SARbot™

Operations & Training

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Contents

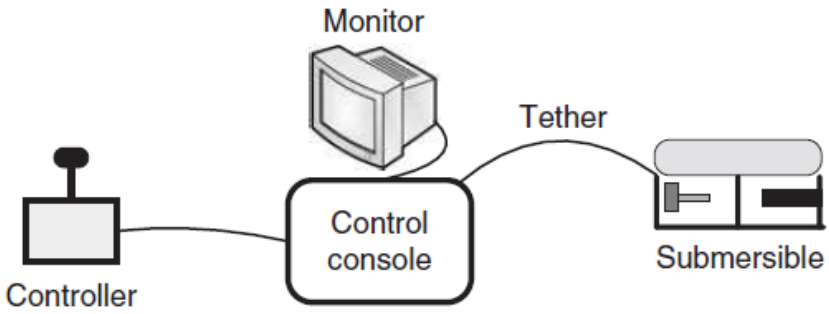
Introduction

Acronyms

- ESC – Electronic Speed Controller (Motor Controller)
- FLS – Forward Looking Sonar
- QGC – QGroundControl (ROV User Interface)
- ROV – Remotely Operated Vehicle
- SPC – Surface Power Console
- TMS – Tether Management System
- VPS – Vehicle Power Supply

Definition of an ROV

Simplistically, an ROV is a camera mounted in a waterproof enclosure, with thrusters for maneuvering, attached to a cable to the surface over which a video signal is transmitted. [Source - The ROV Manual]



History Lesson – SARbot

The original SARbot was created by SeaBotix in 2009. It was designed to operate as a true "Search & Rescue" ROV for First Responders in the UK. The idea was based on locating and recovering the drowning victim within the "golden hour" to revive them and save their lives. The SeaBotix SARbot System was a very well thought out kit but unfortunately not many First Responder organizations could afford the price tag. This SARbot follows in the footsteps of its predecessor but is primarily focused on "Search & Recovery".

SARbot - ROV, Components & Accessories

SARbot

Base ROV Platform (BlueROV2 Heavy)

The SARbot ROV is built starting with the battery operated BlueROV2 Heavy frame and most of its electronics. The BlueROV2 is a proven open frame ROV design with over 3000 units in the field. The equally vectored lateral thrusters allow for almost equal thrusters in any lateral direction and the four vertical thrusters are not only for lift, but can stabilize the ROV as well as change the pitch and/or the roll of the ROV.

VPS (Vehicle Power Supply)

The VPS is mounted in the lower, aft of the ROV. The VPS takes the high voltage (low current) electricity coming from the tether and converts it to a lower voltage (high current) power source the ROV needs to operate. The middle connector with the male pins is where the tether connects. The 3-pin female connector on the black cable sends the lowered voltage up to the 4 inch main electronics enclosure. The 8-pin female connector on the orange cable bridges the data connection from the tether to the 4 inch main electronics enclosure.

Gripper (Newton Subsea Gripper)

The gripper is a single function design with ≈28lbf closing force near the middle of the standard jaws. The SARbot package adds the larger “SAR” jaws to the Newton Gripper.

LED Lights

There are four daisy chained, dimmable LED lights on the SARbot. Each light emits up to 1500 lumens providing a total of up to 6000 lumens of light. The lights are dimmable by using the prefigured buttons on the hand controller.

Forward Looking Sonar (FLS)

The FLS is a multibeam imaging sonar that produces a “ping” underwater and then calculates the time the echo takes to return to create an image. The more reflective a surface is underwater, the stronger the echo will be, thus producing a brighter target on the sonar screen.

Underwater GPS / USBL Tracking System (Optional)

USBL (**ultra-short baseline**) is a method of underwater acoustic positioning. A complete USBL system consists of a transceiver, which is mounted on a pole under a ship, and a transponder or responder on the seafloor, on a towed system, or on an ROV. A computer, or "topside unit", is used to calculate a position from the ranges and bearings measured by the transceiver.

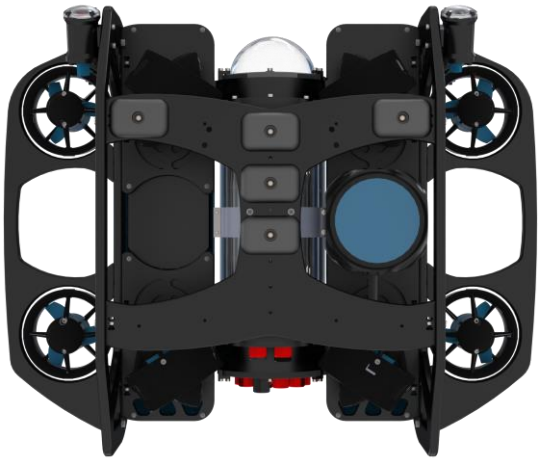
An acoustic pulse is transmitted by the transceiver and detected by the subsea transponder, which replies with its own acoustic pulse. This return pulse is detected by the shipboard transceiver. The time from the transmission of the initial acoustic pulse until the reply is detected is measured by the USBL system and is converted into a range.

To calculate a subsea position, the USBL calculates both a range and an angle from the transceiver to the subsea beacon. Angles are measured by the transceiver, which contains an array of transducers. The transceiver head normally contains three or more transducers separated by a baseline of 10 cm or less. A method called "phase-differencing" within this transducer array is used to calculate the direction to the subsea transponder.

Combined with a known GPS position at the surface the USBL system can compute the latitude and longitude of the transceiver under water often placing the position in real-time on a map or chart on a computer at the surface.

Doppler Velocity Logger (DVL, Optional)

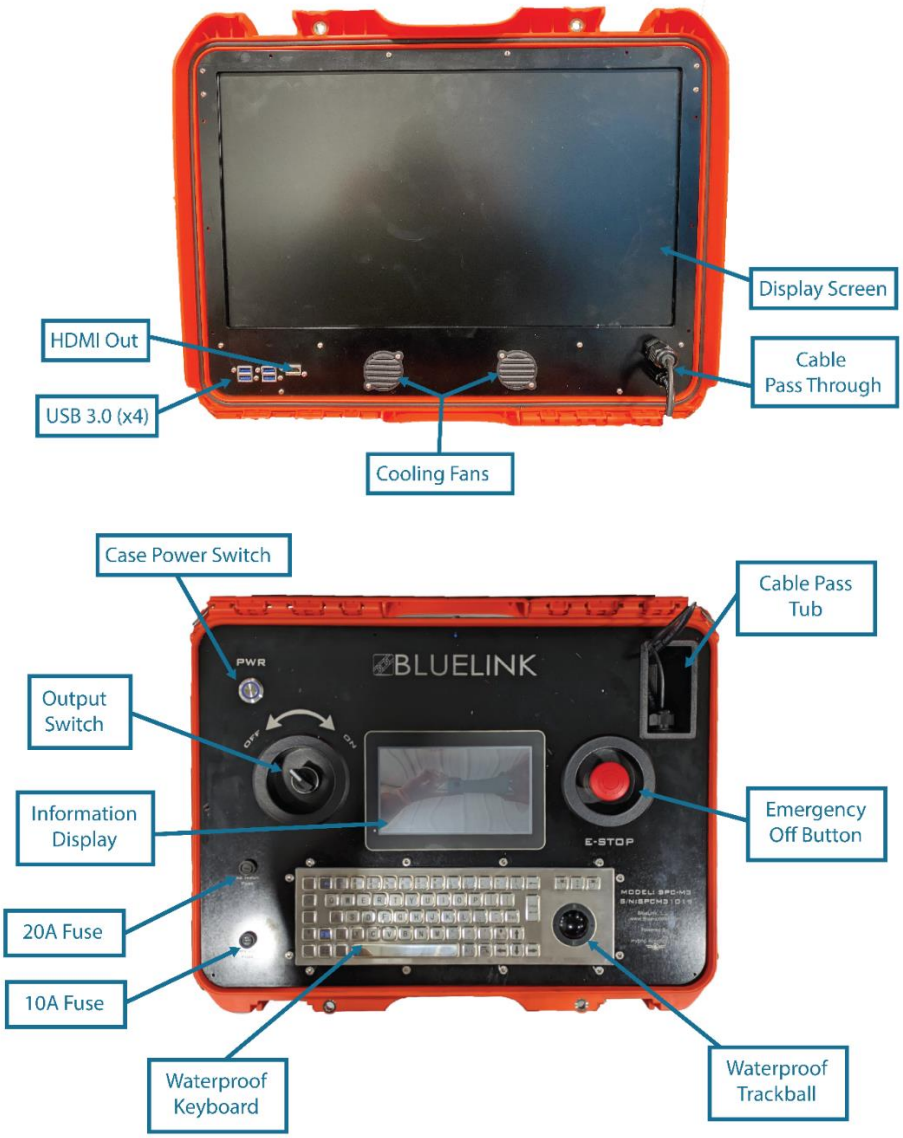
A Doppler Velocity Log (DVL) is an acoustic sensor that estimates velocity relative to the sea bottom. This is achieved by sending a long pulse along a minimum of three acoustic beams, each pointing in a different direction. Typically, this produces estimates of velocity converted into an XYZ coordinate frame of reference – the DVL's frame of reference. Together with a heading estimate, these velocity estimates may be integrated over the ping interval to estimate a step-by-step change of position – i.e. displacement = velocity × time step. [Nortek]

