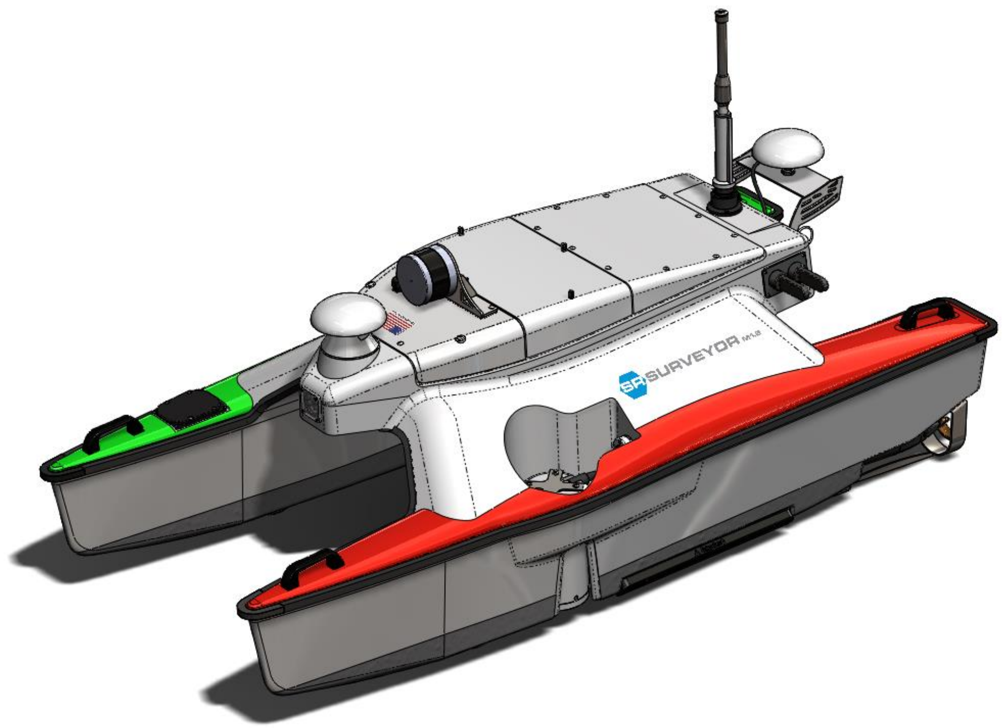
MANUAL, OPERATIONS and MAINTENANCE, SURVEYOR



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Potential Hazards

SeaRobotics Corp. autonomous surface vehicles (ASVs) are safe and reliable systems when used and cared for properly. However, certain hazards do exist and should be carefully observed. It is impossible to anticipate all unexpected conditions that may occur, particularly in difficult marine environments. This document is written for use by trained, competent, experienced personnel. Backup and/or supervisory personnel should be present when warranted by work conditions. It is assumed that personnel are known to be able to work safely and effectively in the demanding conditions frequently encountered in marine and offshore environments. Furthermore, it is assumed that personnel have been trained in the recommended service procedures of SeaRobotics Corp. products, including the use of common hand tools and any special SeaRobotics tools that may be required.

Thruster Propellers

Keep propellers clear of obstructions. Do not put fingers near propeller at any time. Be careful with loose clothing. A “Kill Switch” is supplied which disables power to the thrusters. The switch should be kept in the “Kill” position (lanyard pulled out, switch toggle pointing down) whenever the ASV is not in operation.

Liability

SeaRobotics Corp. shall not be held liable for improper procedures resulting in damages, injuries, or losses as a result of the improper following of procedures. Additionally, SeaRobotics Corp. shall not be held liable for any damages, injuries, losses, or problems associated with a system that has been modified without written consent from SeaRobotics Corp.

Lithium-Ion Batteries

This vessel contains lithium-Ion batteries which are designated Class 9 Hazardous Materials. Care must be observed in handling, transporting, and charging of these batteries. The customer is fully responsible for shipping and/or transportation of the batteries. Rules and regulations regarding the freight of Li-Ion batteries vary region to region. Prior to shipping Li-Ion batteries by land, air, or sea, contact a local authority to ensure compliance with rules and regulations.

IMPORTANT! NEVER SPRAY ELECTRICAL ENCLOSURES OR CONNECTORS WITH HIGH PRESSURE WATER! Remove high pressure nozzles from hoses to flush all components with low pressure fresh water after each use.

IMPORTANT! NEVER USE POWER TOOLS WHEN SERVICING THIS VEHICLE. Doing so could damage the vehicle and cause failures. All fasteners are to be tightened with hand tools only.

Always inspect vehicles with POWER OFF.

How to use this User’s manual

This manual should be thoroughly reviewed prior to operating the ASV. Ensure the instructions are understood.

Abbreviations & Definition of Terms

	Definition
AIS	Automatic Identification System
ASV	Autonomous Surface Vehicle
AUX	Auxiliary
BCU	Boat Control Unit
CFE	Customer Furnished Equipment
COTS	Commercial-off-the-shelf
DAC	Data Acquisition Computer
dBm	Decibels ref. 1 mW
DOF	Degrees of Freedom
ERP	Emergency Recovery Point
FAT	Factory Acceptance Test
GUI	Graphical User Interface
GNSS	Global Navigation Satellite System
ICD	Interface Control Document
I/O	Input / Output
INS	Inertial Navigations System
Li-Ion	Lithium-Ion
LOS	Line of Sight
MEMS	Micro-Electromechanical Sensor
MPES	Multi-Phase Echo Sounder
MRU	Motion Reference Unit
NTRIP	Network Transport of RTCM via Internet Protocol
OIS	Operator Interface System
PDU	Power Distribution Unit
PGN	Parameter Group Number
POE	Power Over Ethernet
PPS	Pulse Per Second
PTC	Positive Temperature Coefficient (self-resetting fuse)
PTZ	Pan / Tilt / Zoom Camera
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematics
RUDICS	Router Based Unrestricted Digital Internetworking Connect Solution
SBD	Short Burst Data
SIM	Sonar Interface Module
SPS	Standard Positioning Service
SRC	SeaRobotics Corp.
SST	Stainless Steel
SWL	Safe Working Load
USV	Unmanned Surface Vehicle
VDC	Volts, Direct Current
VNC	Virtual Network Computing
VIN	Vehicle Identification Number
VPN	Virtual Private Network
VSP	Virtual Serial Port
VRS	Virtual Reference Station
WAAS	Wide Area Augmentation System
Wi-Fi	Wireless local area network

Reference Documents

Reference Documents		
Item	Doc. No.	Title
1		Schematic, ASV 1.8M
2		
3		

1.0 Introduction

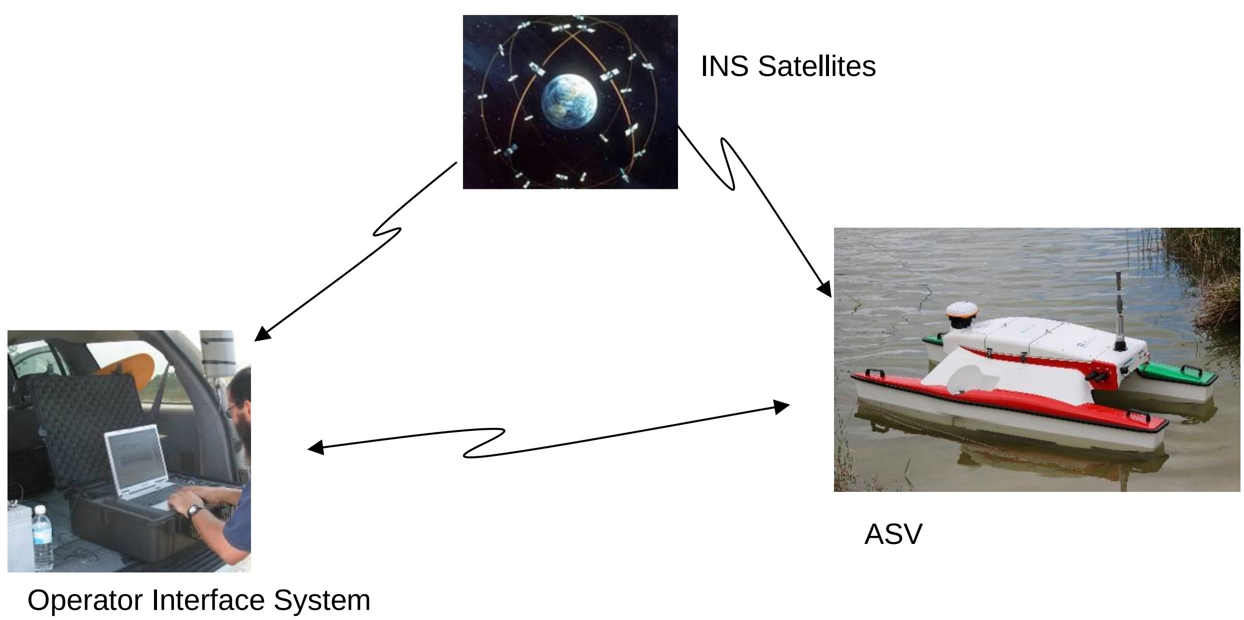
This manual describes the basic operation and usage of the ASV system.

The system is comprised of the ASV and an Operator Interface System (OIS). Ancillary equipment includes the battery charger and the antenna tripod.

The system can be run in various modes of operation from manual to fully autonomous control. The system utilizes the Operator Interface System (OIS) for bi-directional communications with the vehicle via a 2.4 / 5.8Ghz radio for monitoring, mission modification, or manual control in all modes. Additionally, a satellite receiver is incorporated in the vehicle which can utilize various methods of differential correction.

The design of the system is intended to maximize the use of Commercial-Off-The -Shelf (COTS) sensing hardware and software. The catamaran design is an ideal solution to the requirement for shallow water (minimum draft), stable operation. Consistent with the emphasis on use of COTS equipment the OIS software is designed to utilize the payload sensors “native application” software wherever possible. This will preserve standard data formats and file structures required for post processing and presentation of the sensor data.

The ASV system utilizes software and sensing hardware which are supplied by manufacturers other than SeaRobotics, as such the user must consult the manuals supporting these components for detailed instructions on their use. Information not found in the manual may be available directly from SeaRobotics. See Appendix of a list of the manufacturers and their contact information.



2.0 Specifications

Vessel

General	One-to-two man portable remote and autonomous vessel tightly integrated with an array of sensors
Mission profiles	Bathymetric surveys, Water quality studies, source water volumetric calculations, pollutant identification and mapping, habitat mapping, etc.
Operating Environment	Beaufort force 3 Salt or freshwater
Hull Form	Catamaran hull
Construction	Glass Reinforced Plastic
Size	Length = 1.8 meters (5.9') Width = 0.86 meters (2.8') Height = .8 meters w/o antenna (2.6') Draft = 0.18 meters (7") with all options Base Weight = 57 kg (125 lbs.)
Thrusters	2x fixed brushless electric thrusters, 24 VDC
Steering	Differential thrust
Max Speed	Forward: 7.5 knots Reverse: 4 knots
Battery	1x 29 VDC (nominal) Lithium-Ion battery 1500 Watt-hour 60 Amp max discharge rate 29.4V to 20.0 V (Max to Auto Shut-Off)
Power Supply	12 vdc, 200 watt
Backup Power Supplies	Redundant board mount for control and DAC computers, provide routine shutdown of computers in the event of power shutdown or loss
Estimated Endurance	8.5 hours @ 2 knots 6.0 hours @ 3 knots 2.8 hours @ 4 knots
Control Computer	PC-104 SBC with Linux and custom adapter / conditioning board
Standard Vehicle Sensors	Camera: 1080 p @ 30 fps, 720 p @ 60 fps and 640 x480 p 60/90 with IR filter, full Color in daylight Orientation Sensor (AHRS): Advanced Navigation Orientus Dual GNSS Antennas: Septentrio POLANT MC 1.1 meter spacing Side Scan / Sub-Bottom Sonar: Edgetech 2205 Sound Velocity Probe: AML Micro SV
Control system	Remote (WiFi) or autonomous control (RC remote is optional) Auto heading, Station keeping, Waypoint navigation, Mission planning Emergency Return based on various faults and/or user events
Onboard Computer	Data Acquisition Computer, i5 processor (i7 Optional), Windows 10 operating system, 500 Gb SSD Drive
Options for Mission Planning software	HyPack (Survey or Max) & HySweep* QinSy Hydro
Options for fully integrated INS Sensor	All units made by SBG, utilize the POLANT dual antennas and are available with Lite or PRO software: Options: Ekinox D or Apogee D

Other Optional Sensors (reconfigurable)	ADCP: Sontek M9* RiverSurveyor or HydroSurveyor LIDAR: Velodyne PUCK RTK Navigation Options: Cellular, Radio Base Station, or combination

*Sontek M9 requires HyPack MAX

Operator Interface System

Features	Laptop PC, radios, joystick, and required gear for control, communication, and storage of survey data
Case	Sealed, rugged plastic suitcase with bulkhead connectors
Dimensions (airline carry-on)	46 x 34 x 17 (cm) 18.2 x 13.4 x 6.7 (inches)
Weight	5 kg (11 lb)
Power	120 vac / 1 Ø / 5 amps
Remote Monitoring	Communications software is socket based allowing for monitoring of almost all sensor and communication protocols

Communications / Telemetry

Radio – short range	High bandwidth omnidirectional, 22 dBm, 2.4/5 GHz radio with Ethernet interface Line of sight: 1.5 km / .9 miles (estimated)
Radio – long range (Optional)	2.4, 5.8 GHz or Cellular
RC Control (Optional)	Short range for use when OIS is located away from the launch & recovery location
Antenna Tripod	Telescopic, 2 to 6 meters (5 to 18 feet)

Shipping, Accessories & Spares

Shipping Crate (L x W x H)	1 crate for all standard parts, wooden, re-useable, internationally rated 81 x 45 x 38 (inches) 206 x 114 x 97 (cm) 280 kg (600 lb) typical shipping weight
Cart (Optional)	2-wheel aluminum hand cart for Launch & Recovery
Recommended Spares	Battery, motor controller, thruster motor, PCB control stack, DAC computer

3.0 Major Vessel Components

3.1 Hull

The hull consists of a top and bottom parts molded from fiberglass and permanently bonded together. All Compartments, cable penetrations and equipment installations are sealed for environmental protection. All cabling inside the boat that is below the waterline is routed through waterproof conduits and the hull is foam filled for added protection.

Two compartments in the hull hold various electronic devices and a third compartment houses the battery. The battery compartment opens without tools allowing for rapid battery exchange. All access hatches are rubber sealed to eliminate water ingress.

The camera is housed internal to the upper section with a clear viewport looking forward. The orientation sensor is in a separate compartment on the forward end of the starboard hull.

Waterproof ports are provided for attaching memory sticks that can be used for data storage or software keys. At the aft end of the hull is an on/off switch, charge port, status light and a thruster kill lanyard.

The thrusters are protected from collisions by stainless steel keel guards. The boat can be placed directly on the ground without damaging any components.

User sensors can easily be removed and exchanged from the outside of the hull.

