connections Summary, Command: vr_refresh, Command: vr_enum, Command: vr_setid, Command: vr_debug_putty

Video - In VideoRay context, the image from the ROV's camera or the ability to record this image

Tether Specifications, ROV Submersible, Camera Module, Operator Control Console, Switches and Connections, Computer, Snapshot, Video Record, Cycle Display Mode, Snapshot, Video Record, Cycle Display Mode, Tether, Tether Specifications, Mission Support Accessories, VideoRay Interface Overview, Video / Sensor Recording, Project Completion, Image and Video Production, Still Images, Piloting Tactics, Low Visibility

Video Encoder - Defines a method of storing a video image within a file format

Video Window - Display component that displays the video image from the camera

Snapshot, Video Record, Snapshot, Video Record, VideoRay Interface Overview, Video / Sensor Recording, Image and Video Production, Still Images

Virtual COM Port - A software feature that allows two applications on the same computer to communicate without requiring physical ports

Visibility - Measure of the clarity of water

Camera Module, Mission Planning, On-site Operations, Piloting Tactics, Low Visibility

Whip - A short length of tether attached to the ROV or Operator Control console

Switches and Connections, ROV to Tether

White Balance - Camera feature to color correct images from the camera

Yaw - The left or right turning attitude or motion of the ROV

AHRS Module, ROV Nomenclature, Thruster Module, Yaw Control, Yaw Control

Zoom - Camera image magnification

Camera Module

FAQ (Frequently Asked Questions)

New users typically have some basic questions about the MSS ROV Systems. Before getting to the details, this section is provided to address the questions asked most frequently, without having to scan through the manual to find the answers.

If you have questions about a problem with a MSS ROV Systems, see the Diagnostics and Repair section of the Maintenance Guide for more information.

1. **How hard is it to learn how to operate the MSS ROV Systems?**

   The MSS ROV Systems is easy to learn to operate. In a few hours, users should be able to pilot the ROV confidently in clear, calm water and know enough about it to maintain it in good condition for years. However, mastering all the knowledge and developing the skills to be able to pilot the ROV in much more demanding situations with near zero visibility and swift current will require more experience. See the Quick Start Instructions for more information.

2. **How deep can the MSS ROV Systems go?**

   The rated depth of the MSS ROV Systems is 1,000 meters (3,280 feet).

3. **How fast can the MSS ROV Systems go?**

   The rated speed of the MSS ROV Systems is 4 knots.

4. **In how much current can the MSS ROV Systems operate?**

   While the logical answer seems to be that it can not operate in current faster than the vehicle can go in calm water, operational tactics can be used to operate in current that exceeds the maximum speed of the ROV. See the Piloting in Current section of the Operations Guide for more information.

5. **How much can you pick up with the MSS ROV Systems?**

   The MSS ROV Systems manipulator closes with about 4.5 kilograms (10 pounds) of force, and the vehicle has the ability to lift about 15 kg (33 pounds). However, if you can grab a secure hold of an object, you can retrieve more weight by pulling on the tether. Items weighing up to 20 kilograms (80 pounds) in water have been successfully retrieved. See the Tether section in the Equipment Guide for more information.

6. **How much tether can you use with the MSS ROV Systems?**

   The maximum tether length is about 600 meters (2,000 feet). Tether is like conventional electric extension cords and multiple sections can be plugged in together. Longer tether can be supported using fiber tether. See the Tether section in the Equipment Guide for more information.

7. **How do you adjust the buoyancy and trim of the MSS ROV Systems?**

The buoyancy and trim can be adjusted by adding or removing the ballast weights. See the Pre-Dive Preparations section of the Quick Start Instructions for more information.

8. **Can you record pictures and video from the MSS ROV Systems?**

   Pictures and videos can be recorded in digital format on the computer. See the Images and Videos section in the Operations Guide for more information.

9. **How much maintenance is required for the MSS ROV Systems**

   The MSS ROV Systems is easy to maintain. There are very few consumable parts, and these have been designed to be as easy to replace as possible. Cleaning the vehicle after each use is one of the most important maintenance requirements.

More Questions?

Additional questions and answers are available online at www.rovfaq.com, which is also linked at the bottom of each page. The online FAQ is updated regularly.

Requirements

The VideoRay Mission Specialist Defender requires an external power source capable of producing 100 - 240 V DC; 50, 60 Hz output with a minimum steady-state capacity of 3,000 Watts.

The Defender ROV weighs approximately 34 kg (75 pounds) in its case. The ability to lift at least that much weight is required to transport and deploy the ROV.

Using trained operators and technicians is highly recommended.

Specifications

Specifications for the VideoRay Mission Specialist Defender are provided on the following pages.

⚠ Mission Specialist Pro 5
features and specifications are subject to change without notice.

Product News

See www.videoray.com for the most up-to-date product information.

ROV System Specifications

File not found!

Open in New Window

⚠ Mission Specialist Defender features and specifications are subject to change without notice.

Specifications for the ROV Modules

Specifications for the VideoRay M5 Modules are provided on the following pages.

Power Module Specifications

Depth Rating

- 2,000 meters (6,500 feet)

Mechanical

- Dimensions: 18 cm x 13 cm x 4 cm (7.1 inches x 5.1 inches x 1.6 inches)
- Weight in Air: 1.14 kg (2.5 pounds)
- Weight in Water: 0.55 kg (1.2 pounds)

Connections

- 8-Pin Male Connector (Tether)
- 9-Pin Female Connector (Communications)
- 5-Pin Female Connectors (Thrusters and LEDs) 2X

Power Input

- Input Voltage Range: 200 - 420 V DC

Power Output

- 48V: 1500 W
- 24V: 300 W
- 12V: 120 W

⚠ M5 Power Module features and specifications are subject to change without notice.

Communications Module Specifications

Depth Rating

- 2,000 meters (6,500 feet)

Mechanical

- Dimensions: 25.5 cm x 15.2 cm x 5.3 cm (6.12 inches x 6.0 inches x 2.1 inches) not including cable
- Weight in Air: 1.19 kg (2.6 pounds)
- Weight in Water: 0.55 kg (1.2 pounds)

Connections

- 9-Pin Male Connector (Upstream, Port 1)
- 9-Pin Female Connectors (Accessories, Ports 2 - 6) 5X

Power Input

- 24V: 300 W
- 12V: 120 W

Power Output

- 24V: 300 W
- 12V: 120 W

Communications

- Ethernet
- RS-485

Sensor Feedback

- Current Monitoring
- Voltage Monitoring

M5 Communications Module features and specifications are subject to change without notice.

AHRS Module Specifications

Depth Rating

- 2,000 meters (6,500 feet)

Mechanical

- Dimensions: 17.8 cm x 7 cm x 5.4 cm (7.0 inches x 2.75 inches x 2.12 inches) not including cable
- Weight in Air: 0.55 kg (1.2 pounds)
- Weight in Water: 0.21 kg (0.46 pounds)

Connections

- 9-Pin Female Connector

Power Input

- 12 VDC

Communications

- Ethernet
- RS-485

Sensor Feedback

- 9 DOF IMU
- Magnetic compass
- RPM
- Pressure Based Depth Sensor (100 Bar, with 400 Bar optional)

IMU Features

- 0.2 degree Static Roll/ Pitch
- 0.5 degree Dynamic Roll/ Pitch
- 1.0 degree Yaw
- 18 degree/h Gyro Bias Stability

M5 AHRS Module features and specifications are subject to change without notice.

Thruster Module Specifications

Depth Rating

- 2,000 meters (6,500 feet)

Mechanical

- Dimensions: 13.2 cm x 12.2 cm x 11.8 cm (5.19 inches x 4.80 inches x 4.64 inches) not including cable
- Weight in Air: 0.65 kg (1.4 pounds)
- Weight in Water: 0.33 kg (0.73 pounds)

Connections

- 5-Pin Male / Female Connector (Stackable)

Power Input

- 48 VDC at 750-Watt Max input

Communications

- RS-485 Galvanically Isolated Control

Sensor Feedback

- Input Current Total
- Input Voltage
- RPM
- Internal Temperature

Features

- Direct Drive Brushless Motor
- Several Mounting Options
- 90mm Diameter Propeller
- 3 Blade Propeller with quick connect/release Collet
- Smooth Start at 120 RPM
- Instant Reverse
- No Cogging
- Very Quiet and Smooth Operation

M5 Thruster Module features and specifications are subject to change without notice.

Camera Module Specifications

Depth Rating

- 2,000 meters (6,500 feet)

Mechanical

- Dimensions: 15.4 cm x 8 cm diameter (6.1 inches x 3.1 inches diameter) not including cable
- Weight in Air: 0.66 kg (1.45 pounds)
- Weight in Water: 0.9 kg (0.20 pounds)

Connections

- 9-Pin Female Connector

Power Input

- 12 VDC; Power Consumption: 57w

Communications

- Ethernet
- RS485

Sensor Feedback

- Internal Pressure/Vacuum Integrity
- Internal Humidity
- Internal Temperature
- Tilt Position

Protocols

- Video: Ethernet
- Camera Control: Ethernet
- Servo Control: RS485

Visibility

- Internal Tilt: 85 Degrees
- Horizontal Field of View: 80 Degrees

Features

- Optical BK7 Glass Dome
- Autofocus
- Whitebalance Control
- 16x Digital Zoom
- 13.19 Megapixel Still Capture

M5 HD Camera Module features and specifications are subject to change without notice.

LED Light Module Specifications

Depth Rating

- 2,000 meters (6,500 feet)

Mechanical

- Dimensions: 7.6 cm x 7 cm x 2.8 cm (3.0 inches x 2.75 inches x 1.12 inches) not including cable
- Weight in Air: 0.14 kg (0.31 pounds)
- Weight in Water: 0.09 kg (0.10 pounds)

Connections

- 5-Pin Male / Female Connector (Stackable)

Power Input

- 48 VDC at 76 Watt

Communications

- RS-485 Galvanically Isolated Control

Sensor Feedback

- Input Voltage
- Input Current Total
- Internal Temperature

Features

- 3,000 K CCT, 80 CRI White
- 2,880 Calculated minimum flux (lm) per array, 5,760 total lm per light module
- Individually Controlled Arrays (16 emitters per array, 32 total)
  - 60 Degree Spot Beam
  - 110 Degree Flood Beam
- Hard Anodized, Potted Housing

M5 LED Light Module features and specifications are subject to change without notice.

Specifications for the ROV Accessories

Specifications for the VideoRay Mission Specialist Defender accessories can be found on the respective information pages of each accessory. See the Optional Accessories section for more information.

Tether Specifications

Tether Diameter

Units \ Type	Negative	Neutral	Performance
mm	8.51 +/- 0.38	11.18 +/- 0.50	8.18 +/- 0.50
inches	0.335 +/- 0.015	0.440 +/- 0.020	0.322 +/- 0.020

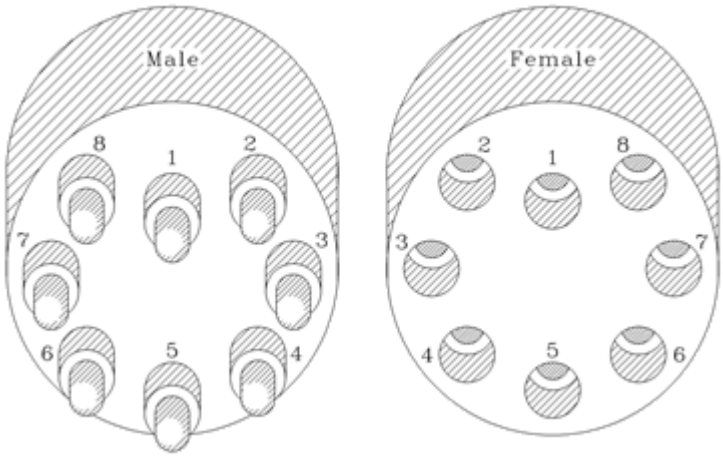
New tether was introduced in 2018. These tethers include a braided Kevlar around the conductors, are slightly different diameter and can be identified by an "FB" code printed on the tether.

Units \ Type	FB Neutral	FB Performance
mm	12.2 +/- 0.25	9.1 +/- 0.25
inches	0.440 +/- 0.010	0.358 +/- 0.010

Minimum Tether Bend Radius

Units \ Type	Negative	Neutral	Performance
mm	88.9	114	82.5
inches	3.5	4.5	3.25

Tether Connector Pin Configuration



Tether pin numbering in the connector is shown above. When looking at the mating surface of the connector, Pin 1 is the offset pin / socket. For male connectors, pins 2-8 proceed in a clockwise direction. For female connectors, sockets 2-8 proceed in a counter-clockwise direction.

Tether Pin Function and Conductor Wire Gauge

Pin	Function	Negative	Neutral	Performance
1	Interlock (GND)	24	24	28
2	Interlock (Sense)	24	24	28
3	400 VDC +	16 (x2)	20 (x2)	24 (x2)
4	M100 EOP+	24	28	28
5	Ground	16 (x2)	20 (x2)	24 (x2)
6	M100 EOP-	24	28	28
7	RS-485 A	24	28	28
8	RS-485 B	24	28	28

⚠ All conductors are straight through, such that pin 1 in the male connector is connected to socket 1 in the female connector, and so on for all eight pins / sockets.

⚠ Conductor pairs 1 & 2, 4 & 6 and 7 & 8 are twisted.

⚠ Pins 3 and 5 use 2 conductors each for maximizing power transmission and tether flexibility.

Tether Buoyancy

Performance and Neutral tether includes buoyancy compensating foam that provides near neutral buoyancy in fresh water. Negative tether contains no foam and will sink. The connectors do not contain any buoyancy compensation and will sink slightly.

Tether Strength

All tether types include Kevlar that is rated at 450 kg (1,000 pounds), the connectors are rated 80 kg (175 pounds).

CAUTION These values are breaking strength. The tether should not be subjected to a working strength greater than one half of the breaking strength. The ROV and tether are equipped with a strain relief cable and connectors, which are rated at 136 kilograms (300 pounds). The strain relief cable should be used to avoid separation of the tether connectors and loss of the ROV.

The maximum usable tether length is limited by the ability of the tether to transmit power and data signals. The maximum usable tether length of MSS systems is about 550 meters (1,800 feet). MSS systems can use fiber tether to extend the range. See the Tether Management section of the Operations Guide for more information.

Kevlar is a registered trademark of E. I. du Pont de Nemours and Company

System Voltage Advisory

AC Input

Input voltage is universal at 100-240 VAC; 50, 60 Hz. The power requirement for the Mission Specialist operating at full power settings is 3,000 Watts. A 2,000 Watt source (i.e. generator) can be used if the system will not be used at full power settings.

ROV DC Power

Historically, the tether voltage to power the ROV has been increasing. Economy models (including the Scout, Explorer and Voyager), Pro 3 variants and the Pro 4 Ultra use 48 V DC for vehicle power. The Pro 4 uses 74 V DC. Mission Specialist systems uses 400 V DC with plans to use higher voltages in the future. Systems with voltages higher than 48 V DC include a LIM (Line Insulation Monitor) protection module in the ROV DC circuit.

CAUTION System components should not be connected to voltage sources higher than their rating.

VideoRay Negative, Neutral and PPT tethers are rated to 600 V DC and are safe to use on any system through the Mission Specialist 400 V DC.

CAUTION The standard TDS and Extended TDS are only rated to 300 V DC and should not be used with Mission Specialist systems or components.

The new version of the extended TDS is available that includes a 600 V rated slip ring.

If you have any questions about system voltage and compatibility, contact VideoRay Support.

Equipment Guide

Understanding the features and capabilities of the MSS equipment is essential to get the most value out of using the system. The sections within this Equipment Guide provide details about each of the components.

Topics in this Section

- ROV

- Operator Control Console

- Hand Controller

- Tether

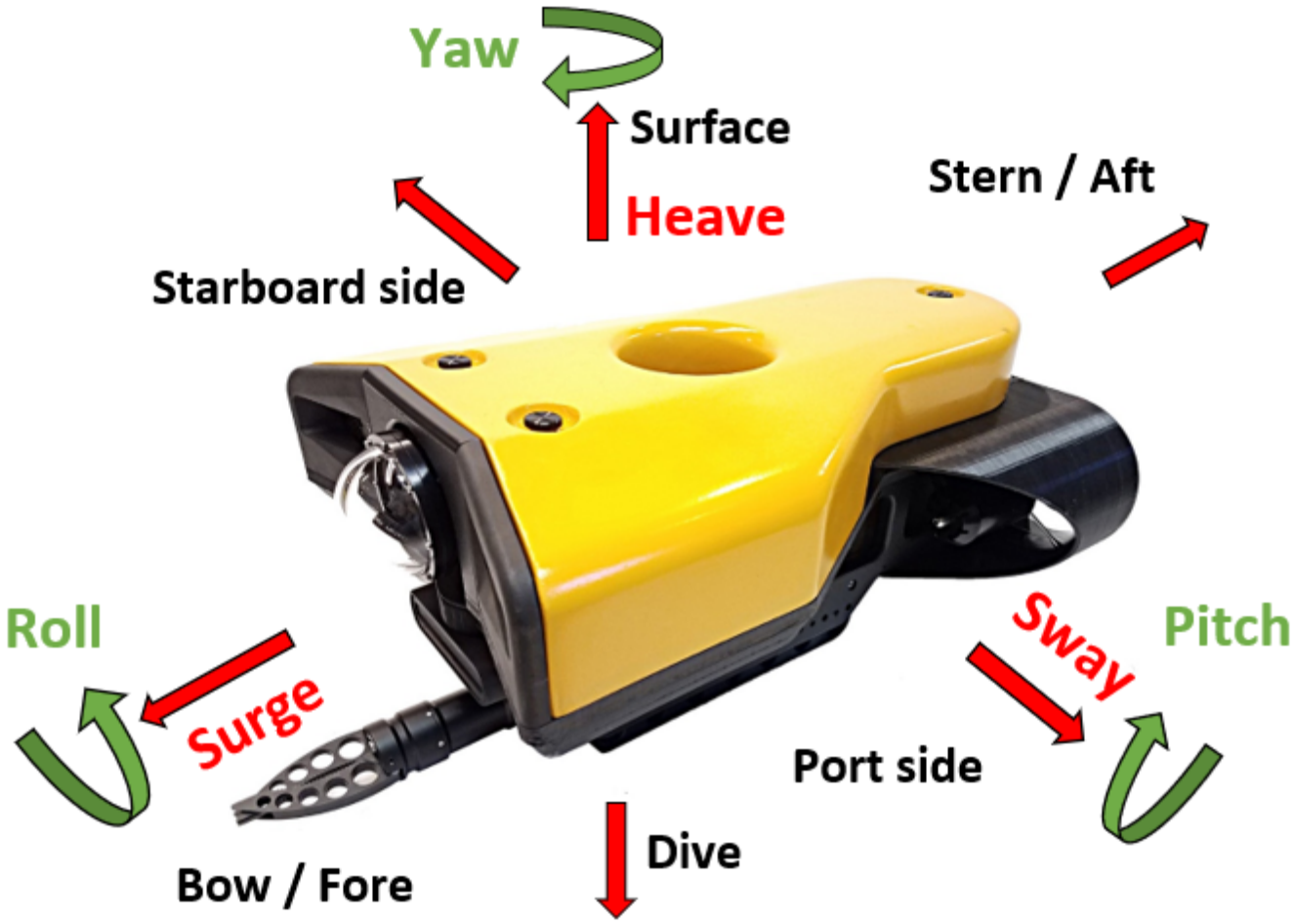
ROV

The Mission Specialist ROV consists of modular components (thrusters, lights, cameras, sensors) and a custom frame. Each Mission Specialist vehicle is designed to meet the requirements of a specific underwater mission. The frame and sensor payload can be optimized to deliver the vehicle to its intended destination and accomplish the tasks, whether that be recording video, taking measurements of various parameters, or navigation and remote sensing such as sonar or laser imaging.

The sections that follow provide information about the frame and modular components.

ROV Nomenclature

ROV nomenclature follows the general pattern for seagoing vessels. The image below provides a visual reference for the directions and attitude relative to the ROV.



ROV Orientation and Directions Reference

Bow - The front of the ROV.

Stern - The rear of the ROV

Port - The left side of the ROV when facing forward.

Starboard - The right side of the ROV when facing forward.

Fore - Towards the front or The forward direction.

Aft - Towards the rear of the rearward direction.

Surface - To ascend or move up in the water column to a shallower depth.

Dive - To descend or move down in the water column to a deeper depth.

ROV Attitude and Motion Reference

Surge - Forward and Reverse motion of the ROV, forward is positive.

Heave - Up and Down motion of the ROV, up is positive.

Sway - Left (to port) and Right (to starboard) lateral motion of the ROV, left is positive.

Yaw - Right (to starboard) and Left (to port) rotational motion of the ROV, right (clockwise, viewed from the top) is positive.

Pitch - Bow Up or Bow Down inclination of the ROV, bow up (clockwise, viewed from the port side) is positive.

Roll - Port UP or Port Down relative to Starboard, port up (clockwise, viewed from the rear) is positive.