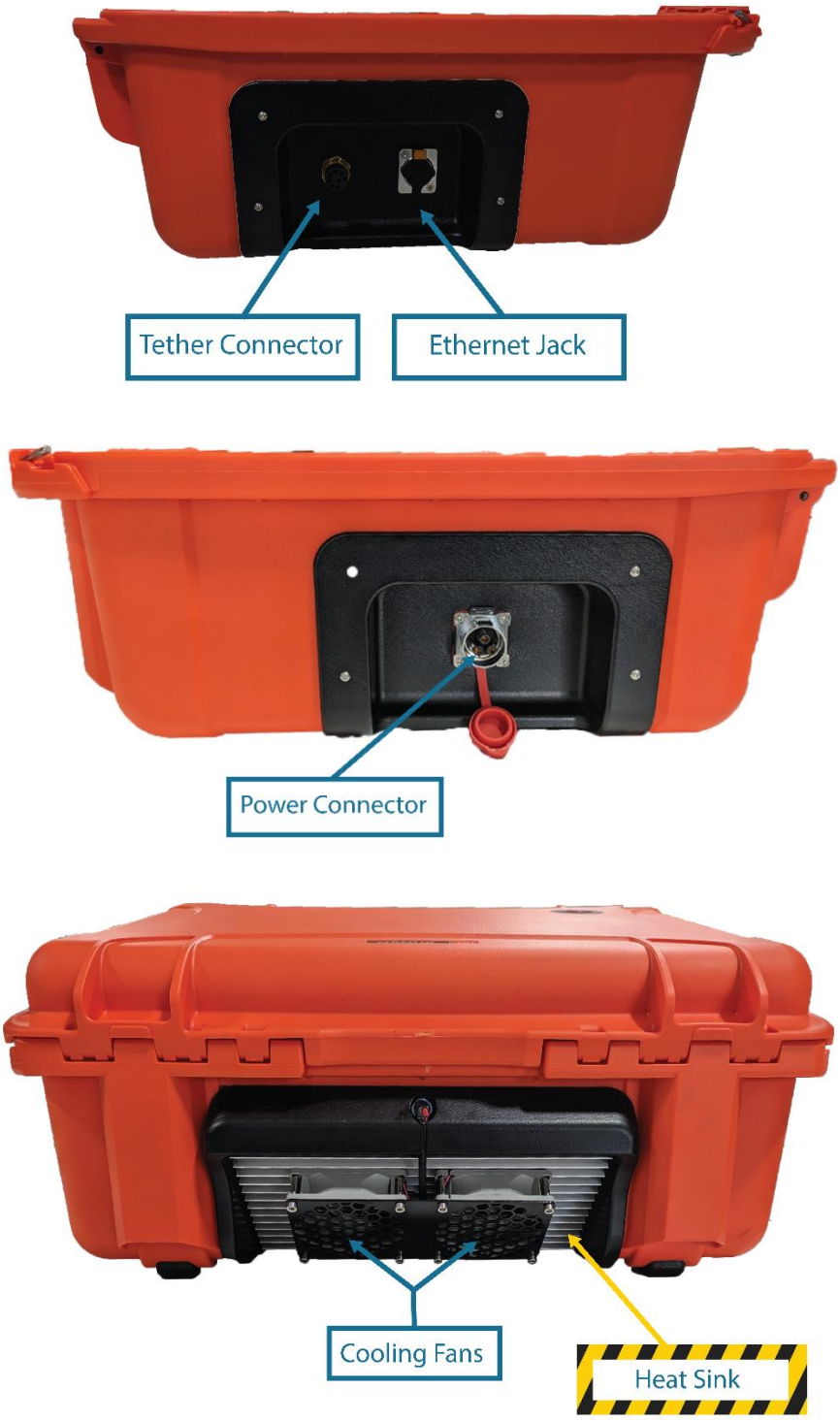


The DVL enables the SARbot to autonomously hold/maintain position relative to the bottom. This function will only work up in low water currents.

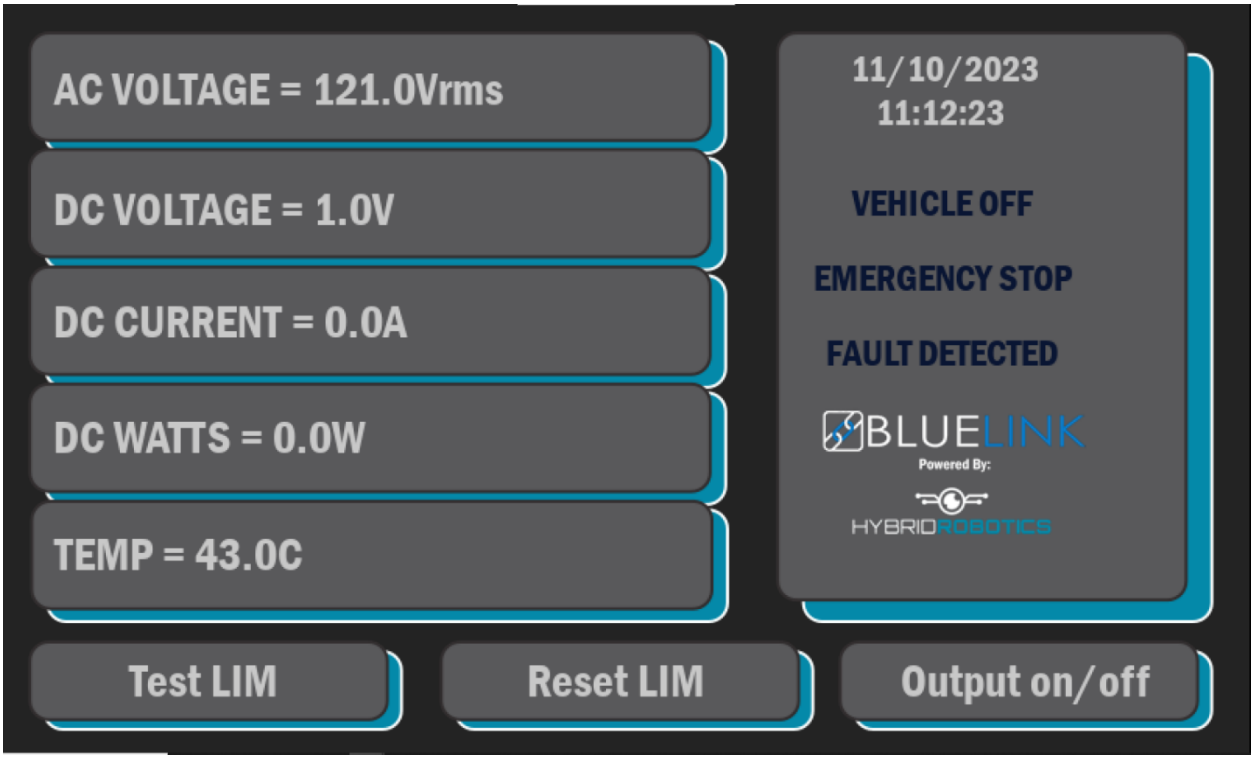
Surface Power Console – Model 3

The SPC-M3 is a fully integrated topside control console that not only supplies the appropriate power down the tether to the SARbot but includes everything needed to operate the system's software and log the video and sonar data. An Xbox style USB hand controller is used to control the SARbot that connects to one of the four USB ports in the upper panel. On the right side of the SPC, is the 8-pin female connector for the tether (or deck lead) and an Ethernet jack to provide a network connection to the CPU inside the SPC. On the left side of the SPC is the connection for the AC high voltage input that would come from the wall, ship's power, or a generator (2000W+ recommended).




Tether Connector
Ethernet Jack
Power Connector
Cooling Fans
Heat Sink

On the lower panel of the SPC, there is a small LCD that provides critical details of the power supply.