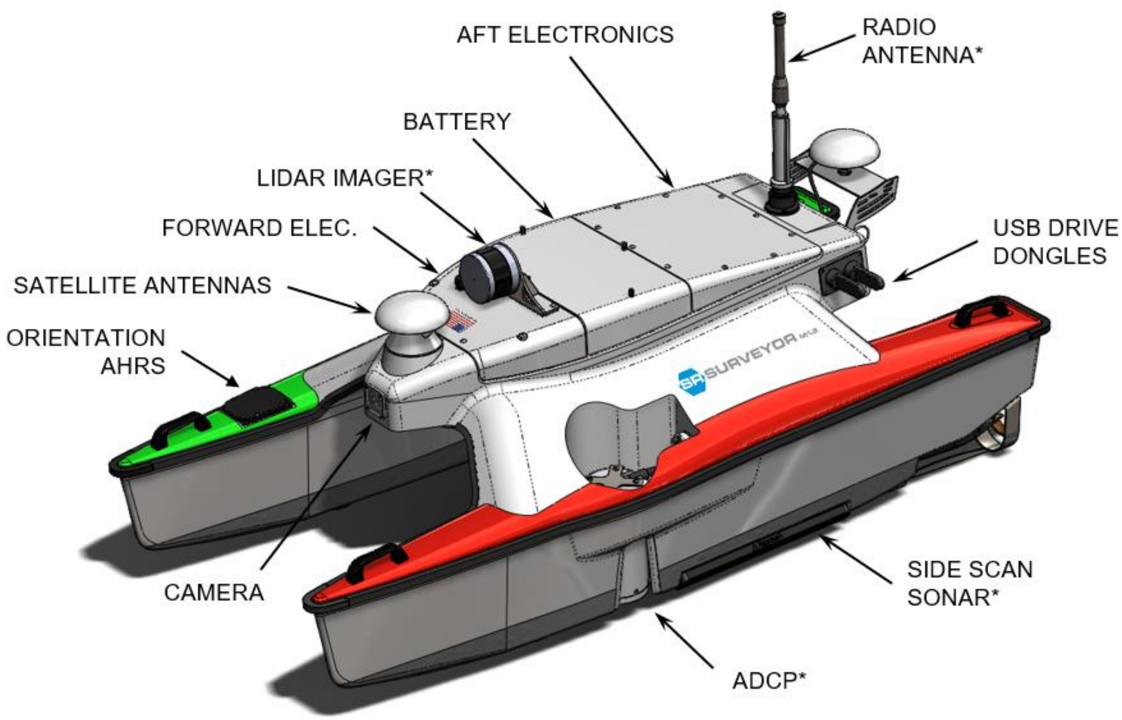


Figure 1 Vessel Layout – Forward

*Various Configurations Available

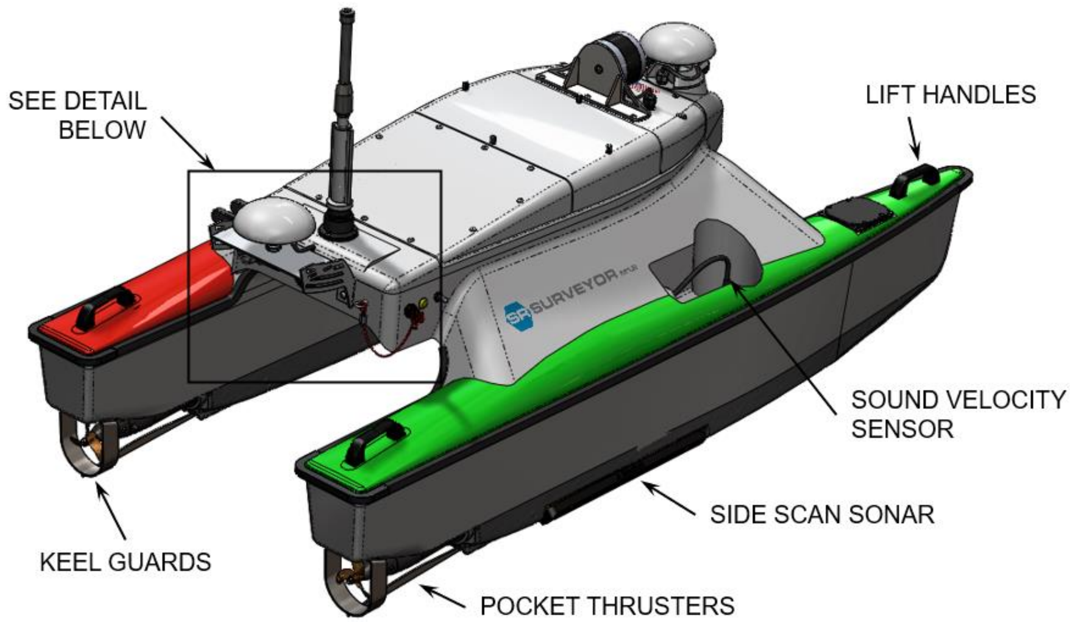


Figure 3 Vessel Layout - Aft

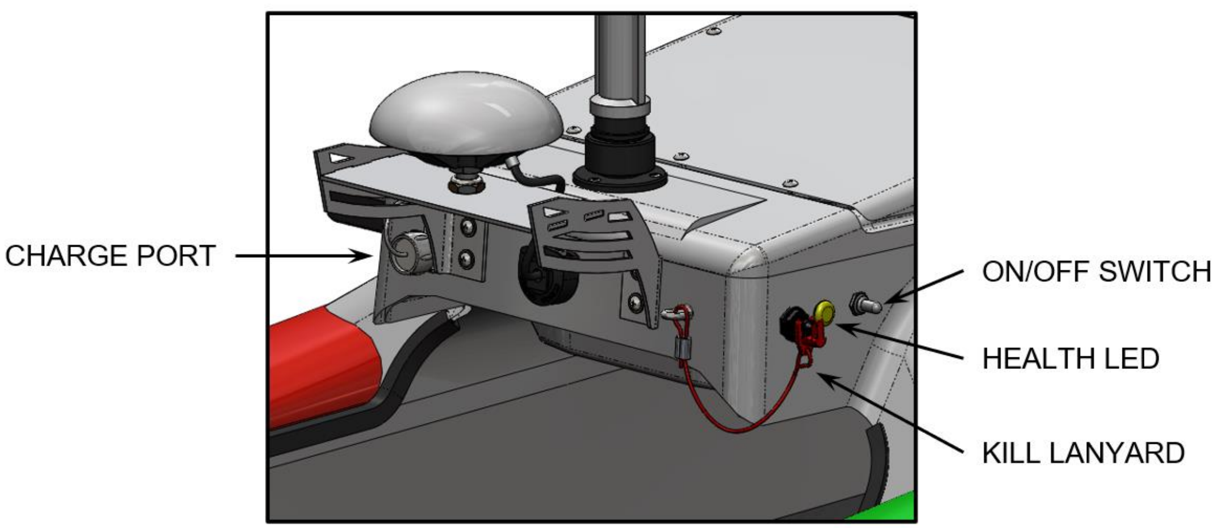


Figure 2 Vessel Layout – Aft Detail

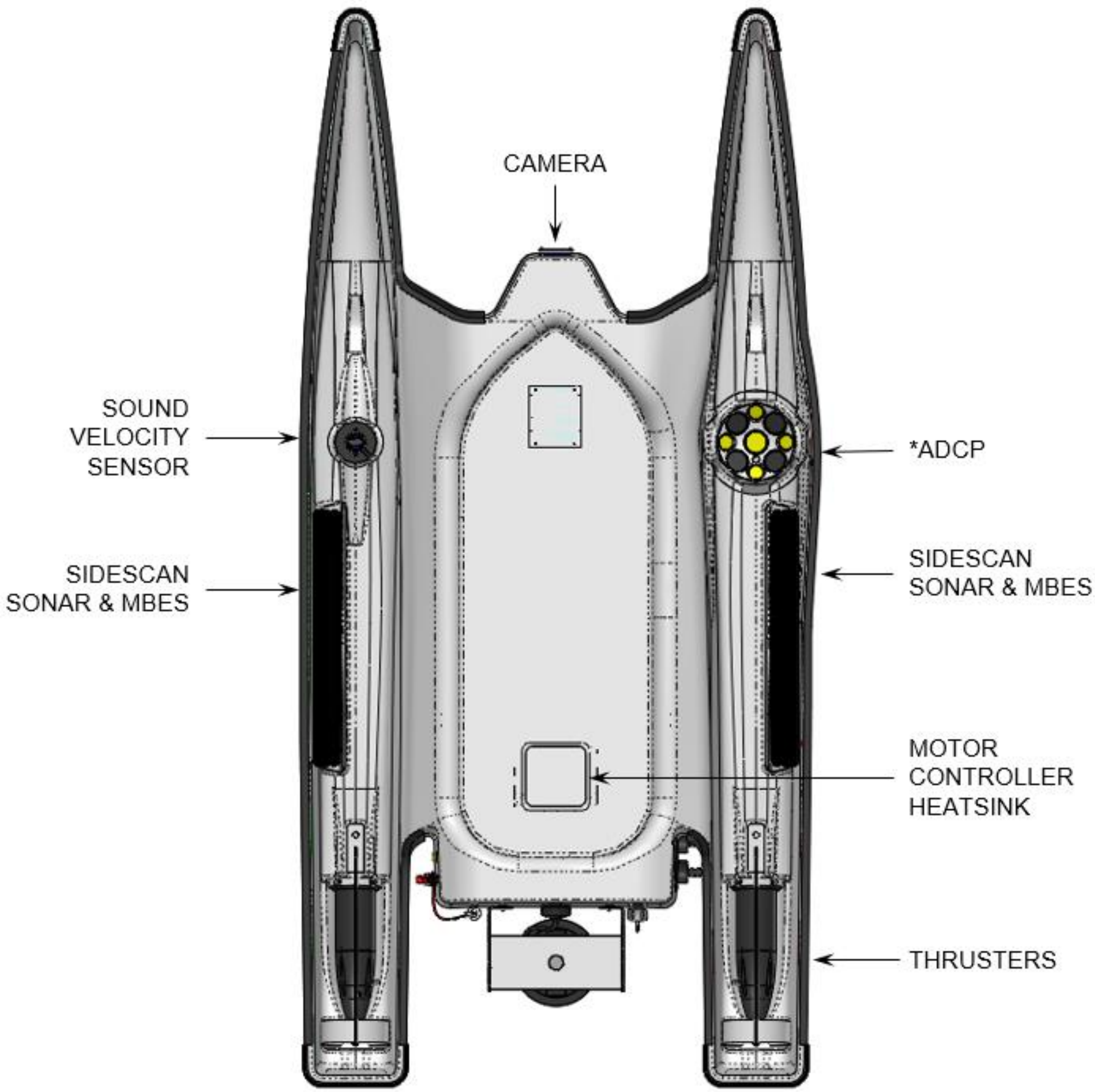


Figure 4 Vessel Layout - Bottom View

*Various Configurations Available

3.2 Propulsion

The vessel is steered by using differential thrust commands to the port and starboard thrusters. No rudders are used on the Surveyor model boat. The thruster motors are brushless DC motors and the gearboxes are sealed. Dual shaft and body seals increase reliability. The thruster assembly is easily removable.

The motors rotate in opposite directions with opposite-pitch propellers to eliminate torque induced steering errors. The motor controller monitors the operating parameters of each motor including amps, temperature, voltage, etc. These data points are displayed on the GUI. Stainless steel propeller guards and skegs protect the motor and propeller from weeds and impacts.

Figure 5 Thruster Assembly

3.3 Forward Compartment

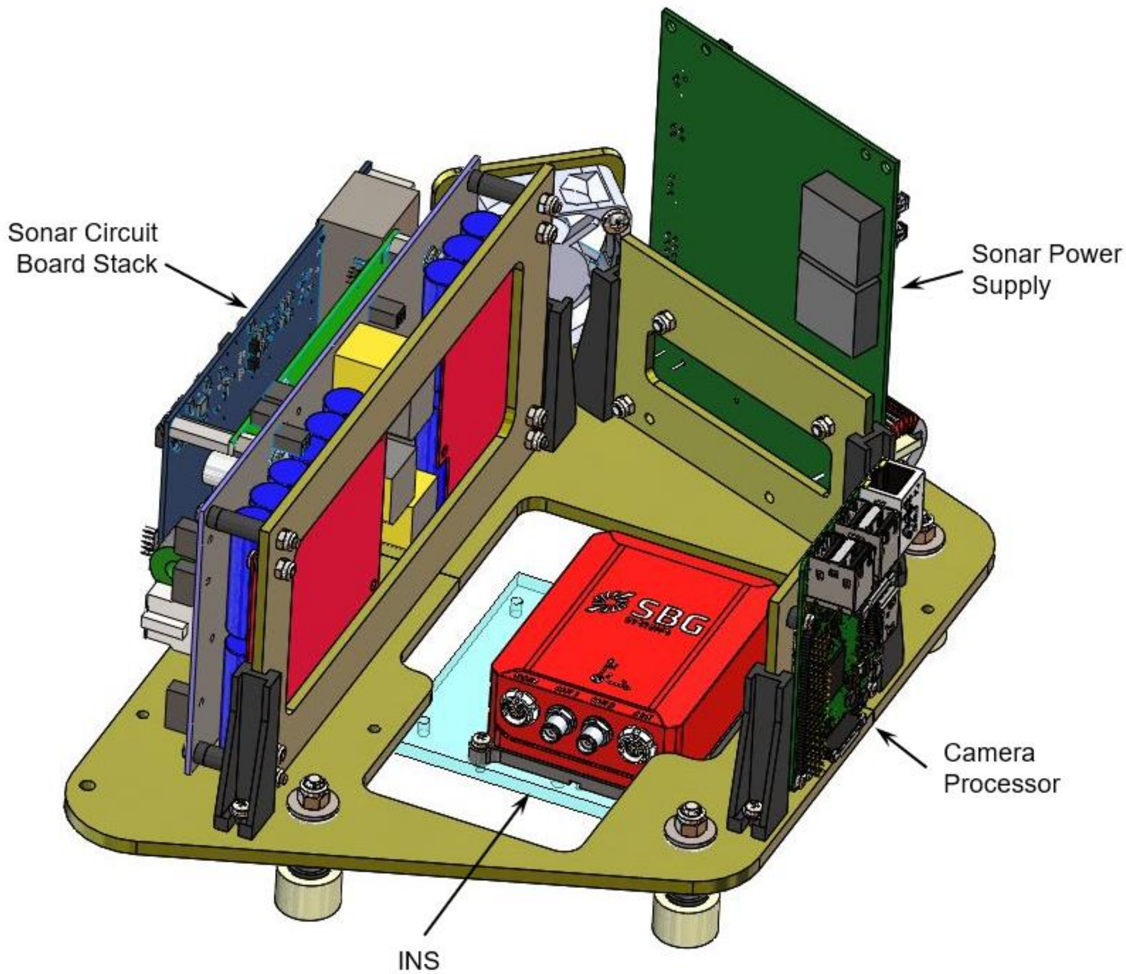


Figure 6 Forward Stack Assembly

The forward compartment contains the Edgetech circuit card stack and power supply, the control board for the camera, the INS system and a fan. The circuit board subassemblies are mounted on slides for easy maintenance and the entire assembly is shock mounted. If RTK is installed in the system, then an RS-232 to Ethernet converter will also be installed in the forward compartment. The Raspberry Pi is a small embedded computer which prepares the video for transmission by the radio to the OIS for viewing.

The sonar board is powered with a relay on the interconnect board where it is also protected with a fuse. The relay is energized from the adapter board with a command from the GUI. The camera board is powered with 5 and 12 volts from the adapter board when the boat is turned on. The ethernet switch is also powered at start-up with 12 volts from the adapter board. Both the camera board and the ethernet switch are protected with PTC devices.

3.4 Battery Compartment

The vehicle is supplied with a custom Lithium-Ion battery to provide all power for the boat. The battery has an internal circuit board which protects it from over discharging or charging and short-circuit protection.

The battery is located in the center compartment of the vessel. It is isolated from the rest of the boat so that the batteries can be exchanged in any weather.

The ON/OFF switch on the starboard aft side is turned on to provide power to the vessel. The vessel is equipped with a charging port/connector on the aft face of the hull as shown on the diagram above. An off-board charging system is supplied. The safety lanyard provided next to the power switch disables the thrusters.

It is recommended that the battery be completely disconnected from the system during storage.

To remove the battery, unplug each of the three connections identified below:

Figure 7 Battery Connections

3.5 Aft Compartment

The control stack in the aft compartment consists of the control computer, the DAC, an I/O extender board for the DAC, an ethernet switch, the SRC adapter board, two backup power supplies, and the motor controller. The SRC interconnect board with a 12V Power Supply is also located in the aft compartment.

The assembly is shock mounted. The adapter board and control computer stack is mounted on hinges for easy access to the components below the unit. Diagnostic indicators are used throughout the system to aid in troubleshooting.