Pro 5 Frame

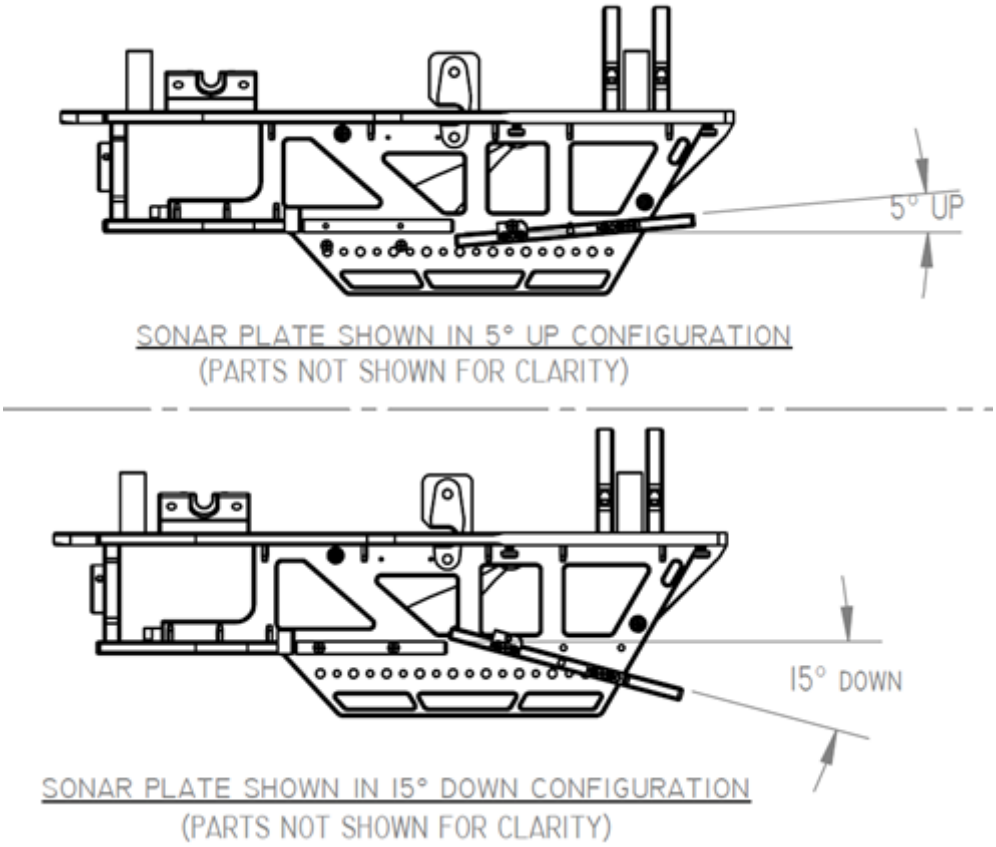
The Pro 5 Frame is similar to the VideoRay Pro 4 using 2 horizontal thrusters x 1 vertical thruster. It is designed to carry a complement of accessories including sonar and manipulator. Other accessories would require a payload mounting platform for each accessory.

Pro 5 Exploded Views

Open in New Window

Sonar Tilt Mount

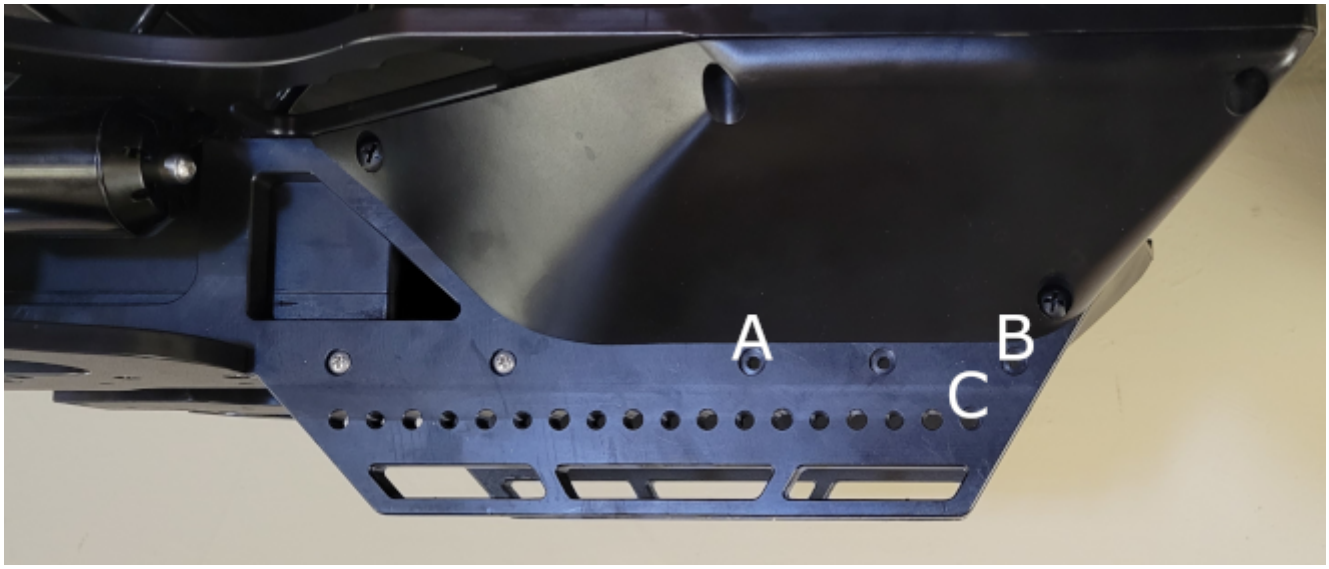
The sonar mounting plate on the Pro 5 can be tilted up 5 degrees or down 15 degrees to improve viewing angles while looking at ship's hulls or searching the bottom.



Adjusting the Tilt

To position the sonar for horizontal use (the default tilt), the mounting plate hole 2 should be aligned with frame hole A, and the mounting plate hole 4 should be aligned with frame hole B. The plate should be secured using the supplied 8-32 x 3/4" screws.

Sonar Mounting Plate



Sonar Mounting Frame

Downward Tilt Use

To position the sonar for 15 degree downward use (for bottom searching), the mounting plate hole 2 should be aligned with frame hole A, and the mounting plate hole 3 should be aligned with frame hole C.

Upward Tilt Use

To position the sonar for 5 degree updward use (for viewing ship's hulls or the underside of docks), the mounting plate hole 1 should be aligned with frame hole A, and the mounting plate hole 4 should be aligned with frame hole B.

Pro 5 Buoyancy

Pro 5 Ballast

Power / Communications Module

The Power Module receives power from the topside and converts it to power levels required by the various modules, sensors and accessories.

8 Pin Male Tether Connector

Pin	Function
1	Interlock (GND)
2	Interlock (Sense)
3	Tether V+
4	M100 EOP+
5	Tether V-
6	M100 EOP-

7	RS-485 A
8	RS 485 B

5 Pin Female High Power (Thruster, Lights) Connector (2)

Pin	Function	Wire AWG	Color
1	48 V DC +	20	Red
2	GND	22	Green
3	48 V DC -	20	Black
4	RS-485 A	24	Gray
5	RS-485 B	24	White

Power is rated at 750 Watts per port for 1,500 Watts total.

Power Module Arrangement

The communications module is the "brains" of the vehicle and coordinates vehicle control systems and provides data paths for sensors and accessories.

9 Pin Female Interface Connectors

⚠ The ports are not numbered in sequence.

Pin	Function
1	ETH_RXP +
2	ETH_RXP -
3	24 V DC +
4	ETH_TXP +
5	GND
6	ETH_TXP -
7	RS-485 A
8	RS-485 B
9	12 V DC +

Power is rated at 300 Watts for the 24 Volt circuit and 120 Watts for the 12 Volt circuit. This is the total output of the internal DC/DC converters and is divided across all connections as demanded by each externally connected device. Each connector pin is rated to 5 Amps, which should not be exceeded. For any one connector, the maximum Watts should not exceed 120 Watts for the 24 Volt circuit and 60 Watts for the 12 Volt circuit.

Communications Module Arrangement

Port Number	Module/Device Assignment	TCP Port	Baud Rate	Notes
1	Power	7444 (vrport1)	115200	
N/A	Communications Module	7444 (vrport1)	115200	
2	N/A	N/A		
3	High Definition Camera	7446		

4	N/A	N/A	
5	AHRSD	7448	
6	Rotating Manipulator	7449	115200

Defaults: Group ID - 193; Node ID - 2; IP address - 192.168.1.64; RS-485 accessible

AHRS Module

AHRS - **A**ttitude and **H**eading **R**eference **S**ystem

The AHRS is also sometimes referred to as an Inertial Measurement Unit, or IMU. It provides feedback on the vehicle's orientation. Measurements include magnetic heading, attitude and rates of change. The AHRS also includes a pressure sensor to determine the depth of the vehicle.

⚠ The AHRS compass may require a Magnetic Field Calibration. See the Compass Calibration page for more information.

Cable Pinout

Pin	Function
1	ETH_RXP +
2	ETH_RXP -
3	24 V DC +
4	ETH_TXP +
5	GND
6	ETH_TXP -
7	RS-485 A
8	RS-485 B
9	12 V DC +

AHRS Module Arrangement

The Pro 5 vehicle AHRSD is mounted in the top center of the ROV frame.

AHRSD Location	Group ID	Node ID	Application ID	TCP/IP Address	TCP/IP Port Number	Notes
Top Center	194	3	N/A	192.168.1.65	2 (7446)	Port 7444 IMU, Port 7445 Depth

Thruster Module

Mission Specialist vehicles use a modular thruster configuration that allows vehicle designs to be optimized for water conditions and payload delivery requirements. Modular thrusters are also easy to replace in the field.

Thruster Propeller

The propellers are designed to be used on counter-rotating thruster arrangements to eliminate torque roll or yaw. Propellers are identified by their pitch orientation using left and right based on their pitch. The convex edge of the propeller blade is the leading edge during motion that is considered forward for that thruster.

- Right-hand propellers can be identified as follows:
  - The top blade has the leading edge on the right when viewed from the end with the nut.
  - The blades appear to curve counterclockwise when viewed from the end with the nut.
  - Right hand propellers have a stainless steel collar on the hub at the shaft end.

- Left-hand propellers can be identified as follows:
  - The top blade has the leading edge on the left when viewed from the end with the nut.
  - The blades appear to curve clockwise when viewed from the end with the nut.
  - Left hand propellers have hub that is all plastic.

Cable Pinout

The Thruster connector uses a male / female stackable connector allowing the thrusters and LED lights to be connected in series.

Pin	Function	Wire AWG	Color
1	48 V DC +	20	Red
2	GND	22	Green
3	48 V DC -	20	Black
4	RS-485 A	24	Gray
5	RS-485 B	24	White

Thruster Arrangement

The Pro 5 vehicle is a Defender frame that uses a vectored horizontal thruster arrangement, and three vertical thrusters. The thrusters are configured as shown below:

Thruster Location	Group ID	Node ID	Motor ID	Propeller Orientation	Reverse Option	Maximum Power (Watts)	Notes
Starboard	129	5	0	Right	Disable	600	
Port	129	6	1	Left	Enable	600	
Vertical	129	7	2	Right	Enable	600	

Camera Module

The camera module provides a live video feed from the vehicle to the surface.

Cable Pinout

Pin	Function
1	ETH_RXP +
2	ETH_RXP -
3	24 V DC +
4	ETH_TXP +
5	GND
6	ETH_TXP -
7	RS-485 A
8	RS-485 B
9	12 V DC +

Camera Arrangement

High Definition Camera

Camera Location	Group ID	Node ID	TCP/IP Address	Notes
Forward Center	196	4	192.168.1.11	

LED Light Module

The LED Light Module provides variable levels of illumination and beam pattern control.

Cable Pinout

The LED Light connector uses a male / female stackable connector allowing the LED lights and thrusters to be connected in series.

Pin	Function	Wire AWG	Color
1	48 V DC +	20	Red
2	GND	22	Green
3	48 V DC -	20	Black
4	RS-485 A	24	Gray
5	RS-485 B	24	White

Lights Arrangement

Light Location	Group ID	Node ID	Application ID	Notes
Forward Top Port	131	11		
Forward Top Starboard	131	12		

ROV Connections

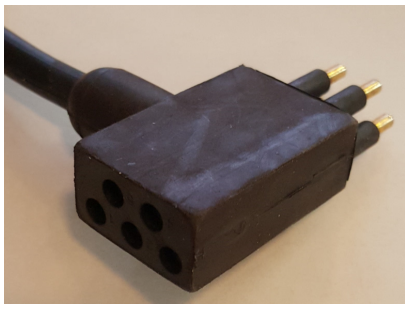
The Mission Specialist ROV system uses 3 types of connectors for power and communications between the control panel, vehicle modules and accessories.

8 Pin Tether Connector

Pin	Function
1	Interlock (GND)
2	Interlock (Sense)
3	Tether V+
4	M100 EOP+
5	Tether V-
6	M100 EOP-
7	RS-485 A
8	RS 485 B

Pin numbering starts at 1 for the offset pin and is clockwise on the male connector and counter clockwise on the female connector.

5 Pin Thrusters and Lights Connector

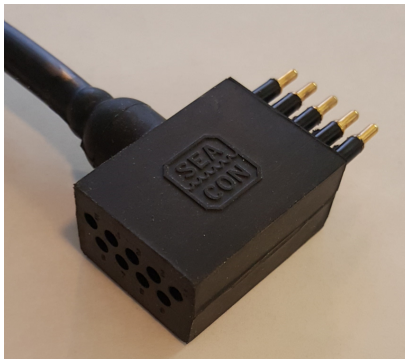


Pin	Function
1	48 V DC +
2	Vehicle Local Ground (12 V, 48 V return)
3	48 V DC return
4	RS-485 A
5	RS-485 B

Pin numbering is clockwise starting at 1 in the upper left when looking at the face of the male connector with the row of 3 pins on top.

9 Pin Accessory Connector

Pin	Function
1	ETH_RXP+
2	ETH_RXP-



3	24 V DC +
4	ETH_TXP +
5	Ground
6	ETH_TXP -
7	RS-485 A
8	RS-485 B
9	12 V DC +

Pin numbering is clockwise starting at 1 in the upper left when looking at the face of the male connector with the row of 5 pins on top.

ROV Connections

Operator Control Console

The Operator Control Console provides power, communications and a video interface between the surface and the ROV through the tether. The computer, which runs software to control the ROV, is housed in the Operator Control Console along with a display monitor .

Operator Control Console Power Specifications

The VideoRay MSS operates on typical residential power in the range of 100-240 Volts AC, 50,60 Hz. This can be provided from the land-based grid, a generator, or a battery with an inverter (optional). The typical power requirements for operating from a generator or inverter are 3,000 Watts continuous minimum.

The system includes a GFCI (Ground Fault Circuit Interrupter) / Circuit Breaker to protect the operator.

The power in the tether is 400 Volts DC. This circuit is protected by a LIM (Line Insulation Monitor).

The procedures for testing the circuit safety components can be found in the Pre-Dive Preparations section of the Quick Start Instructions.

CAUTION Do not block the Operator Control Console fans. Blocking the fans can lead to overheating and component failure.

Display Monitor Tilt Arm

The Display Monitor Tilt Arm on the left side of the Operator Control Console can be used to adjust the angle of the Operator Control Console lid and monitor. To adjust the angle of the monitor, loosen the locking collar, adjust the lid to the desired angle and tighten the locking collar.

CAUTION Make sure to loosen the display monitor tilt arm before closing the Operator Control Console lid, and be careful when closing the lid to avoid damaging the computer or monitor or pinching any cables.

Safety Circuits

The Operator Control Console includes three safety circuit components.

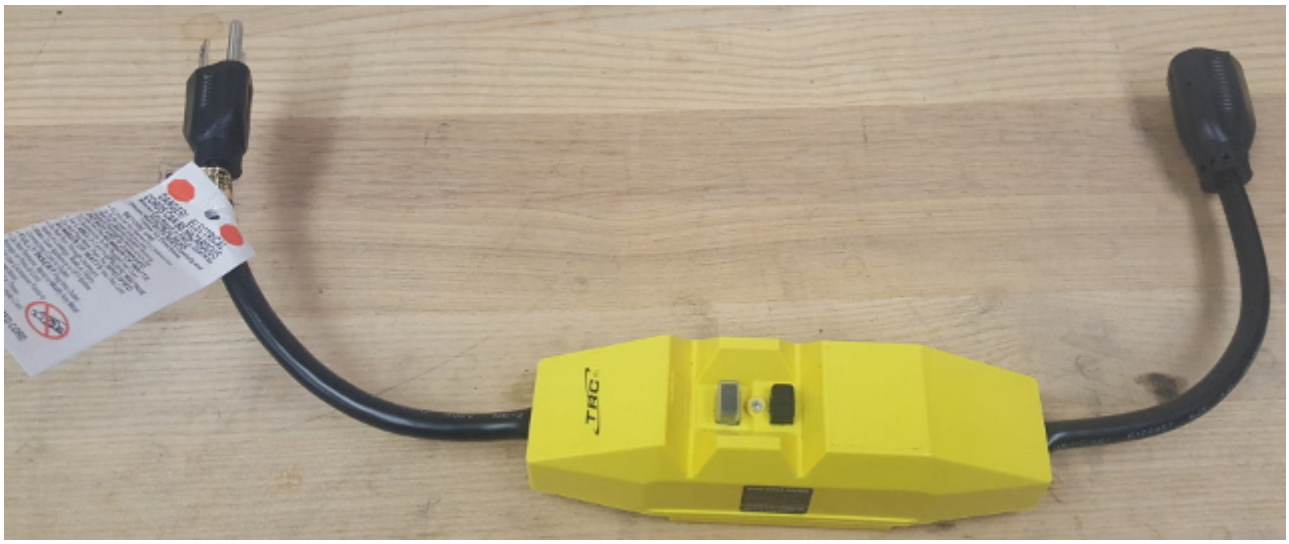
- GFCI (Ground Fault Circuit Interrupter)
- LIM (Line Insulation Monitor)
- ROV Power Safety Interlock

GFCI (Ground Fault Circuit Interrupter)

The GFCI protects the operator from shock from the AC circuit of the power source.

The GFCI is inline with the power cord. When initially connected to a power source, it is in the Off state. You must press the Reset Button to enable it. When enabled, the green LED will be illuminated.

⚠ When using a power source that includes a GFCI, the VideoRay supplied GFCI is not needed and can be removed from the power cord.



LIM (Line Insulation Monitor)

The LIM protects the operator and persons in the water nearby from shock from the DC circuit of the tether. While the GFCI switches are part of the GFCI component and must be turned on to operate the Operator Control Console, the LIM is automatically enabled when the system is turned on. The LIM operates on a principle similar to the GFCI and monitors the quality of the insulation of the conductors in the tether. If the resistance between the conductors drops below the safe threshold, the LIM will trip.

A normal reading on the LIM display is > 4 M-Ohm, indicating that the insulation of the power conductors in the tether is good. If there is any degradation of insulation, the value displayed will decrease. The MSS LIM is two stage. When the LIM detects the resistance between the ROV power conductors falls below 900 kOhms, the yellow LIM Alarm A1 LED will turn on, but the power circuit will remain on. When the LIM detects the resistance falls below 200 kOhms, the yellow LIM Alarm A2 LED will turn on and the ROV power circuit will be disabled. The LIM can be reset by pressing and holding the R button. The yellow LIM Alarm light should turn off. To test the LIM, press and hold the T button. If the LIM continues to trip, the system should be inspected for a fault before being used.

The LIM has additional features that are described in more detail in the LIM Module Manual.

ROV Power Safety Interlock

The ROV Power Safety Interlock prevents the ROV power from being engaged unless an ROV is plugged into the tether. This feature protects users from accidentally contacting the ROV power circuit of an open tether connector.

See the Operator Control Console Switches and Connections section for more information about these components and their locations, and see the Pre-Dive Preparations section of the Quick Start Instructions for information about testing these components.

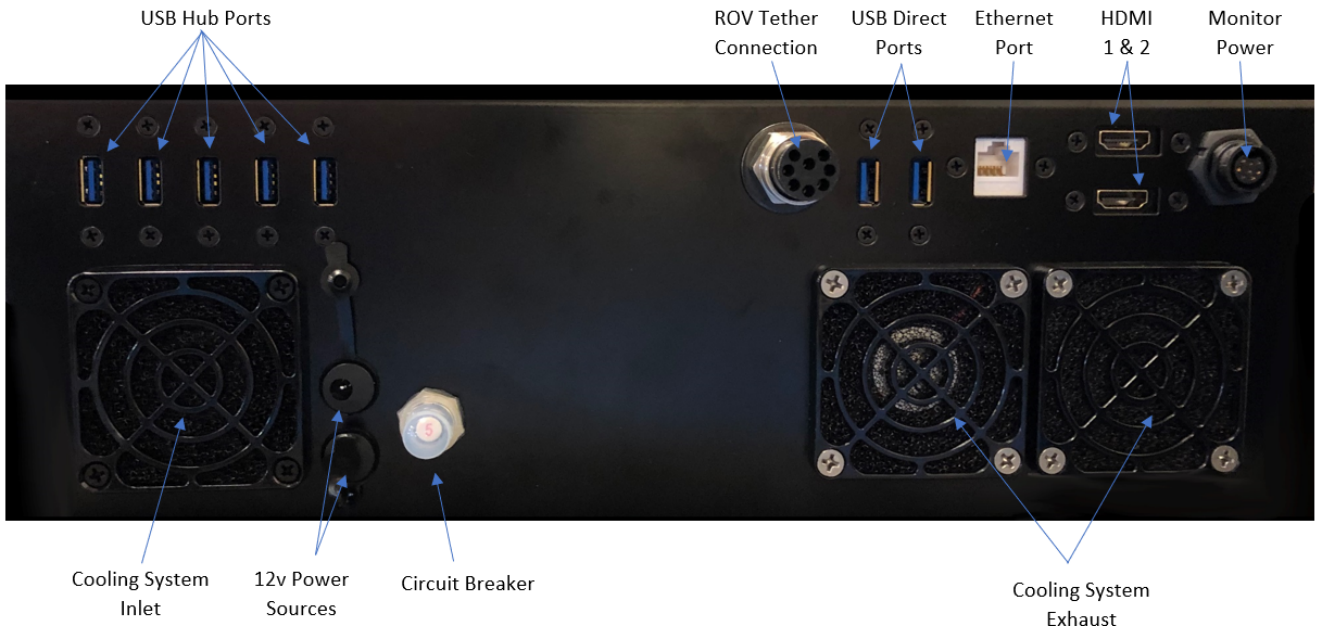
Switches and Connections

The Operator Control Console top includes the following switches:

SWITCH	LOCATION	FUNCTION
Main Power Switch	Operator Control Console top upper left	Turns the Operator Control Console on and off.
ROV Power Switch	Operator Control Console top central left	Turns the ROV power on and off. Twist in the direction of the arrows to turn on the ROV power and press the switch to turn it off.
LIM Module	Operator Control Console top central right	Test and Reset buttons can be found on the LIM.