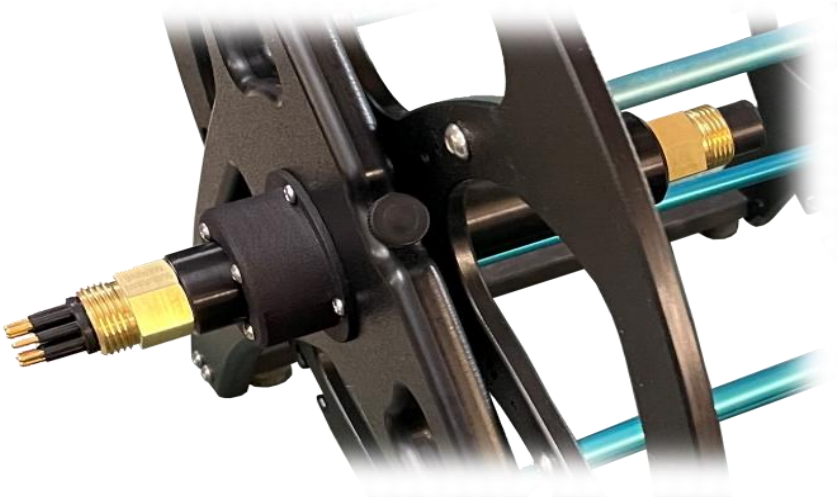
(Voltages may vary depending on E-stop or vehicle being powered on）

- **AC Voltage = AC Input Voltage (Power Source)**
- **DC Voltage = DC Output Voltage to Tether (to the ROV)**
- **DC Current = DC Output Current to Tether (to the ROV)**
- **DC Watts = Power Output to Tether (drawn from ROV)**
- **Temp = current temperature of CPU and PHP temperature**
- **Test LIM (Button) = test ground fault detection (Lin Isolation Monitor, LIM)**
- **Reset LIM (Button) = Reset LIM alarms (Line Isolation Monitor, LIM)**
- **Output on/off (Button) = Toggles power output the same as the output switch**

Components & Accessories

Tether & Reel

High Voltage Slip Ring



Wetmate Connectors (Subconn Type)

Used on the following connection points of the ROV system:

- SPC to Deck Lead
- Deck Lead to Slip Ring on TMS
- Slip Ring to ROV tether (inside the drum of the TMS)
- Tether to VPS
- VPS to Electronics enclosure for both communications and power (optional)

The female side of the wetmate connectors need periodic greasing using a light amount of dielectric grease rubbed into each socket.

Basic Operations

Ballasting (Trimming)

Ballasting: Adding or subtracting weight on the ROV to achieve the desired buoyancy of the SARbot.

Generally, an ROV buoyancy of just 'slightly positive' is optimal for more operations. This means that if the operator stops all commands to the ROV, it will very slowly float towards the surface. There are two main reasons for this:

1. If the tether is severed, the ROV will rise to the surface for recovery.
2. As the ROV approaches a silty and/or muddy bottom, the operator can stop vertical thrust commands and the ROV will float away from the bottom. If the ROV is negativity buoyant, the operator would have to give an ascend command where the vertical thruster will push water downward stirring up the silty/muddy bottom and this will most likely have an adverse effect on water clarity and video camera visibility.

Note: When ballasting the ROV, make sure you roll and tilt the ROV under the water in all directions allowing ALL bubbles to escape any possible entrapment.

Pre-dive

Vacuum Check - Main Enclosure & VPS

To perform the vacuum test, you will need:

- 1 x Hand Operated Vacuum Pump
- 1 x Bag with vacuum hoses and fittings

Assemble the vacuum tee.

Now you are ready to perform the predive vacuum test.

1. Test your vacuum pump to ensure that it is not leaking. This is done by plugging both ends of the vacuum tubes and pulling a vacuum. If the pressure holds solid for 10 minutes, the vacuum should be considered operable

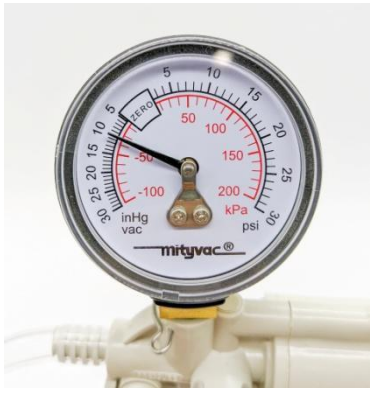
2. Insert one of the vacuum plugs into the VPS vent penetrator.

3. Insert the other vacuum plug into the Electronics Enclosure vent penetrator.

4. Turn the knob on the side of the vacuum pump so it is in the “VACUUM” setting.

5. Pump the vacuum until the gauge reads 10 inHg [34 kPa] vacuum.

It may take quite a bit of pumping before the gauge starts to move. On average it should take 140 to 145 pumps using the provided Mity-vac pump to get to 10 inHg.



6. Let the ROV and pump sit for 15 minutes.

7. If the gauge reads 9.5 inHg [31 kPa] or above after 15 minutes, your seals are acceptable.

If the gauge reads below 9 inHg [31 kPa] vacuum after 15 minutes, you should check the following:

1. Check the VPS and electronics enclosure separately by plugging one of the vacuum tube ends.

2. Make sure that the M3 screws on the front and back end cap of the electronics enclosure are tightened using the M2.5 hex driver. If you are able to tighten one or more, attempt the vacuum test again.

3. Make sure that the penetrators on the VPS and electronics enclosure are fully tightened. Check by attempting to loosen by hand. If you are able to loosen one or more, tighten them then attempt the vacuum test again.

If you are still having trouble holding vacuum, please contact us at support@blue-linked.com .

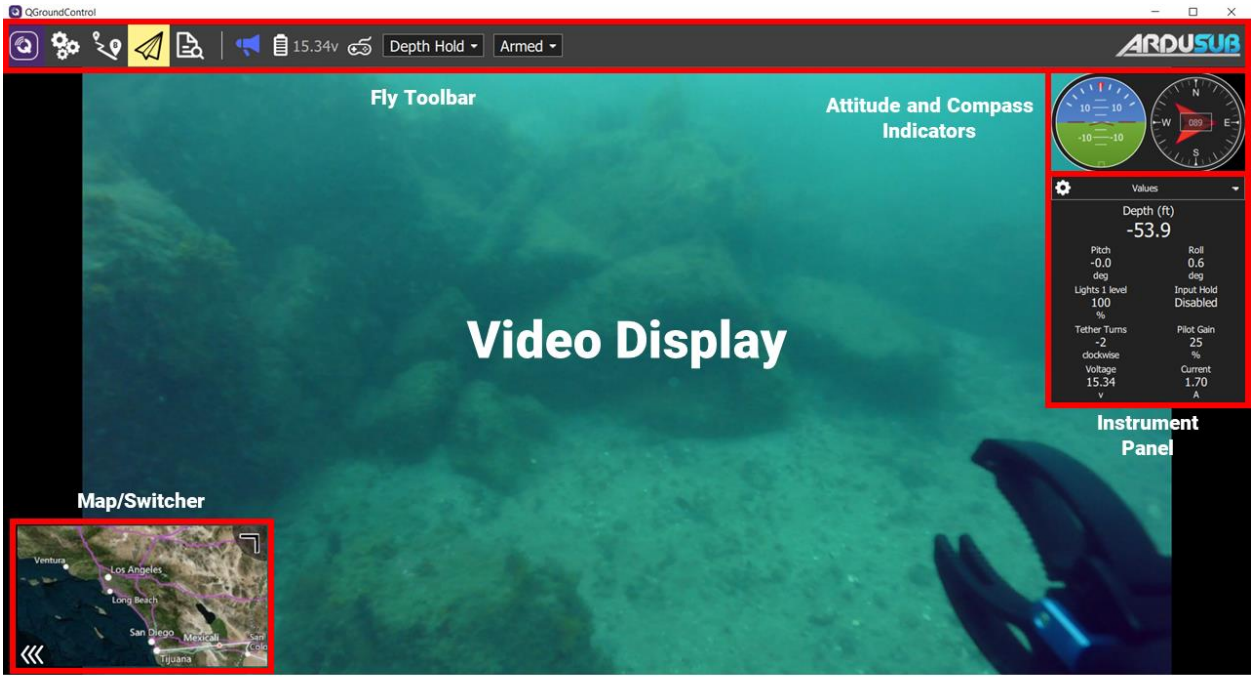
Pre-dive Checklist

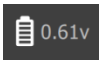
This checklist should be performed every time prior to putting the ROV in the water.
(Important: The tether should NEVER be attached or detached to/from the ROV while the ROV power switch is in the "on" position.)

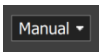
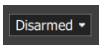
	Vacuum Check the ROV. **(REPLACE VENT PLUGS AFTER VACUUM CHECK)**
	Connect AC power cable to SPC.
	Connect the orange 8m deck lead to SPC and slip ring on the tether reel. (Make sure the deck lead does not pose a tripping hazard around the work area.)
	Connect tether shackle to ROV. (This should ALWAYS be done prior to connecting the tether connector to the ROV.)
	Connect the tether connector to the VPS.
	Connect USB Hand Controller
	Visually inspect ROV for any damage, loose screws and loose frame.
	BEFORE powering on the system, check that all propellers spin freely
	Extend gripper arm to full reach
	Power on the system by 1. Pressing the silver power button (PWR). (Should take ≈ 45-60 seconds to boot up.) 2. Make sure E-Stop is released. **3. Wait until 5" screen on lower panel states "READY"** 4. Twist Power Output switch to the "on" position. (You should hear the ROV power up at this point by making several beeps and whistles.) (For more details, see the "System Power Up" section below.)