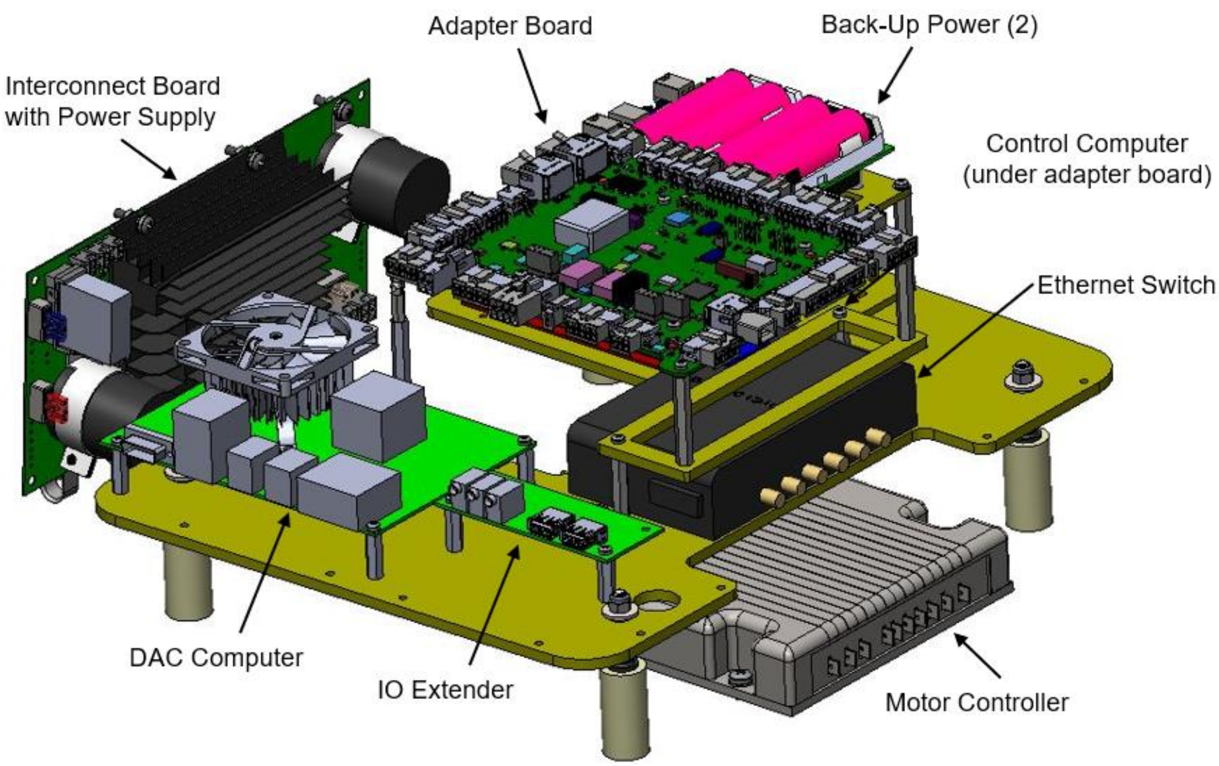


Figure 8 Aft Control Stack & Interconnect Board

4.0 Onboard Power and Control Systems

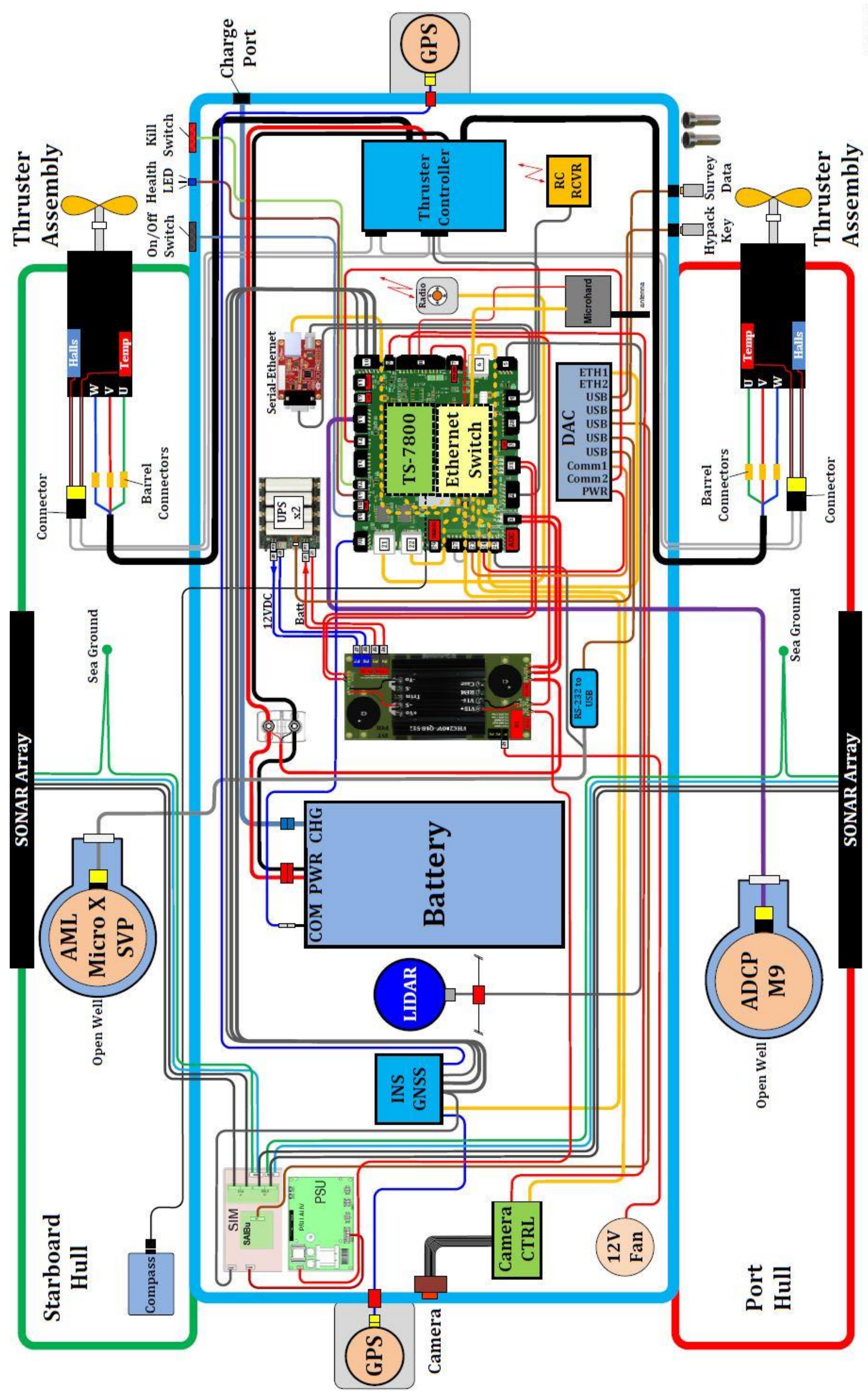


Figure 9 Electrical Block Diagram

4.1 Power and Circuit Protection

Battery power is connected to the DC power bus terminal block in the aft compartment and from there it is routed to the motor controller and the interconnect board.

The interconnect board includes a 12 volt power supply, a power relay for the sonar and various fuses. It is located forward of the aft stack in the aft compartment and is the power distribution point for the vessel. The interconnect board provides 12 volts and battery voltage (24 volts nominal) to the adapter board, as well as battery voltage to the sonar and the UPS boards. 12 volts produced by the UPS boards is also routed through the interconnect board for connection to the adapter board.

There are multiple Positive Temperature Coefficient (PTC) resettable fuses utilized in the system. Please review the system schematics for their usage and current values. A PTC will automatically reset once the short circuit is removed.

4.2 Interconnect Board with 12 VDC Power Supply

The The interconnect board includes a 12 volt power supply, power relays and fuses. The power supply has internal over-current and short circuit protection. There are no fuses on the output of the power supply. Should a fault/short circuit occur on this supply the output voltage will continually turn on and off until the fault is eliminated. In the event of a fault the individual 12V loads can be temporarily removed from the terminal blocks one at a time until the problem load is found. The resistance of each load could also be checked with a multi-meter to check for short circuits.

SRC interconnect board converts and distributes power to the entire vessel. The primary component on the board is a 12 volt power supply. It also contains a relay to control power to the side scan sonar as well as fuses for the main battery input, the sonar and the 2 UPS boards. There are no diagnostic LEDs on the interconnect board.

Interconnect Board Fuses		
Fuse	Amps Rating	Assignment
1	10	Battery input
2	3	Sonar output
3	5	UPS No. 1 12 volt Output
4	5	UPS No. 2 12 volt Output

Figure 10 Interconnect Board

4.3 Uninterruptible Power Supplies

Two redundant 24 volt UPS boards are powered from the interconnect board. They are used to provide 12 volt backup power to the DAC and the control computer. The 12 volt output is routed through the interconnect board prior to connecting to the adapter board. A USB connection with one of the UPS boards controls the shutdown of the DAC.

A green and red LED are mounted next to the USB port. A solid green LED indicates that the UPS is operating from the vessel battery. A solid red LED indicates that the UPS is operating from the onboard UPS board. A solid green and a blinking red (30 ms on, 30 ms off) indicates that one or more of the UPS batteries is outside of its nominal characteristics.

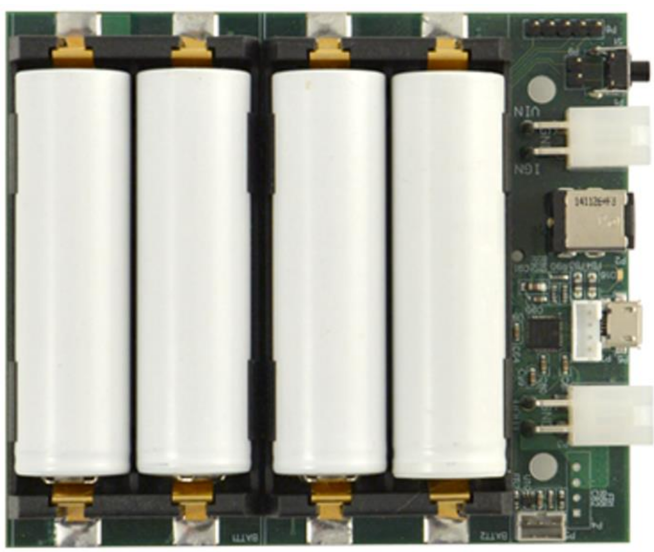


Figure 11 Uninterruptable Power Supply

4.4 SRC Adapter Board

The SRC Adapter Board is both a signal breakout board for the various signals on the control computer, a signal conditioning board, and a source of switched power for multiple peripheral components. Two of the mounting standoffs on the adapter board are hinged to allow access to components located underneath the board.

When the main vessel power switch is turned on 24 vdc is enabled to the interconnect board and the motor controller. The 12 volt supply on the interconnect board then enables 12 volts at the adapter board. 24 volts is also sent to the adapter board from the interconnect board. Power is then switched for several devices by the adapter board. Each switched output is illuminated with a red LED when the output is enabled. Other diagnostic LEDs are included on the adapter board for diagnostic purposes.

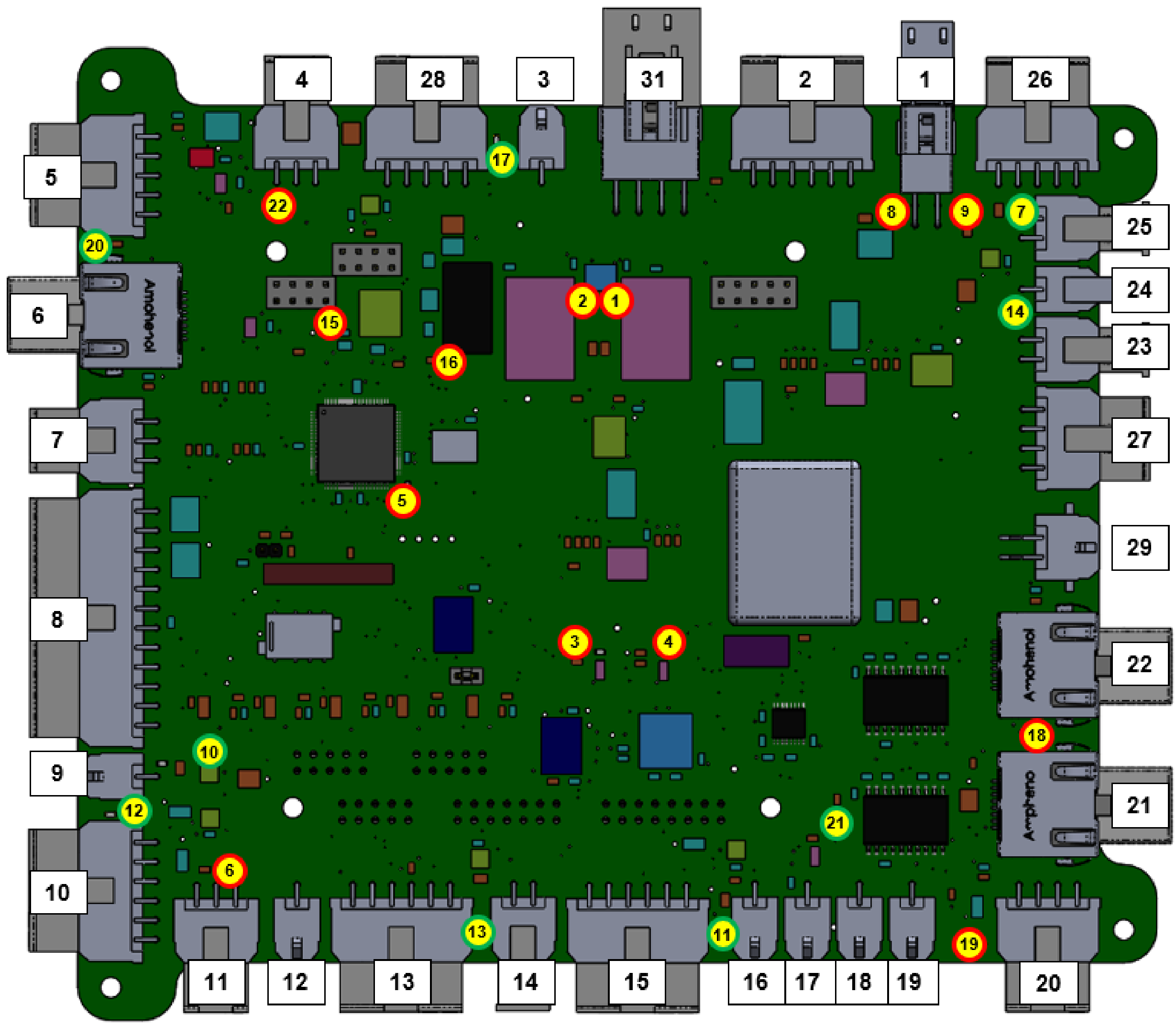


Figure 12 Adapter Board Layout

Description	LED No.
UPS 1 power in use	1
UPS 2 power in use	2
INS PPS	3
INS Tx Transmit	4
Microprocessor Health (LED Blink => OK)	5
IMU / AHRS power (not used)	6
SVP power	7
Adapter board power, 24 v (LED On => PWR On)	8
Adapter board power, 12 v (LED On => PWR On)	9
Edgetech sonar (to power board relay) (LED On => PWR On)	10
Thruster Kill switch (LED On => closed)	11
INS / GNSS power and data	12
ADCP power	13
DAC power	14
3.3 v power supply (LED On => PWR On)	15
5.0 v power supply (LED On => PWR On)	16
RC Controller (LED On => power on)	17
Radio POE (LED On => PWR On)	18
ON / OFF Switch	19
LIDAR - power	20
Health LED (LED On => health pulse)	21
GNSS RS232 Eth. Converter - power (LED On => PWR On)	22

Figure 13 Adapter Board LED Designations

4.5 Control Computer

The control computer is a Linux-based high performance single board computer that executes custom SeaRobotics software. It is mounted directly to the bottom of the adapter board and includes several headers that attach directly to the adapter board.

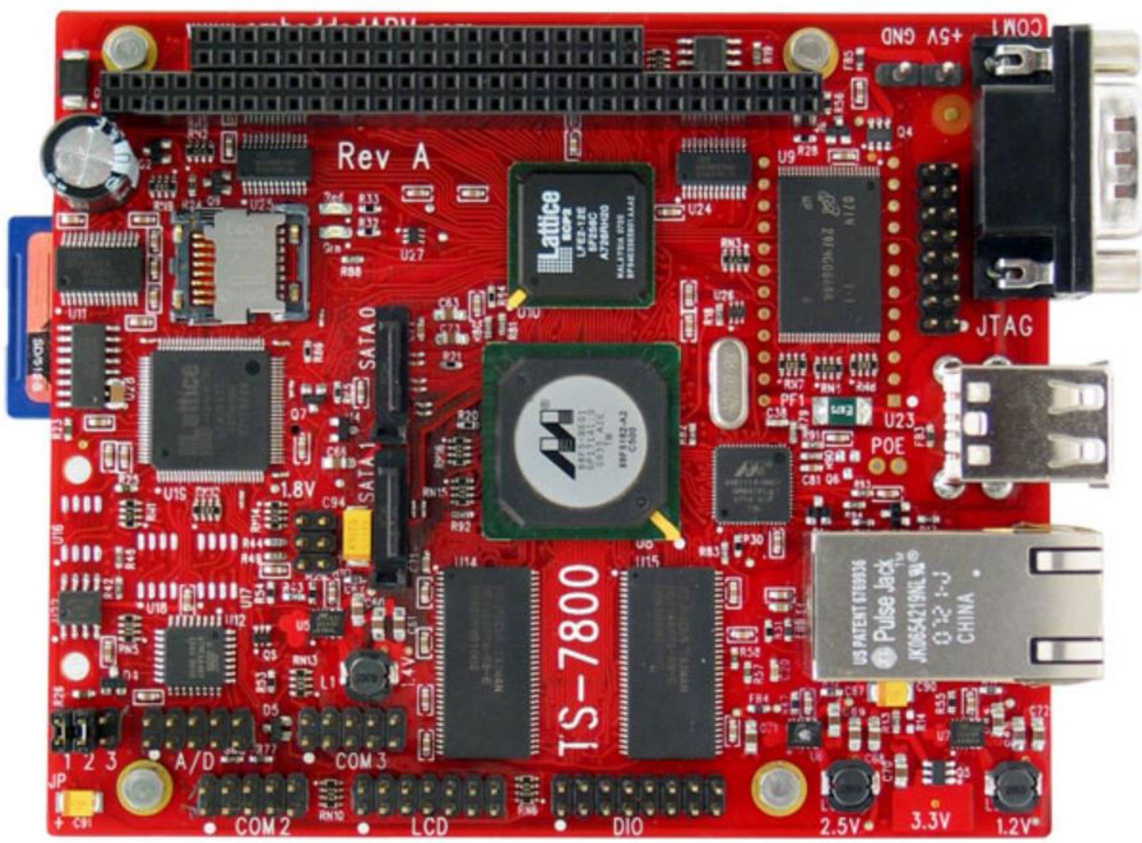


Figure 14 Control Computer

The control computer has two on-board LEDs, one red and one green. When power is first applied the green LED will blink momentarily and then turn off.