The Operator Control Console top includes the following connections:

CONNECTION	LOCATION	FUNCTION
Power (100-240 Volts AC, 50, 60 Hz)	IEC male	Used to connect the Operator Control Console to a power source.



The Operator Control Console side includes the following connections:

CONNECTION	TYPE	FUNCTION
Tether Whip (Specifications)	8 pin round female	Used to connect the Operator Control Console to the tether for power, communications, video and accessory support.
Monitor Power		Provides 12 Volts DC. Used to provide power to the monitor.
Monitor Signal	Display Port Female	Used to provide the video signal to the monitor.
USB Ports (3)	Type A female	Can be used to connect USB devices to the computer via the Operator Control Console.
Ethernet	RJ-45 female	Can be used to connect the Operator Control Console to the computer for Ethernet based ROV accessories.

⚠ The Display Port cable uses a locking locking connector. Make sure to press the release button when disconnecting the cable to avoid damaging the connector.

Computer

The computer provides the hardware and operating system platform for VideoRay ROV control software and image and video editing and production. The computer is embedded in the Operator Control Console.

⚠ For information about using the computer in general, see the instructions that came with it.

⚠ VideoRay does not recommend installing additional hardware or software on the computer unless you are familiar with its operation and confident it will not interfere with the VideoRay control software or the computer's ports. Software that is packaged with VideoRay accessories has been tested and is approved for use.

The computer includes the following connections (which are passed through to connectors on the Operator Control Console):

CONNECTION	TYPE	FUNCTION
USB (3)	Type A female	Can be used to connect USB devices to the computer.

Ethernet	RJ-45 female	Can be used to connect the computer to a network, or the Operator Control Console for Ethernet based accessories.
Display Port	Display Port Female	Provides an HD video signal. This can be used to connect the computer to an external monitor.

Additional Specifications

Operating System

- Ubuntu

Temperature

- Operating Temperature: -40 C - 70C
- Storage Temperature: -40 C - 85C

Power Input

- 9 - 48 VDC

Hard Disk Space

- 256 Gb

⚠ Computer specifications are subject to change without notice.

HD Monitor

CAUTION The display port cable has a latching connector. Make sure to press the latch button before trying to remove the connector.

The monitor includes a brightness knob.

The monitor includes the following connections:

CONNECTION	Type	FUNCTION
Power	12 Volt DC	Used to connect the monitor to a power source. The control panel provides a matching 12 Volt DC connector.
Display Port In	Display Port	Used to connect the monitor to the computer.

Additional Specifications

Size

- 18.5" Diagonal

Power Input

- 12 VDC

Native Resolution

- 1920 X 1080

Brightness

- **High Bright ? 1000 nits**

Features

- **Wide Viewing Cone**
- **10 Point PCAP Touch**
- **Front Full Range Diming Pot**

⚠ **Monitor specifications are subject to change without notice.**

Hand Controller

The hand controller is used to operate the VideoRay and its features. Several types of hand controllers are supported. Controllers not included in your configuration are available from VideoRay for purchase. Supported controllers include:

VideoRay IP65 Hand Controller

Microsoft Xbox Elite Gamepad Style Hand Controller

The hand controller functions are described in more detail in the following pages of this guide.

Hand Controller Compatibility

Any Microsoft® Windows® compatible game controller can be used with the Mission Specialist, but each controller requires a configuration file to map the joystick, buttons and knobs to the ROV functions.

Microsoft is a registered trademark of Microsoft. Windows is a registered trademark of Microsoft.
Logitech is a registered trademark of Logitech.

VideoRay Industrial Controller Mapping

Forward / Reverse Control
Yaw Control
Depth Control
Lights Intensity
Camera Tilt Up
Camera Tilt Down
Camera Focus In
Camera Focus Out
Snapshot
Video Record
Cycle Display Mode
Manipulator Open
Manipulator Close
Manipulator Rotate

Hand Controller Connection

CONNECTION	TYPE	FUNCTION
USB	Type A male cable connection	Used to connect the hand controller to a USB port on the control panel or the computer.

Forward / Reverse Control

The joystick is used to control the forward / reverse motion of the ROV.

Location

⚠ The Joystick does not have a label.

Use

Displace the joystick forward (away from you) to move the ROV forward. Displace the joystick rearward (toward you) to move the ROV backward.

The greater the displacement from the center position, the faster the ROV will move or turn in that direction.

The joystick can be moved in any direction to simultaneously move forward or backward while turning or moving laterally.

CAUTION Do not run the horizontal thrusters in air for an extended period of time. Doing so may cause overheating and damage to the components.

Forward / Reverse Control

Yaw Control

The joystick is used to control the yaw motion of the ROV.

Location

⚠ The Joystick does not have a label.

Use

Rotate the Joystick to the left to turn (yaw) the ROV to its left. Rotate the Joystick to the right to turn (yaw) the ROV to its right.

Displace the Joystick to the left to slide the ROV to its left. Displace the Joystick to the right to slide the ROV to its right.

The greater the displacement from the center position, the faster it will move or turn in that direction.

The joystick can be moved in any direction to simultaneously turn while moving forward/backward or laterally.

CAUTION Do not run the horizontal thrusters in air for an extended period of time. Doing so may cause overheating and damage to the components.

Yaw Control

Depth Control

The Depth Control knob is used to make the ROV dive or surface by controlling the direction and amount of vertical thrust.

Knob Location and Label

Use

Rotate the Depth Control knob forward (counterclockwise) to dive. The greater the rotation from the center position, the faster it will dive. Rotate the Depth Control knob backward (clockwise) to surface. The greater the rotation from the center position, the faster it will surface.

CAUTION Do not run the vertical thruster in air for an extended period of time. Doing so may cause overheating and damage to the components.

⚠ The Depth Control Knob has a center detent so that, by feel, you can tell when the knob is centered.

Lights Intensity

The Lights knob controls the intensity of the lights.

Control Location and Labels

Lights Intensity

Use

Rotate the Lights Intensity knob counter clockwise to dim the Lights and clockwise to increase the intensity of the lights.

CAUTION Do not leave the lights on for an extended period of time. Doing so may cause overheating and damage to the components.

Lights Intensity

Camera Tilt Up

The Camera Tilt Up button increases the vertical angle of the front camera in the upward direction.

Button Locations and Labels

Tilt Up

Use

Press and hold the Tilt Up button to tilt the front camera up. Release the button when the camera has tilted to the desired setting or has reached the end of its range.

⚠ You should not continue to hold either tilt button when the camera has reached the end of its tilt range.

Camera Tilt Up

Camera Tilt Down

The Camera Tilt Up button increases the vertical angle of the front camera in the downward direction.

Button Locations and Labels

Tilt Down

Use

Press and hold the Tilt Down button to tilt the front camera down. Release the button when the camera has tilted to the desired setting or has reached the end of its range.

⚠ You should not continue to hold either tilt button when the camera has reached the end of its tilt range.

Camera Tilt Down

Camera Focus In

The Camera Focus In button adjusts the focus of the front camera for near objects.

Button Location and Label

Focus In

Use

Press and hold the Camera Focus In button to adjust the camera focus for near objects. Release the button when the camera has focused to the desired setting or has reached the end of its range.

Camera Focus In

Camera Focus Out

The Camera Focus Out button adjusts the focus of the front camera for far objects.

Button Location and Label

Focus Out

Use

Press and hold the Camera Focus Out button to adjust the camera focus for far objects. Release the button when the camera has focused to the desired setting or has reached the end of its range.

Camera Focus Out

Snapshot

The Snapshot button saves a still image from the active camera.

Button Location and Label

Use

Press the Snapshot button to capture a still image from the active camera.

Snapshots are saved as .JPG formatted files in the gss_logs folder. They are automatically named by date and time. For more information, see the Snapshots section of the Operations Guide.

You can capture a snapshot will recording video.

Video Record

The Video Record button toggles the video record feature for the active camera.

Button Location and Label

Use

Press the Video Record button to start recording a video from the active camera. Press the Video Record button again to stop recording a video from the active camera.

When the recording is active, the record icon button is illuminated green.

Video Recordings are saved as .MP4 formatted files in the gss_logs folder. They are automatically named by date and time. For more information, see the Video Recording section of the Operations Guide

You can capture snapshots while recording video.

Cycle Display

The Cycle Display button cycles through the display modes of the control software.

Button Location and Label

Use

Press the Cycle Display button to switch the display modes of the control software. Display modes include:

- Normal
- Full Screen Video
- Full Screen Sonar
- Split Screen Video / Sonar

Cycle Display Mode

Manipulator Open

The Manipulator Open button opens the jaws of the manipulator.

Button Locations and Labels

Manipulator Up

Use

Press and hold the Manipulator Open button to open the jaws of the manipulator. Release the button when the manipulator jaws open the desired amount or have reached the end of their range.

⚠ You should not continue to hold the Manipulator Open button when the jaws have reached the end of their range.

Manipulator Open

Manipulator Close

The Manipulator Close button closes the jaws of the manipulator.

Button Locations and Labels

Manipulator Close

Use

Press and hold the Manipulator Close button to close the jaws of the manipulator. Release the button when the manipulator jaws close the desired amount or have reached the end of their range.

⚠ You should not continue to hold the Manipulator Close button when the jaws have closed on an object or reached the end of their range. You can press and release the button a few times to tighten the jaws.

Manipulator Close

Manipulator Rotate

The Manipulator Rotate knob rotates the jaws of the manipulator.

Button Locations and Labels

Manipulator Rotate

Use

Rotate the Manipulator Rotate knob clockwise to rotate the manipulator jaws clockwise (when viewed from the rear of the manipulator). Rotate the Manipulator Rotate knob counterclockwise to rotate the manipulator jaws counterclockwise (when viewed from the rear of the manipulator). Center the Manipulator Rotate knob to stop the manipulator jaws from rotating.

Manipulator Rotate

VideoRay IP65 Controller Mapping

Forward / Reverse Control
Yaw Control
Depth Control
Lights Intensity
Camera Tilt Up
Camera Tilt Down
Camera Focus In

Camera Focus Out
Snapshot
Video Record
Cycle Display Mode
Manipulator Open
Manipulator Close
Manipulator Rotate

Hand Controller Connection

CONNECTION	TYPE	FUNCTION
USB	Type A male cable connection	Used to connect the hand controller to a USB port on the control panel or the computer.

Forward / Reverse Control

The joystick is used to control the forward / reverse motion of the ROV.

Location

⚠ The Joystick does not have a label.

Use

Displace the joystick forward (away from you) to move the ROV forward. Displace the joystick rearward (toward you) to move the ROV backward.

The greater the displacement from the center position, the faster the ROV will move or turn in that direction.

The joystick can be moved in any direction to simultaneously move forward or backward while turning or moving laterally.

CAUTION Do not run the horizontal thrusters in air for an extended period of time. Doing so may cause overheating and damage to the components.

Forward / Reverse Control

Yaw Control

The joystick is used to control the yaw motion of the ROV.

Location

⚠ The Joystick does not have a label.

Use

Rotate the Joystick to the left to turn (yaw) the ROV to its left. Rotate the Joystick to the right to turn (yaw) the ROV to its right.

Displace the Joystick to the left to slide the ROV to its left. Displace the Joystick to the right to slide the ROV to its right.

The greater the displacement from the center position, the faster it will move or turn in that direction.

The joystick can be moved in any direction to simultaneously turn while moving forward/backward or laterally.

CAUTION Do not run the horizontal thrusters in air for an extended period of time. Doing so may cause overheating and damage to the components.

Yaw Control

Depth Control

The Depth Control knob is used to make the ROV dive or surface by controlling the direction and amount of vertical thrust.

Knob Location and Label

Use

Rotate the Depth Control knob forward (counterclockwise) to dive. The greater the rotation from the center position, the faster it will dive. Rotate the Depth Control knob backward (clockwise) to surface. The greater the rotation from the center position, the faster it will surface.

CAUTION Do not run the vertical thruster in air for an extended period of time. Doing so may cause overheating and damage to the components.

⚠ The Depth Control Knob has a center detent so that, by feel, you can tell when the knob is centered.

Lights Intensity

The Lights knob controls the intensity of the lights.

Control Location and Labels

Lights Intensity

Use

Rotate the Lights Intensity knob counter clockwise to dim the Lights and clockwise to increase the intensity of the lights.

CAUTION Do not leave the lights on for an extended period of time. Doing so may cause overheating and damage to the components.

Lights Intensity

Camera Tilt Up

The Camera Tilt Up button increases the vertical angle of the front camera in the upward direction.

Button Locations and Labels

Tilt Up

Use

Press and hold the Tilt Up button to tilt the front camera up. Release the button when the camera has tilted to the desired setting or has reached the end of its range.

⚠ You should not continue to hold either tilt button when the camera has reached the end of its tilt range.

Camera Tilt Up

Camera Tilt Down

The Camera Tilt Up button increases the vertical angle of the front camera in the downward direction.

Button Locations and Labels

Tilt Down

Use

Press and hold the Tilt Down button to tilt the front camera down. Release the button when the camera has tilted to the desired setting or has reached the end of its range.

⚠ You should not continue to hold either tilt button when the camera has reached the end of its tilt range.

Camera Tilt Down

Camera Focus In

The Camera Focus In button adjusts the focus of the front camera for near objects.

Button Location and Label

Focus In

Use

Press and hold the Camera Focus In button to adjust the camera focus for near objects. Release the button when the camera has focused to the desired setting or has reached the end of its range.

Camera Focus In

Camera Focus Out

The Camera Focus Out button adjusts the focus of the front camera for far objects.

Button Location and Label

Focus Out

Use

Press and hold the Camera Focus Out button to adjust the camera focus for far objects. Release the button when the camera has focused to the desired setting or has reached the end of its range.

Camera Focus Out

Snapshot

The Snapshot button saves a still image from the active camera.

Button Location and Label

Use

Press the Snapshot button to capture a still image from the active camera.

Snapshots are saved as .JPG formatted files in the gss_logs folder. They are automatically named by date and time. For more information, see the Snapshots section of the Operations Guide.

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The Video Record button toggles the video record feature for the active camera.

Button Location and Label

Use

Press the Video Record button to start recording a video from the active camera. Press the Video Record button again to stop recording a video from the active camera.

When the recording is active, the record icon button is illuminated green.

Video Recordings are saved as .MP4 formatted files in the gss_logs folder. They are automatically named by date and time. For more information, see the Video Recording section of the Operations Guide

You can capture snapshots while recording video.

Cycle Display

The Cycle Display button cycles through the display modes of the control software.

Button Location and Label

Use

Press the Cycle Display button to switch the display modes of the control software. Display modes include:

- Normal
- Full Screen Video
- Full Screen Sonar
- Split Screen Video / Sonar

Cycle Display Mode

Manipulator Open

The Manipulator Open button opens the jaws of the manipulator.

Button Locations and Labels

Manipulator Up

Use

Press and hold the Manipulator Open button to open the jaws of the manipulator. Release the button when the manipulator jaws open the desired amount or have reached the end of their range.

⚠ You should not continue to hold the Manipulator Open button when the jaws have reached the end of their range.

Manipulator Open

Manipulator Close

The Manipulator Close button closes the jaws of the manipulator.

Button Locations and Labels

Manipulator Close

Use

Press and hold the Manipulator Close button to close the jaws of the manipulator. Release the button when the manipulator jaws close the desired amount or have reached the end of their range.

⚠ You should not continue to hold the Manipulator Close button when the jaws have closed on an object or reached the end of their range. You can press and release the button a few times to tighten the jaws.

Manipulator Close

Manipulator Rotate

The Manipulator Rotate knob rotates the jaws of the manipulator.

Button Locations and Labels

Manipulator Rotate

Use

Rotate the Manipulator Rotate knob clockwise to rotate the manipulator jaws clockwise (when viewed from the rear of the manipulator). Rotate the Manipulator Rotate knob counterclockwise to rotate the manipulator jaws counterclockwise (when viewed from the rear of the manipulator). Center the Manipulator Rotate knob to stop the manipulator jaws from rotating.

Manipulator Rotate

Tether

Tether connects the ROV to the surface and provides power, communications, video and an APIC (Auxiliary Pair of Independent Conductors) for accessory use. The tether consists of conductors, a Kevlar® strength member, flotation (for Neutral and Performance tethers) and an outer jacket. It is available three types: Negative, Neutral and Performance (often called PPT), and can be purchased in standard and custom lengths. Neutral and Performance are neutrally buoyant in fresh water because they have a specially designed foam jacket.

While larger conductors provide the best power transmission capacity, they lead to thicker tethers, which results in higher drag. Negative tether has the largest conductors (best power transmission capacity), followed by Neutral, and then Performance. Negative and Performance tether have the smallest diameter (least drag), while Neutral tether has the largest diameter.

The tether connectors are wet mateable and can be connected while they are wet. One of the pins in the connector is offset. To connect the tether to the ROV, control panel or another tether, align the offset pin of the connectors and press the two connectors together until the base surface of each connector are touching each other. Then, connect the tether locking sleeves by screwing them together to secure the connection.

Multiple tethers can be connected in series like conventional power extension cords. See the Tether Management section of the Operations Guide for recommended tether configurations.

CAUTION Always secure the tether connectors using the locking sleeves and strain relief system to avoid separation and loss of the ROV.

The strain relief system includes a carabineer that could get hooked on something underwater and cause the ROV to become trapped. To avoid this possibility, tape over the carabineer with electrical or duct tape.

CAUTION The tether connectors should be kept clean to avoid abrasion and corrosion on the electrical contacts and damage to the rubber insulation. Tether connectors should not be lubricated with petroleum products or grease. Petroleum will degrade the rubber and grease will attract dirt and lead to abrasion and corrosion. VideoRay recommends lubricating the tether connectors with pure silicone spray.

Tether Specifications

Tether Diameter

Units \ Type	Negative	Neutral	Performance
mm	8.51 +/- 0.38	11.18 +/- 0.50	8.18 +/- 0.50
inches	0.335 +/- 0.015	0.440 +/- 0.020	0.322 +/- 0.020

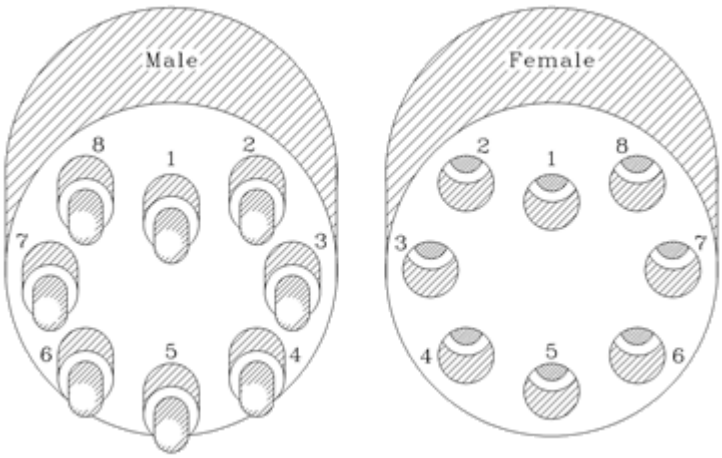
New tether was introduced in 2018. These tethers include a braided Kevlar around the conductors, are slightly different diameter and can be identified by an "FB" code printed on the tether.

Units \ Type	FB Neutral	FB Performance
mm	12.2 +/- 0.25	9.1 +/- 0.25
inches	0.440 +/- 0.010	0.358 +/- 0.010

Minimum Tether Bend Radius

Units \ Type	Negative	Neutral	Performance
mm	88.9	114	82.5
inches	3.5	4.5	3.25

Tether Connector Pin Configuration



Tether pin numbering in the connector is shown above. When looking at the mating surface of the connector, Pin 1 is the offset pin / socket. For male connectors, pins 2-8 proceed in a clockwise direction. For female connectors, sockets 2-8 proceed in a counter-clockwise direction.

Tether Pin Function and Conductor Wire Gauge

Pin	Function	Negative	Neutral	Performance
1	Interlock (GND)	24	24	28
2	Interlock (Sense)	24	24	28
3	400 VDC +	16 (x2)	20 (x2)	24 (x2)
4	M100 EOP+	24	28	28
5	Ground	16 (x2)	20 (x2)	24 (x2)
6	M100 EOP-	24	28	28
7	RS-485 A	24	28	28
8	RS-485 B	24	28	28

⚠ All conductors are straight through, such that pin 1 in the male connector is connected to socket 1 in the female connector, and so on for all eight pins / sockets.

⚠ Conductor pairs 1 & 2, 4 & 6 and 7 & 8 are twisted.

⚠ Pins 3 and 5 use 2 conductors each for maximizing power transmission and tether flexibility.

Tether Buoyancy

Performance and Neutral tether includes buoyancy compensating foam that provides near neutral buoyancy in fresh water. Negative tether contains no foam and will sink. The connectors do not contain any buoyancy compensation and will sink slightly.

Tether Strength

All tether types include Kevlar that is rated at 450 kg (1,000 pounds), the connectors are rated 80 kg (175 pounds).

CAUTION These values are breaking strength. The tether should not be subjected to a working strength greater than one half of the breaking strength. The ROV and tether are equipped with a strain relief cable and connectors, which are rated at 136 kilograms (300 pounds). The strain relief cable should be used to avoid separation of the tether connectors and loss of the ROV.

The maximum usable tether length is limited by the ability of the tether to transmit power and data signals. The maximum usable tether length of MSS systems is about 550 meters (1,800 feet). MSS systems can use fiber tether to extend the range. See the Tether Management section of the Operations Guide for more information.

Kevlar is a registered trademark of E. I. du Pont de Nemours and Company

Tether Strain Relief

The Pro 5 strain relief is used to secure the ROV to the tether to prevent separation and loss of the vehicle if the tether connection becomes separated. The strain relief also minimized the load on the tether connector.