	Check that the ROV has connected to QGC. ● Open QGC software for the ROV. ● Live video feed from ROV is visible. (This can take up to one minute.) ● Live telemetry data from ROV is displayed. (Quickest way to confirm this is to rotate the ROV left/right and confirm the compass is responding.) ● Open FLS software and any other accessory software.
	Using the hand controller, “arm” the ROV and in “manual mode” check that the lights, gripper and thrusters are all working. Disarm ROV.
	Check that the FLS on the ROV has connected to Sonar Software and any other accessory software.
	DO NOT FORGET TO REPLACE VENT PLUGS AFTER VACUUM CHECK. **DO NOT FORGET TO REPLACE VENT PLUGS AFTER VACUUM CHECK.** **DO NOT FORGET TO REPLACE VENT PLUGS AFTER VACUUM CHECK.**

QGC Software



	Configure the QGroundControl application
	Configure and tune your vehicle
	Waypoint is not available in Ardu-Sub. Additional sensors will need to be added in order to use.
	ROV Operator View - Control and monitor your ROV, including streaming video
	Download logs, and access the MAVLink console
	Click to show a dropdown of messages from the vehicle. This will change to a Yield sign if there are critical messages
	Voltage supplied the ROV

	Click to show the joystick status. The icon will be red if no joystick is connected and/or it is not enabled. After a joystick is calibrated and enabled, the icon will turn white.
	Current flight mode. Click or press an assigned button to change flight mode.
	This dropdown shows the arming status of the vehicle

Site Survey

Practically every deployment site will be different so it is important to build a habit of taking a close look around the operational area prior to deployment.

What to look for:

- Set up of surface operating equipment (SPC, generator, extension cords, etc.)
  Things to consider:
  - Where the sun is and where it is going to be. Even though the SPC has a high nit LCD which is specified as sunlight readable, keeping direct sunlight off the LCD will result in better viewing.
  - Foot traffic from the public and other personnel connected to the deployment.
  - Where power will be supplied to the system.
  - What areas are you attempting to access and will the tether reach to those areas from where you want to set up.
  - Access to the water for deploying and recovering the ROV.

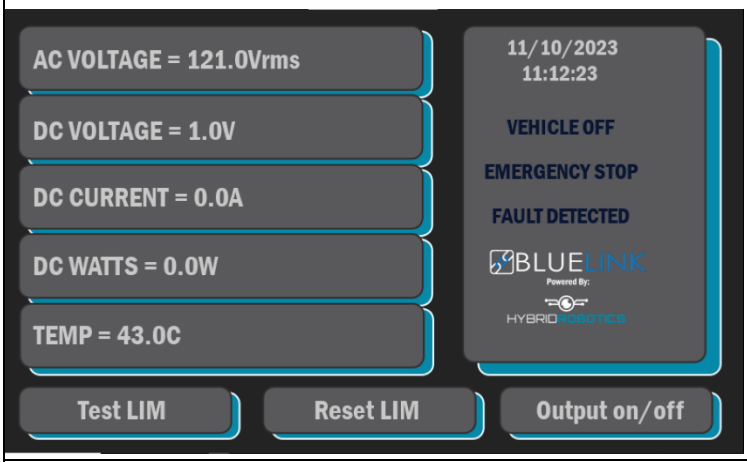
- Operating Environment (river, lake, coastal, offshore, etc.)
  Things to consider and look for:
  - Visible objects in the water that are partially submerged or completely submerged.
    - Example – There may be an intake pipe that enters the water nearby. This can be used for orientation and/or navigation while operating the ROV.
  - Water currents and eddies.
  - Surface boating traffic.
  - People fishing nearby.

System Power Up

Power Up SPC

1. Push power button ON blue LED will appear

2. Check power levels on display for proper levels shown below.



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- **DC Voltage = DC Output Voltage to Tether (to the ROV)**
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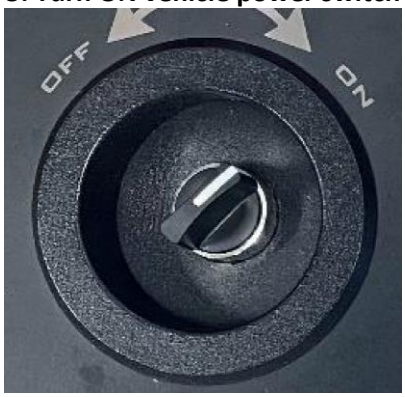
- **DC Watts = Power Output to Tether (drawn from ROV)**

Power Output to ROV

4. Make sure E-Stop is released

5. Turn ON vehicle power switch



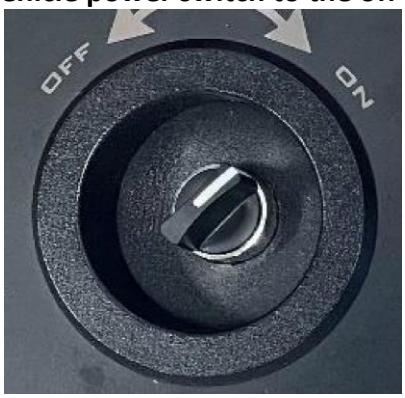
Note: Following turning on power to the ROV, you should hear a series of beeps and whistles coming from the ROV. This confirms power is supplied to the ROV successfully.

(The beeps are a good way to troubleshoot too. The actual sound is produced from the thruster, so a thruster needs to be connected to an ESC properly for it to produce sounds. There should be five beeps total:

- *The initial 3 rising beeps happen as soon as the ESCs receive power. These beeps are produced regardless of whether the ESCs are connected to a signal source or not. They are a good indicator of the ESCs receiving power.*
- *The next low beep is an indicator of the ESC detecting a signal source on its signal wire. If you don't hear this beep it could be an indicator of a problem with the signal source, e.g., a problem with the Pixhawk.*
- *The final high beep indicates that the ESC has received the correct arming signal and is ready for operation. If you don't hear this last beep it means a correct arming signal is not being sent to the ESCs.)*

System Shutdown

1. Turn vehicle power switch to the off position.



2. Shut down the computer in the SPC through the Windows terminal.

3. Push the power button and the blue LED will disappear.

4. Unplug the main power from the power source.

ROV Operations

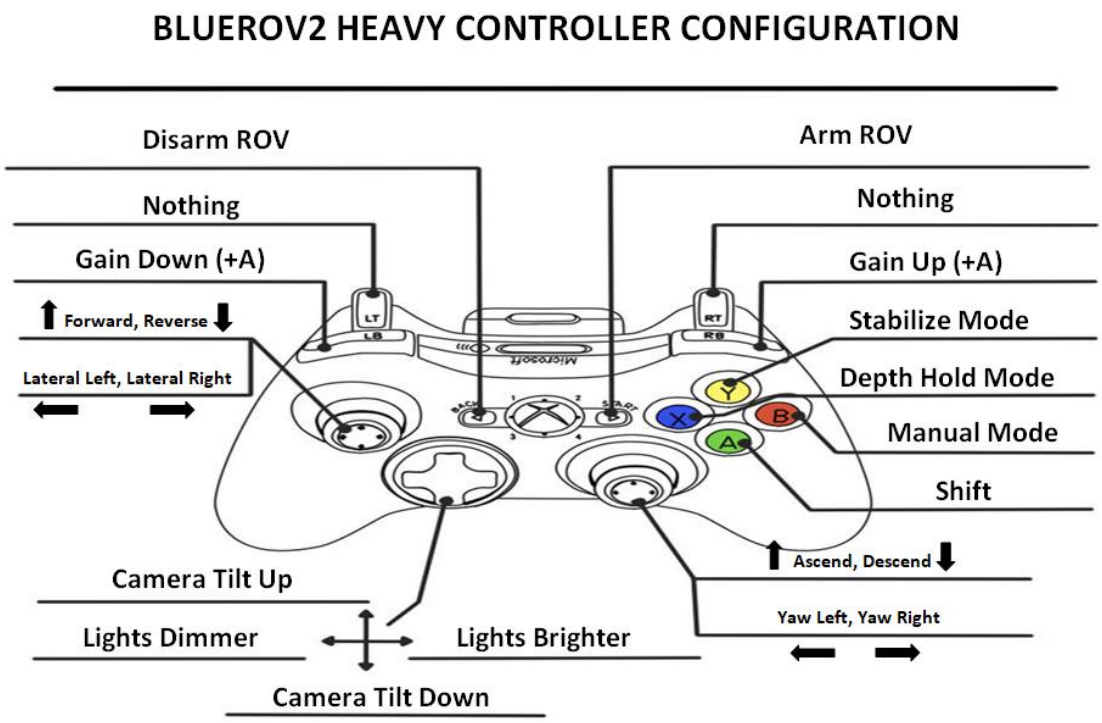
Safety

1. Most importantly is understanding that this ROV system can have high voltage both at the surface and at the ROV. Attempting to open, access, repair, inspect the electrical components of the ROV system is not recommended.

2. Keep the ROV system and all its components in a controlled and/or locked area where a person who does not have familiarity with the system cannot attempt to set it up and operate it.