There are three user settable jumpers located on the top side of the TS-7800 right next to the A/D header. Jumper 1 ‘ON’ forces the TS-7800 to boot from an SD card, this is useful if the board has been bricked, and allows the NAND flash to be reprogrammed. Jumper 2 ‘ON’ enables console output on COM1. Jumper 3 ‘ON’ scales down the processor to run at 333 MHz which will also lower overall power consumption slightly. The default position for all three jumpers is “OFF” or “OPEN”. The SRC software is stored on the installed SD card for back up. Jumper No. 1 can be closed if it is necessary to boot from the SD card.

The control computer receives power from the adapter board and boots up immediately when the boat ON/OFF switch is turned on. The “health” LED on the outside of the boat indicates that the system has booted up and is ready for operation. It will pulse at 2 Hz.

4.6 Data Acquisition Computer

The DAC is a 3.5" high performance industrial grade single board computer running Windows 10. The solid-state hard drive has a total capacity of 500GB. All third-party software runs onboard the DAC.

A real-time connection to the DAC from the OIS is established via VNC. Two external USB drives are connected directly to the DAC to allow for safe and rapid data storage and transfer. Reference the Appendices for DAC operation.

The transfer of files from the DAC to the OIS laptop is accomplished by dragging and dropping files from the folders "DAC Share" on the desktop of each unit.

The location and default position of each jumper is listed below. The LED indicates hard drive activity and the status of the power to the board.

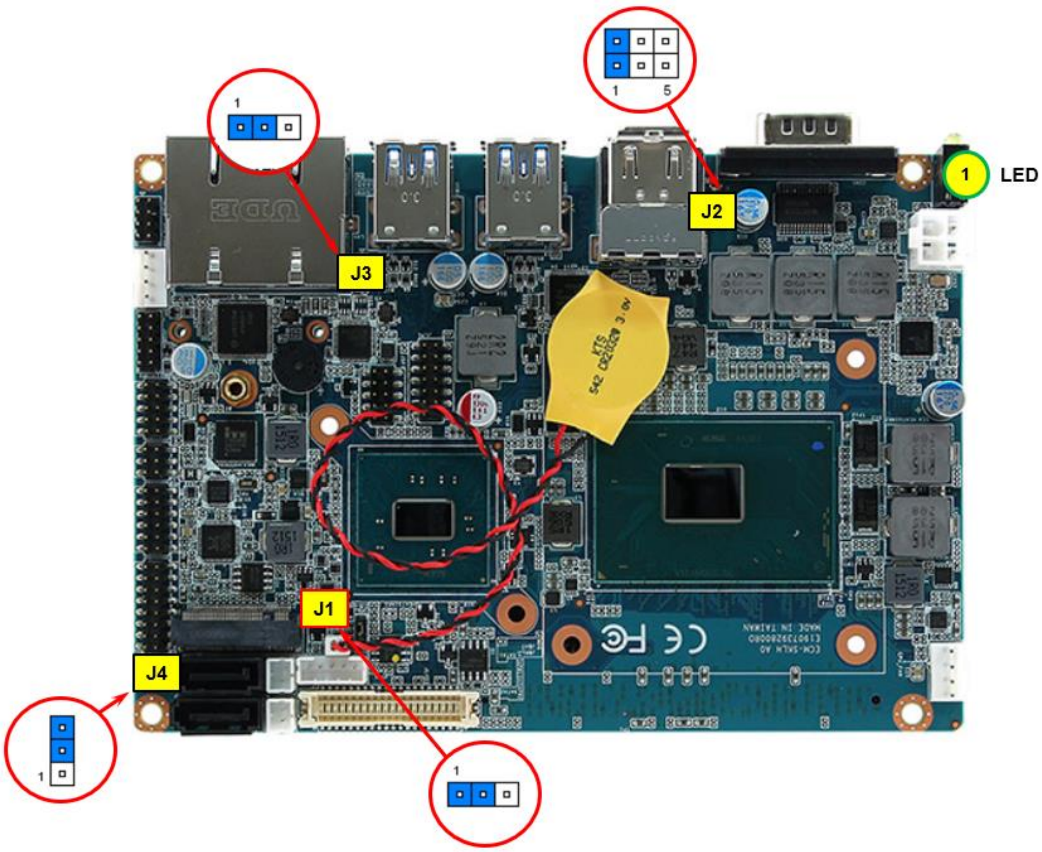


Figure 15 DAC Layout

DAC Jumpers			
Jumper	Name	Default	Description
1	JCMOS	Protect	Clear CMOS
2	JR1	Ring	Serial Port 1 pin9 signal select
3	JAT1	AT	AT / ATX Input power select
4	JVR	DC Mode	LCD Backlight brightness

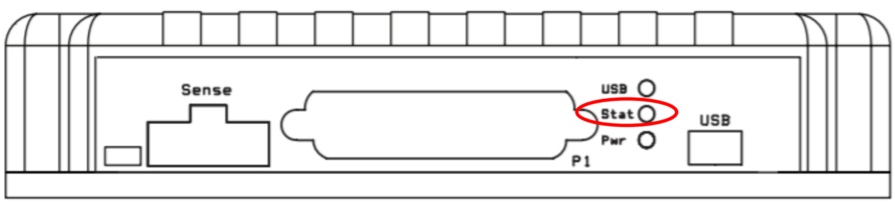
4.7 Motor Controller

The motor controller is a dual-channel controller. It is operated with commands from the control computer and provides feedback data to the OIS such as communication status, motor voltage, motor current and temperature.

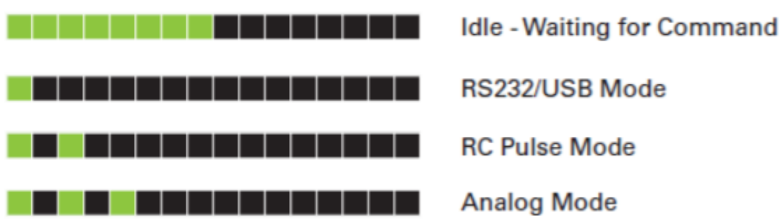
The motor controller receives 24 volt battery power from the terminals in the aft compartment. It is powered up immediately when the vessel switch is turned on. The controller has internal circuit protection. The safety lanyard (or "kill" switch) on the outside of the hull only disables the unit, it does not disconnect the power.

Three LEDs are located on the front of the motor controller. The top one indicates the status of the USB port, the middle one is a status indicator and the bottom LED indicates that the unit has power.

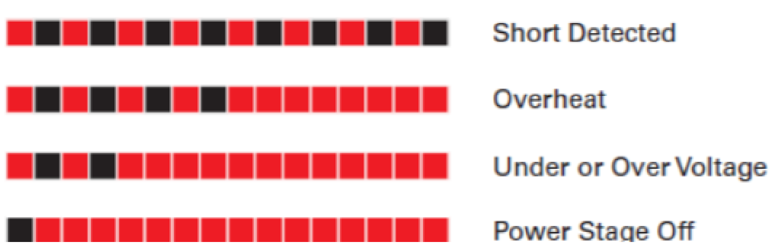
The behavior of the status LED is shown below.



Status LED during normal operation (idle mode => 2 seconds ON, 2 seconds OFF)



Status LED during fault condition



5.0 Navigation and Attitude

5.1 Satellite Navigation

The standard ASV configuration includes Septentrio POLANT MC GNSS dual antennas with 1.1 meters of separation.

"The POLANT MC is a lightweight, sturdy high precision geodetic multi-frequency multi-constellation antenna for use in physically demanding applications. This high-gain antenna incorporates a low-noise amplifier and is built into a rugged and environmentally sealed housing with aluminum bottom plate."

Two models of receivers are available for use with the antennas as listed in the systems specifications above. Reference the appropriate OEM manuals for operational instructions and technical support for the appropriate product and to the system schematics for complete connection of the navigation system.

EKINOX2-D-G4A2-F1VB
High Performance MEMS INS
With integrated dual antenna L1/L2 GNSS receiver
GPS+GLO+BDS L1/L2 RTK RAW
(300°/s, 8g, Standard Perf.)

[100-2211] APOGEE-D-G3A3-220-V2
Apogee Marine Series
Ultimate Performance MEMS INS
With integrated dual antenna L1/L2/L5/L-Band GNSS receiver
GPS+GLO+GAL+BDS
RTK
(200°/s, 10g)

The receivers are powered from the adapter board through a switched 12 volt output with a PTC fuse. A red LED on the adapter board will be illuminated when the power is activated. The receivers provide position data to the LIDAR and to the DAC. They also transmit a PPS signal to the Edgetech sonar and the SRC buffer on the adapter board.

5.2 RTK Options

Cellular, radio-based or a combination of cellular and radio-based RTK options are available.

If cellular based RTK is used, then a modem is added to the aft compartment next to the DAC. If radio based RTK is used at the OIS then no additional components are required in the vessel. The RTK data is sent from the OIS over the radio to the ASV in an Ethernet embedded serial stream. RTK corrections are then sent to the INS on the ethernet network.

5.3 Orientation Sensor

The Orientus is a ruggedized miniature orientation sensor and AHRS that provides accurate orientation under the most demanding conditions. It combines temperature calibrated accelerometers, gyroscopes and magnetometers in a sophisticated fusion algorithm to deliver accurate and reliable orientation.

Figure 16 AHRS Sensor

The AHRS sensor is mounted at the forward end of the starboard hull and can be accessed by removing four screws in the mounting plate. The plate is sealed with an O-Ring to a mating ring in the hull.

The sensor contains very high performance MEMs inertial sensors that are able to detect when there is magnetic interference present and ignore magnetic data until the interference disappears. It uses an algorithm to compensate for linear accelerations. This allows Orientus to maintain accurate roll and pitch through short term linear accelerations that typically cause significant errors. For long term linear accelerations an external GNSS receiver is installed for full linear acceleration compensation.

The internal filter runs at 1000Hz. This allows for control of dynamically unstable platforms and makes the sensor immune to vibration. The hardware is protected from reverse polarity, overvoltage, surges, static and short circuits on all external interfaces.

The sensor is powered on from the USB port on the vehicle control computer. It turns on when the boat is energized. There are no diagnostics or indicator lights on the Orientus.

6.0 Communication

6.1 Radio

The ASV communications system is composed of an outdoor wireless radio and an omni-directional antenna. The radio operates at 2.4/5 GHz and is used in the Wireless Internet Service Provider industry using the Time Division Multiple Access (TDMA) protocol. It is advertised to provide 300 Mbps real TCP/IP throughput and it is manufactured for outdoor use. The radio is compatible with several different style antennas.

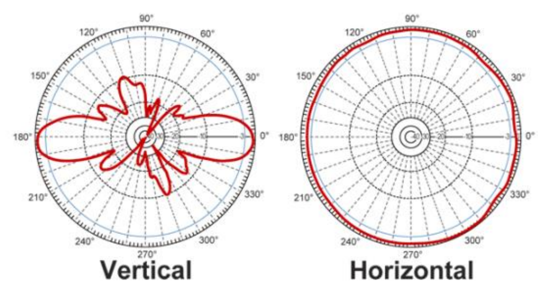
The radio receives power via POE from an ethernet port on the adapter board. It is powered up immediately when the vessel is energized. LED number 18 on the adapter board will illuminate to indicate that power has been enabled to the radio.

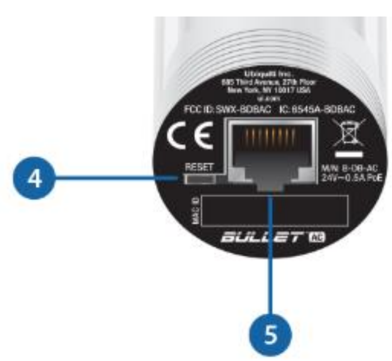
One radio/antenna combination is located aft and on the centerline of the ASV and the other is supplied as part of the OIS for use with a tripod.

The radio system allows the operator to remotely connect to various on-board instruments utilizing the application software packages provided with the instruments. Ultimate range and bandwidth of the radio system is dependent on antenna heights, motion artifacts and ambient conditions.

A high power version of the radio is available.

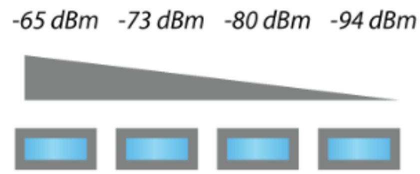
Figure 17 Radio Components & Indicators





1 Signal LEDs

In airOS®, you can modify the threshold values for the wireless signal strength LEDs on the Advanced tab under Signal LED Thresholds. The default values are shown below:



2 Ethernet LED

The Ethernet LED will light steady blue when an active Ethernet connection is made and flash when there is activity.

3 Power LED

The Power LED will light blue when the device is connected to a power source.

4 Reset Button

To reset to factory defaults, press and hold the Reset button for more than 10 seconds while the device is powered on.

5 Ethernet Port

This 10/100/1000 Ethernet port is used to connect the power and should be connected to the LAN and DHCP server.

6.2 *Cellular* (Option)

A cellular based modem such as the MicroHard DX2-CAT12 can be installed in the aft compartment with an internal antenna. The system is advertised to provide up to 450 Mbps of data throughput. The modem is powered on immediately with the vessel via the 12 volt buss. An external antenna can also be installed by adding a thru-hull penetrator.

Integration consists of connecting the vessel modem to the ethernet switch and enabling communication with the modem via the OIS. Meanwhile the GUI is also setup to communicate with the vessel via the OIS with either a hardwire or WiFi connection to the internet. The user is responsible for providing the cellular service and SIM card for the modem.

7.0 Auxiliary Sensors

7.1 ADCP

The M9 by SonTek is an easy to use river discharge and bathymetry measurement system. The unit has 9 beams: (4) 3MHz, (4) 1MHz and a center beam. The ADCP automatically switches between frequencies depending on operating depth. The ADCP can be mounted in one of two positions. One for Bathymetry (hydro-surveying) and one for RiverSurveyor. Bathymetry mode orientation is 222.5° to centerline. Reference the factory manuals for operational instructions and technical support.

The ADCP received power from the adapter board. It uses switched 12 volt power that is indicated with red LED 13. It also receives INS position data from the buffer on the adapter board.

Figure 18 ADCP Sensor

7.2 Sonar

Multibeam / Side-scan sonar imagery is a commonly used tool for seabed mapping, fisheries research, dredging operations and environmental studies. It also has military applications including mine detection.

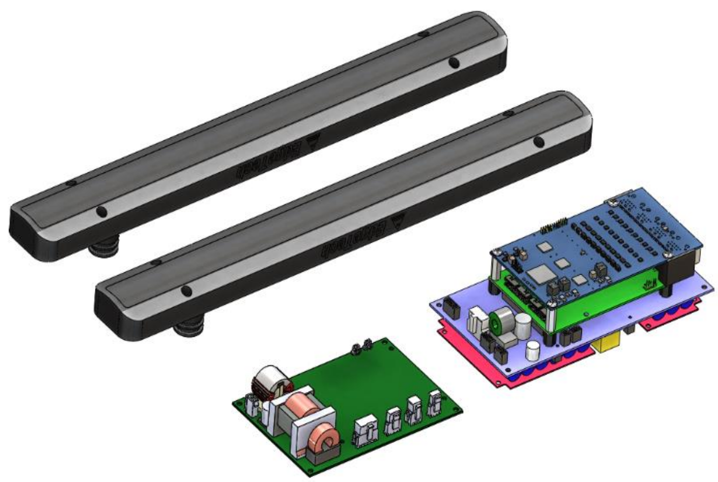


Figure 19 Sonar

Side-scan uses a sonar device that emits conical or fan-shaped pulses down toward the seafloor across a wide angle perpendicular to the path of the sensor through the water. The intensity of the acoustic reflections from the seafloor of this fan-shaped beam is recorded in a series of cross-track slices. When stitched together along the direction of motion, these slices form an image of the sea bottom within the swath (coverage width) of the beam. Higher frequencies yield better resolution but less range. In addition to sidescan data the sonar delivered with the ASV simultaneously collects MPES data.

The standard unit delivered with the USV includes a sidescan sonar operating at simultaneous frequencies of 540 and 1600 kHz and a bathymetric MPES operating at 540 kHz. The side scan sonars provide ranges of 35 and 150 meters per side. The sidescan and bathymetry transmitters and receivers are integrated into a pair of symmetrical transducers, one port and one starboard.