There are two different strain relief systems. One is for use between the ROV and tether and the second is for use when connecting two tethers together. There is not a strain relief system for the topside connection.

Instructions for using these strain relief systems is found on the following pages.

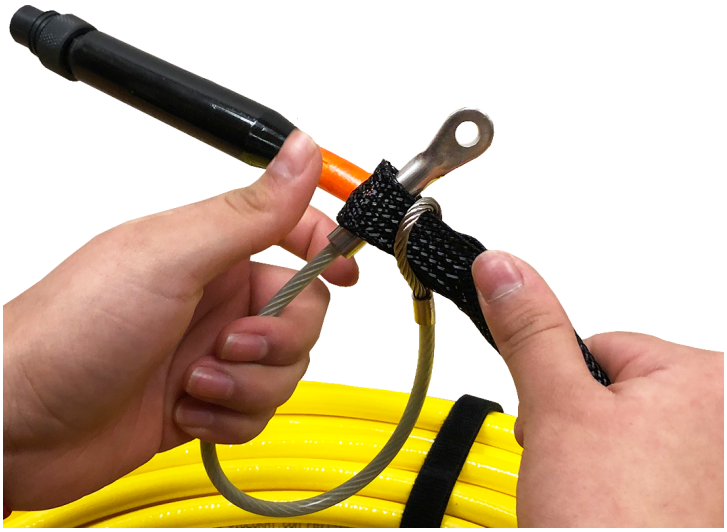
ROV to Tether Strain Relief

Use the following procedures to install and secure the vehicle to the tether to prevent loss of the vehicle due to a connection failure. The strain relief cable may already be attached to the tether. If so, you can skip steps 1 to 3.

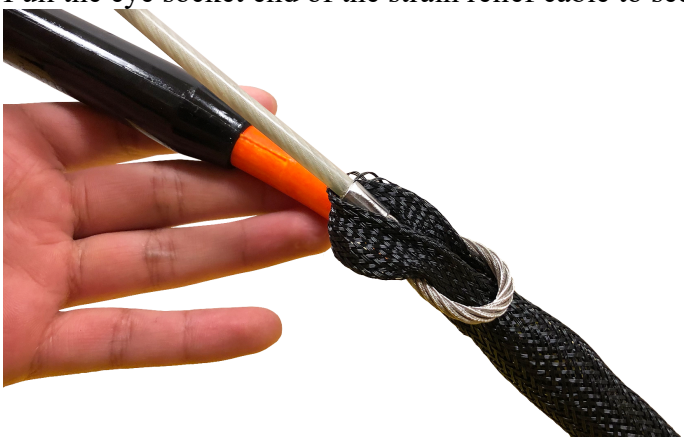
CAUTION Failure to connect the strain relief properly may result in loss of the vehicle.

1. Insert the loop end of the tether webbing into the loop end of the strain relief cable.

2. Pass the eye socket end of the strain relief cable through the loop end of the tether webbing.



3. Pull the eye socket end of the strain relief cable to secure the connection.



4. Align the pins and insert the male ROV whip connector to the female tether connector until the faces mate. Secure the connection with the locking collar.

5. Insert the strain relief eye socket into the hole in the frame and secure it with the retaining screw.

6. Make sure the connection is secure and that all of the load is carried by the strain relief and there is no load on the tether connection.

When working in an area where there is a chance the tether can become snagged on a protruding object, the connection can be wrapped with tape to prevent a protruding object from passing through the space between the tether and the strain relief cable.

Tether to Tether Strain Relief

When connecting multiple tethers for an operation, each connection should be secured with a tether to tether strain relief to prevent separation of the connection. Use the following procedures to install and secure the strain relief cord for tether to tether connections. The ROV strain relief cable may already be attached to the tether. If so, it should be removed.

CAUTION Failure to connect the strain relief properly may result in loss of the vehicle.

1. Ensure that you have all three parts of the tether to tether strain relief as shown below.

2. Ensure that both carabiners are labeled with '600lbs'. Older models of VideoRay ROVs used the '450lbs' rated carabiners and these should not be used with Mission Specialist systems.

CAUTION Using the incorrect carabiners may cause the strain relief to fail under loading.

3. Connect one of the carabiners to one loop end of the tether to tether strain relief cord.

4. Connect the carabiner to the tether strain relief webbing and secure the carabiner locking nut.

5. Repeat steps 3 and 4 using the second carabiner and strain relief webbing from the second tether.

6. Make sure the strain relief cable connections are secure so that all of the load is carried by the strain relief and there is no load on the tether connection.

When working in an area where there is a chance the tether can become snagged on a protruding object, the connection can be wrapped with tape to prevent a protruding object from passing through the space between the tether and the strain relief cable.

Connections Summary

The following connections are required:

1. Connect the female end of the tether to the ROV.
2. Secure the tether strain relief to the ROV.
3. Connect the male end of the tether to the Operator Control Console.
4. Connect the keyboard to a USB port on the Operator Control Console.
5. Connect the hand controller to a USB port on the Operator Control Console.
6. Connect the power cord to a suitable power source.

Accessories

Numerous accessories can be used with the MSS to extend its capabilities and range of performance. These accessories allow the MSS

Multiple accessories can be connected in parallel by the use of a stackable connector. The manipulator and cutter do not use a stackable connector, but can be used with other accessories by plugging in their connector as the last one in sequence.

CAUTION The accessory port must be sealed with a terminated accessory connector or the accessory port terminator dummy plug. Failure to seal the accessory port may lead to loss of control of the ROV or damage to the components.

Included Accessories

Several topside accessories are included with all Mission Specialist system configurations.

Sun Shade

The sun shade can be attached directly to the control panel lid and provides shade for the computer and monitor to make it easier to see the displays when working in bright light. See the label on the sun shade for installation instructions.

Tool Kit

A basic tool kit is provided in order to perform routine maintenance and field repairs. The tool kit also contains some spare parts including ballast weights, propellers and other items.

Additional Sensors and Tooling

This configuration includes the following sensors and tooling:

- Rotating Manipulator

Optional Accessories

The following pages provide information about the various accessories that are supported on the VideoRay Defender. Your configuration may or may not include all of these accessories.

Blueprint Oculus Sonar 750D

The Blueprint Oculus Sonar 750D is a general purpose dual-frequency sonar used for navigation and high resolution imagery of near field target identification. For more information on the Oculus 750D sonar see the Datasheet and User Manual

For operation of the Sonar within the Greensea software, see page 39 in the Greensea EOD Workspace Manual

⚠ This device includes it's own operating instructions, however it is integrated through our software and no 3rd party software should be necessary.

Rotating Manipulator

For operation of the manipulator, see the section about the hand controller.

Mission Support Accessories

In addition to the equipment that is included with each MSS configuration and the commercially available accessories, VideoRay recommends users procure a variety of mission support items. The list of recommended items will vary depending on the typical mission requirements, although it will be obvious that some of these items have general applicability to all mission profiles.

These brief lists are intended to provide a sample and stimulate thinking about what you might want to add to your "operations kit:"

General Logistical Support

- Basic operations support items including tables and chairs, foul weather gear, food, water, etc.
- Power sources including generators and batteries/inverters
- Supplemental video display devices for large group viewing (this can help prevent people from hovering over and distracting the pilot)
- Supplemental tools, such as a flashlight, knife, tape, cable ties, etc.
- Supplemental spare parts for field repairs (Basic spares are included for some items)

Tactical Operations Support

- Tether weights and davit
- Retrieval devices or baskets

In general, VideoRay does not supply these items, and users must procure them on their own.

Software Guide

Mission Specialist software consists of three main components:

1. Topside User Interface, installed on the Operator Control Console and used to control the ROV.
2. Configuration and diagnostic software installed on the Operator Control Console used to configure and test each ROV module.
3. Module Firmware installed on each module to allow the module to perform its functions.

The topside Operator interface software is available in several versions:

1. Greensea Systems Inc., with fully autonomous capabilities
2. VideoRay basic interface
3. User developed software

Greensea User Manuals for the Defender

Greensea control software comes in three versions:

- Greensea EOD Workspace User Manual - includes Autonomous Navigation Control* (Military Use Only)
- Greensea Professional Workspace User Manual - includes Autonomous Navigation Control*
- Greensea Basic Workspace User Manual

⚠ Autonomous control features require a DVL.

VideoRay Interface Overview

There are four applications that are required to operate the VideoRay vehicle control software. These are stored in the ~/Flighthack folder.

- Start the thruster controls using vr_engage.py
- Start the camera controls using vr_engage_camera.py
- Start the video window

  ⚠ Video is automatically in record mode when the video window is started.

  ⚠ When stopping video, you must enter CTRL-C in the text window to close the file properly.
- Start the manipulator controls (optional) using vr_engage_manip_rotating.py

Each application may be started in any sequence, but following a consistent sequence such as above is recommended.

Software Management

This section provides information about the software environment and managing the software.

Folder Structure

Home/ - User Root Folder

charts/ - Recommended location for charts

firmware/ - Module Firmware

flighthack/ - Mission Specialist Utilities

gss_config/ - Configuration Files

gss_logs/ - Recordings

gss_mission/ - Mission Definition Files

Software Updates

Software updates can be downloaded from https://videoray.exavault.com/

Username: quarterdeck
Password: quarterdeck

⚠ In the instructions below, replace <<name>> with the appropriate name for the most recent version. This name will be provided on any release notice you might receive. If do not know the name, it will be named using the following format: <<date>>_videoray_topside_<<ubuntu reference>>.run.

⚠ In the instructions below, <<configName>> is "defender" and "pro5" (use only one at a time and do not use the quotes).

1. Log in to the download site
2. Navigate to the greensea folder
3. Download the latest <<name>>.run to the Downloads folder
4. Open a Terminal Window and enter the following commands:
    a. rm gss_configs (*(If this reports an error, use:* rm -r gss_configs *)*
    b. rm -r gss_configs-<<configName>> *(repeat for each vehicle model config file)*
    c. cd Downloads
    d. chmod +x <<name>>.run
    e. sudo ./<<name>>.run oculus *(or use the desired sonar)*
    f. When prompted enter the password, use: videoray
5. Start the workspace using the desktop icon

6. Exit the workspace
7. In the Terminal Window, enter the following commands
    a. cd .config/greensea_systems
    b. rm workspace.ini
    (Do not delete any other files, specifically gss.key)
8. Close the Terminal Windows

The new version should be installed and ready to run. Contact VideoRay support if you need assistance.

Module Configuration

The modular concept requires that modules be configured prior to installation or replacement in a specific vehicle arrangement.

⚠ Configuration information is specific to each vehicle. Information about the configuration for a specific vehicle can be found in the Submersible section of the Equipment Guide.

Conceptual Overview

Thrusters and other modules can be thought of as employees, and the vehicle as the jobsite. Each employee (Module) has a unique name (Serial Number stamped or printed on the module and coded in the firmware). When the employee goes to work at the jobsite (is installed on the vehicle), it is assigned an employee number (Node ID) by the person doing the configuration. The jobsite supervisor (control software) communicates with the employees using their employee number, so the employee number for each module on a jobsite must be unique. Work instructions are announced to all employees at the same time, so each employee must listen for their specific instructions and ignore the instructions for other employees. When there are multiple employees of the same type on a jobsite, these employees may be assigned specific work tasks (Application ID or Motor ID). The employee will only listen for instructions related to their work task. For example a starboard thruster will only respond to horizontal control inputs, while a vertical thruster will only respond to vertical control inputs. This approach allows vehicles to be configured with great flexibility. Examples include:

- A vehicle can be configured with one LED light, or with multiple LED lights. Multiple LED lights can be controlled in unison, or divided into banks that operate independently.
- A vehicle can be configured with a single vertical thruster, or additional vertical thrusters can be added to create a heavy lift vehicle, or to enable pitch and roll control.

General Requirements

1. Each employee (Module) must have a unique name (Serial Number).
2. Each employee (Module) must have a unique employee number (Node ID) on a jobsite (vehicle), but different vehicles may use repeated Node IDs.
3. Some employees (Modules) may be assigned specific work tasks (Application ID or Motor ID).
4. At a specific jobsite (Vehicle) more than one employee (Module) may be assigned the same work task (Application ID or Motor ID).
5. Modules may have additional parameters that can be configured that can affect their operation or performance, such as temperature cut-off, RPM limit or calibration values.

The following sections provide information about module replacement.

Configuration Commands

The following configuration commands are available for updating firmware and configuring M5 modules for MSS vehicle systems:

- **vr_refresh** - Refresh the firmware for a module
- **vr_enum** - Enumerate (list) the connected modules
- **vr_setid** - Set the Node ID and Group ID for a module
- **vr_debug_putty.py** - Debug and/or configure a module
- **vr_create_virtport_all.sh** - Create virtual ports for modules not connected directly to the RS-485 bus

⚠ These commands are entered using a terminal window.

⚠ These commands are case sensitive.

More information about using these commands can be found in the following section of this guide.

Command: vr_refresh

The vr_refresh command is used to update the firmware on a module.

Use

vr_refresh [OPTIONS] [SINGLE_HEX_FILE_NAME]

- [Options] - See the table below
- [SINGLE_HEX_FILE_NAME] - The file name of the firmware update, including its path.

OPTION	Alternate	Argument(s)	Description	Default
-?	--help		Display this help information	
--version			Display the Version Number	
-c	--com	Com_Port_Name	Com port to use	dev/ttyUSB0
-i	--id	Node_ID	Node ID of the Module to update, use 255 for broadcast to all nodes	255
--sn		Serial_Number	The Serial Number	any
--block_size		Block_Size	The block size of the firmware	1024
--timeout		Timeout	Set the connection Timeout in mS	1500
--skip_bootcheck			Skip sending a bootcheck command	
--skip_initial_reset			Skip sending an initial reset command	
-v	--verbose		Output verbose diagnostics	
-r	--reset		Reset device upon completion	
--UNLOCK			Allow programming of the bootloader	
---input_file		Filename	The file name of the firmware update file, including its path	

⚠ Some of the options use two dashes "--," not a long dash

Updating Firmware

Firmware can be found locally in the Home/firmware/ folder. The most up-to-date firmware is available from VideoRay's FTP server. You can download the firmware to the local folder by connecting to the

Internet and using the following command:

vr_pull_firmware.sh

⚠ To use vr_refresh on modules connected to the communications module, you need to open a virtual port and specify the port to use. See vr_create_virtport_all.sh for more information.

Example firmware update commands for different modules are shown below. In each case, *X.Y.Z* should be replaced by the actual version number. Each vr_refresh command should be entered on one line. Ignore any line breaks that may appear in the vr_refresh commands displayed below.

Power Module

vr_refresh -i 1 ~/firmware/power_converter-*X.Y.Z*.hex --block_size 16384

Communications Module

- vr_refresh -i 2 ~/firmware/comms_hub-*X.Y.Z*.hex --block_size 16384

AHRS Module

- Required commands before running vr_refresh on the AHRS Module":
  cd flighthack
  ./vr_create_virtport_all.sh &
- vr_refesh command for the AHRS Module:
  vr_refresh -c vrport2 -i 3 ~/firmware/attitude_sensor-*X.Y.Z*.hex --block_size 16384

Thruster Module (Use the correct Node ID)

vr_refresh -i ~/firmware/motor_controller-*X.Y.Z*.hex

Camera Module

- Required commands before running vr_refresh on the Camera Module:
  cd flighthack
  ./vr_create_virtport_all.sh &
- vr_refesh command for the Camera Module:
  vr_refresh -c vrport3 -i 4 ~/firmware/camera_adapter-*X.Y.Z*.hex --block_size 16384

LED Module (Use the correct Node ID)

vr_refresh -i 11 ~/firmware/led_controller-*X.Y.Z*.hex

Firmware Block Sizes

Module	Block Size	Comms Path
Power Module	16384	Direct
Communications Module	16384	Direct
AHRS Module	16384	vport2
Power Module	Default	Direct
Camera Module	16384	vport3
LED Module	Default	Direct

Command: vr_enum

The vr_enum command is used to enumerate (list) the modules that are connected to the vehicle.

Use

vr_enum [OPTIONS] [min explcit id] [max explicit id]

- [Options] - See the table below
- [min explicit id] - The minimum Node ID to include the list
- [max explicit id] - The maximum Node ID to include in the list

OPTION	Alternate	Argument(s)	Description	Default
-?	--help		Display this help information	
--version			Display the Version Number	
-c	--com	Com_Port_Name	Com Port to use	dev/ttyUSB0
-p	--pretty		Use nicer human readable device type display	
-v	--verbose		Output verbose diagnostics	
--timeout		Timeout	Connection timeout in mS	1,000
-	--retry_count	Retry_Count	Set retry count for broadcast enumeration	5
--explicit		either max_node_id or min_node_id max_node_id	Explicit nodes to search,	

Examples

⚠ To use vr_enum on modules connected to the communications module, you need to open a virtual port and specify the port to use. See vr_create_virtport_all.sh for more information.

For Power, Communications, Thrusters and LEDs

- vr_enum

For the AHRS and camera modules, you need to include the virtual port.

AHRS Module

- vr_enum -c vrport2

Camera Module

- vr_enum -c vrport3

⚠ Some of the options use two dashes "--," not a long dash

Command: vr_setid

The vr_setid command is used to set the Node_ID and Group_ID of a module.

Use

vr_setid [OPTIONS] SN Node_ID Group_ID

- SN - See the table below
- Node_ID - The Node ID to program into the module (1 - 255)
- Group_ID - The Group ID to program into the module (1 - 255)

OPTION	Alternate	Argument(s)	Description	Default
-?	--help		Display this help information	
--version			Display the Version Number	
-c	--com	Com_Port_Name	Com port to use	dev/ttyUSB0
--arguments		Node_ID Group_ID	The Node_ID (1 - 254) and the Group_ID (1 - 254) to program into the module	

Examples

⚠ To use vr_enum on modules connected to the communications module, you need to open a virtual port and specify the port to use. See vr_create_virtport_all.sh for more information.

For the examples below, replace "S.N" with the actual serial number. The serial number is case sensitive.

Power Module

- vr_setid S/N 1 196

Communications Module

- vr_setid S/N 2 193

AHRS Module

- vr_setid S/N -c vrport2 3 194

Thruster Module (Use the correct Serial Number and Node ID)

- vr_setid S/N 5 129

Camera Module

- vr_setid SN -c vrport3 4 196

LED Module (Use the correct Serial Number and Node ID)

- vr_setid S/N 11 131

⚠ Some of the options use two dashes "--," not a long dash

Command: vr_debug_putty.py

The vr_debug_putty.py command is used to configure or test a module.

Use

./vr_debug_putty.py [OPTIONS] [N [N...]]

- [Options] - See the table below
- N - The Node ID of the module to reset and enter debug mode.

⚠ This command must be executed from the flighthack folder and requires the preceding "./"

OPTION	Alternate Argument(s)	Description	Default
-?	--help	Display this help information	
-c	--com	Com port to use	dev/ttyUSB0

Power Module

- vr_debug_putty.py 1

Communications Module

- vr_debug_putty.py 2

AHRS Module

- vr_debug_putty.py -c vrport2 3

Thruster Module (Use the correct Node ID)

- vr_debug_putty.py 5

Camera Module

- vr_setid SN -c vrport3 4

LED Module (Use the correct Node ID)

- vr_debug_putty.py 11

⚠ Some of the options use two dashes "--," not a long dash

Command: vr_create_virtport_all.sh

The vr_create_virtport_all.sh command is used to create virtual ports that allow the Ethernet protocol to be used to communication with modules connected to the communications module.

Virtual Ports

MSS communications are supported using Ethernet and RS-485 protocols. Modules may use one protocol or the other, or both. The configuration commands described on the previous page, including vr_enum, vr_setid, vr_refresh and vr_debug_putty.py use only the RS-485 protocol. For modules that only support Ethernet, a virtual port must be set up to bridge the RS-485 to Ethernet for the Communications Module port to which the device is attached. The vr_create_virtport_all.sh can be used to create the required virtual ports.

Use

./vr_create_virtport_all.sh &

There are no arguments for this command.

⚠ This command must be executed from the flighthack directory and requires the preceding "./"

⚠ The trailing "&" allows this command to run in the background, otherwise you would need to open a new terminal window to use commands that access the virtual ports. When finished using the virtual ports, they should be removed using the following command: killall socat.

Example Using Virtual Ports to Communicate with a Camera

This example assumes that a Camera Module with serial number CAMADP000123 is plugged into port 2 of the Communications Module.

1. Connect and power up the system, but do not start the control software.
2. Launch the terminal program and use the following commands to access the camera.
3. Navigate to the working folder, type: cd flighthack
4. Enumerate the modules on the system, type: vr_enum You will notice that the camera does not show up in the list of enumerated modules.
5. To create the virtual ports, type ./vr_create_virtport_all.sh &
6. Now, when you enumerate the modules using vr_enum, the camera and any other non-RS-485 devices should show up in the list. You can also see the virtual ports using the standard directory listing command, ls
7. To send a commands to the camera, you need to include the -c portNumber option, where the portNumber to use is the one to which the device is attached on the Communications Module (in this case port 3, so vrport3).
    - To set the Node_ID and Group ID:
      vr_setid -c vrport3 CAMADP000123 4 196
    - To enter Debug mode:
      ./vr_debug_putty.py -c vrport3 4

Operations Guide

This Operations Guide is provided to go beyond the Equipment and ROV control software guides to describe not just how the MSS works, but how to work with the MSS. There are numerous topics and tips that are outside of the scope of conventional system documentation that focuses only on the hardware and software. You will find recommendations and best practices, but you are also encouraged to use your best judgment and apply all of the information in this documentation and your experiences to your specific applications.

In addition to this guide, there are other sources of information about ROV operations that you might consider. These include training, support and user forums. There are links to these resources at the bottom of each page. The Community Link at the bottom of the page provides access to http://www.rovinfo.com, which is a great resource to meet other VideoRay and ROV operators and exchange information and tips with them.