3. Confirm that all connectors are properly connected and fully engaged prior to power up.

Hand Controller Layout



Changing the Button Setup

If you do not like the button settings, you can change the button setup in QGroundControl.

1. Go to *Settings* then select “Joystick”.

2. Under “Button actions:” QGroundControl shows what all buttons are currently set to control.

3. Press the button that you are interested in changing. The button number will light up.

4. Select what you would like the button to do from the dropdown to the right of the button number.

Operation Modes:

- In **Manual Mode** the ROV will only output motor controls based on the pilot input from the joysticks. There is no feedback stabilization, heading holding, or depth holding.
- In **Stabilize Mode** the ROV will stabilize roll to level and it will maintain heading when not commanded to turn. The vertical control is left entirely to the pilot.
- In **Depth Hold Mode** the ROV will hold depth unless you command it to dive/ascend. It will also stabilize roll to level and maintain heading when not commanded to turn.

Orientation

Prior to deploying the ROV into the water, you should already have located North and potential underwater landmarks like pier pilings or other structures. Once in the water, orientate the ROV to North and make target observations using the image the FLS is providing. Once you have comfortably observed what is to the North of the ROV, slowly rotate the ROV 360 degrees making the same observations to get familiar with the immediate environment around the ROV. Make note of major targets and/or underwater structures not seen from the surface.

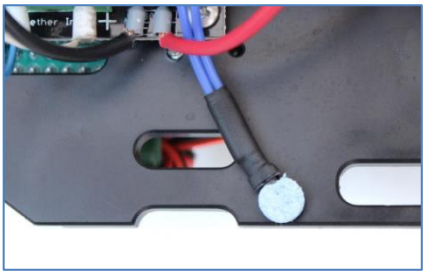
Tether Management

When deploying the ROV the tether will require some active management. Here are some guidelines for good tether management:

- Maintain the minimum length of tether in the water for successful operations.
- Keep the tether away from propellers or jets if you are operating on a boat.
- Keep the tether and ROV away from other boats that are not aware that it is in the water.
- Keep the tether away from sharp objects such as coral, rocks, etc.
- Do not deploy too much tether. Excess tether in the water will add drag to the ROV and opportunity for the tether to get caught on something.
- Do not deploy the tether over sharp edges or rough ground.
- Do not step on the tether.

Water Leak Detection

Inside the ROV there are leak detectors along the bottom of the main bracket in the electronics Enclosure. If water enters the electronics enclosure while the system is powered on, a "Water Leak Detection" warning will pop up in QGC. If that happens:



- Priority is to cut power to the ROV.
    - Note: Make sure the ROV is in a retrievable location before cutting power.
- Once power has been cut, pull the ROV back to your deployment site, retrieve the ROV and set on a flat surface.
- Inspect for water ingress.
    - Note: If the ROV has the black aluminum tube (and not the acrylic tube), it may be hard to determine if water has entered the electronics enclosure. Raise the rear of the ROV up to a 45 degree angle. This will allow water to drain to the main view port where the camera is located. If you do not see water by doing this, it does not mean there is no water inside. It just means that most likely only a very little water entered.
- Please see 'Troubleshooting' for further instruction.

Deployment Log Book

[See Appendix for the Dive Log Sheet & Dive Log Table]

Postdive

Checklist

	AFTER THE SYSTEM IS DISARMED AND POWER OFF….
	Disconnect tether connector from ROV
	Disconnect shackle
	Spool remaining tether onto reel
	Properly coil and pack power cable and deck lead
	Inspect ROV for damage and rotate thrusters by hand to make sure thrusters are free spinning
	Thoroughly rinse ROV with fresh water
	Let ROV and any wet components completely air dry prior to storage.

Storage

Short Term

If you have a break between dives where the BlueROV2 is out of the water for more than 15 minutes, make sure to keep it in a shaded area. If there is no shade nearby, a towel draped over the ROV will supply sufficient shade.

Long Term

DO NOT STORE ANY COMPONENTS OF THE ROV SYSTEM DAMP OR WET. MAKE SURE EVERYTHING IS THOROUGHLY DRY.

Maintenance

Every 24 Hours of Operation or Every 2 Months

- Visually check the radial seals on the electronics enclosure are lubricated with silicone grease and intact (not cracked or sliced).
- Inspect all thrusters and make sure all are spinning freely. If any are not spinning freely, it may be necessary to detach the thruster from the frame and remove the propeller for inspection.

Every 100 Hours of Operation or Every 6 Months

- Replace radial electronics enclosure cap O-rings on the flanges at both ends of the electronics enclosure.
- Replace vent plug O-rings on both the electronics enclosure and VPS.
- Remove all tether from reel for cleaning and removing any twists in the tether. This is best done on a large sports field.

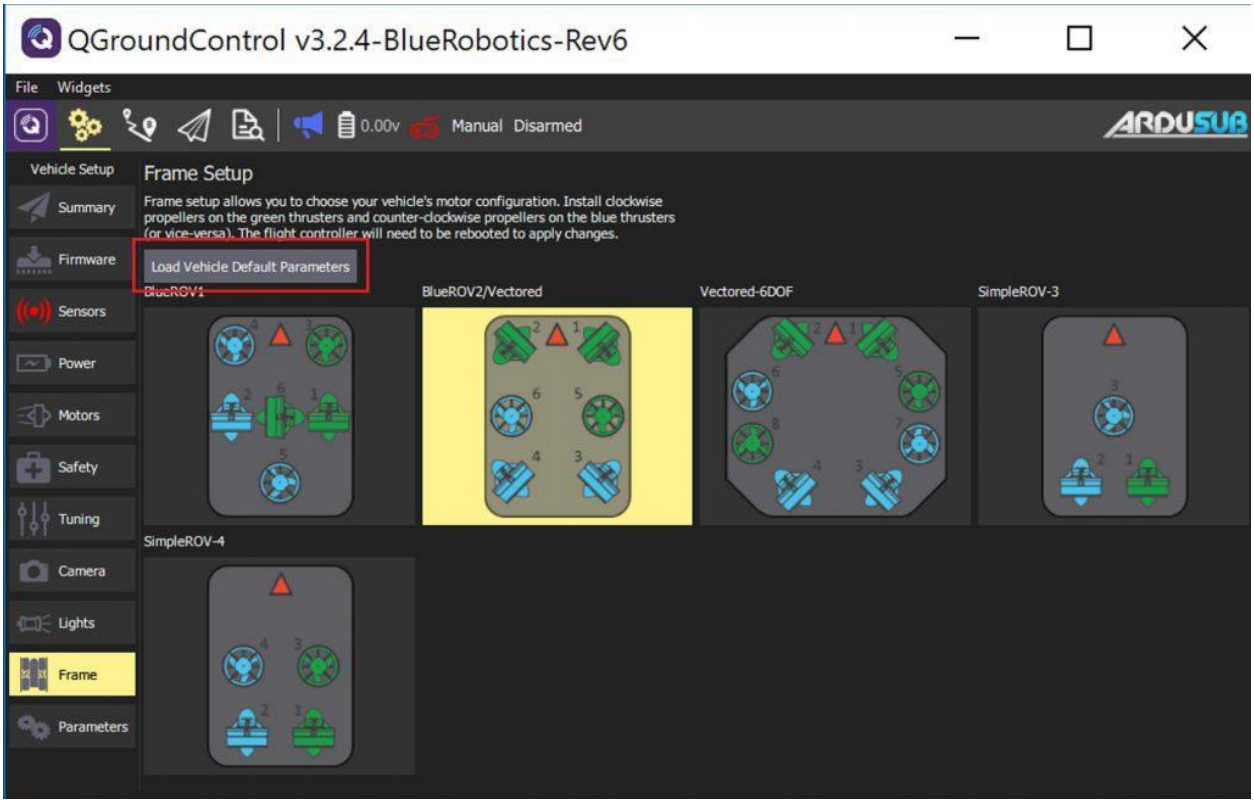
TroubleShooting - Hardware

NOTE: QGroundControl Software updates fairly frequently. If the below information and screen captures do not match the version of the QGC software your system is running, please see the link below for more up-to-date information and guidance.

https://docs.qgroundcontrol.com/master/en/

Camera Tilt and/or Lights not operating when appropriate buttons pushed.

- If your camera tilt or lights do not work when the appropriate buttons are pushed, please reload the *BlueROV2* default parameters.
- Navigate to the *Frame* tab of the *Vehicle Setup* page and select *Load Vehicle Default Parameters* and then either *Blue Robotics BlueROV2* or *Blue Robotics BlueROV2 Heavy* depending on your hardware configuration.
- Wait for the green loading bar to finish writing the parameters.



- Follow the respective guide for re-entering the parameter values for the Power Module (depreciated) or Power Sense Module (current).

TroubleShooting - Software / Firmware

Vehicle Control

Vehicle has telemetry (video and sensor info) but does not respond to joystick

Make sure you followed the instructions in Joystick/Gamepad Calibration and that the "Enable joystick input" checkbox is checked.