The operating software for the sonar is executed on the DAC. Battery power to operate the sonar is switched at the interconnect board and is protected with a fuse. The power relay is controlled by the GUI. The sonar data is geo-referenced by the interlacing of the INS data. The system receives a PPS signal and a trigger directly from the INS. Data from the system is broadcast on the ethernet network and is processed by the mission planning software.

7.3 Sub-Bottom Profiler (Option)

The Edgetech SBP is powered and controlled with the side scan sonar control interface. It is a full spectrum FM CHIRP system with amplitude and phase weighting. A variable ping rate is user selectable up to 10 Hz with a maximum output power of 200 watts. It can penetrate up to 130 feet in clay or 7 feet in sand. The electronics are mounted in the forward compartment.

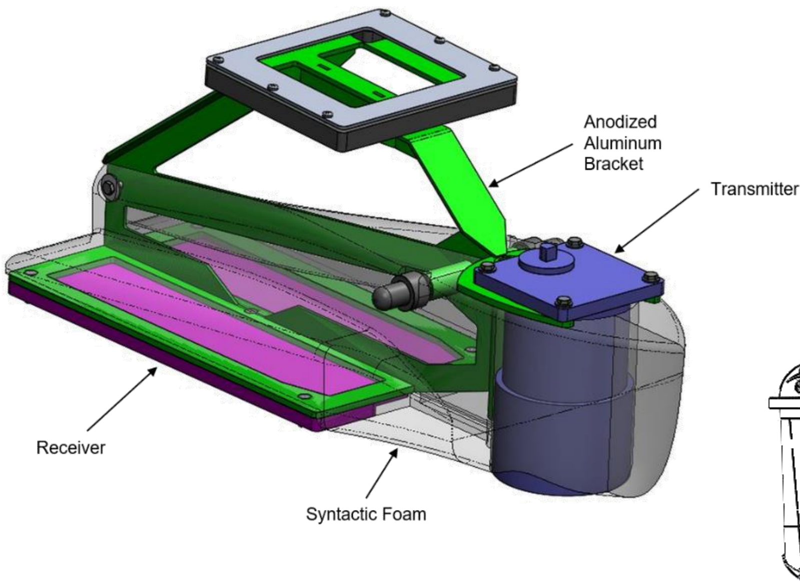


Figure 21 SBP Mount (DW-424)

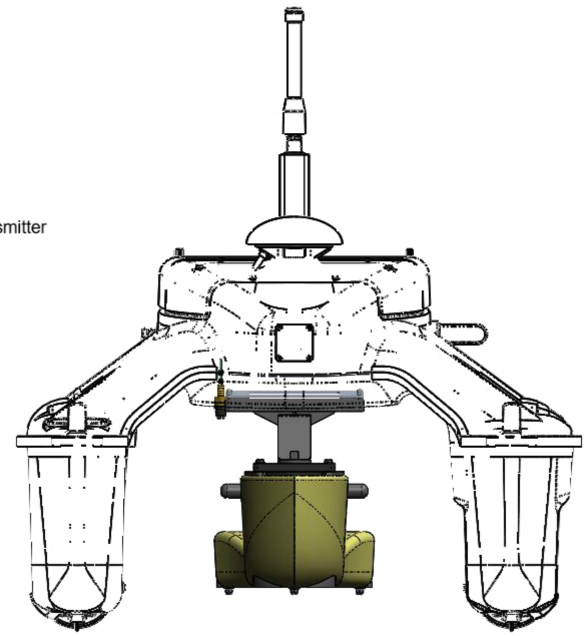


Figure 20 SBP Front View

Figure 22 SBP Mount

8.0 Operator Interface Systems

The Operator Interface System acts as a base station and is the central control point for the ASV. It consists of the OIS, the joystick controller and the radio communication system. An optional Remote Control feature is also available for controlling the vessel in those applications where the OIS may be out of sight of the launch / recovery location (e.g. on the internet in a different city).

The operator uses the OIS to define missions, monitor the ASV during missions, manually control the ASV, interact with all the optional sensors packages, and run optional sensor application software. The OIS is packaged in a lightweight waterproof case for ease of use and transport.

Figure 23 Operator Interface System

The operator interface utilizes a laptop PC to execute the vehicle command and communication functions as well as providing a platform to run sensor processing and third party application software. Through the use of an Ethernet connection to the vehicle and use of virtual serial ports on the PC the vehicle and its sensor suite is able to communicate simultaneously with several application software programs. These programs include SRC vehicle command and monitoring software and the mission planning software. Third party software packages such as River Surveyor from Sontek, sidescan sonar software and HYPACK MAX can also be included.

RF Radio

The Primary radio in the OIS is the same radios used on the ASV.

OIS Radio Antenna

The antenna used with the OIS radio is the same antenna used on the ASV. See the Communication' Section for additional information on the radio and antenna.

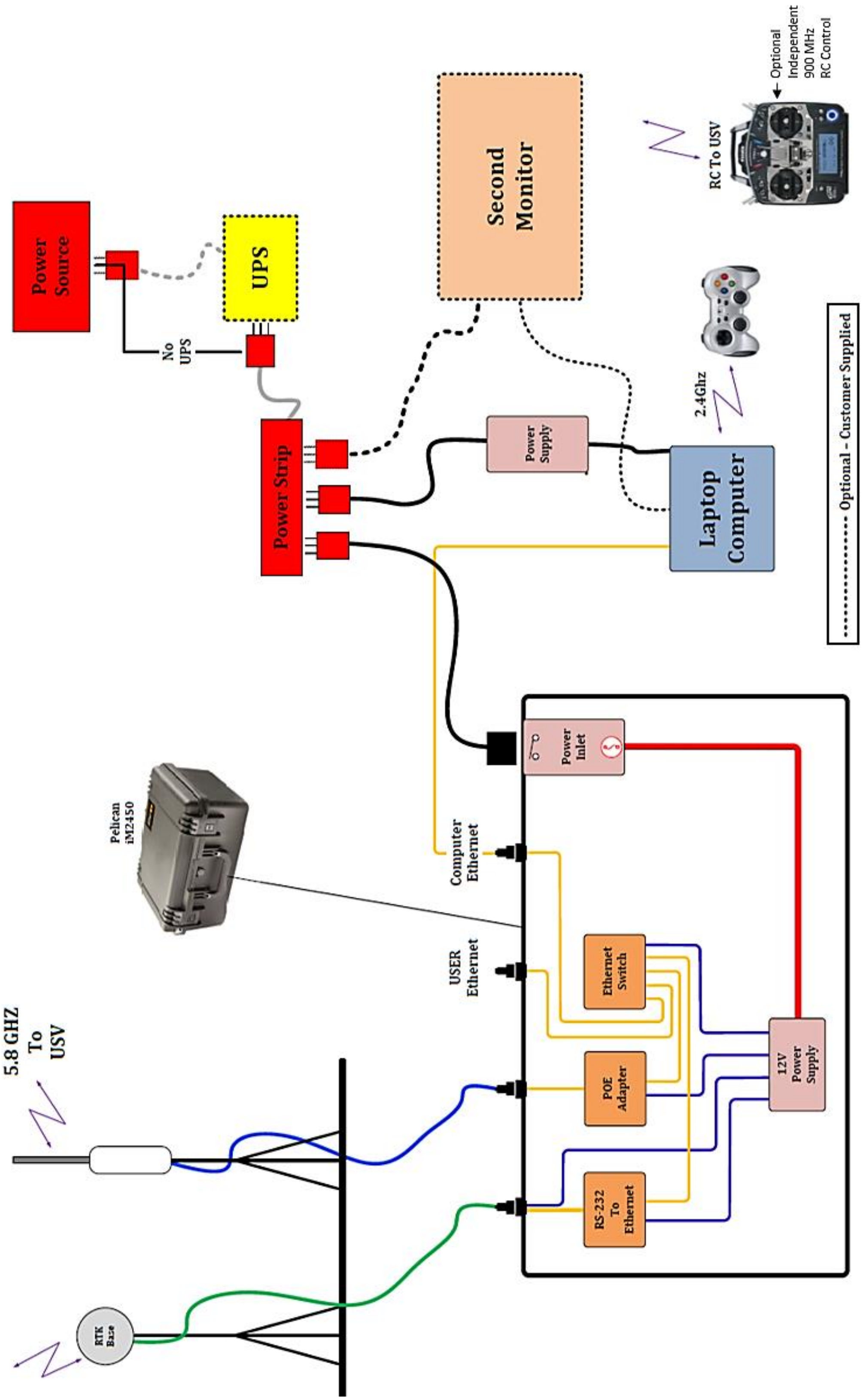


Figure 24 OIS Block Diagram

Figure 25 OIS Internal Arrangement

OIS Joystick

The wireless joystick is a common gaming quality joystick which is low cost and readily available. It operates at 2.4 GHz. The receiver for the joystick is plugged into a USB port of the laptop. Range of reception is approximately 20' from the receiver. The joystick is stored on the deck of the OIS.

Note: Prior to starting SRC GUI utility, press the "MODE" button twice to wake the controller joystick. If the joystick is not operating in SRC GUI, exit the GUI, press the mode button on the controller twice, then reopen the GUI.

Figure 26 Joystick - Top View

Important – there is a small slide switch on the front face of the joystick. This switch is called the "Game Mode Button" must be in the "D" position. If the switch is not in the "D" position the ASV motions will be unpredictable.

Figure 27 Joystick - Front View

Thruster Mode Button Assignments:

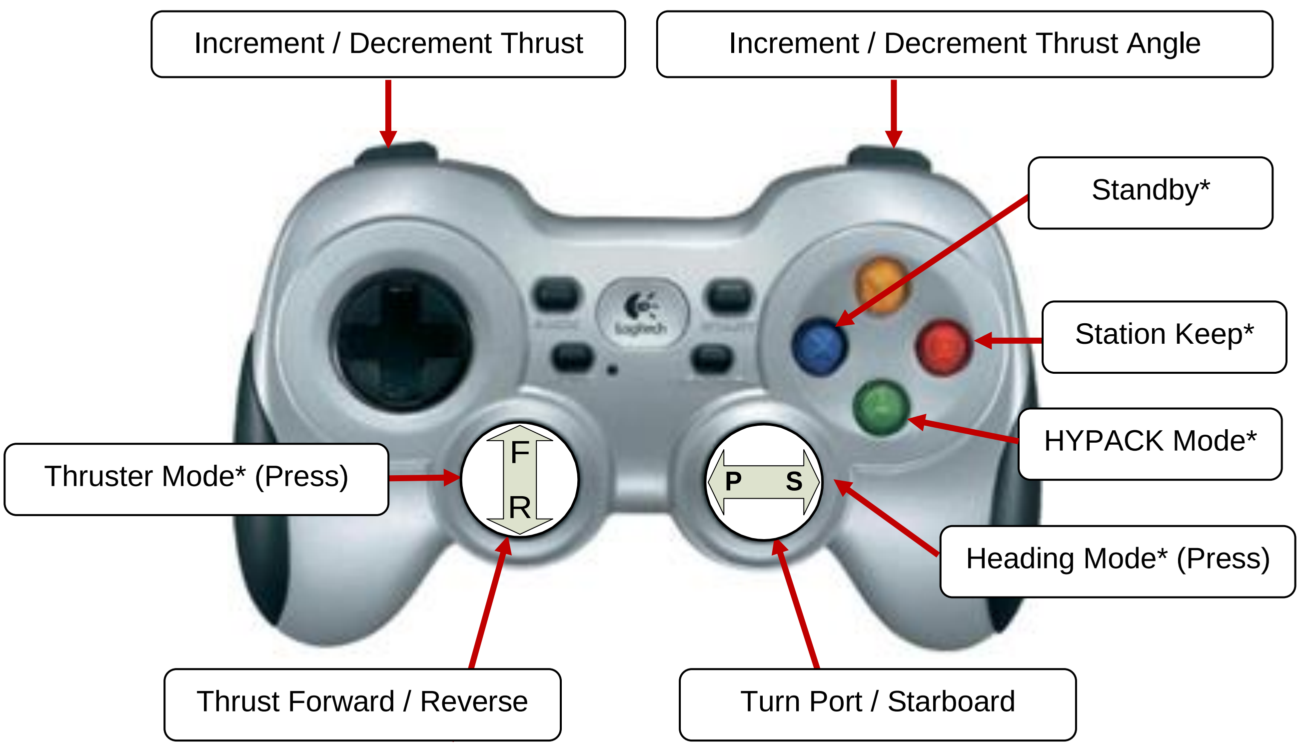


Figure 28 Joystick - Thruster Mode

Heading Mode Button Assignments:

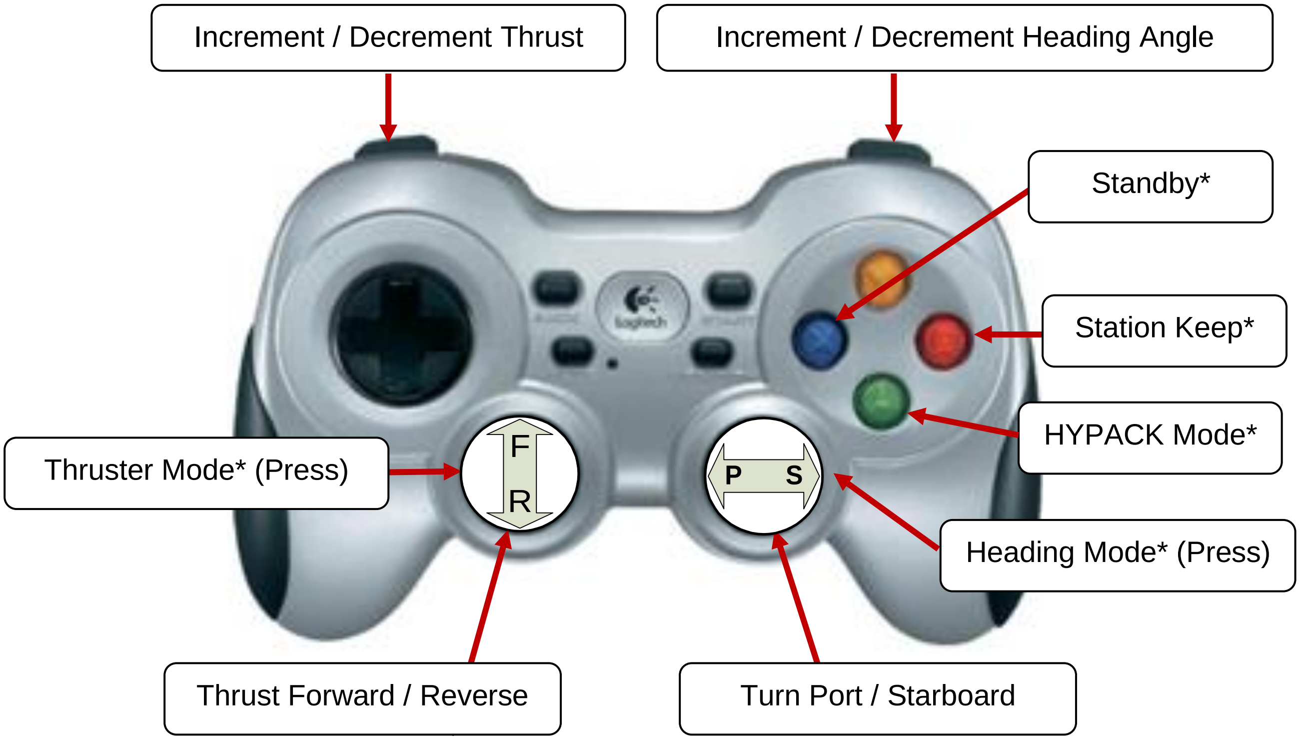


Figure 29 Joystick - Heading Mode

The batteries on the joystick will last approximately 100 hours. When the batteries (Two Double "A") are low the mode light will blink every few seconds.

8.1 SeaRobotics Graphical User Interface

The control of the ASV is mainly accomplished by using the SRC graphical user interface (GUI) but can also be achieved by using the RC controller from close proximity. The RC controller is useful for operating the boat whenever it is out of visual range of the OIS.

Operation of the GUI is based on normal Windows type of mouse-clicks. Each page or tab is described below.

8.1.1 Display Screens

Main Display

The abbreviated status display is partitioned into several sections. The upper section of the display is devoted to the heading and course of the vehicle. The compass presents both heading (yellow hull shape) and course over ground (black arrow) as is illustrated. In addition, Heading (Hdg), Course over Ground (COG), water Depth as measured by the single beam echo-sounder, and Speed Over Ground (SOG) are displayed.