Acceptable Use

The ROV system was designed to be operated in accordance with the instructions in this manual. Make sure to use a power supply that meets the stated requirements and is in safe operating condition. Do not exceed the depth rating. Uses of the ROV system other than for its intended design purposes and environments should not be attempted. If you have any questions about use of the ROV in specific situation or conditions, contact VideoRay.

System Voltage Advisory

AC Input

Input voltage is universal at 100-240 VAC; 50, 60 Hz. The power requirement for the Mission Specialist operating at full power settings is 3,000 Watts. A 2,000 Watt source (i.e. generator) can be used if the system will not be used at full power settings.

ROV DC Power

Historically, the tether voltage to power the ROV has been increasing. Economy models (including the Scout, Explorer and Voyager), Pro 3 variants and the Pro 4 Ultra use 48 V DC for vehicle power. The Pro 4 uses 74 V DC. Mission Specialist systems uses 400 V DC with plans to use higher voltages in the future. Systems with voltages higher than 48 V DC include a LIM (Line Insulation Monitor) protection module in the ROV DC circuit.

CAUTION System components should not be connected to voltage sources higher than their rating.

VideoRay Negative, Neutral and PPT tethers are rated to 600 V DC and are safe to use on any system through the Mission Specialist 400 V DC.

CAUTION The standard TDS and Extended TDS are only rated to 300 V DC and should not be used with Mission Specialist systems or components.

The new version of the extended TDS is available that includes a 600 V rated slip ring.

If you have any questions about system voltage and compatibility, contact VideoRay Support.

Environmental and Chemical Compatibility

The VideoRay MSS is designed and approved for use in fresh or naturally occurring salt water and non-hazardous fresh air environments. While VideoRay recognizes that some customers may desire to use the vehicle in other solutions or environments, such use is entirely at the discretion and liability of the customer and doing so may void the product warranty.

The following additional solutions have been researched by VideoRay and use in these solutions is deemed to fall within the acceptable use guidelines and will not affect the warranty.

Solution	Notes
Chlorine / Bromine	Solutions of no more than 400 PPM. Follow use with 30 minute soak and rinse in fresh water.
pH Range	6 < pH < 8. Follow use with 30 minute soak and rinse in fresh water.

Temperature

The maximum recommended temperature for sustained use is 50 C.

Non Approved Solutions and Environments

VIDEORAY EXPLICITLY DOES NOT CONDONE THE USE OF ITS PRODUCTS IN ANY SOLUTIONS OR ENVIRONMENTS OTHER THAN THOSE EXPLICITLY LISTED ABOVE, AND ASSUMES NO LIABILITY FOR USE IN OTHER SOLUTIONS OR ENVIRONMENTS.

Risks of using VideoRay Systems in Non Approved Solutions or Environments may include, but are not limited to:

- **Biological contamination and illness**
- **Chemical contamination and illness**
- **Poisoning**
- **Death**
- **Fire**
- **Explosion**

USE OF VIDEORAY PRODUCTS IN OTHER SOLUTIONS OR ENVIRONMENTS IS ENTIRELY AT THE DISCRETION OF THE CUSTOMER / OPERATOR AND THE CUSTOMER / OPERATOR ASSUMES ALL LIABILITIES FOR SUCH USE.

ROV Materials List

The following is a list of materials used in the vehicle:

Open in New Window

Users may check this list against chemical compatibility charts available from several sources.

This information is provided for convenience. Providing this information does not explicitly or implicitly extend the warranty to cover the use of VideoRay products in solutions that are not specifically listed in the Environmental Compatibility section. VideoRay is not responsible for errors or omissions in any of the presented information.

VideoRay can provide engineering services for a fee to determine chemical compatibility. Contact VideoRay for more information.

Project Management

While the differences between conducting a recreational dive, an inspection of an offshore well riser, and a drowning victim recovery are quite dramatic, each of these dive missions usually consist of the following phases:

1. Establish the need, objectives and acceptable outcomes of the mission
2. Plan the mission
3. Prepare for the mission
4. Execute the mission
5. Conclude the mission
6. Compile and deliver project reports

Of course, how critical a successful outcome is deemed and how much lead time and how many resources are available will dictate how much effort can or will be afforded to each phase.

The essential knowledge and skills required for a consistent ability to "get the job done" go well beyond just being able to set up and pilot an ROV. In this section, the following topics will be discussed to help broaden your understanding of the scope of practical ROV applications.

- Mission Planning
- General Logistics
- On-site Operations
- Project Completion

Mission Planning

Once the basic objectives for an ROV mission have been established, there are several additional, and critical, requirements that need to be identified before rushing off to the dive site. Each of these additional requirements can be defined by developing a list of questions and thinking through the answers. Some of the answers may lead to more questions. With the information gathered by answering the questions, appropriate decisions can be made and your plan developed.

Below is a representative list of requirements and corresponding questions. This list is not comprehensive, and is only intended to serve as a guide for you to develop your own list of appropriate requirements and questions.

- **Define the safety requirements**
  - How many PFDs are needed?
  - Are there any known hazards in the operating area?
    - Is the water contaminated or potentially contaminated?
- **Define the ROV equipment requirements**
  - How much tether will you need?
    - How deep do you plan to dive?
    - How far is the dive target from the set up location?

    - Are accessories needed?
        - What is the water visibility?
        - Will you need to retrieve anything?

- **Define the additional equipment requirements**
    - What are the site conditions?
        - Will you have power available or need to supply your own?
        - Will you need insect repellent?
    - What will the weather be?
        - Will you need to bring extra clothes or rain gear?
        - Will you need to bring sun screen?
    - How long do you expect the mission to last?
        - Will you need to bring food?
        - Will you need extra staff for multiple shifts?

- **Define the time-frame requirements**
    - How long do you think it will take to accomplish your goals?
    - How long do you have to accomplish your goals?
    - Are there any schedule constraints?

- **Define the staff skill requirements**
    - Will you need extra staff to transport the equipment?
    - Will you need someone to liaise with the public on-site?

- **Define the transportation requirements**
    - Will you be operating from the shore or a vessel?
    - How much equipment and how many people will you bring?

- **Define any unique requirements**
    - Is the area of operation under any jurisdiction that requires you to get a permit for access or ROV operations?

Additional Notes

The use of checklists can facilitate the execution of the planning, logistics and operating phases of ROV missions. Consider using the ones provided with this documentation, or customize them or create your own to better meet your specific needs.

General Logistics

In addition to the ROV system and its accessories, you will typically need to provide other equipment to support your mission. The first items on your list should be those required for safety of the crew, such as personal flotation devices and a first aid kit. Depending upon your specific requirements that should have been identified in the planning phase, recommended equipment might also include:

- Items for personal comfort including appropriate clothing, chairs, tables, pop-up tents for shade
- Tools and spare parts to make field repairs
- Items to document the mission including topside cameras
- Short and long range communications equipment including cell phones and/or two-way radios

- Lights for night time operations
- Code "A" flag (similar to the "Diver Below" flag) to indicate to those around you that the ROV is deployed and they should exercise caution when entering your area

VideoRay Power Requirements

The VideoRay MSS operates on 100-240 Volts AC, 50,60 Hz. This can be provided from the land-based grid, a generator, or a battery with an inverter. Minimum generator or inverter requirements are 3,000 Watts.

Transportation

Land or water transportation will likely be required and you will need to ensure that you have enough space for your crew and equipment. You may also want to bring maps or charts of the operating area, and you should try to ascertain access points and plan your route accordingly. Carts to transport equipment while at the site may be helpful if the terrain is accommodating.

Site-specific Requirements

Often, river or shoreline sites have steep banks. For these locations, you might want to bring rappelling equipment or at a minimum some ropes to assist in climbing or transporting equipment up and down.

Sea sickness remedies for vessel operations can make the difference between a successful mission and an aborted attempt.

Unequal Grounds

All power grounds are not created equal... It is more common than you would imagine that the power ground is not at the same potential as the water. This will create a ground loop that can cause noise on the video signal or even lead to a shock if you touch a grounded part of the system and water at the same time. VideoRay includes a ground lift adapter cord that can be used to isolate the control panel ground. All connected devices must be connected through this adapter. For example, a monitor connected directly to the power source and to the computer via a monitor cable, will reintroduce the bad ground into the system.

On-site Operations

On-site operations can be hectic and demanding. The following information can help maintain order and productivity.

Site Selection and System Set Up

The following recommendations should be considered when selecting a site and setting up the equipment:

- Select a level site if possible
- Orient the panel for best visibility (avoid glare), and piloting reference (directions on the screen match real world directions)
- Watch for tripping hazards from the tether or power cord
- When operating from a vessel, make sure the system is physically secure in case of rough seas
- Watch for tether pinch points hazards around docks or chaffing hazards around rocks or coral

The ROV Team, Their Roles and Responsibilities

While one person can operate a VideoRay, having multiple people participate can be valuable or may even be required in some situations. The following roles and responsibilities are suggested to assist in developing an efficient and effective ROV team.

Role	Responsibility and Tips
Pilot	Pilots are responsible for operating the ROV in a safe manner while navigating the ROV to achieve the mission objectives. Pilots should wear dark colored shirts to avoid brightly colored glare in the monitor.
Tether Handler	The tether handler, also affectionately called the "Tether Monkey," supports the pilot by managing the tether, including: making sure the right amount is deployed, keeping it away from surface hazards like a propeller, keeping loose tether on the surface neat and communicating with the pilot. The Tether handler should wear gloves to assist in gripping the tether, to keep their hands warm and dry, or for protection when operating in contaminated water.
Accessory Operator	On some missions the pilot must focus intently on navigating the ROV. Trying to have the pilot operate an accessory at the same time may be counter productive. Having an accessory operator will reduce the burden on the pilot and allow the accessory operation to be conducted with more attention to its requirements.
Supervisor	The supervisor should manage the team, and make sure the objectives of the project are being met. On long duration missions, supervisors should consider rotating shifts or rotating roles to keep the crew at peak performance levels. Supervisors are often called upon to log the operations to maintain a record of the dive.
Technician	Technicians maintain the equipment and repair it as necessary. They should also maintain maintenance and repair logs. Technicians can also serve as equipment and logistics managers.

Additional Notes

The use of operations logs is highly recommended to track operations and develop historical profiles of the equipment, operators and missions. Consider using the ones provided with this documentation, or customize them or create your own to better meet your specific needs.

Video Recording

Videos are .MP4 format, named by date and time and are stored in the Home/gss_logs folder.

Project Completion

On-site, the system should be cleaned as best as possible and stowed for transport. Be careful when closing lids to avoid pinching any cables or damaging the video display components of the computer or the control panel.

Upon return to the home base, other tasks that should be considered before stowing the equipment include:

- Clean and inspect the equipment.
- Make any necessary repairs so system is ready to go next time.
- Complete any operations and maintenance logs.
- Produce and deliver the project reports.

Project Deliverables

Often, the completion of a project means delivering a product, such as images or videos of an inspection, or retrieval of an item. These can be delivered as isolated products or as part of a formal report. See the Images and Videos section of the Operations Guide for more information about still image and video post-processing and production.

Image and Video Editing and Production

You can record snapshots and video.

You can edit and produce video files or DVDs. The following sections provide more information on each of these steps.

The best quality output requires good input. Adjust the lights and focus to give the best starting image quality. More light does not always provide a better picture - back scatter from particles can obscure your intended objective. Light position can also make a big difference. Auxiliary lighting from the side can produce an image that looks like it was taken in air.

Video Snapshot Images

Snapshot Images are .JPG format, named by date and time and are stored in the Home/gss_logs folder.

Data Management

Images and videos captured during a mission are store in the Home/gss_logs,. These files should be moved to a project folder after each mission so that the imagery folder does not get overpopulated with mix of files from various projects. When viewing files, it can be hard to distinguish one underwater location from another. Preferably, these files should also be backed up to separate media.

Emergency Situations

⚠ This Emergency Situations guide is not meant to be comprehensive. The focus in on common emergency situations involving the ROV equipment. Not all possibilities are identified and covered. First aid is not covered. Users are encouraged to learn about these topics as necessary prior to undertaking operations.

During the course of operations, it is possible that an emergency situation may arise. The following rules of thumb apply to all emergency situations:

- Be prepared.
- Do not panic.
- Unless there is a danger of immediate peril, pause to completely assess the situation and develop a recovery plan.
- Seek help when needed. Many resources exist and you can contact VideoRay.

Emergency Response to a Flooded Module

If you suspect that a module is experiencing a leak during operations, there are four critical steps to remember:

1. **Turn off the power.**
2. **Retrieve the ROV.**
3. **Clean affected components of any corrosive elements.**
4. **Dry affected components.**

⚠ Some modules cannot be opened. If a leak is detected, the only recourse is to replace the module.

Additional details are provided below, but it is important that you cut the power as soon as a leak is suspected and clean and dry the system as soon as possible. You should not attempt to "test" the equipment until you are sure it is completely dry. Turning the power on while the components are wet will likely cause more damage.

The following detailed procedures will not guarantee recovery from a flood incident, but they will provide the best chances of salvaging as much as possible

1. Turn off the power.
2. Retrieve the ROV if not already retrieved.
3. Open the module (if possible) and drain any water
4. Determine if any electronic components got wet.

5. Rinse wet components in distilled water as soon as possible. If you do not have distilled water, use fresh water as soon as possible and follow up with a rinse in distilled water as soon as possible after that.
6. Rinse the components with alcohol.
7. Place the components in a sealed container with a desiccant for at least 24 hours. Uncooked rice can be used as a desiccant.
8. Remove the components from the desiccant and examine them for signs of corrosion or other damage such as loose parts.
9. If no damage is observed, reassemble the circuits, without sealing the module.
10. Test the ROV functions.
11. Reassemble the module to the sealed state.

Emergency Response to a Snagged Tether/ROV

If the tether or ROV appears to be tangled or stuck, remember:

Do NOT Panic!

Do NOT Pull the Tether!

The first step is to assess the situation. Above all, you do not want to make the situation worse by trying to maneuver without knowing whether doing so will help or hurt.

If you can maneuver the ROV, try to turn around until you find the tether and follow it back to the point of the snag. You may need to turn left and right and with the camera looking up and down in order to find the tether.

If you are sure there are no knots in the tether, or it is not likely to get snagged tighter, you can try to pull the tether from the surface or by using the ROV to pull it away from the snag.

Tips and Possible Options

If you have a manipulator on the ROV, you may be able use it to assist with the untangling process. Even if you don't have a manipulator, you may be able to use a part of the ROV such as the skid to assist with manipulating the tether.

If you have a second ROV system available, you may be able use it to fully assess the situation and develop a plan or even assist with recovery.

If you can pilot the ROV to the surface, you can disconnect it and try to retrieve the loose tether. Make sure to turn off the power before disconnecting the ROV.

Thoughts on Being Prepared

Untangling a tangled or stuck tether is an important part of all ROV Pilot's training. If you have not been trained in these and other emergency procedures, you should consider participating in such training. Good pilots will also regularly practice untangling the tether and ROV along with other piloting exercises.

Emergency Response to a Cut Tether

If the tether is suspected of being nicked or cut, follow these steps:

1. **Turn off the power.**
2. **If possible, retrieve the ROV.**
3. **If the tether is completely separated, mark the spot to facilitate a search for the ROV.**
4. **Remove the tether from the water as soon as possible to prevent water ingress.**
5. **Tether can often be spliced.**

Tether Field Repair

Hot glue or Silicone / RTV glue can be used to repair a tether in the field. These items should be considered for inclusion in a field tool kit. Field repairs should be repaired using more permanent techniques at the first opportunity.

Emergency Response to a Loss of Function

If control of the ROV is lost, follow these steps:

1. **Check the GFCI and LIM status.**
2. **Turn off the power.**
3. **Check all connections.**
4. **If possible, retrieve the ROV.**

Loss of function often results from a hardware problem. Assuming the ROV can be recovered, remove the tether and connect the ROV directly to the control panel. This will isolate the problem to either the tether or some other component.

Emergency Response to Loss of Control

If you suspect that the ROV is not responding to control inputs as it should, there may be several causes:

- Broken or lost propeller
- Obstructed or jammed propeller
- Thruster failure
- Joystick failure

CAUTION Operation of the vehicle while there is an obstruction or jammed propeller can cause damage to the thruster motor or system electronics. It is best to try to recover the vehicle by hand rather that to continue to operate it in this condition.

Universal Practices

Several practices are common to almost all ROV operations. This section provides some guidelines for the practices.

Deployment Platforms

VideoRay ROVs can be deployed from land, vessels, remotely or even some very unique situations. Power can be provided by a shore based system, a generator or a battery with an inverter.

Height above Water Surface

VideoRays can be deployed from a significant height above the water surface by lowering the vehicle by its tether.

Land

For land-based deployments using shore power the biggest issue is usually how close can you get to the water. When operating in tanks, beware of active inlets or discharges and avoid using the ROV or tether near these areas. Many tanks also have cathodic protection systems, which can become a snare and entrapment hazard to the ROV.

Vessels

When operative from vessels, it is important to be aware of potential risks to personnel or the equipment. Whenever possible, conduct ROV operations when the vessel is at anchor or adrift without the propulsion system engaged. When the vessel's propulsion system must be engaged during ROV deployment, tether management is critical to ensure the tether or the ROV do not come in contact with the vessel's propulsion systems. Water intakes and discharges can also be hazardous to the ROV and should be locked out or the ROV and tether kept a safe distance.

Remote Operations

VideoRays can be operated remotely using Internet technologies. See the section on Using Network Remote for more information.

Other

Other unique deployment platforms include:

- Air - from a helicopter
- Underwater - as a fly-out vehicle

- Under Ice

Tether Management

Tether management can have a significant affect on the ability to pilot the ROV and achieve the objectives of the mission.

Tether Management includes selecting the appropriate type of tether and managing the deployment and retrieval of it during operations.

Choosing the right tether and managing it can have a very significant impact on the outcome of an ROV dive.

Tether is available in neutral or negative buoyancy. Negative tether sinks but has larger conductors, which means longer lengths can be used without affecting the power available at the ROV. Neutral tether is neutral in fresh water (slightly buoyant in salt water), but has thinner conductors. Neutral tether is available in standard diameter and performance diameter (also called PPT), which is thinner. Thinner tether has less drag, but also has smaller conductors and less power transmission capacity. Selecting the right tether is a balancing act between performance and handling characteristics.

General Tether Use Recommendations

- Make sure tether connections are secure.
- Use the shortest amount of tether required to operate in the target area.
- Use Performance or Neutral tether at the ROV and if more tether is needed use Negative at the control panel.
- Do not use more than one section of Performance Tether.
- If possible, select a deployment site that aids in ROV piloting and tether management. Usually, this means up-current from the zone of operations and with a direct line of sight to avoid snags.
- Only deploy what is needed - too little will affect piloting - too much may result in snags, tangles or propeller cuts.

Tether Storage

Make sure the connectors are clean before mating, and clean the connectors after each use by soaking in fresh water. Do not let the tether connectors drag on the ground.

Tether should be stored on a TDS or coiled using an over/under or figure eight technique. Coiling the tether in one direction will result in twists that are hard to remove.

Special Situations

Certain environmental situations, such as temperature extremes, water contaminants and others may call for special handling and procedures. The following sections provide some suggestions for operating in these conditions.

Cold Weather Operations

The system may act sluggish in cold weather conditions. If you must operate in conditions with ambient temperatures below 32 F (0 C) Follow these steps to minimize the effects of cold on the system.

- Keep the system warm when not in use. Do not leave it exposed to the cold overnight if possible.
- Operate in sunlight and out of the wind.
- Provide some direct heat to the control panel, computer and monitor if possible. Chemical pocket hand warmers can be applied to try to keep these components warm.

Hot Weather Operations

The control panel can overheat in hot weather. If you must operate in conditions with ambient temperatures above 90 F (32 C) Follow these steps to minimize the effects of heat on the system.

- Do not run the ROV in air for extended periods.
- Operate the control panel in the shade and provide adequate ventilation and air circulation.
- Remove the computer from the control panel to provide better cooling to both components.

Equipment Disinfection for Use in Potable Water

VideoRays are used by many companies for inspections in potable water systems. Always check with regional and local authorities for specific regulations and compliance requirements regarding the use of ROVs in potable water systems.

Failure to follow regional or local requirements for disinfection and use of ROVs in potable water may introduce contaminants into the water system and be detrimental to the public. Only those who are trained and qualified should use ROVs in potable water systems.

At the time this document was compiled, the MSS thrusters use an oil and dye that have not been rated for use in potable water systems. The MSDS and other product information for the oil is available: Oil MSDS Oil Product Data Sheet. The MSDS for the dye is also available: Dye MSDS. Please check with VideoRay regarding the current specifications for thruster oil and use in potable water systems.

The following procedure to disinfect the ROV prior to entering a potable water tank is recommended by John Conrady of Conrady Consultant Services and is used with permission.

⚠ Use of this procedure for decontamination of the equipment requires that the equipment has not been used in any liquid other than potable water is in a clean state. Equipment that has previously been used in salt or contaminated water or other liquid cannot be used in potable water.

1. Create a 400 ppm chlorine solution by mixing of 1/2 ounce of bleach with 1 quart of water.
2. Both of the operator's hands and a cloth glove should be sprayed with the 400 ppm chlorine solution.
3. The ROV is removed from the case and the entire ROV exterior and the section of the tether which will be inserted into the potable water is sprayed with the 400 ppm chlorine solution while turning it to insure all surfaces are disinfected.

4. The operator's hands and the cloth glove are periodically resprayed with the disinfectant solution and the ROV is lowered into the potable water by using the tether with the tether being additionally disinfected by the person by sliding the tether/umbilical through the hand/glove which is resprayed with the disinfectant solution every few seconds until the desired length of disinfected tether is inserted into the potable water.