Vehicle flips itself over

Check that the motor directions are configured correctly. Also check that the motors are connected to the correct motor outputs on the flight controller, according to the supported frame diagrams.

Vehicle turns or moves even when not controlled to do so.

Please check RCx_TRIM parameters to make sure that all trims are set to 1500, with the exception of RC3_TRIM, which should be set to 1100.

Motors spin as soon as the vehicle is armed.

Make sure that the vehicle is in *Manual* mode.

The flight controller attempts to stabilize the vehicle's attitude so that it is perfectly level. If the vehicle's attitude is off from level, even a fraction of a degree, the flight controller will spin the motors in an attempt to correct the error. If the vehicle is sitting on land, the error will not change, and the flight controller will spin the motors faster and faster as it tries harder and harder to correct the error. Testing the vehicle on land should be done in MANUAL mode, which just passes pilot inputs to the motors with no stabilization.

Surface Power Supply Outputs

To test that the SPC is outputting the proper power to the ROV, please follow these steps:

(NOTE: These tests involve high voltage power that can be very dangerous. Please do not attempt to perform these tests if you are unfamiliar with this level of power testing.)

Pin 1 on the deck lead and tether is the high voltage power.

Pin 5 on the deck lead and tether is the high voltage ground.

**For more information on the pinouts of the different connectors on the system, please see appendix.

Using a multimeter, pin 1 + pin 5 should read with the ‘Power Switch’ in the ‘on’ position:

- ~385 volts DC output to the ROV.

TroubleShooting - Errors

"No io thread heartbeat" message constantly appears.

This message indicates that the APM io thread has stopped running. The most likely cause is a corrupted filesystem on the micro SD card. Remove the card from the pixhawk, and format it as FAT32. If the error persists, you will need to replace the SD card, or disable dataflash log files by setting the LOG_BACKEND_TYPE parameter to None (0).

No Telemetry / "Waiting for Vehicle Connection" (No Autopilot Connection)

Verify Network Configuration

Verify that your network settings are correct. Verify your network configuration by entering the command `ipconfig` (Windows) or `ifconfig`(Mac/Linux) on the surface computer command line. The output should show that your Ethernet IP address is 192.168.2.1 and the subnet mask is 255.255.255.0.

Carefully double check that you have entered these numbers correctly. The Ethernet IP address should be *exactly****192.168.2.1***and the subnet mask should be *exactly****255.255.255.0***.

You should be able to ping the companion computer from the surface computer. On the surface computer's command line enter:

```
ping 192.168.2.2
```

If you do not get a ping response, then something is wrong with the network communication between the surface computer and the companion computer. You may have to adjust your firewall and/or antivirus settings to allow QGroundControl access to the network.

Firewall and Antivirus

Antivirus and firewall software can block the incoming connection from the ROV. Make an exception/rule to allow *inbound and outbound* traffic on UDP ports 5600 and 14550, or turn off your antivirus and firewall software.

Cabling

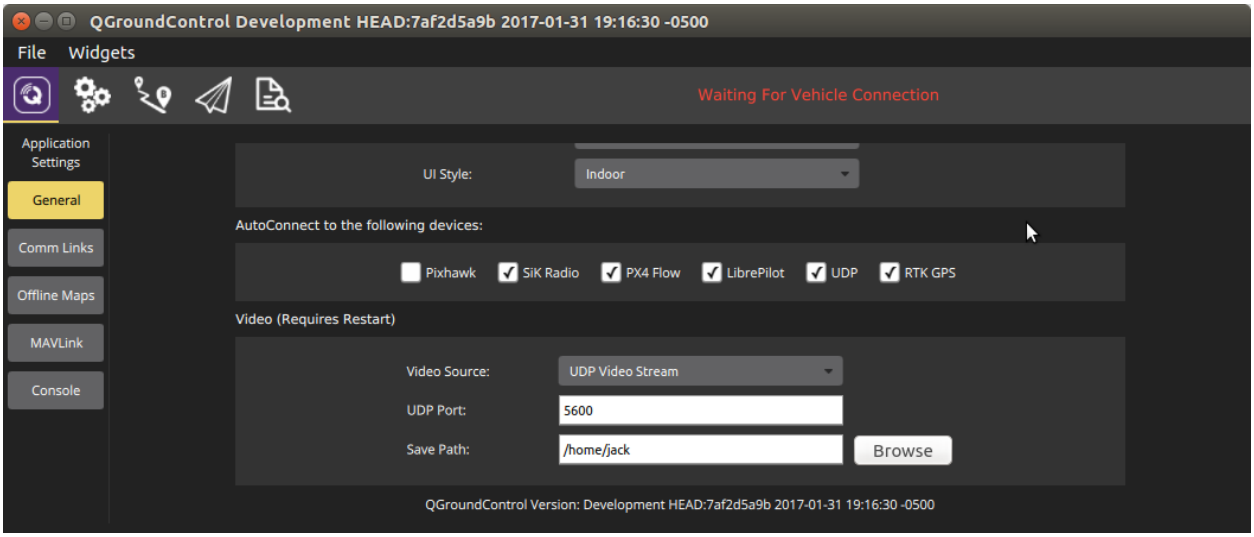
Try replacing your Ethernet cable. Sometimes the wires inside a cable break, and the cable stops working.

Reboot Computer

If you are using Windows, sometimes the computer needs to be rebooted for network settings to take effect.

Verify QGC Auto Connect settings

Make sure that the QGroundControl is configured to automatically connect to UDP and USB links. Click on the 'Q' icon in the upper left to view the Application Settings. Click on the 'General Settings' tab. In the options for 'Auto Connect to:', make sure the UDP option is checked.



Verify Autopilot USB Connection

Check if the Autopilot is connected with following steps:

Navigate to the system page in the Companion web interface

Check the list of detected serial devices for an entry that says`Pixhawk Autopilot`

If you do not see an entry that says `Pixhawk Autopilot`, check the autopilot connection with the Companion computer.

You can test the autopilot and the usb cable by connecting the autopilot directly to your surface computer and checking the connection with QGroundControl.

If you cannot connect to the autopilot:

Try using a different usb cable. Make sure that the USB cable has data lines, some USB cables only provide power and will not allow communication. You can connect the Pixhawk to the surface computer directly with the USB cable to verify that the USB cable works.

Try connecting the autopilot to a different usb port

Try replacing the autopilot

If you see an entry in the detected serial devices list that says`Pixhawk Autopilot (bootloader)`, you must flash the autopilot with ArduSub firmware. Click the 'Restore Default Firmware' button on the system page, and wait for the text on the bottom of the page to indicate that the process is complete.

If you do not see the system web page, make sure the companion computer is powered on with a supply that is capable of delivering at least 2A. Check the activity lights on the Raspberry Pi Ethernet Jack. The lights should be on or blinking. If the lights are not on, make sure that you are using a network patch cable, not a crossover cable. Look closely at the color of the wires inside connectors on either end of the network cable, the order of the wires should be the same on both ends of the cable. If everything appears ok with the companion computer and the physical network connection, check your network settings (below).

Check MAVProxy

If your network is configured correctly, but you still have no telemetry, we need to make sure that MAVProxy is running on the companion computer and that the autopilot and MAVProxy are communicating.

To verify that MAVProxy is running, visit the system page in the companion web interface, and look for the `mavproxy` entry under the list of active services.

To verify that MAVProxy and the autopilot are communicating, log into the Companion computer via the web terminal, ssh, or PuTTY (user: pi, password: companion), and enter the command:

```
screen -r mavproxy
```

If Mavproxy and the autopilot are working correctly, the output should contain something like this:

```
APM: ArduSub V3.4 (422c10cf)
```

```
APM: PX4: 96a4c296 NuttX: 580f5354
```

```
APM: Frame: ROV_VECTORED_FRAME

APM: PX4v2 0048003B 3135510C 35333436

Received 608 parameters

Saved 608 parameters to mav.parm
```

To return to the command line and keep the mavproxy process running, press ‘Ctrl’ + ‘a’ then type 'd' (to detach).

If you still do not have telemetry after all of these steps, please reboot the surface computer and the companion computer, and try again. If it is still not working after rebooting, please send an email to support@blue-linked.com with notes on your results of all of the above troubleshooting steps, and we will assist you as soon as possible.