This portion of the display is comprised of a voltage indicator gauge and a series of status lights. If the light is:

Green Indicates all functions in this category are operation normally

Yellow Indicates some function in this category is operating in a marginal capacity

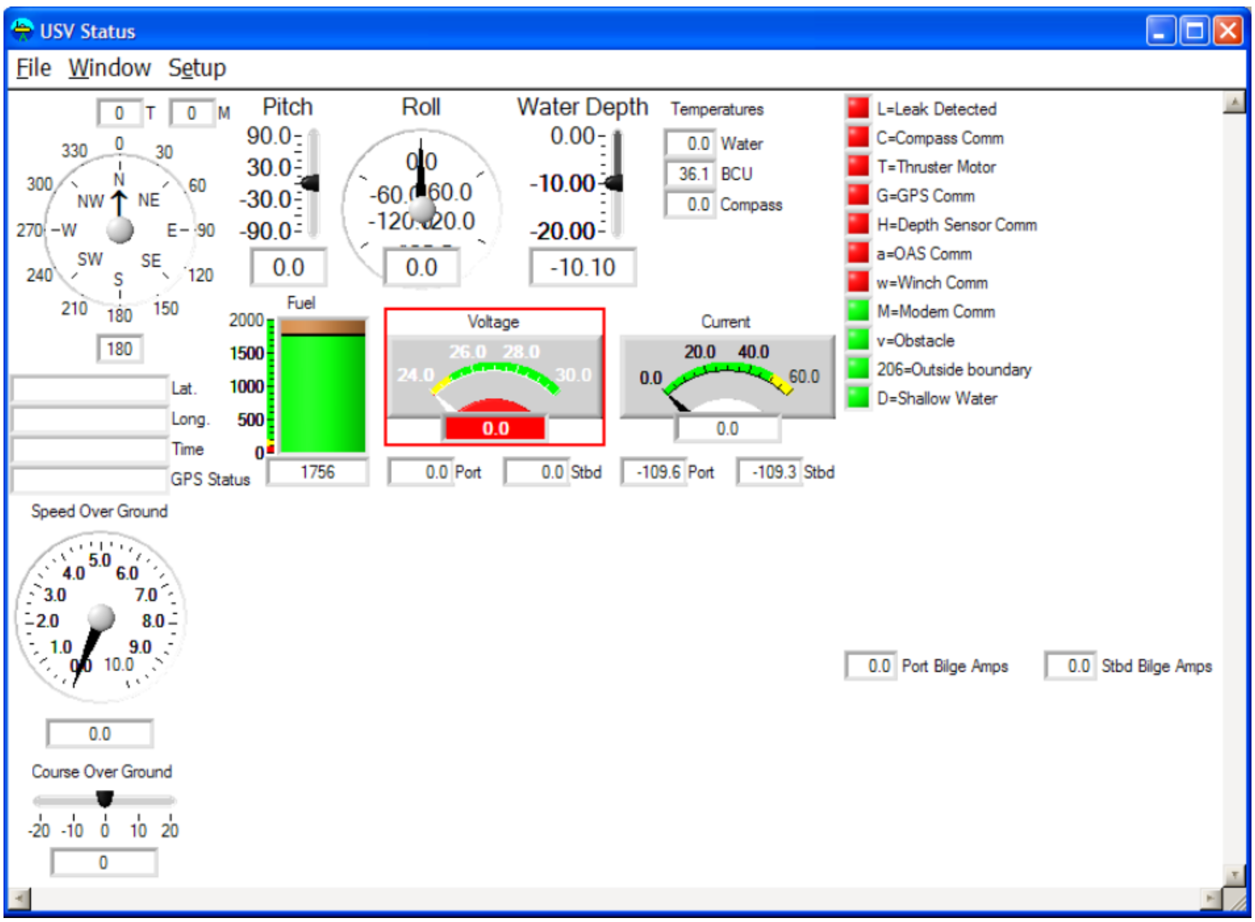
Red Indicates some function in this category is operating abnormally

When the indicators are either yellow or red the operator is being informed to check the detailed status on the subsystem which is available on one of the supporting displays illustrated below.

Status Display

The status display is comprised of vehicle attitude data, state information such as temperature, voltage, current, “fuel level”, speed and course over ground), various other pieces of pertinent information, as well as a list and indicators or various fault conditions which could occur. This screen is needed only for system debug. It is not required to be referenced during normal operation.

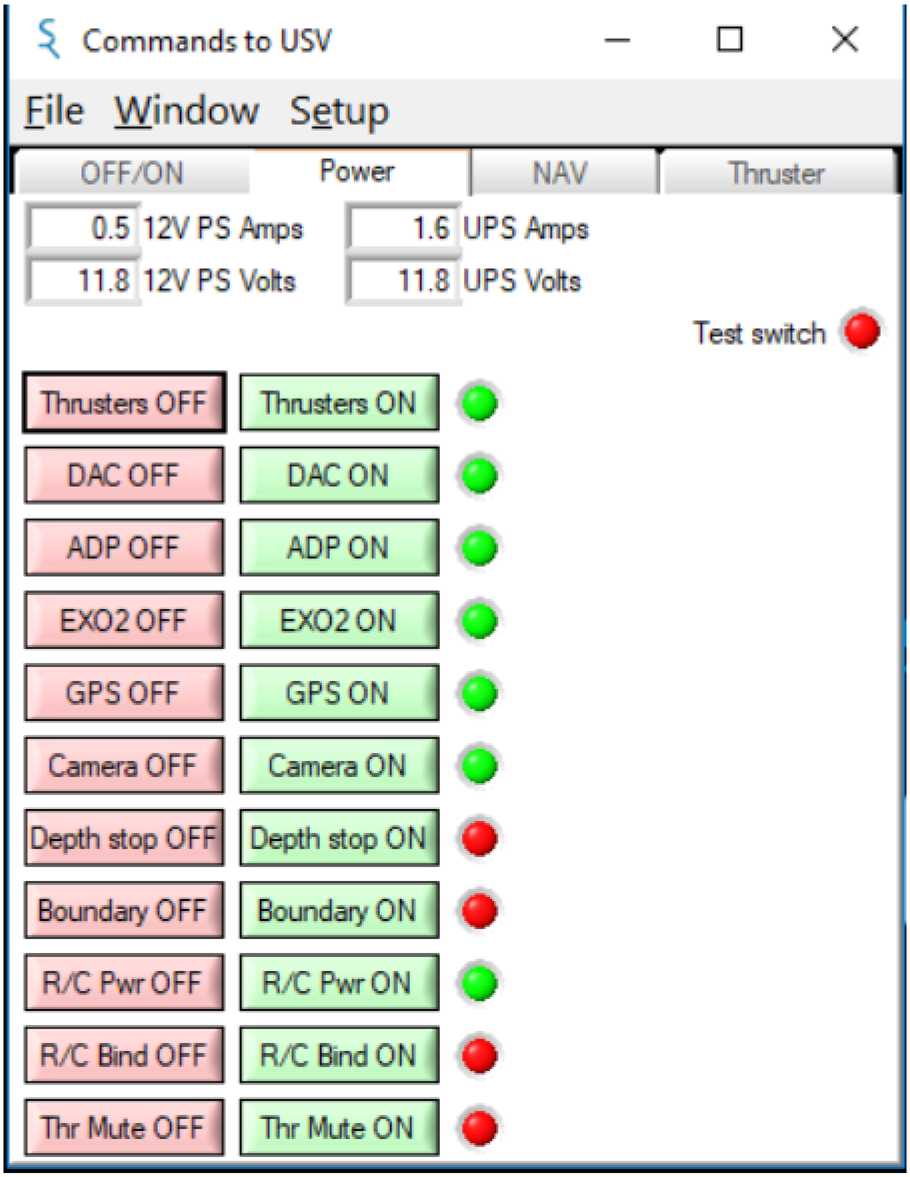
BCU temperature, from the control computer board, is monitored on the ASV status screen.



8.1.2 Commands to ASV

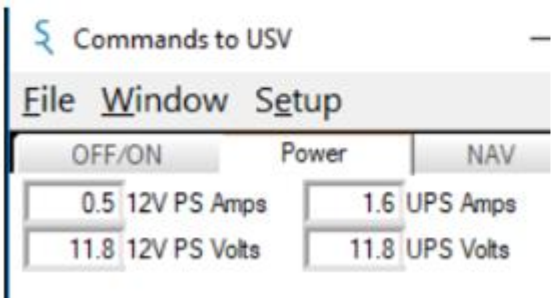
The following display windows are used to send commands to the ASV in a manual control mode. The commands are executed when selected.

Control Panel -Power Tab



Fields at top of the Power tab indicate status of the two onboard battery backups. The volt values will normally read approximately 12 volts.

Thrusters OFF/ON – Turn the thrusters on/off. **The thrusters default to the "OFF" position at start up for safety. Before operating the Thrusters will need to be turned on.**



DAC OFF/ON – Power control to Data Acquisition Computer.

This button does not run the DAC thru a proper Windows shutdown. Rather it is a physical switch to the supply power. Turning this off will hard shutdown the DAC. If power cycling the DAC the user must 1st do a proper Windows shutdown. By default, the DAC is powered on automatically at vehicle Startup. An onboard battery backup will automatically send the DAC a shutdown sequence once the vehicle main power switch is turned off. Under normal operation there is no need for the user to power cycle the DAC.

ADP OFF/ON- Power control of SonTek M9. M9 is on as default at system start up. It will turn off automatically at shutdown. Under normal operation there is no need for the user to power cycle the M9

EX2O OFF/ON- Power control of EXO2 shorty. EXO2 is on as default at system start up. Under normal operation there is no need for the user to power cycle the EXO2.

GPS OFF/ON- Power control of the GNSS. The GNSS is on as default at system start up. It will turn off automatically at shutdown. Under normal operation there is no need for the user to power cycle the GNSS.

Camera OFF/ON- Power control of the camera. The camera is on as default at system start up. It will turn off automatically. Under normal operation there is no need for the user to power cycle the camera.

Depth Stop OFF/ON – **Enable and disable stopping the ASV for shallow depth. If the depth stop is on and the water depth is at or less than the abort depth, the ASV will go into Station Keep mode. When that happens, the depth stop should be turned off (Depth stop OFF) and the ASV should be manually guided to water at or greater than the resume depth. The depth stop can then be turned back on (Depth stop ON).**

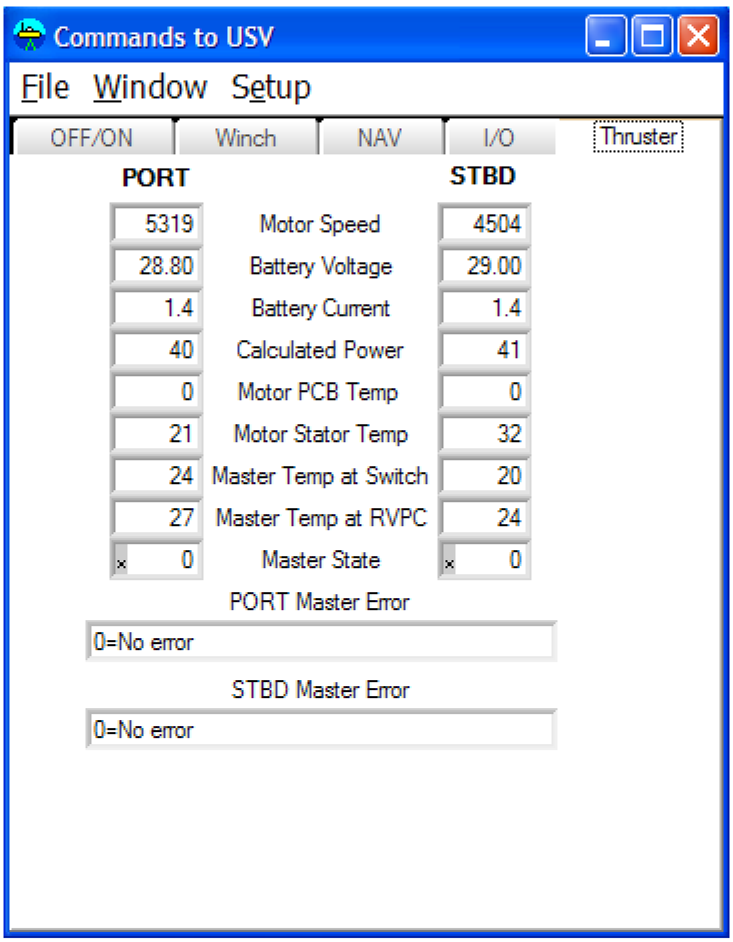
Boundary OFF/ON – **Enable & disable the working zone boundary. This will work like the obstacle avoidance software. If the boundary is on and HYPACK detects that the ASV is outside the boundary, the ASV will go into Station Keep mode. When that happens, the boundary should be turned off (Boundary OFF) and the ASV should be manually guided inside the boundary. The boundary can then be turned back on (Boundary ON).**

R/C Power OFF/ON –Cycles power to the optional backup 2.4Ghz remote control telemetry system if installed. R/C power default is on at start up. It will turn off automatically. Under normal operation there is no need for the user to power cycle the camera.

R/C Bind OFF/ON- This will be used if installing the backup optional 2.4Ghz remote control telemetry system post factory delivery. Otherwise this will not be used.

Thruster Mute OFF/ON –This feature is for administering system software updates. It will not be used under normal operation.

Thruster Status Display



This panel shows the status of the two electric thrusters. This panel is for display purposes only.

Motor Speed – motor RPM before the gear reduction.

Battery Voltage – Voltage reported by the motor controller.

Battery Current Amps–: Actual current of the motors as reported by the controller.

Calculated Power – Watts calculated by the OIS software based on motor current and battery voltage.

Motor PCB Temperature – Not applicable to this ASV.

Motor Stator Temperature degrees C– This is the temperature of the motor housing. There is a temperature sensor embedded in the motor windings.

Master Temp at Switch degrees C– Motor Controller internal temperature.

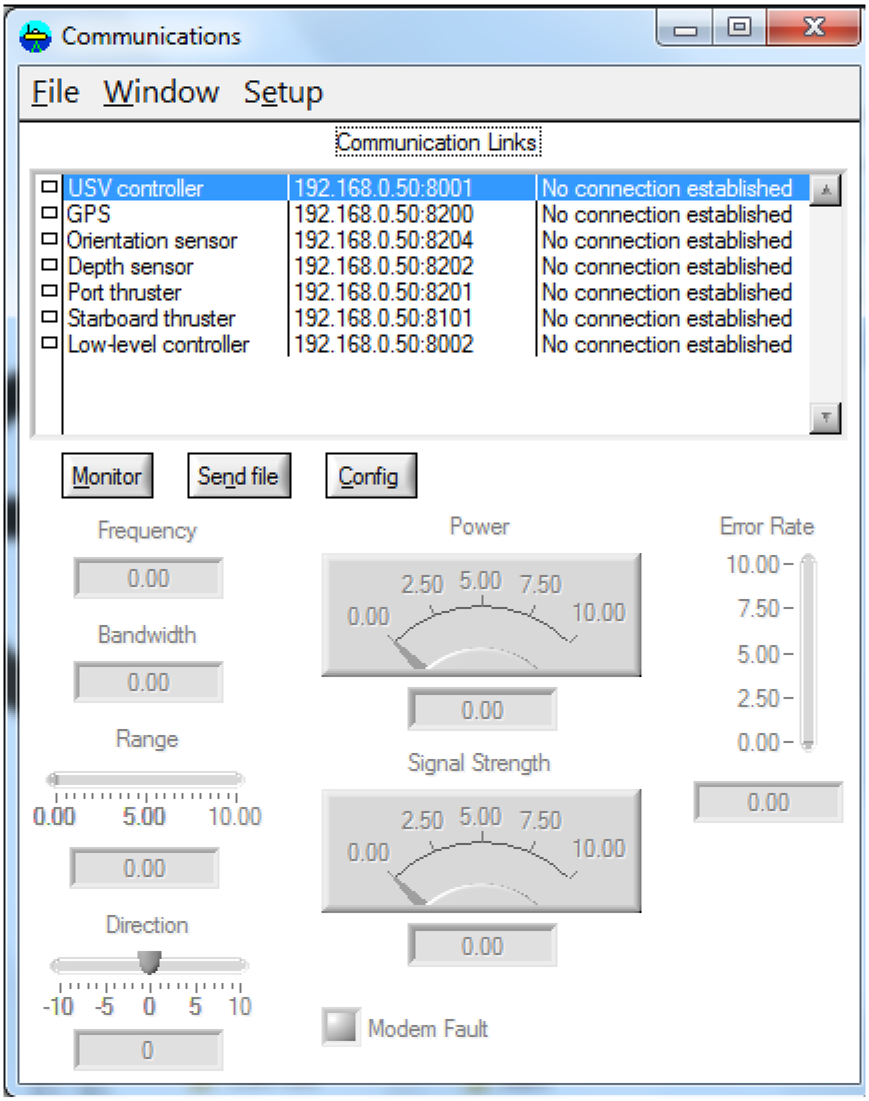
Master Temp at RPVC – Motor Controller heat sink temperature.

Master State – Not applicable to this ASV.