Use in Contaminated Water or Other Liquids

DANGER CAUTION Operating in contaminated water or other liquids poses hazards and creates risks to the operator and equipment. Risks include those encountered during the operation as well as after the fact during decontamination, transport and storage. When possible it is best to avoid operating in contaminated water or other liquids.

The information provided here is solely to alert you to the possibility of these dangers and is not a comprehensive treatment of this topic. You should seek professional advice from experts for the conditions in which you plan to operate if you must operate in anything other than naturally fresh or salt water.

⚠ AS THE OWNER / OPERATOR OF VIDEORAY EQUIPMENT, IT IS YOUR RESPONSIBILITY TO:

- UNDERSTAND THE HAZARDS AND RISKS OF USING THIS EQUIPMENT IN CONTAMINATED WATER AND OTHER LIQUIDS.
- DETERMINE WHETHER THE WATER OR LIQUID IN WHICH YOU OPERATE IS CONTAMINATED IN ANY WAY.
- DECIDE WHETHER OR NOT TO USE THE SYSTEM IF SUCH CONDITIONS EXIST.
- TAKE ANY NECESSARY PRECAUTIONS BEFORE, DURING AND AFTER ANY SUCH OPERATIONS.

⚠ VIDEORAY IS NOT RESPONSIBLE FOR IDENTIFYING WATER CONDITIONS OR ANY EFFECTS OF OPERATING IN ANY ENVIRONMENT, WHETHER CONTAMINATED OR NOT. ⚠

Use of VideoRay equipment in contaminated water or other liquids is not recommended and damage to the equipment from operating in such conditions is not covered under warranty.

USE PPE (Personal Protective Equipment)

If you think there is the possibility of contaminants in the water or liquid in which you are operating, Personal Protective Equipment appropriate for such contaminants is strongly advised.

Bio-Hazards

Bio-hazards include both working in potable water and ensuring bio-hazards are not introduced into the water system by the ROV (see the section on Use in Potable Water), and working in bio-hazard contaminated water such as in or around water treatment plants or effluents.

Equipment Decontamination after Use in Bio-hazard Contaminated Water

Standard post-dive procedures call for soaking the ROV and tether in fresh water for at least 30 minutes. In situations where the equipment is used in water suspected to contain contaminants, you can review US EPA guidelines documents regarding contaminated water and divers and dive equipment.

CAUTION While alcohol is noted as an acceptable decontaminant in the US EPA guidelines, it should not be used as a decontaminant for the ROV because it reacts adversely with the main domes and light domes.

Chemical Compatibility

Use of VideoRay equipment in liquids other than water should be checked against standard chemical compatibility charts, available from a variety of sources such as Cole-Parmer.

For situations where poor chemical compatibility ratings exist, it may be necessary to avoid use altogether, or replace parts after use. For more information about chemical compatibility, contact VideoRay.

Additionally, post dive procedures such as those in the US EPA guidelines documents regarding contaminated water and divers and dive equipment, or other more aggressive procedures may be employed to clean the equipment after use. You should also check the chemical make up of any cleaning agent to ensure that it does not react adversely with the equipment.

CAUTION While alcohol is noted as an acceptable decontaminant in the US EPA guidelines, it should not be used as a decontaminant for the ROV because it reacts adversely with the main domes and light domes.

Volatile Environments

DANGER VideoRay is not classified as "Intrinsically Safe" or "Explosion Proof" and should not be used in environments requiring such a classification.

Piloting

Piloting a VideoRay ROV requires a combination of understanding the system's operating principles, features and capabilities, situational awareness (which is much more challenging when you cannot see the vehicle), personal skills and experience.

The VideoRay MSS Systems have several pilot assist tools that provide auto control of the vehicles functions and other sensors that help with situational awareness. Several optional accessories can provide even further situational awareness, such as sonars and position tracking systems. Autonomous operation is also possible through advanced navigation control software.

The following sections provide information about built in pilot-assist tools and piloting tactics for specific situations.

Piloting Tools

VideoRay MSS control software provides several tools to assist the operator when piloting the ROV. These include:

- Auto Modes
  - Auto Heading
  - Auto Depth
  - Auto Altitude
  - Auto Pitch
- Station Keeping
- Course Following
  - Incremental
  - Go to...
  - Waypoint Routes

Auto Flight and Course Following Checklist

⚠ Auto flight and course following modes rely on vehicle sensors to control vehicle motion. It is important that the the vehicle sensors be calibrated or configured correctly and operating properly. The following checklist can be used to ensure the system is configured and prepared for auto flight.

1. Open the Diagnostics Panel
    1. Set Desired Units of Measure
    2. Configure Text Overlay
    3. Set Initial Thruster Gain
2. Return to the Flight Operations Panel
    1. Zero Depth
        - Verify Depth
3. If Using a DVL
    1. Set DVL Range
        - Verify Depth
4. If Operating Using Geolocation

1. Load Map
2. Set Declination
    - Verify Heading
3. Fuse GPS
    - Verify Location
    - Turn off Fuse GPS

Fuse GPS should only be used when Station Keeping and Waypoint Following is Off. If either is on when Fuse GPS is selected, the ROV may make a rapid and unexpected excursion.

Auto Modes

Auto Modes on the Mission Specialist operate differently than on the Pro 4. On the Pro 4, auto modes are engaged when the inputs (heading or depth) are in their neutral position. When the operator applies input, auto mode temporarily disengages and reengages when the input is returned to neutral.

When in auto flight mode on the Mission Specialist, joystick inputs control set points. When the input is neutral, the set point remains constant. Inputs are used to control the set point. Auto modes are much more fly-by-wire.

If you are familiar with auto modes of the Pro 4, caution should be observed to monitor the set point.

Auto Heading

Auto Heading can be used to maintain an existing Heading, or turn the ROV to a specified Heading. Auto Heading is designed to be as seamless as possible so that you can pilot without having to constantly engage and disengage it when alternating between holding a course and changing directions.

How Auto Heading Works

When Auto Heading is engaged, the ROV will automatically respond to changes in heading (measured by the compass) by applying horizontal thrust to maintain the current heading.

Using Auto Heading to Hold a Heading

To engage Auto Heading, click on the Auto Heading button. This will engage Auto Heading at the current heading. You will also notice a heading value in square brackets in the text overlay and a green heading indictor in the compass. These indicate the target heading. To turn to a new heading, either turn the ROV using the joystick until the target indicator reaches the desired heading, or type in the heading next to the Auto Heading button and click the Apply button.

Additional Notes

When Auto Heading is On, the horizontal thrusters may spin on their own. Keep fingers, hair and objects away from the horizontal thrusters when Auto Heading is On.

Auto Depth

Auto Depth can be used to maintain an existing depth, or surface or dive to a specified depth. Auto Depth is designed to be as seamless as possible so that you can pilot without having to constantly engage and disengage it when alternating between hovering and changing depths.

How Auto Depth Works

When Auto Depth is engaged, the ROV will automatically respond to changes in depth (measured by the pressure sensor) by applying vertical thrust to maintain the current depth (pressure).

Using Auto Depth to Hover

To engage Auto Depth, click on the Auto Depth button. This will engage Auto Depth at the current depth. You will also notice a depth value in square brackets in the text overlay and a green depth indictor in the depth display. These indicate the target depth. To move to a new depth, rotate the depth control knob using the joystick until the target indicator reaches the desired depth, or type in the desired depth next to the Auto Depth button and click the Apply button.

Additional Notes

When Auto Depth is On, the vertical thruster may spin on its own. Keep fingers, hair and objects away from the vertical thruster when Auto Depth is On.

Auto Altitude

Auto Altitude requires an altimeter or DVL.

Auto Altitude can be used to maintain an existing altitude off of the bottom, or surface or dive to a specified altitude. Auto Altitude is designed to be as seamless as possible so that you can pilot without having to constantly engage and disengage it when alternating between hovering and changing altitude.

How Auto Altitude Works

When Auto Altitude is engaged, the ROV will automatically respond to changes in altitude (measured by an altimeter (optional accessory) by applying vertical thrust to maintain the current altitude.

Using Auto Altitude to Hover

To engage Auto Altitude, click on the Auto Altitude button. This will engage Auto Altitude at the current altitude. You will also notice an altitude value in square brackets in the text overlay and a green altitude indictor in the altitude display. These indicate the target altitude. To move to a new altitude, rotate the depth control knob using the joystick until the target indicator reaches the desired altitude, or type in the desired altitude next to the Auto Altitude button and click the Apply button.

Additional Notes

When Auto Altitude is On, the vertical thruster may spin on its own. Keep fingers, hair and objects away from the vertical thruster when Auto Altitude is On.

Auto Pitch

Auto Pitch can be used to maintain an existing Pitch, or pitch the vehicle to a specified Pitch. Auto Pitch is designed to be as seamless as possible so that you can pilot without having to constantly engage and disengage it when alternating between hovering and changing pitch.

How Auto Pitch Works

When Auto Pitch is engaged, the ROV will automatically respond to changes in Pitch (measured by the IMU in the NAV module) by applying vertical thrust to maintain the current pitch.

Using Auto Pitch to Maintain Pitch

To engage Auto Pitch, click on the Auto Pitch button. This will engage Auto Pitch at the current Pitch. You will also notice a pitch value in square brackets in the text overlay. This indicates the target pitch. To tilt the vehicle to a new Pitch, press the the Pitch control buttons on the joystick until the target value reaches the desired Pitch, or type in the desired Pitch next to the Auto Pitch button and click the Apply button. You can zero the pitch using the Zero Pitch control button.

Additional Notes

When Auto Pitch is On, the vertical thrusters may spin on their own. Keep fingers, hair and objects away from the vertical thrusters when Auto Pitch is On.

Auto Roll

Auto Roll can be used to maintain an existing roll, or roll the vehicle to a specified roll. Auto Roll is designed to be as seamless as possible so that you can pilot without having to constantly engage and disengage it when alternating between hovering and changing roll.

How Auto Roll Works

When Auto Roll is engaged, the ROV will automatically respond to changes in roll (measured by the IMU in the NAV module) by applying vertical thrust to maintain the current roll.

Using Auto Roll to Maintain Pitch

To engage Auto Pitch, click on the Auto Roll button. This will engage Auto Roll at the current Roll. You will also notice a roll value in square brackets in the text overlay. This indicates the target roll. To roll the vehicle to a new roll, type in the desired Pitch next to the Auto Pitch button and click the Apply button.

Additional Notes

When Auto Roll is On, the vertical thrusters may spin on their own. Keep fingers, hair and objects away from the vertical thrusters when Auto Roll is On.

Station Keeping

⚠ Station Keeping requires a DVL.

Station Keeping will maintain the current location of the vehicle. If auto heading and/or auto pitch is on, the orientation will be maintained as well.

Auto modes will only maintain a specific parameter and if there are currents or the tether is pulled, the location may change.

Course Following

⚠ Course following modes require a DVL.

While auto modes maintain specific parameters, course following allows operators to direct the motion of the vehicle by means other than the joystick. This includes moving the vehicle in incremental amounts, going to specific locations, or setting up a course to follow.

Incremental Motion

Incremental motion controls can be used to move the vehicle a specified amount through various degrees of freedom, including forward or back, laterally left or right, changing heading or up and down. The motions can be controlled independently and the increments can be set to desired values.

Go to...

Go to modes include, go to a position (selected by clicking on the screen), go to a marker (whose location set by mouse or key-in), or go to waypoints (whose location is set by mouse or key-in).

Waypoint Route

Waypoint Routes can be defined and the vehicle will follow the course defined by the waypoints. Waypoints can be selected by mouse or entered by coordinates. Course controls include setting a tolerance for establishing whether a waypoint is achieved or not, head towards waypoint or crab, speed between waypoints and whether depth should be considered a criteria for achieving a waypoint or not (the system will try to achieve the waypoint depth, but this feature allows the course to continue if the depth is not achieved). There are also override controls that can be used during the waypoint route following to change the order or speed of the course.

Power Management

Power utilization in Mission Specialist systems is demand based. If vertical thrusters demand more power for lifting operations, the system responds up to its capacity based on the topside power supply output from

the Operator Control Console and the tether's capacity to deliver that power to the ROV. This design feature allows VideoRay to maximize the performance of the vehicle for specific tasks. This also means that the system can, at times, demand more power than can be delivered, which could result in a system brown out. The system is protected, so a brown out is not harmful to the components, but it can cause the system to reset.

Power utilization depends on several factors, including: rapid manual or autonomous control inputs, the intensity of the lights, the attached accessories power demand, the amount and type of tether being used, water currents, etc.

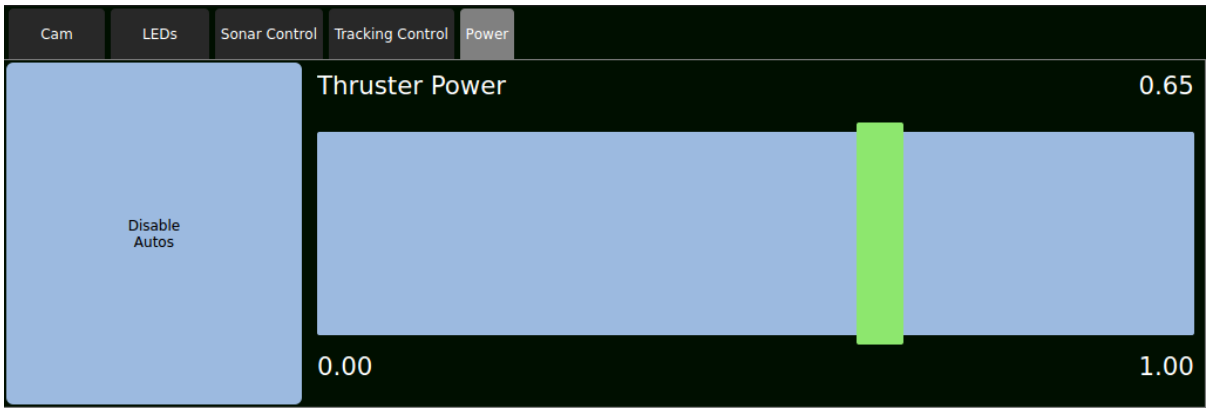
There are two design options when dealing with this situation. The first is to reduce the allowed power consumption of all of the components combined to never exceed the capacity of the topside and longest tether possible. While this would prevent brown outs completely, the system could never take advantage of the fact that when lifting, horizontal thrust may not be required, or when working with short tethers, more power can be delivered to the ROV than when operating with longer tethers. The second is to allow each component to demand as much power as it can up to its maximum design capability. This can result in a total power demand that exceeds what is available, but maximizes selected performance when required. VideoRay has chosen to implement this second option.

Power Management Implementation

VideoRay is working to improve the power management software of the system to automatically adjust the power utilization and prevent brown outs.

⚠ Until the automated power management tuning is implemented, users may need to adjust the power management settings manually to optimize the performance of the ROV for the equipment configuration and operating conditions.

In the interim, the Greensea control software includes a manual power setting. This setting can be found in the Power tab under the video display. The default value is 65% as seen in the upper right of the image below. You can change the power setting to increase the power utilization or reduce the incidence of brown out by sliding the slider. To increase the power utilization, move the slider to the right towards 100. To decrease the power utilization, move the slider to the left towards 0.00.



💡 Depending on the operating conditions, increasing the power management setting may help provide more thrust.

⚠ Increasing the power management setting may result in experiencing more brown outs, and in some situations, the power management setting may need to be decreased from the default to prevent brown outs.

⚠ When fully automated power management is available, the need to use the manual slider will be reduced to special situations.

Piloting Tactics

Piloting a VideoRay is generally easy in clear, calm water and can be learned quickly. Real world operations are generally more challenging and demanding. Pilots should be comfortable in clear calm water before attempting more challenging conditions. Unless you work in a controlled environment, such as tanks, you are likely to encounter low visibility, current, deep conditions, or even all three. Each of these takes special techniques or accessories.

The following suggestions will help you advance your piloting skills.

- Use a light touch on the controls. The VideoRay is very agile and if you apply too much control input, you will tend to over steer or over shoot your objectives. This will often require reverse control input to compensate, which is inefficient.
- You should learn to operate the ROV by watching it on the surface and by watching only the video display. Expert pilots will often navigate on the surface to the desired area of operations before descending, but once the ROV is underwater, they may not be able to see it from the surface and must rely on the video from the ROV.
- Start out by practicing simple maneuvers like going in a straight line and making 90 degree turns.
- Also work on simple vertical maneuvers by following a line or piling. Tilt your camera down when diving and tilt it up when surfacing to see where you are going.
- Notice that when the ROV is on the surface and the camera is tilted up, you should be able to see above the waterline. This capability can be used to reference navigate using surface landmarks, like the sun, buildings, trees or vessels.
- While you can operate the VideoRay by yourself, it is a good idea to have another person help manage the tether - if you have too little tether in the water, you will have a hard time piloting the ROV, and too much tether can lead to tangles.

Piloting in Low Visibility

When piloting in low visibility, there are several techniques that can be used to help you navigate to your objective or find and observe your target.

- Rather than navigate underwater to the target, navigate on the surface to a point above the target and try to drop down on the target. If you can operate above the target in a vessel, you can drop a weighted line and follow the line to the bottom.
- Do not always assume more light will help - you may find that you can pick up shadows of objects from ambient light alone.

Depending on the objectives, depth and distance, low visibility may require an accessory like sonar and/or a position tracking system.

Piloting in Swift Current

Working in current presents challenges that you may not be able to overcome if the current is too strong, but there are several strategies that you can apply depending upon the situation. Current can be consistent

throughout depth, or there may be wind driven current on the surface, and tidal or other currents below. This will of course complicate the situation, but there are techniques to try before giving up.

- Use the minimum amount of tether possible and use performance or negative tether to minimize the effects of drag.
- If you are working deep or along the bottom, add a weight to the tether several meters behind the ROV. Make sure to distribute the stress of the weight connection along a section of tether rather than tying the weight to one point.
- To turn around while facing downstream, you must get the tension off of the tether. If you do not, then attempts to turn around to go upstream will probably result in overturning and facing back downstream again. To turn around, first apply reverse thrust to relieve the tension, and then turn.
- If you can position yourself upstream, you can try to weather vane the ROV and let it float downstream while you move side to side if necessary. By moving your tether deployment location, you may be able to cover the areas needed.

Piloting in Deep Water

Working in deep water presents its own set of challenges.

- For long tether runs, use negative tether because it can transmit more power and has minimal drag. A short section of performance or neutral tether should still be used at the ROV unless the tether can always be held above the ROV.
- Add a weight to the tether several meters behind the ROV. Make sure to distribute the stress of the weight connection along a section of tether rather than tying the weight to one point. Remember, you will need to retrieve the weight, and this can be difficult if the tether is long.
- To speed descent, grasp a disposable weight in the manipulator. When you reach your operating depth release the weight in order to be able to pilot the ROV better.
- Use the vertical thruster to pitch the nose downward, and then use the horizontal thrusters to add more power to dive or surface.

Piloting in Confined Spaces

When piloting in confined spaces, the gravest concerns are getting stuck or getting the tether snagged on an obstruction.

The best techniques are:

- Ballast the ROV as close to neutral as possible
- Proceed slowly and plan ahead before entering tight spaces
- Observe the entire immediate surroundings, including up and down, for any obstacles that might entrap the ROV or snag the tether
- Have someone feed tether as close to the entry point as possible
- Move slowly and deliberately to avoid stirring up silt

If the ROV or tether does get stuck, assess the situation as best as possible in order to avoid making the situation worse. See the section on Emergency Response to a Snagged Tether/ROV for additional tips.

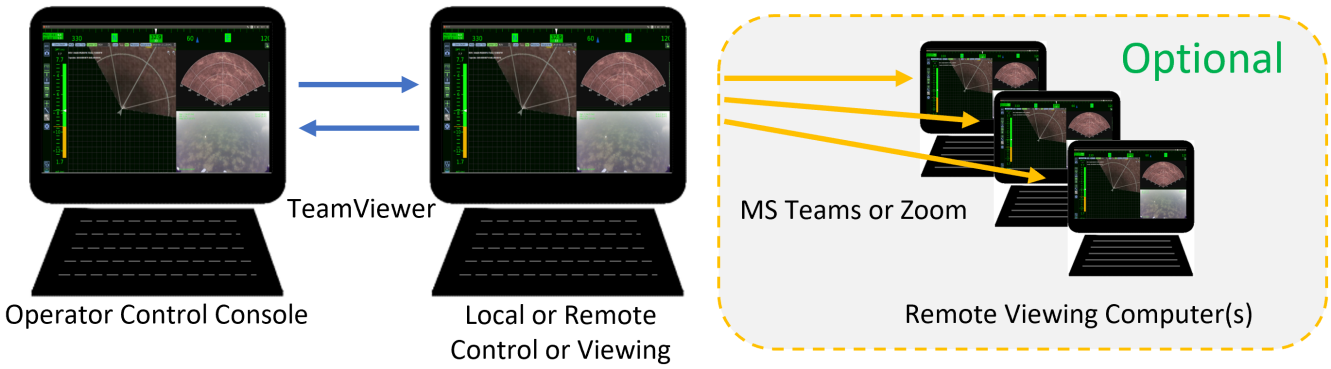
Remote Operations and Streaming

Mission Specialist systems can be controlled remotely over the Internet or set up to stream video to remote destinations.

Requirements

1. Mission Specialist System
2. TeamViewer Software [Download]
3. Addition computer for control and/or streaming (Windows or Ubuntu)
4. An additional computer for each remote viewing location
5. Internet connection at local operating or viewing location and all remote locations (control or viewing)

Configuration Overview



The local or remote control or viewing computer is connected to the Operator Control Console locally over a LAN or remotely over a WAN using TeamViewer software. When set up, this computer can control the ROV and/or be used for viewing only. If additional remote locations require viewing, these can be connected to the local or remote control or viewing computer using a virtual meeting application like Microsoft Teams, Zoom, Google Meet and other similar applications.

⚠The remote operations configuration does not support joystick use on the remote control computer. Autonomous control using the screen or keyboard inputs is supported.