Reset MavProxy Options

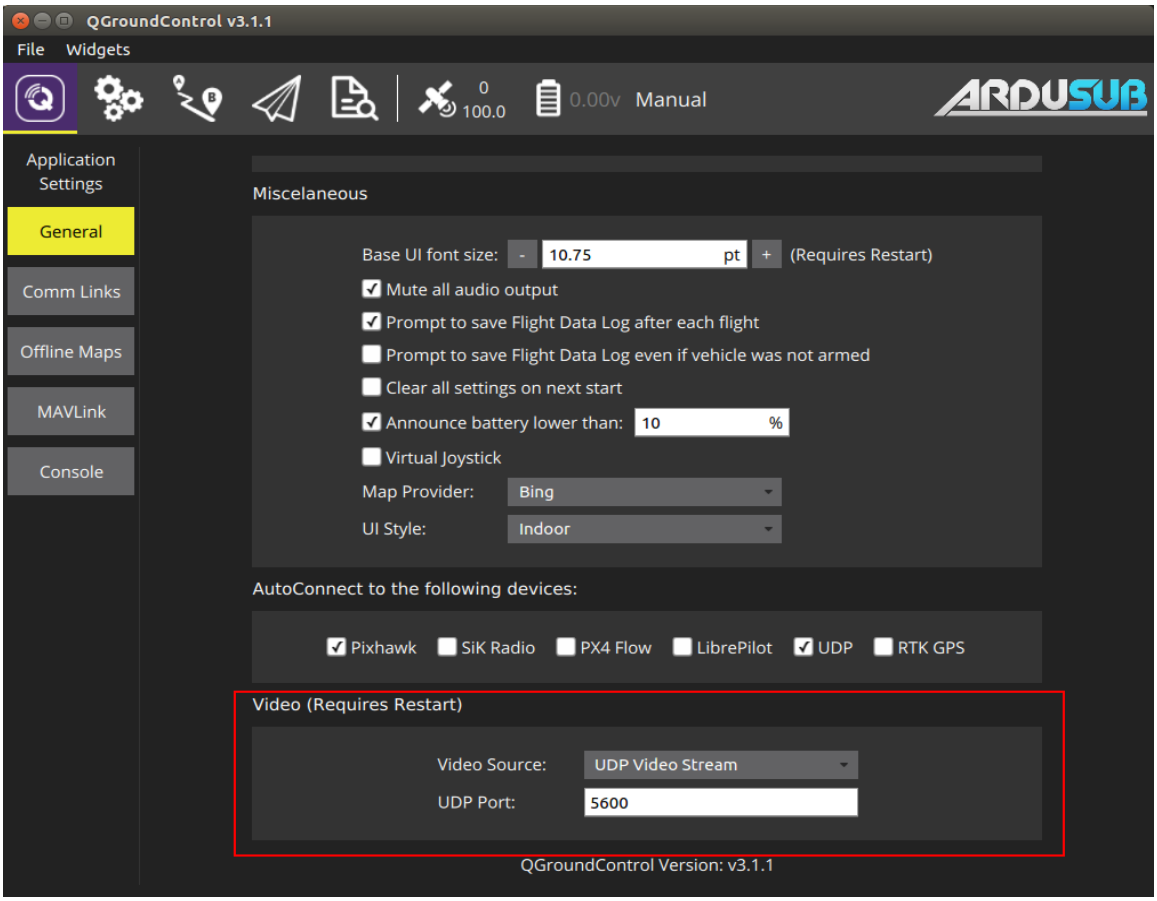
Some updates require changes to the MavProxy options. To avoid overwriting user changes, those do not apply until you **Restore Default Options**. Navigate to the MavProxy page and click **Restore Default Options**. This will erase the current options, revert to the default for the current companion version, and reset the MavProxy service.

Trouble Shooting – Video Stream

NOTE: If you also do not have telemetry, please troubleshoot that first according to the above instructions.

Begin by verifying that your network settings are correct, your Ethernet IP address should be 192.168.2.1 and the subnet mask should be 255.255.255.0 and your default gateway should be set to 192.168.2.50.

If you have telemetry, but no video, make sure the video settings are correct in QGroundControl. The video settings are found in the General tab of the Application Settings (Q icon) view. The video source should be set to UDP video, and the port baud rate to be 5600. These are the default settings. If you change these settings, you will need to close and relaunch QGroundControl.



Verify that your camera is detected by seeing it listed under the detected video devices section on the Companion system webpage. If your camera is not detected, make sure that the camera supports H.264 video output, and make sure the cable is well-seated into the connector. If still failing try another camera cable.

Verify that the video streaming service is active; it should be listed under the active services on the Companion system webpage.

If you are using a Windows computer:

- Disable/re-enable the network interface
- Reboot
- Launch QGC as an administrator, by right clicking the program and selecting “launch as administrator”
- QGC installs three shortcuts: *QGC*, *QGC (GPU Safe Mode)*, and *QGC (GPU Compatibility Mode)*. Try launching QGC with each of these shortcuts

Poor video streaming performance

The video stream should have about 200ms delay, just barely noticeable. There are many factors that could cause lag, low framerate, and pixelation/tearing in the video.

Here are some tips for troubleshooting poor video performance:

In general:

- Bandwidth - Test the bandwidth at 192.168.2.2:2770/network. The maximum theoretical bandwidth on a Raspberry Pi 3 is 100Mbps, if the bandwidth tests achieve greater than 70Mbps, it is a very good connection. Systems with bandwidths below 15Mbps should be diagnosed for issues.
- Try another cable - Not all cables are created equal; some are junk.
- Update Software - Use the latest software to make sure you are getting the best performance.
- Companion computer power supply - Most companion computers require a power supply capable of providing 5V at 2A. Smaller/weaker power supplies can severely affect performance of the companion computer.
- Tether interface power supply - If you are using a tether interface board, make sure it has a solid power supply. Some laptop USB ports cannot provide enough power for the tether interface board to perform optimally. Try using a portable USB battery charger.
- Tether interface connections - Make sure that all connections are well-seated and tight.
- System resources - Open the system resource monitor (or task manager) and look at how much CPU and RAM your computer is using. Try closing other unused programs like internet browsers and screen recorders to make more system resources available to programs used to operate the vehicle.
- Resolution - Modify the video stream Frame Size at 192.168.2.2:2770/camera. Change it to a value equal to or less than the resolution of your display(be aware that this can cause distortion in your video depending on the resolution or aspect ratio you chose)

If you are using a Raspberry Pi camera:

- Delete the '--intra 1' setting at 192.168.2.2:2770/camera and restart the camera.
- Update the companion computer software at 192.168.2.2:2770/system.

If you are using a Windows computer:

- **Upgrade to Windows 10!**
- When using the original power supply that supplies the laptop (but not charging at the same time) there is something in the settings that slowsdown the graphics card to save energy. That makes the processor do some of the graphics calculations. (And actually consume even more energy!) Solution: Go on battery or use a large power supply (in our case 120W) How to

quicklycheck if this is the problem: pull out power supply, if this is the case, latency disappears in two seconds.

- Nvidia powerful graphic cards use an engine called PhysX for games etc. It seems QGC does not use that. Also QGC works default on motherboard graphic card, not on the more powerful Nvidia extension card. Solution: In Nvidia's “control panel” select under “Programs” QGC so Nvidia forces QGC to use an Nvidia card. Some graphic cards also needs tweaking in Nvidia 3D setup (same place as above line)
- Real crazy in a few computers: Switch system fonts from 125% size to 100% (Right click desktop, “adjust screen” then “monitor” translated from Swedish OS) Check the 100% tick box instead of 125% Logout and log in again, fixed….

Troubleshooting - Miscellaneous

Camera does not tilt

The output servo rail on the Pixhawk requires a separate 5V power supply. The power module and USB power inputs on the Pixhawk will not power the servo rail. Make sure you have a 5V input on the servo rail via an ESC, BEC or standalone BEC.

Check that input/output channels are configured for camera tilt.

Check that joystick buttons have been assigned to camera tilt functions.

Compass heading drifts while the vehicle is stationary

The compass inside of the ROV is very sensitive and will be affected by large iron/steel structures, including rebar in concrete. You will get the best compass calibration outside, away from large structures and concrete. It is possible to calibrate inside, you may need to increase the value of the COMPASS_OFS_MAX parameter before you get a passing calibration. Note that the compass will always be affected by ferrous structures because they distort Earth's magnetic field, however the heading should remain stationary (maybe incorrect) while the vehicle is stationary in any case.

Perform these steps to recalibrate the compass:

- Power on the vehicle and wait 10 minutes to ensure the sensors are warmed up.
- Make sure that the INS_GYR_CAL parameter value is set to 'Never'.
- Perform an accelerometer calibration.
- Perform a compass calibration.
- Reboot the vehicle. The compass should be still.