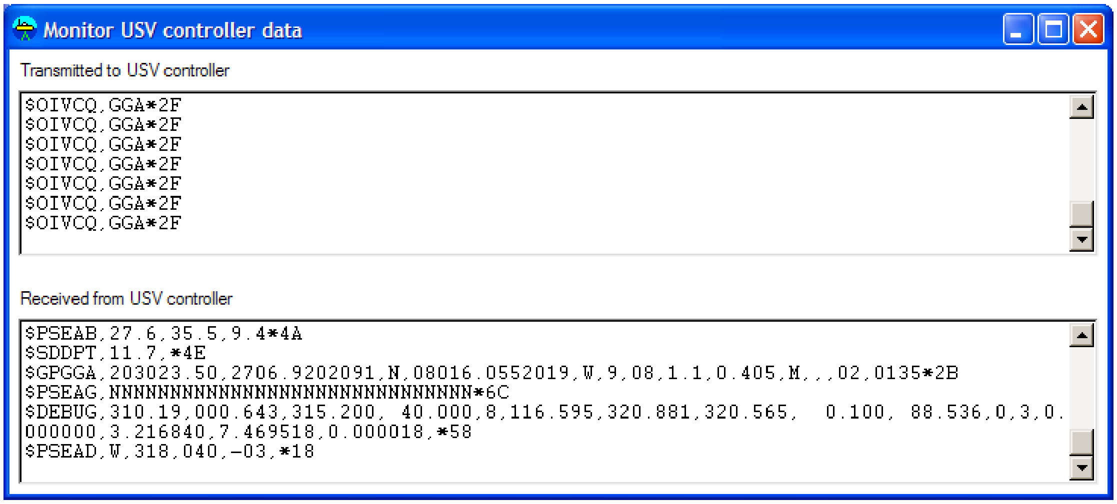
Master Error Fields – Controller fault status. Errors that occur during operation will be displayed in these fields.

8.1.3 Communications Display

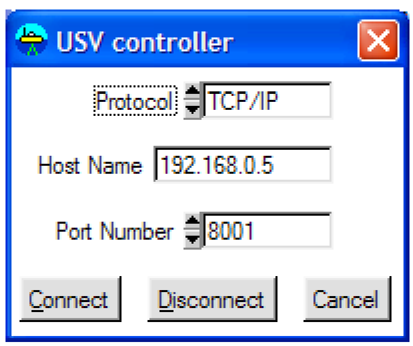
The communications display allows the operator to establish a communication link to the devices listed in the Communication links window. A communication channel is opened to a link by selecting that device, which can then be monitored by selecting the "Monitor" button. The communication link status gauges are provided to allow feedback when the communications RF radios provide the associated information.



In the example above the Vehicle Controller link has been opened and its status is connected. When a link is connected and the monitor button is selected, a window like the window below (in this case Vehicle Controller) is opened and the communications to that device are seen in real time. Transmitted and received communication strings are seen in separate windows.



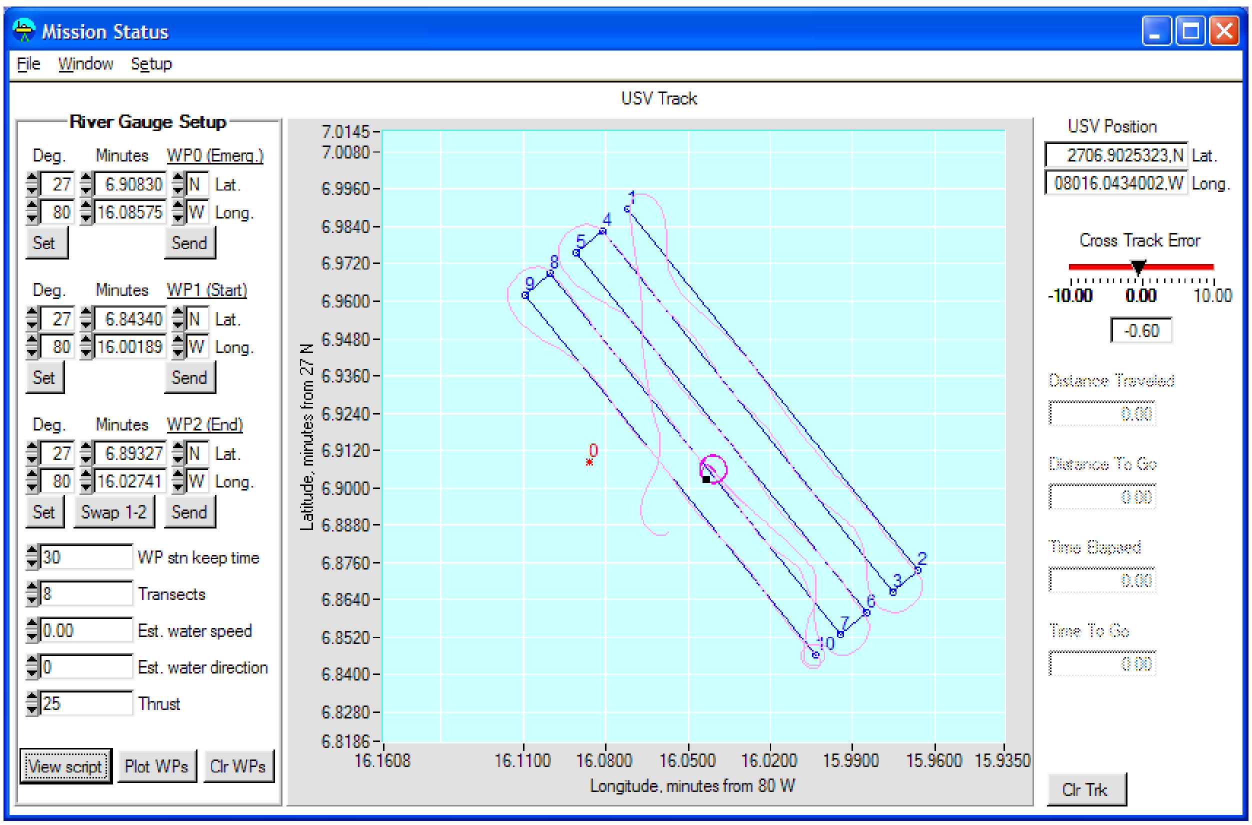
When the **Config**. Button is selected in the main communications window a small set-up window will appear (below) which allows the operator to modify the communication port settings for that device.



8.1.4 Mission Status Display

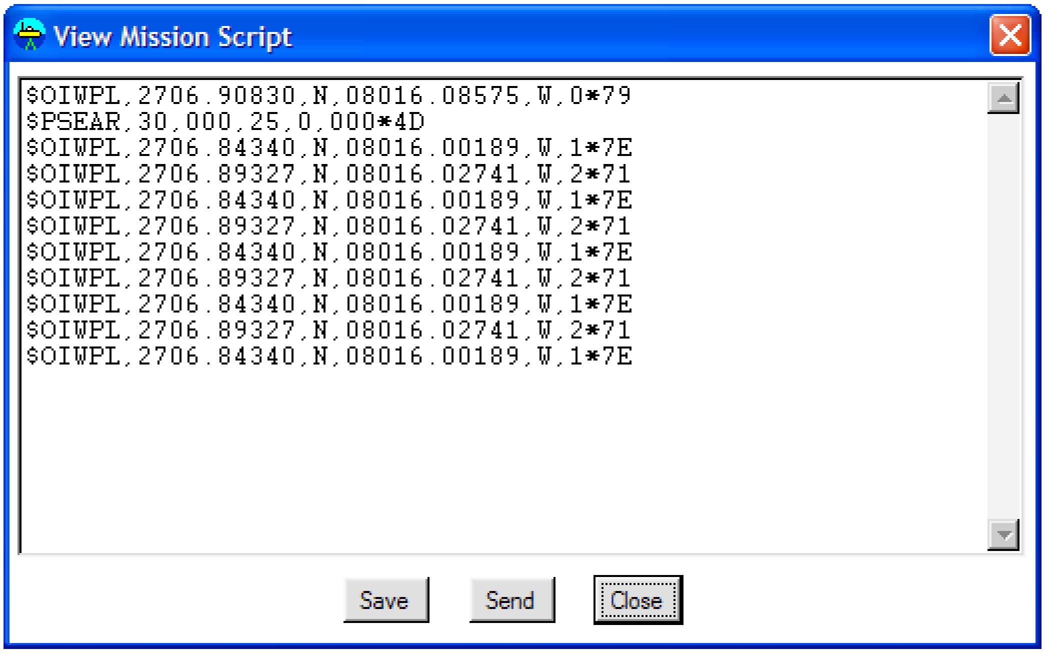
The mission status display is comprised of three sections, which divide the screen horizontally. The first section is used to set-up missions in the River Navigator mode. The operator can enter waypoints either manually by setting the numerical values in the data windows or by selecting the **Set** button, which will enter the vehicles current position as the waypoint. Waypoint 0 is used as an “Emergency Home” position; the location the vehicle will transit to when in an emergency fault condition. Waypoint 1 (start), and Waypoint 2 (end) define the endpoints for the gauging transect. The Preview Mission button can be used to launch the Preview Mission display which is described below. The Send Mission button is used to send the mission to the vehicle for execution.

The center section of the display is used to track the vehicle during the mission, and the right side of the display is used to provide data on the status of the mission on a transect by transect basis.

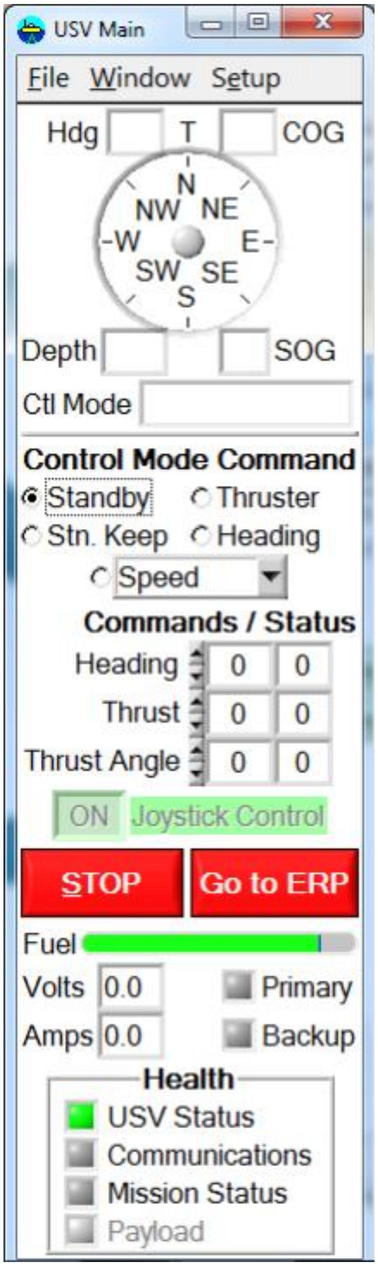


Preview Mission Display

Missions are defined as series of commands stored in a script file, which is downloaded to the vehicle and run in sequence. The Preview Mission display is used to review the mission script for accuracy. Refer to section 1.5.5 for creating missions.



8.2 Control Modes



Various control modes are provided in anticipation of the common tasks performed by the vehicle. The operator interface for the ASV systems has been designed to allow the operator access to required vehicle status information while preserving a focus on interfaces provided for the various integrated sensors. The vehicle status information is provided through health indicators which can direct the operator to further investigate any anomaly in a simple manner.

Standby

In Standby mode, the vehicle uses minimal energy while listening for commands from the Operator Interface System via the RF modem. The OIS transmits a message to the vehicle once per second with new commands or confirming the continuation of standby mode. Communications from the ASV to the OIS in this mode.

Thruster

In thruster mode, the operator has direct control of the forward and reverse thrust commanded to the vehicle, as well as thruster angle (on ASVs with a single VECTORED Thruster) or thrust differential (on ASVs with dual stationary thrusters), providing a port or starboard turning moment. Thrust commands are provided through a choice of joystick input, keyboard arrow key input, selection of displayed arrow buttons, or numerical keyboard entries for selected display values. In thruster mode, the operator is directly driving the vehicle. The thruster control mode is used to provide the most responsive vehicle control and can be utilized for maneuvering in tight quarters.

Heading

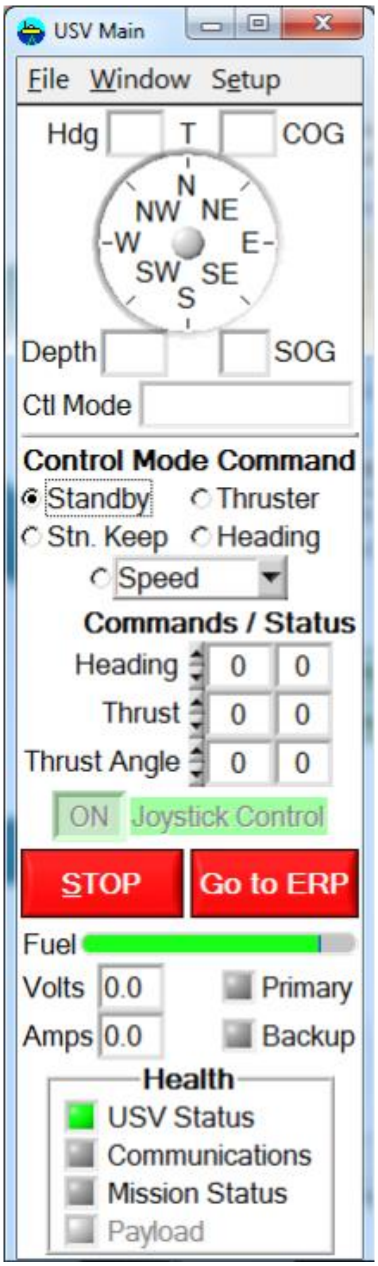
Heading control mode is used to decrease the operator's workload through the utilization of an automatic closed loop heading control system. The control system uses compass and yaw-rate sensor feedback to minimize the error between the heading set point commanded by the operator and the actual heading of the vehicle. After setting the desired heading the operator can set a thrust command. As an example, the operator may set a heading of 90 degrees and a thrust of 40% causing the vehicle to traverse a course with the vehicle pointing due east with 40 % of the available thrust. This control mode can be used to traverse long distances with a fixed heading using little or no operator intervention. The heading control mode can also be used to follow a course over ground (COG). While monitoring COG provided by the INS system, the operator can provide minor heading adjustments to maintain the desired COG. Additionally, the vehicle can be driven to a dock or launch point using the heading control mode by making appropriate adjustments to the vehicle heading command. Command entry options are like those discussed in thruster mode.

8.2.5 Station Keeping

Station keeping mode is used to maintain the vehicle's position near a desired point. In station keeping mode the vehicle will approach a waypoint and maintains a position within the accuracy of the INS system. Some maneuvering will be seen during the station keeping process especially when no wind, current or other fixed disturbances are present. In the presence of fixed disturbances, the station keeping controller functions with minimal maneuvering.

8.2.6 HYPACK

SeaRobtoics and HYPACK have developed a driver that allows the vehicle to be controlled and operated via HYPACK survey. Please reference Quick Start Appendix 1 section 5.1 for details.



Set the desired thrust in the Thrust Command box, then select Hypack in the pull-down list under Control Mode Command. The ASV will not move without a thrust command set.

The Thrust may be adjusted while in Hypack Control Mode, using the GUI and the joystick controller.

The operator can take control at any time by changing control modes and can return control to HYPACK Survey by selecting Hypack Control Mode.

The "Outside boundary" alarm is the only one that will cause the ASV to do something.

However, they all will be reported to the operator.

8.2.7 Waypoint

Waypoint mode has been defined to provide general purpose mission execution. A mission is defined by a series of waypoints as well as a set of commands used to define the vehicle function at each waypoint. In waypoint mode Waypoint 0 (WP0) is considered the emergency recovery position. This may be the launch point or some other designated safe location for the vehicle. In the event of a fault the vehicle will transit to this point. Waypoint 1 (WP1), Waypoint 2 (WP2), and all subsequent waypoints are used to define mission segments or transects. A mission is comprised of a series of mission segments, instantiated with the commands required to describe the functions executed at each waypoint. Additional parameters which can be set are station keeping time (the amount of dwell time at each waypoint), desired thrust, estimated water speed, sensor status (such as power on/off, or start sampling), etc. Commands for the control of optional sensing systems can also be incorporated into the mission plan, such as the commands required for the control of a side scan sonar system.

A mission segment is defined as the transit from one waypoint to the next waypoint. The first segment of the mission is from WP1 to WP2. The second transect is from WP2 to WP3 and so on. At each waypoint during the mission a station keeping time can be set and executed. If the station keeping time is set to 30 seconds, the vehicle will perform a station keeping function for 30 seconds at each waypoint. A mission script is generated by the definition of waypoints and the functions executed at each waypoint. The mission duration is defined by the transit distances, station keeping times, and the other functions executed during the mission

Once a mission is defined using mission planning tool, the operator can download the mission to the vehicle for execution.