💡 If only viewing is required locally, an easier solution is to use the second HDMI output port of the Operator Control Console and connect a second monitor or an HDMI splitter with multiple monitors for more viewing stations.

Configuration Set Up Information

To connect the local or remote control or viewing computer to the Operator Control Console, follow these steps:

1. Download and install TeamViewer on the Operator Control Console. See installation note below.

2. After the correct version of TeamViewer is installed on the Operator Control Console, you will have to run the application to view the user ID and password in order to login.
3. Download and install the correct version of TeamViewer for the local or remote control or viewing computer.
4. Start TeamViewer on the Operator Control Console.
5. Start TeamViewer on the local or remote control or viewing computer.
6. Use the User ID and Password from the Operator Control Console version of TeamViewer to login to the Operator Control Console through the local or remote control or viewing computer.
7. You should be able to view and control the Operator Control Console when successfully connected.

To add optional remote viewing locations follow these additional steps:

1. Start your virtual meeting software on the local or remote control or viewing computer.
2. Create or schedule a meeting.
3. Invite remote viewers to the meeting.
4. The remote viewers can connect to the meeting as usual.

⚠ VideoRay installs the TeamViewer Service Queue on the Operator Control Console by default. You will need to install the Ubuntu, Debian x86 64bit version. [Download].

Internet Configuration Issues

⚠ If you are unable to connect to the vehicle and the Internet at the same time, you will have to adjust the following network settings:

1. On the Operator Control Console, minimize the TeamViewer User ID and Password window.
2. Open the network tab in the upper right corner.
3. Select Edit Connections. This will open a new window.
4. Under the Ethernet Tab, Select the MSS - Vehicle. Then the Edit option.
5. In the new window, select the tab titled IPv4 Settings.
6. Check the box at the settings called "Require IPv4 addressing for this connection to complete."
7. Select Save and close the window.

⚠ These steps must be undone before exiting the TeamViewer session on the Operator Control Console or the system may not work properly afterward.

⚠Adjusting the network settings may cause feed delays or interference with accessories.

Maintenance Guide

This section will describe the maintenance requirements and procedures for periodic or common maintenance requirements. It will not be detailed enough to be considered a component level repair manual, but will address component replacement of modular components.

User Maintenance Policy

User's are ultimately responsible for the safe operation and longevity of their VideoRay equipment by minimally following best practices outlined in the Operator's / Maintenance Manual, recognized industry standards and using common sense.

⚠ VideoRay strongly recommends that all service and repair of VideoRay equipment owned by users be carried out by VideoRay Certified Technicians at VideoRay Authorized Service Centers. Equipment leased from VideoRay MUST be returned to a VideoRay Authorized Service Center for service and repair.

VideoRay also understands that logistics and other issues may make it difficult and costly to return the equipment to a Factory Authorized Service Center for completion of some of the simpler procedures. The following procedures are considered acceptable for the owners and lessees to complete without impact on the warranty. Note that cleaning components is a required condition for continued warranty protection and that failure to exercise reasonable care during these procedures may result in warranty claims being denied.

- Cleaning components
- Lubricating connectors
- Removing and replacing:
    - Float Block
    - Skid
    - Propellers
    - Thruster Nozzle
    - Modules in their entirety
    - Externally Mounted Accessories

Instructions for performing these procedures are included in the Operator's / Maintenance Manual. Users who do not feel comfortable completing these procedures are invited to contact VideoRay for assistance.

⚠ Opening modules or the control panel may void the warranty.

For users who want to complete service and repair procedures beyond the scope of the above list on their own, VideoRay offers Advanced Maintenance courses and Factory Service manuals for additional fees. These may be valuable for situations where the equipment will be used for mission critical applications or in remote locations. However, the best advice in these situations is to maintain spare equipment on-site for instant resumption of operations in the event of failure.

Basic Equipment Care

Do not abuse the VideoRay and be careful not to damage the system's components through normal use. For example, avoid letting the tether connectors come in contact with the ground where rough surfaces or dirt can damage the contacts.

Cleaning

VideoRay systems should always be cleaned after use. When used in salt water or contaminated environments, make sure to thoroughly rinse and then soak all wet components. It is especially important that you rinse the pressure sensor and allow it to drain. You must remove the float block to do this.

CAUTION Use care when cleaning the pressure sensor to avoid damaging the sensor. Do not insert anything into the pressure sensor cavity, and do not apply high pressure spray to the sensor.

Storage and Transport

Always pack the system securely to make sure it is not damaged in transport.

Periodic Maintenance

Maintenance Best Practices

DANGER CAUTION To avoid injury or damage to the VideoRay, disconnect the system power and tether before commencing any maintenance and/or repairs.

The best maintenance programs begin before trouble occurs, and preventative maintenance should be your first step on the road to reliable system performance.

Inspections

Inspections should be carried out before and after every dive as part of the pre- and post-dive procedures. Be observant for signs of loose parts, wear or impending failure - catch small problems before they become big problems. A

CAUTION Example: Failure to inspect the thruster oil level indicator telltales for low oil levels and refill the oil may lead to premature thruster failure..

Trained Operators

Do not subject equipment to accidental or inadvertent abuse by someone who is not trained in its proper use.

Trained Technicians

Maintenance should be completed by trained and certified technicians, and using factory authorized parts. VideoRay recommends that you create and maintain a system logbook. The logbook entries can include details of missions (date, location, conditions, dive time, etc.) and maintenance performed (date, procedure, parts replaced, etc.). The logbook may help identify possible causes of problems and systemic issues that should be reported to VideoRay for further investigation.

Service

Follow recommended periodic maintenance schedules, documented procedures and use the proper tools. Work in a clean environment. For any service or repair procedure beyond the scope of the simpler procedures defined in the User Maintenance Policy, contact VideoRay for assistance.

Well Equipped Shop

A well equipped shop is organized, clean, and well lit. Ideally all work can be conducted in such an environment, however there may be times when maintenance or repairs must be completed in the field. For those occasions,

Maintenance Tools Required

VideoRay is designed with ease of maintenance in mind, and only a few tools are required to service the system. In fact, many maintenance procedures, such as changing light modules can be done without tools. VideoRay also includes a small tool and spares kit with each system delivered that contains most of the required tools. The following list of tools is recommended:

TOOL	TYPICAL USE
O-ring lubricator	Lubricating O-rings and O-ring grooves and landings.
Multi-tip screwdriver with Phillips and straight blades	Miscellaneous frame and mounting screws
3, 4 and 5 mm Allen wrenches (nut driver style preferred)	Miscellaneous frame and mounting screws
7/16" Open end wrench	Propeller locking nuts
Multi-meter*	Electrical circuit testing
Soldering iron*	Electrical circuit repair
Flashlight*	Internal inspections

* - These items are not included in the standard tool kit that comes with MSS systems.

Additionally, small trays to hold parts and fasteners are recommended.

Field Tool Kit

Ideally all work can be conducted in a workshop environment, however there may be times when maintenance or repairs must be completed in the field. For those occasions, it is recommended that you carry a well stocked tool kit, and a clean mat that can be used as a clean workspace for maintenance.

Special Handling

CAUTION VideoRay ROVs and their components can be damaged by improper care and handling. The following sections provide guidelines and procedures for working with these components.

Connector Care and Handling

Connectors should be handled with care and inspected and cleaned regularly. Always follow any specific instructions provided by the manufacturer for connector care. The following general guidelines are provided to help extend the life of the connectors.

1. Do not allow dirt or debris to get into the female sockets.
2. Do not allow the male pins to suffer from abrasion.
3. Make sure the connector is clean before mating. Do not use an abrasive cleaner.
4. Make sure the connector is dry before mating unless the connector is designed to be wet mate-able or rated to be connected underwater.
5. Apply a light coating of silicone lubricant before connecting to its mate (unless the connector has explicit instructions to the contrary).
6. Make sure to align the pins with sockets carefully to prevent damage while mating.

7. Make sure any sealing O-rings are in good condition and installed properly.
8. Make sure the connection is completely sealed when connected.
9. Use the connector locking devices when they are supplied for the connector.
10. Use the appropriate strain relief if applicable for the connection and make sure the strain relief is connected properly to ensure there is no strain on the connector.
11. For underwater connectors, rinse the connector in fresh water any time is has been disconnected from its mate.
12. Periodically, disconnect the connector and inspect each side for corrosion or damage and inspect the sealing surfaces or O-rings.

Specific Instructions from the Manufacturer for IE55 Connectors (used on the BluePrint Sonar, Manipulators, USBL)

1. Lubricate mating surfaces with 3M Silicone Lubricant or equivalent.
2. DO NOT GREASE! Connectors must be lubricated on a regular basis.
3. Lubricate o-rings with Dow Corning #111 Valve Lubricant or equivalent
4. Use dust caps and keep connectors clean to prevent damage in storage and service.
5. Keep o-ring grooves clean and avoid cuts, nicks and tears on rubber surfaces
6. Elastomers can be seriously degraded if exposed to direct sunlight or high ozone levels for extended periods of time.
7. Clean plugs and receptacles with soap and fresh water.
8. Rinse out with alcohol, allowing connector to air dry.
9. Replace o-rings when re-using connectors.

Tether Care and Handling

Tethers should be handled with care and inspected regularly. The following general guidelines are provided to help extend the life of the tethers.

Tether connectors and connections

1. Do not allow dirt or debris to get into the female sockets.
2. Do not allow the male pins to suffer from abrasion.
3. Make sure the connector is clean before mating. Do not use an abrasive cleaner.
4. Apply a light coating of silicone lubricant before connecting to its mate (unless told otherwise).
5. Make sure to align the pins with sockets carefully to prevent damage while mating.
6. Make sure the connection is completely sealed when connected.
7. Use the connector locking devices.
8. Use the appropriate strain relief and make sure the strain relief is connected properly to ensure there is no strain on the connector.
9. Rinse the tether connectors in fresh water any time is has been disconnected from its mate.

10. Use the tether connector caps to protect the tether connectors when the tether is not in use.
11. Inspect tether connectors Periodically for corrosion or damage and inspect the sealing surfaces.

Tether Operations

1. Do not crush the tether, including such concerns as closing it in the lid, stepping or driving on it.
2. Do not tie the tether in a knot.
3. Do not kink the tether.
4. Do not bend the tether tighter than the minimum bend radius.
5. Avoid passing the tether over rough surfaces or sharp edges.
6. Avoid pinch points both above and subsurface.
7. Coil loose tether using an over under or figure 8 technique to prevent twisting the tether.
8. Do not drive the vehicle in repeated circles to prevent twisting the tether.
9. Use a pulley /sheave to deploy the tether when not deploying directly by hand.
10. Do not exceed the maximum tether strength ratings:
    - Tether cable = 450 kg (1,000 pounds) (internal rated Kevlar)
    - Tether strain relief = 136 kg (300 pounds)
    - Tether connector locking collars = 35 kg (75 pounds)

O-Ring Care and Handling

O-Ring Rule of Thumb - If in doubt, throw it out! Generally, when compared to the equipment they are protecting, O-rings are very inexpensive. Should an incorrectly sized or damaged O-ring be installed, the result can be catastrophic. If there is any doubt as to the suitability or condition of an O-ring it should be replaced.

O-rings and other components with sealing surfaces should never be handled with dirty or gritty hands. A small amount of dirt trapped next to an O-ring will cause leakage, which could result in serious damage to the ROV's internal components. The most common situation is a single strand of hair or lint, so care should be taken to ensure a clean work area. Should an O-ring or sealing surface become dirty, wash it with mild soap and water, and then rinse it with clean water. Avoid scratching the surfaces of the O-ring grooves and landings. Do not use sharp objects such as a knife or screwdriver to pry apart sealed assemblies or remove O-rings. Serious damage to the O-ring or the seat may result.

O-ring Lubrication - VideoRay recommends the use of pure silicone spray or the O-ring lube kit that comes in the standard tool kit. Other lubricants can lead to deterioration and failure of the O-rings and components. Do not use other lubricants! Other lubricants may cause deterioration or attract dirt and lead to leaks or premature failure.

O-ring Inspection - O-rings wear out over time. Inspect all O-rings whenever a sealed assembly is apart. "Healthy" O-rings are soft, flexible and have not been pinched or nicked. Should an O-ring appear brittle, or have apparent cracks, nicks, or evidence of being pinched or permanently compressed, it should be replaced. Sealing surfaces should also be inspected while an assembly is apart. The surfaces should be examined to determine that they are free of dirt, nicks, scratches, or damage, which may result in seal failure once reassembled.

O-ring Storage - O-rings should be stored in clean plastic bags to protect them from dust when not in use. Avoid prolonged storage in direct sunlight as this may result in deterioration of the O-ring material. Stored O-rings should be sorted with regard to type and size with that information noted on the storage bag. Use of an incorrect O-ring can result in an ineffective seal.

Electronics Components Care and Handling

Electronic components (circuit boards) are susceptible to damage from ESD (Electro-Static Discharge). Numerous sources are available that provide background information and recommend procedures for handling these components. These procedures should be followed when directly handling VideoRay's electronic components.

ESD is caused by the build up of static electricity. Steps to reduce the build up of static electricity or drain off any static build up are encouraged in order to prevent ESD damage.

General Guidelines for handling electronic components include:

- Avoid static build up in the work area
    - Avoid carpet in work areas
    - Maintain proper humidity levels: 40 - 60%
- Implement practices to prevent static build up
    - Provide ground points in the work area
    - Wear a grounded wrist strap
    - Provide grounded static dissipative mats on work surfaces and floors
    - Wear static dissipative outer clothing
    - Work standing rather than sitting
- Use ESD protective packaging

If you cannot work in a properly equipped ESD safe area, there are some general precautions you can follow in addition to the above.

- Always touch a metal ground to dissipate any static charge build up before handling circuit boards.
- When transferring a circuit board to another person or work surface, touch the person or surface with your free hand to dissipate and static charge build up.

Hull Materials Care and Handling

Aluminum Hull Components

VideoRay's aluminum parts are protected by anodizing and/or ceramic coatings. The use of metal tools can scratch these coatings leading to corrosion. Be careful when working with with metal tools near hull parts. Use only wood or plastic tools when the tool must contact an aluminum hull component.

Main Dome and Light Dome

The domes should be cleaned with mild soap and water. They are acrylic and small scratches can be buffed out.

CAUTION Do not use cleaners that contain alcohol or other solvents. Solvents can make the domes brittle.

Galvanic Corrosion

Galvanic corrosion results from dissimilar metals being in contact when exposed to a conductive medium like salt water. Make sure all stainless steel fasteners are not in direct contact with aluminum hull parts. VideoRay uses nylon spacers for these contact points to keep the materials separated. Always make sure to use these spacers when reassembling parts after routine maintenance or a repair.

Configuration / Calibration

Compass Calibration

For the best navigation performance, the compass should be calibrated in the following situations:

- When the system is first received if the compass does not appear to be accurate.
- When using the system in a remote location where it has not been used before if the compass does not appear to be accurate.
- Whenever the compass does not appear to be accurate.

⚠ The compass will be affected by iron or magnetic sources, such as ship's hulls or sheet piling or other natural deposits. Calibrating the compass will not correct for these anomalies.

Step-by-Step Procedures

⚠ Magnetic Field Mapper software must be installed on the Operator Control Console. If the Magnetic Field Mapper software is not installed, It can be downloaded at: https://videoray.exavault.com/files/quarterdeck/xsens/mag_mapper.tgz. The user name is quarterdeck and the password is quarterdeck (use all lower case). After logging in, navigate to the xsens/ folder and download mag_mapper.tgz.

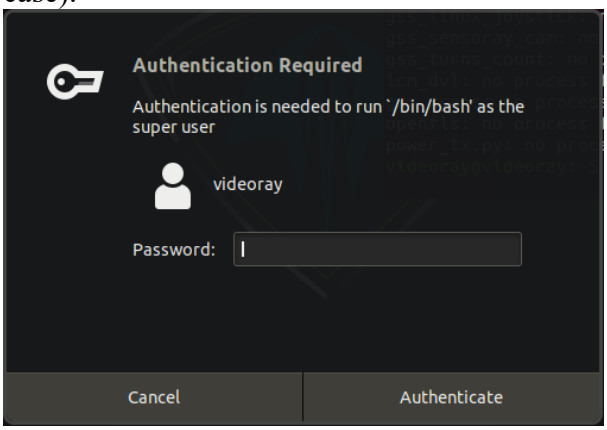
⚠ The AHRS firmware must be updated to attitude_sensor-1.4.4.hex or higher. If the firmware is not up-to-date, see: Command: vr_refresh and its following page for more information about updating the firmware.

1. Connect the system as normal and power on Operator Control Console and the ROV.
2. If EOD Workspace has been started since turning on the Operator Control Console.
    a. Open a terminal window.
    b. Enter the following command: killall_vr.sh
    c. Press the Enter key.
    d. Close the terminal window.
3. Unplug all USB devices from the Operator Control Console, except the keyboard / mouse.
4. Make sure vehicle has been powered on for at least 10 seconds.
5. Move the vehicle to a magnetically "clean" area at least 20 feet from any car or truck, not near concrete (which may contain rebar), away from steel structures etc.

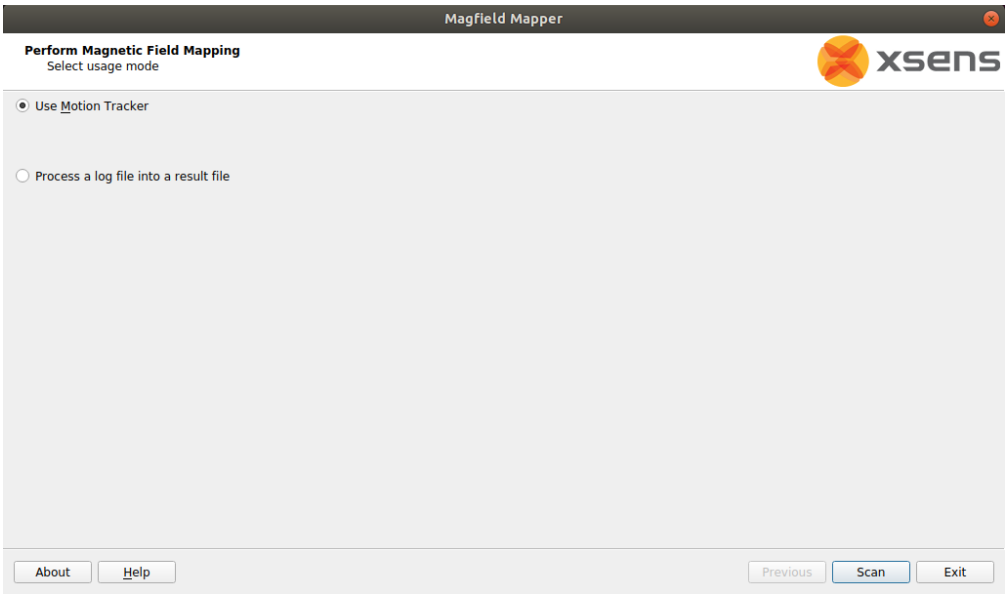
    ⚠ The ROV must be separated as far as possible from iron or magnetic sources during the calibration process for best results.

6. Start the Magnetic Field Mapper software by double clicking on the Magnetic Field Mapper icon on the desktop.

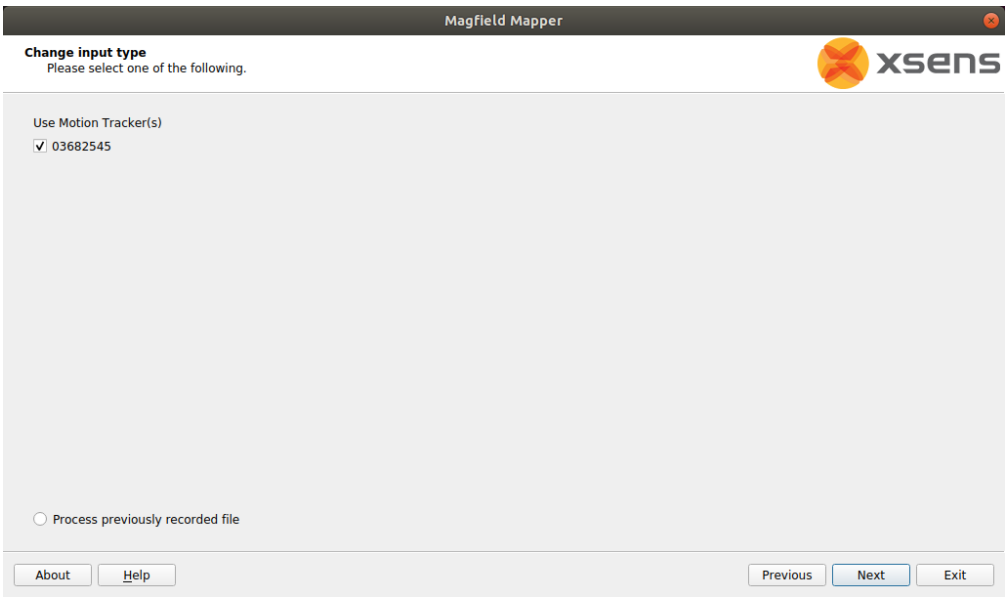
7. When asked if you trust this application and want to Launch it, click on the Yes button.
8. When asked for the password, enter videoray and click on the Authenticate button (use all lower case).