Appendix

Connector Pin-outs

	Type	Connector	Gender	Connection Device	Wire Gauge	Wire Length	Pinout	Solder Connections
Extension Cord		AC Outlet	Male	Wall Outlet	N/A	N/A		1 & 2 - AC Neutral (White) 3 & 6 - AC Earth (Green) 4 & 5 - AC Line (Black)
	Inline	Binder, 6-pin	Female	SPC	N/A	N/A		
SPC Bulkhead	Bulkhead	Binder, 6-pin	Male	Extension Cord	16-18	8in		
	Bulkhead	Baromax, 8-Pin	Female	Deck Lead	Pins 1 & 5 - 14/16	12in		1 - Vcc - Red 2 - Comms 1 (+) White (Red Pair) 3 - Comms 2 (-) Red (Red Pair) 4 - Shield - Black/Shielding from both pairs 5 - Ground - Black 6 - Comms 2 (+) White (Green Pair) 7 - Comms 2 (-) Green (Green Pair) 8 - Shield - Black/overall shield
					Pins 4 & 8 - 22	12in		
					Twisted Pairs	12in		
Deck Lead	Inline/w bend relief	Baromax, 8-Pin	Male	SPC	N/A	N/A		
	Inline/w bend relief	Baromax, 8-Pin	Female	Slip Ring	N/A	N/A		
Tether	Inline/w bend relief	Baromax, 8-Pin	Male	Slip Ring	N/A	N/A		
	Inline/w bend relief	Baromax, 8-Pin	Female	VPS	N/A	N/A		
VPS	Bulkhead	Baromax, 8-Pin	Male	Tether	Pins 1&5 - 14/16	10in		
					Pins 4 & 8	5in		
					Twisted Pairs	6in		
	Bulkhead	Baromax, 8-Pin	Female	Comms Whip	Twisted Pairs	6in		1 - N/A 2 - Comms 1 (+) White (Red Pair) 3 - Comms 2 (-) Green (Green Pair) 4 - N/A 5 - N/A 6 - Comms 2 (+) White (Green Pair) 7 - Comms 2 (-) Red (Red Pair) 8 - N/A
Comms Whip	Inline/w bend relief	Baromax, 8-Pin	Male	VPS	N/A	27in		
ROV	Bulkhead	Baromax, 8-Pin	Female	Sonar Whip	Pins 1 &2 - 14/16	5in		1 - Vcc - Red 2 - Comms 1 (+) White (Red Pair) 3 - Comms 2 (-) Red (Red Pair) 4 - N/A 5 - Ground - Black 6 - Comms 2 (+) White (Green Pair) 7 - Comms 2 (-) Green (Green Pair) 8 - N/A
					Twisted Pairs	12in		
Sonar	Inline	Baromax, 8-Pin	Male	ROV	N/A	N/A		
Power Whip	Inline/w bend relief	Baromax, 3-Pin	Male	VPS	N/A	20in		1 - N/A 2 - Ground - Black 3 - Vcc - Red
VPS	Bulkhead	Baromax 3-Pin	Female	Power Whip	Pins 2 & 3 - 14	6in		
ROV	Bulkhead	Baromax, 3-Pin	Female	Gripper/Lights Whip	Pins 1 & 3 - 16-18	6in		1 - Ground - Black 2 - PWM Signal - Yellow 3 - Vcc - Red
					Pin 2 - 22	12in		
Gripper & Lights	Inline	Baromax, 3-Pin	Male	ROV	N/A	N/A		

Dive Log Table

ROV Dive Log

Dive No: _____ Sheet: _____ of: _____

TIME	OPERATION

Dive Log Sheet

ROV Dive Log

Vessel: _____ No. of Sheets: _____

Location: _____

Date: _____

Dive No: _____

Operations Crew: _____

_____

_____

Conditions:

_____

_____

_____

Purpose of Dive:

_____

_____

_____

_____

Dive Job Summary:

_____

_____

_____

_____

_____

_____

_____

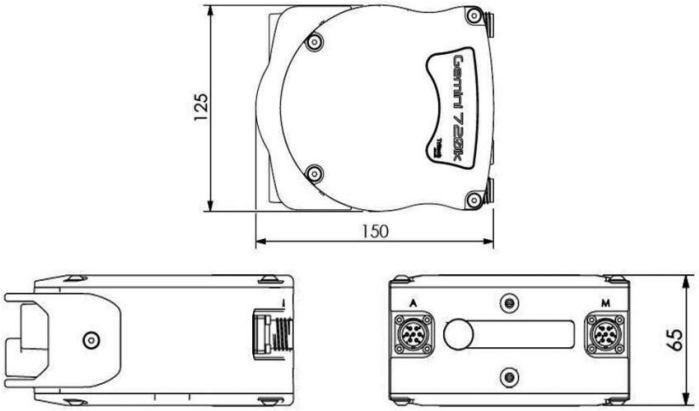
Total Wet Time: _____

Dive Log Complete By: _____ Signature: _____

Forward Looking Sonar

Gemini 720ik

Specification



All dimensions are in mm, not to scale

Acoustic specifications	
Operating frequency	720kHz
Angular resolution	1.0° acoustic, 0.25° effective
Range	0.2m - 120m
Number of beams	512
Horizontal beamwidth	120°
Vertical beamwidth	20° (±10° about horizontal axis)
Update rate	5 - 97Hz (range dependent)
Range resolution	4mm & 8mm[1]
CHIRP support	Yes
Speed of Sound	VoS sensor

Interface	
Supply voltage	19V to 74V DC
Power requirement	16W - 27W (range dependent)[2]
Main port protocol	Ethernet
Auxiliary port (optional)	RS232, TTL in, pass-through power
Connector type	MAIN port: Impulse MKS(W)-307-FCR AUX port: Impulse MKS(W)-307-FCR

Physical specification	
Depth rating	350m
Weight in air	1.40kg
Weight in water	0.43kg
Temperature rating	-10°C to 35°C (operating), -20°C to 50°C (storage)

[1] Software switchable.
[2] The power consumption range quoted is accurate for a standalone unit and ignores cable losses.

Specification subject to change in line with Tritech's policy of continual product development

Marketed by:

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Westhill, Aberdeenshire AB32 6JL
United Kingdom
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Tel: +44 (0)1224 744111

Oculus M750d

oculus

Specification

Mechanical

	M-Series	MT-Series	MD-Series
Dimensions	125mm (L) x 122mm (W) x 62mm (H)	125mm (L) x 122mm (W) x 62mm (H)	125mm (L) *excluding connector* x ø125mm
Construction	Anodised Aliminium	Titanium	Titanium
Weight	980g (Air), 360g (Water)	1350g (Air), 730g (Water)	2.5kg (Air), 1.45kg (Water)
Depth Rating	500m	1000m	4000m
Temp' Range (Operating)	-5°c to +35°c	-5°c to +35°c	-5°c to +35°c
Temp' Range (Storage)	-20°c to +50°c	-20°c o +50°c	-20°c to +50°c

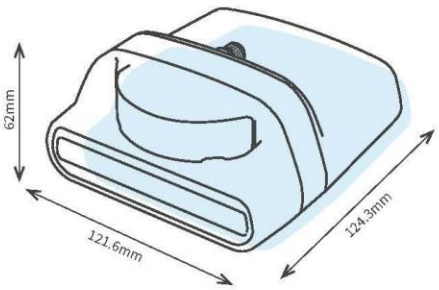
Performance

	M370s MT370s MD370s	M750d MT750d MD750d	M1200d MT1200d MD1200d	M3000d MT3000d MD3000d
Operating Frequency	375kHz	750kHz / 1.2MHz	1.2MHz / 2.1MHz	1.2MHz / 3.0MHz
Range (Max)	200m	120m / 40m	40m / 10m	30m / 5m
Range (Min)	0.2m	0.1m	0.1m	0.1m
Range Resolution*	8mm	4mm / 2.5mm	2.5mm / 2.5mm	2.5mm / 2mm
Update Rate (Max)*	40Hz	40Hz	40Hz	40Hz
Horizontal Aperture	130°	130°/ 130°	130°/ 60°	130°/ 40°
Vertical Aperture	20°	20°/ 20°	20°/ 12°	20°/ 20°
Number of Beams (Max)	256	512	512	512
Angular Resolution	2°	1°/ 0.6°	0.6°/ 0.4°	0.6°/ 0.4°
Beam Separation	0.5°	0.25°/ 0.25°	0.25°/ 0.16°	0.25°/ 0.1°

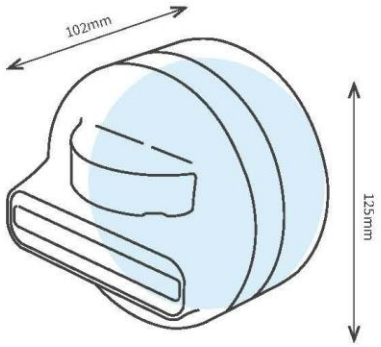
*Indicates parameter is dependent on range.

Please note that all functions & specifications may be subject to change in line with our policy of continual product development.

M and MT-Series



MD-Series



Electrical

	M & MT-Series	MD-Series
Connector	Impulse IE55 Series, 6-way	Impulse MC Series, 6-way (Schilling SeaNet / Burton option)
Communications	4-wire 100-BaseT Ethernet, 2-wire DSL extender module	4-wire 100-BaseT Ethernet, 2-wire DSL extender module
Supply Voltage	12V to 32V DC non-isolated	18V to 32V DC isolated
Power Consumption	10W to 35W (model and range dependent*)	10W to 35W (model and range dependent*)
Integrated Sensors	Water pressure and temperature (for Velocity-of-Sound calculation)	Water pressure and temperature (for Velocity-of-Sound calculation)

DA 148 P01443 05

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