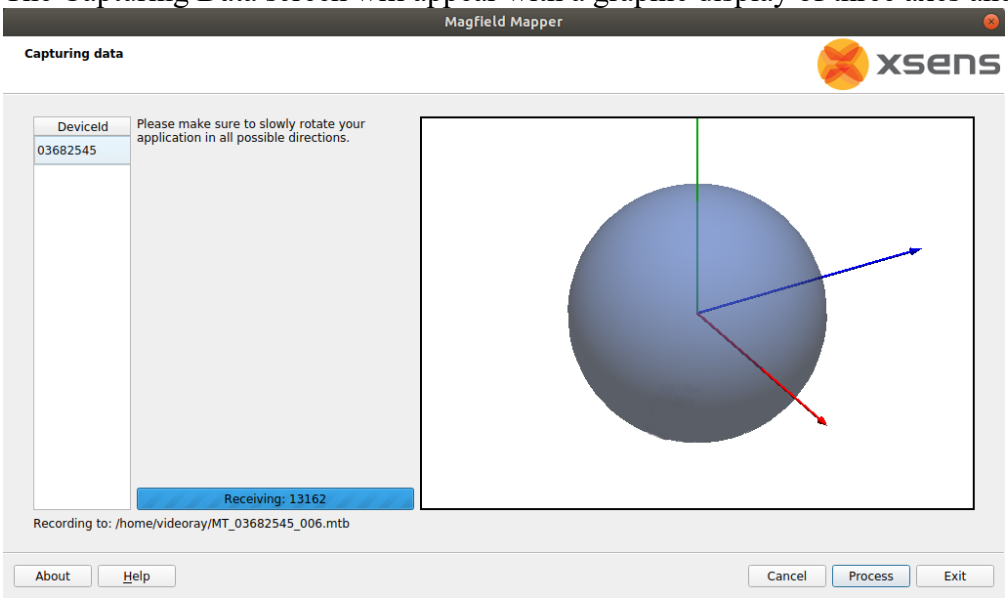
9. When the Magnetic Field Mapper software starts, make sure the Use Motion Tracker option selected and click on the Next and then the Scan buttons.



10. Wait up to 30 seconds for the Magnetic Field Mapper software to find the AHRS Module. If the software reports that it does not find any devices, close the software and restart it and repeat these steps.
11. When the Magnetic Field Mapper software finds the AHRS, which will be listed by a unique ID number, ensure the checkbox in front of the number is checked and click on the Next button.

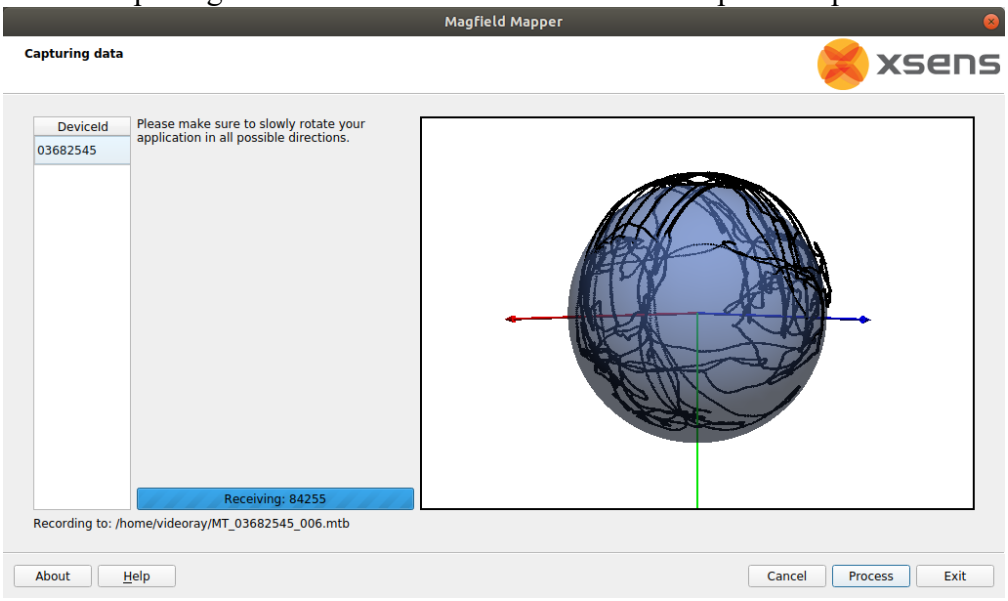


12. The Capturing Data screen will appear with a graphic display of three axes and a sphere.

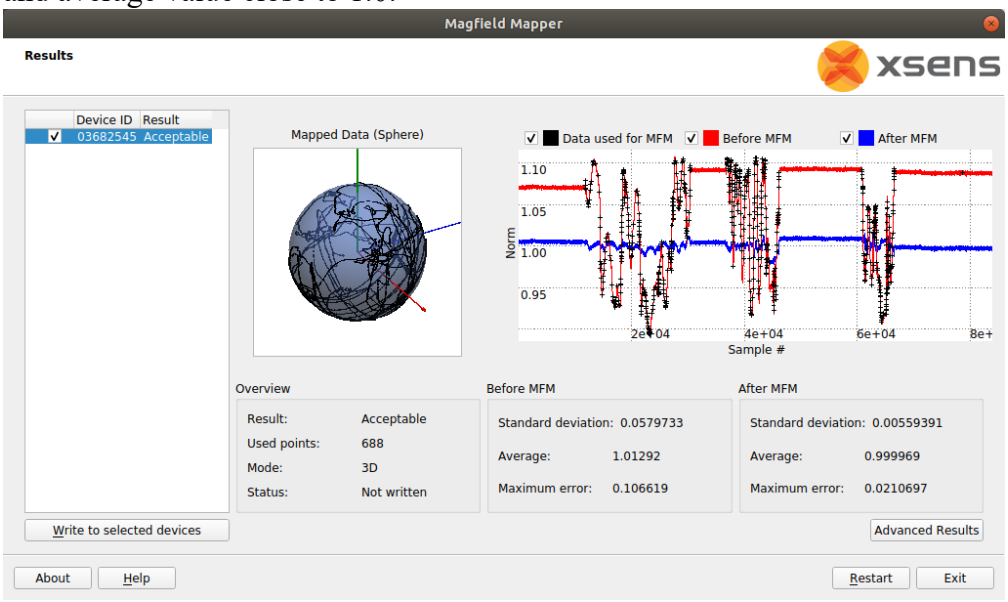


13. The vehicle must be rotated slowly 360 degrees about all axes. As you rotate, the sphere will update with areas that are mapped. The goal is to cover as much of the sphere as possible.
    a. Start by holding the ROV flat and spin around in a circle to rotate about the ROV's vertical axis.
    b. Hold the ROV upside down and spin around in a circle to rotate about the ROV's inverted vertical axis.
    c. Hold the ROV with its port (left) side up and spin around in a circle to rotate about the ROV's pitch axis.
    d. Hold the ROV with its starboard (right) side up and spin around in a circle to rotate about the ROV's inverted pitch axis.
    e. Hold the ROV nose up and spin around in a circle to rotate about the ROV's roll axis.
    f. Hold the ROV nose down and spin around in a circle to rotate about the ROV's inverted roll axis.
    g. The sphere should show six circles, one on each side roughly centered about each axis.
    h. Repeat the above steps, but angle the ROV 45 degrees relative to two axes in each case. An example would be holding the ROV flat, and then tipping the front down 45 degrees and at the same time the left down 45 degrees for the rotation.
    i. This should result in additional circles which should more completely cover the sphere. The sphere does not have to be completely covered, but there should not be any large gaps in the coverage.

14. After completing the rotations to cover as much of the sphere as possible click on the Process button.



15. The display will update with a before (red) and after (blue) graph. The red graph will likely have sections with a lot of variation and be offset from 1.0. The blue graph should have much less variation and average value close to 1.0.



16. Click the Write to selected devices button.
17. Click the Exit button to close the Magnetic Field Mapper software.
18. Turn off the ROV power, wait 10 seconds and then turn the ROV power on again.
19. The compass calibration is complete and the ROV is ready to use.

Diagnostics and Repair

Are you having a bad day with your Mission Specialist system? You have come to the right place.

Solving problems requires either a methodical diagnostics approach, or lots of luck. If you don't like to gamble, the following may help you overcome challenges that inevitably present themselves from time to time.

Before providing the specific details of diagnosing and repairing the MSS?, some basic troubleshooting guidelines are in order. Following these practices should make your efforts much more efficient and successful.

- Suspect and check the obvious first - It's easy to get distracted and overlook something obvious.
- Recheck the obvious - Have someone verify your work. If you're helping someone, verify what you've been told. Sometimes, just talking through the details can help you realized you missed a step or fact.
- Understand correct operation and expected results - How should it work and what should happen? Does it?
- Learn and recognize symptoms - What are the results telling you? What are the most likely suspects and what can be ruled out?
- Isolate, Divide and Conquer - Classify the problem to sub-systems, remove what you can and substitute known working parts if possible. Or, try suspect parts with a known working system.
- One step at a time - Be logical and make each test provide results you can use to narrow down the problem.

The MSS is a collection of relatively simple components, but when something goes wrong, it's easy to get overwhelmed. The following steps should be your first response to a general system malfunction, especially if the power and communications warning indicators in the ROV Health instrument are lit.

1. Power down the system, check the connections and restart using the recommended procedures.
2. To identify whether the tether is a possible source of the problem, connect the ROV directly to the control panel to see if the symptoms persist.
3. Remove all attached accessories to eliminate the possibility that an accessory is the source of the problem.

If the problem is more isolated to a specific function, or these steps fail to resolve a general problem, it's time for a closer look at the symptoms and subsystems.

Module Configuration and Replacement

Power Module Replacement

Replacing a Power Module requires hardware replacement. Currently, the Power Module will be pre-configured when delivered, so there is no need for software configuration procedures.

Hardware Replacement

To remove and replace a Power Module, follow these steps:

1. Power down the system.
2. Remove the top float block by removing the four screws holding the float block to the frame.
3. The DVL will need to be removed in order to remove the Power Module.
4. For the Power Module to be replaced, disconnect the thruster and LED light connector stack from the top of the Power Module.
5. Using a Phillips head screw driver, remove the 4 screws that hold the Power Module to the frame.
6. Remove the damaged Power Module from the vehicle being careful to thread the remaining connected cables through the frame.
7. Remove the cables from the old Power Module and install them in the same locations on the replacement Power Module.
8. Thread the cables through the frame the way they were routed on the old Power Module.
9. Mount the replacement Power Module in the frame and secure it using the Phillips head screws removed earlier. Do not over-tighten these screws.
10. Reinstall the thruster and LED light connector stack into the top connector on the Power Module.
11. Replace the DVL.
12. Replace the float block using the screws removed earlier.

Power Module and Control Software Configuration

This section is reserved for future use.

Communications Module Replacement

Replacing a Communications Module requires hardware replacement. Currently, the Communications Module will be pre-configured when delivered, so there is no need for software configuration procedures.

Hardware Replacement

To remove and replace a Communications Module, follow these steps:

1. Power down the system.
2. Remove the top float block by removing the four screws holding the float block to the frame.
3. The DVL will need to be removed in order to remove the Communications Module.
4. Remove the Communications Module male connector cable from the front of the Power Module.
5. For the Communications Module to be replaced, note the modules connected and order of the module cables connected to the top of the Communications Module, and remove these cables.
6. Using a Phillips head screw driver, remove the 4 screws that hold the Communications Module to the frame.
7. Remove the damaged Communications Module from the vehicle being careful to thread the remaining connected cables through the frame. You may need to remove one or both of the Module cables. If so, note the modules connected and locations where the cables are connected to the Communications Module
8. Thread the cable for the Power Module through the frame the way it was routed on the old Communications Module and connect it to the Power Module.
9. Mount the replacement Communications Module in the frame and secure it using the Phillips head screws removed earlier. Do not over-tighten these screws.
10. Reinstall the module cables on the Communications Module using the same port locations as the cables were originally installed.
11. Replace the DVL.
12. Replace the float block using the screws removed earlier.

Communications Module and Control Software Configuration

Refer to the configuration parameter table in the Communications Module section of the Equipment Guide.:

These steps are only required if a manipulator is being used on the vehicle.

Commands below are case sensitive.

1. Connect and power up the system, but do not start the control software.
2. Launch the terminal program and use the following commands to program the Communications Module.
3. Navigate to the working folder, type:
    - cd flighthack followed by the Enter key
4. Enumerate the modules on the system, type:
    - vr_enum followed by the Enter key

5. The replacement Communications Module serial number should appear in the list of enumerated devices, such as COMHB000356 (COMHB will be present, but the number may be different).

6. Enter diagnostic mode of the new Communications Module, type:
    - ./vr_debug_putty.py 2 followed by the Enter key

    where *2* is the default Node ID of the new Communications Module. This will open a new diagnostic window.

7. To access the configuration menu in the diagnostic window, type:
    - c

    You do not need to type the Enter key. In configuration mode you are now able to configure the baud rate for the rotating manipulator port.

8. Using the values from the Communications Module configuration table change the parameters on the Communications Module to match the baud rate for the manipulator port from the table.

    To change the baud rate value for the manipulator port, follow these steps:
    1. Identify the port where the manipulator is connected and note the option number for the baud rate parameter.
    2. Type the *Option Number* followed by Enter, then type the *Desired Baud Rate Value (38400)* followed by Enter.

9. Press the s key followed by Enter to save the configuration.

10. Press the x key followed by Enter to exit the configuration menu.

11. Press the x key again to exit diagnostic mode. You do not need to press Enter.

12. Close the diagnostic window.

13. Close the terminal window.

AHRS Replacement

Replacing an AHRS requires hardware replacement. Currently, the AHRS will be pre-configured when delivered, so there is no need for software configuration procedures.

Hardware Replacement

To remove and replace an AHRS, follow these steps:

1. Power down the system.

2. Remove the top float block by removing the four screws holding the float block to the frame.

3. For the AHRS to be replaced, follow the AHRS cable to the Communications Module and remove it noting its location.

4. Carefully thread the disconnected cable and connector back through the frame until it is clear.

5. Using a Phillips head screw driver, remove the 2 screws that hold the AHRS to the frame.

6. Remove the damaged AHRS from the vehicle.

7. Mount the replacement AHRS on the frame and secure it using the Phillips head screws removed earlier.

8. Thread the cable and connector through the same routing as the old AHRS. Connect the cable to the same location on the Communications Module as before.

9. Replace the float block using the screws removed earlier.

AHRS and Control Software Configuration

This section is reserved for future use.

Thruster Replacement

Replacing a thruster requires both hardware replacement and software configuration procedures. Each thruster must be configured for its specific location on the vehicle. Configuration parameters are identified in the Thruster section of the Equipment Guide.

Hardware Replacement

To remove and replace a thruster, follow these steps:

1. Power down the system.

2. Remove the top float block by removing the four screws holding the float block to the frame.

3. Note the position of the thruster being replaced in the vehicle frame. The position of the thruster being replaced will determine the propeller orientation and configuration parameters to be programmed into the replacement.

4. For the thruster to be replaced, follow the thruster cable to the main thruster connector stack (located under the main float block) and disconnect the damaged thruster from the stack.

5. Carefully thread the disconnected cable and connector back through the frame until it is clear.

6. Using the 5mm hex driver, remove the two (2) M6 plastic thruster bolts securing the thruster to the frame.

7. Remove the damaged thruster from the vehicle. If the propeller is still in good shape, remove it from the damaged thruster using a 7/16" nut driver.

8. Install a new correct orientation propeller (or the recovered propeller) on the replacement thruster.

9. Note the serial number for the replacement thruster. This number will be used to identify and program the replacement thruster once installed in the vehicle.

10. Install the replacement thruster in the same location as the one being replaced, and thread the cable and connector through the same routing as the old thruster. Connect the cable to the same location in the connector stack as before.

11. Mount the thruster to the frame using the M6 nylon bolts, and the 5mm hex driver. Do not overtighten the bolts.

12. Replace the float block using the screws removed earlier.

Thruster and Control Software Configuration

Refer to the configuration parameter table in the Thruster section of the Equipment Guide.:

⚠ Commands below are case sensitive.

1. Connect and power up the system, but do not start the control software.
2. Launch the terminal program and use the following commands to program the thruster.
3. Navigate to the working folder, type:
   - cd flighthack followed by the Enter key
4. Enumerate the modules on the system, type:
   - vr_enum followed by the Enter key
5. The replacement thruster serial number should appear in the list of enumerated devices. Note that the serial number on the thruster strut is only the ending significant digits. The serial number found in the output from vr_enum uses the complete format, such as THRxxxxxx, where xxxxxx is the sequential number.
6. Register the replacement thruster, type:
   - vr_setid *SN NodeID GroupID* followed by the Enter key

   where *SN* is the serial number of the replacement thruster (case sensitive value as found in the vr_enum output), and the *NodeID* and *GroupID* are from the thruster configuration table This step ensures that each thruster has a unique Node ID on this vehicle.
7. Type:
   - vr_enum followed by the Enter key

   again to verify the replacement thruster is registered with its Node ID.
8. Enter diagnostic mode of the replacement thruster, type:
   - ./vr_debug_putty.py *NodeID* followed by the Enter key

   where *[Node ID]* is the Node ID of the replacement thruster. This will open a new diagnostic window.
9. To access the configuration menu in the diagnostic window, type:
   - c

   You do not need to type the Enter key. In configuration mode you are now able to define the thruster's position on the vehicle (Motor or Application ID) and other operating parameters.
10. Using the values from the thruster configuration table change the parameters on the thruster to match those from the table. Minimally, the following settings should be entered or confirmed:
    1. Whether reverse is Enabled or Disabled (configuration parameter 2)
    2. Maximum Thruster Power (configuration parameter 17)
    3. Motor or Application ID (configuration parameter 31)

    To change the values, follow these steps:
    1. For most parameters, type the *Option Number* followed by Enter, then type the *Desired Value* followed by Enter.
    2. For the Reverse command (configuration parameter 2), simple type 2 followed by Enter to toggle the value from Disabled to Enabled or back again.

11. Press the s key followed by Enter to save the configuration.
12. Press the x key followed by Enter to exit the configuration menu.
13. Press the x key again to exit diagnostic mode. You do not need to press Enter.
14. Close the diagnostic window.
15. Close the terminal window.

Camera Replacement

Replacing a Camera requires hardware replacement. Currently, the Camera will be pre-configured when delivered, so there is no need for software configuration procedures.

Hardware Replacement

To remove and replace a Camera, follow these steps:

1. Power down the system.
2. Remove the top float block by removing the four screws holding the float block to the frame.
3. For the Camera to be replaced, follow the Camera cable to the Communications Module and remove it noting its location.
4. Carefully thread the disconnected cable and connector back through the frame until it is clear.
5. Using a Phillips head screw driver, loosen the 4 screws (2 in each bracket) that hold the Camera to the frame.
6. Slide the camera out of the brackets from the front of the vehicle.
7. Slide the replacement Camera cable and then the replacement camera into the brackets and make sure it is level with the tilt gear on the right (when viewed from the front of the camera) and secure it using the Phillips head screws loosened earlier. Tighten the screws evenly and do not over-tighten the screws.
8. Thread the cable and connector through the same routing as the old Camera. Connect the cable to the same location on the Communications Module as before.
9. Replace the float block using the screws removed earlier.

Camera and Control Software Configuration

This section is reserved for future use.

LED Light Replacement

Replacing an LED Light requires both hardware replacement and software configuration procedures. Each LED Light must be configured for its specific location on the vehicle. Configuration parameters are identified in the LED Light section of the Equipment Guide.

Hardware Replacement

To remove and replace an LED Light, follow these steps:

1. Power down the system.
2. Remove the top float block by removing the four screws holding the float block to the frame.
3. Note the position of the LED Light being replaced in the vehicle frame. The position of the LED light being replaced will determine the configuration parameters to be programmed into the replacement.
4. For the LED Light to be replaced, follow the LED Light cable to the main thruster / Light connector stack (located under the main float block) and disconnect the damaged LED Light from the stack.
5. Carefully thread the disconnected cable and connector back through the frame until it is clear.
6. Using a Phillips head screw driver, remove the 4 screws that hold the LED module to the tilting / pivoting bracket.
7. Remove the damaged LED Light from the vehicle.
8. Note the serial number for the replacement LED Light. This number will be used to identify and program the replacement LED Light once installed in the vehicle.
9. Mount the LED Light in the tilting / pivoting bracket and secure it using the Phillips head screws removed earlier.
10. Thread the cable and connector through the same routing as the old LED Light. Connect the cable to the same location in the connector stack as before.
11. Replace the float block using the screws removed earlier.

LED Light and Control Software Configuration

Refer to the configuration parameter table in the LED Light section of the Equipment Guide.:

⚠ Commands below are case sensitive.

1. Connect and power up the system, but do not start the control software.
2. Launch the terminal program and use the following commands to program the LED Light.
3. Navigate to the working folder, type:
   - cd flighthack followed by the Enter key
4. Enumerate the modules on the system, type:
   - vr_enum followed by the Enter key
5. The replacement LED Light serial number should appear in the list of enumerated devices, such as LED000356 (LED will be present, but the number may be different)
6. Register the replacement LED Light, type:
   - vr_setid *SN NodeID GroupID* followed by the Enter key

   where *SN* is the serial number of the replacement LED Light (case sensitive value as found in the vr_enum output), and the *NodeID* and *GroupID* are from the LED Light configuration table This step ensures that each LED Light has a unique Node ID on the this vehicle.

7. Type:
    - vr_enum followed by the Enter key

   again to verify the replacement LED Light is registered with its Node ID.

8. Enter diagnostic mode of the replacement LED Light, type:
    - ./vr_debug_putty.py *NodeID* followed by the Enter key

   where *[Node ID]* is the Node ID of the replacement LED Light. This will open a new diagnostic window.

9. To access the configuration menu in the diagnostic window, type:
    - c

   You do not need to type the Enter key. In configuration mode you are now able to define the LED Light's position on the vehicle (Application ID) and other operating parameters.

10. Using the values from the LED Light configuration table change the parameters on the LED Light to match those from the table. Minimally, the following settings should be entered or confirmed:
    1. Application ID (configuration parameter 21)

    To change the values, follow these steps:
    1. Type the *Option Number* followed by Enter, then type the *Desired Value* followed by Enter.

11. Press the s key followed by Enter to save the configuration.

12. Press the x key followed by Enter to exit the configuration menu.

13. Press the x key again to exit diagnostic mode. You do not need to press Enter.

14. Close the diagnostic window.

15. Close the terminal window.