Waypoint Mission Overview

A waypoint mission is a sequence of NMEA 0183 commands for the ASV to follow. Typically, it starts with a PSEAR command, which specifies the mission throttle setting and the pause time at each waypoint. The PSEAR command is followed by a series of WPL commands, which specify the waypoint positions to travel to. The first WPL command may have a waypoint ID of 0 to indicate the emergency recovery point for the mission, rather than a position to travel to. Here is a sample mission:

*$PSEAR,0,000,60,0,000*7F*
*$OIWPL,4742.17910,N,12236.89350,W,1*71*
*$OIWPL,4742.24970,N,12236.98910,W,2*7A*
*$OIWPL,4742.25330,N,12236.98310,W,3*7E*
*$OIWPL,4742.18280,N,12236.88760,W,4*7F*
*$OIWPL,4742.19190,N,12236.87290,W,5*78*
*$OIWPL,4742.26240,N,12236.96840,W,6*7E*
*$OIWPL,4742.27150,N,12236.95360,W,7*76*
*$OIWPL,4742.20100,N,12236.85810,W,8*76*

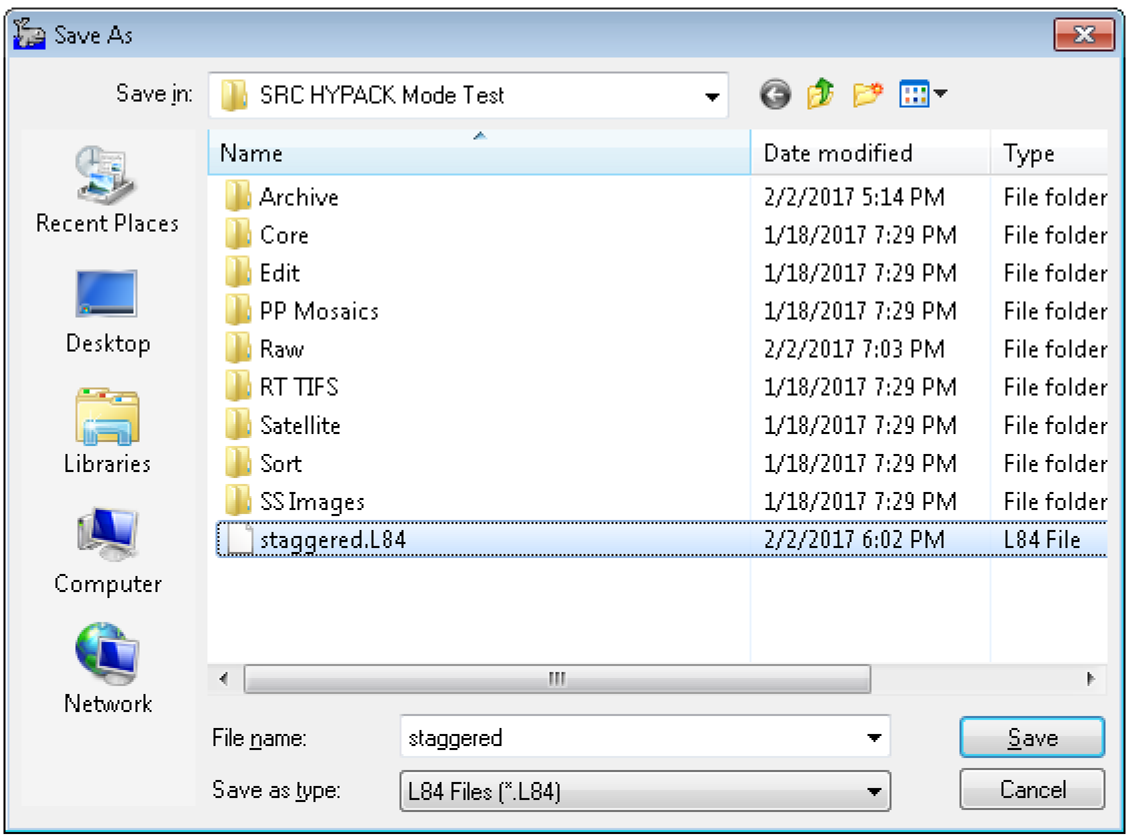
This mission tells the ASV to go to eight waypoints, with a throttle of 60 percent, and zero pause time at each waypoint. It does not specify an emergency recovery position.

HYPACK Planned Line File

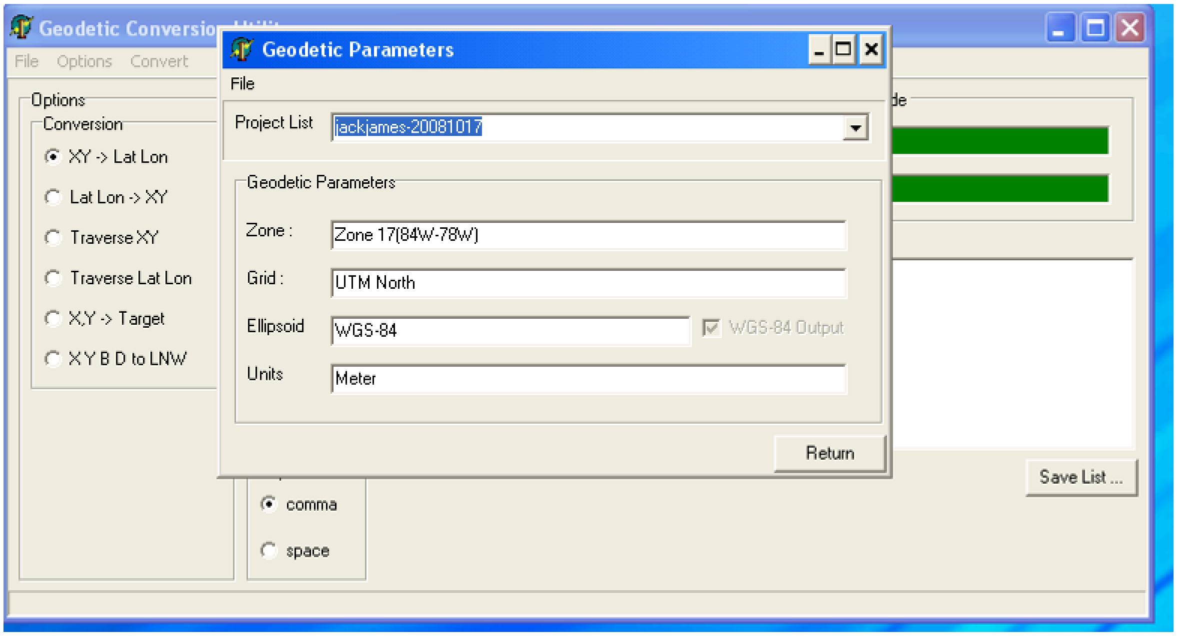
A planned line file from HYPACK can be converted to a waypoint mission. The conversion is done in two steps. The first step is to convert the HYPACK planned line file from the projected coordinate system of the HYPACK project to WGS-84 latitude and longitude coordinates. The second step is to convert the WGS-84 planned line file to a waypoint mission.

Conversion to WGS-84

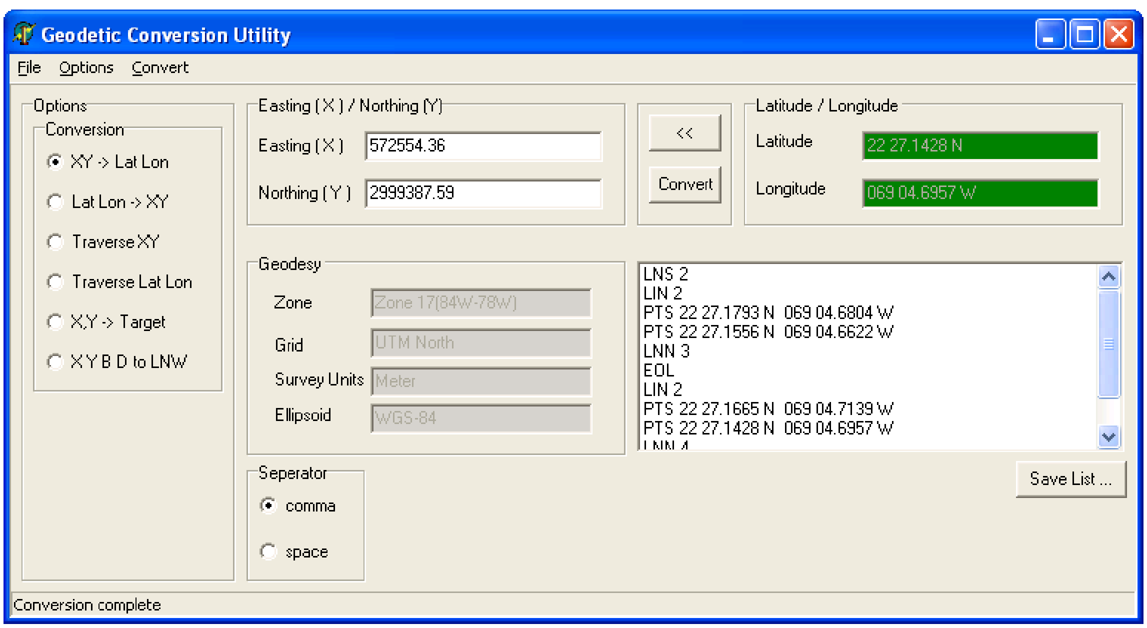
Conversion from the projected coordinate system of the HYPACK project to WGS-84 latitude and longitude coordinates is done with the HYPACK Line Editor. Select File->Save As… and then set Save as type to L84 Files. See "Exporting Planned Lines from the LINE EDITOR" in Chapter 2 of the HYPACK User Manual.



If an earlier version of HYPACK is installed that does not support L84 Files, then conversion from the projected coordinate system of the HYPACK project to WGS-84 latitude and longitude coordinates is done with a utility program called Geo. When Geo is run, first select the Options menu, and then select Geodesy to open the Geodetic Parameters dialog box. In the Geodetic Parameters dialog box, pull down the Project List and select the HYPACK project that the planned line file was created in. When the project is selected, the Geodetic Parameters for that project will be filled in. Click the Return button to close the Geodetic Parameters dialog box.

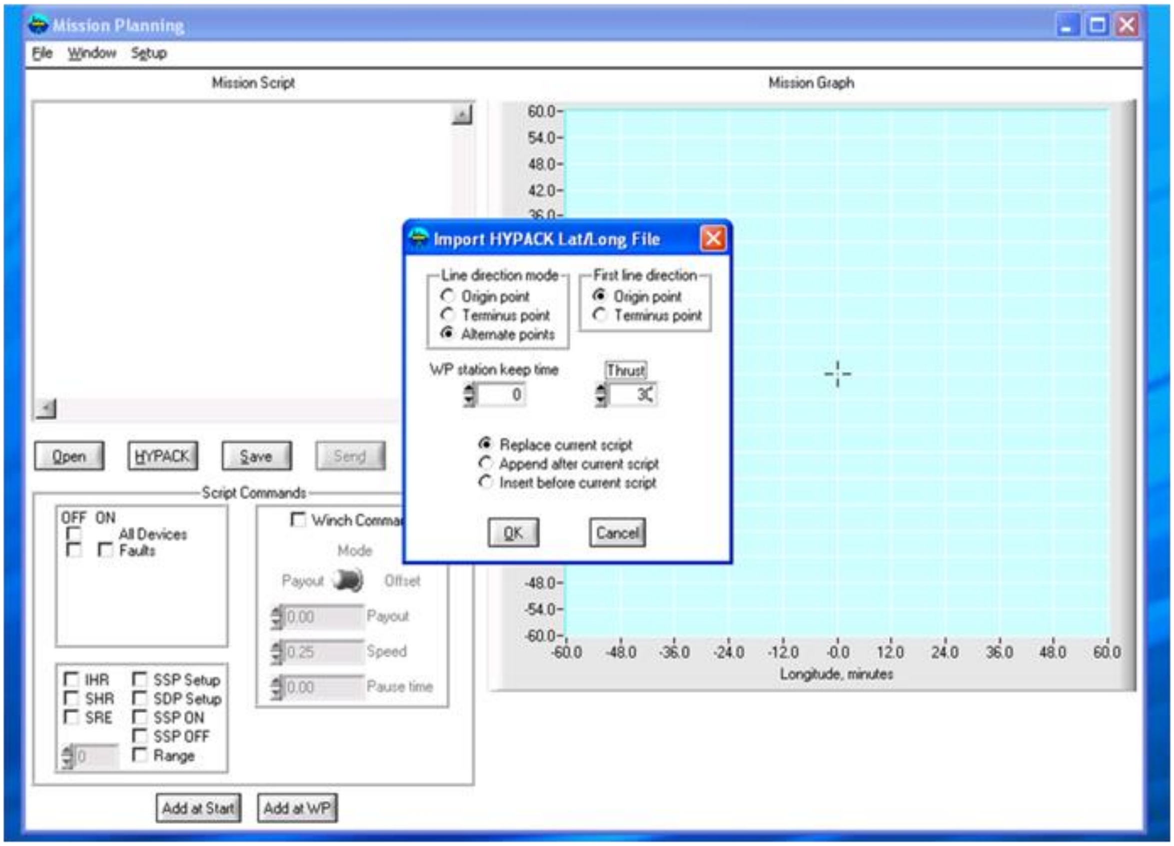


Next, select the File menu, and then select Open File to open the Open dialog box. Set Files of type to HYPACK Line File, and then select the planned line file to convert, and then click the Open button. The converted file will appear in Geo. Click the Save List button to open the Save As dialog box. Enter a name for the file, and then click the Save button to save the file. Exit Geo.

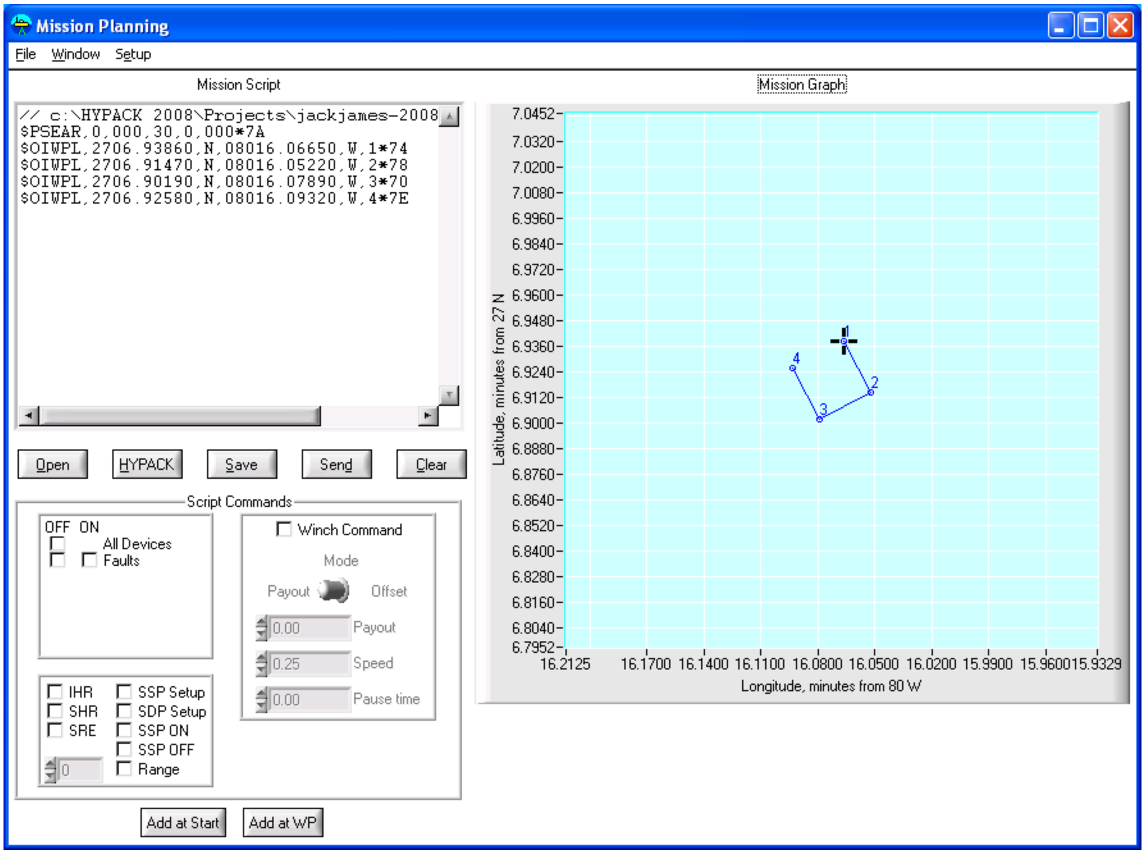


Conversion to Waypoint Mission

Now that a planned line file has been setup in WGS-84 coordinates, it can be converted to a waypoint mission with the SeaRobotics ASV application. Select the Window menu, and then select Mission Loader to open the Mission Loader window. Click the HYPACK button, and then select the WGS-84 planned line file that was saved from HYPACK. The Import HYPACK Lat/Long File dialog box will appear.



The Line direction mode sets the direction that the mission runs the planned lines. Origin point runs every line starting from the HYPACK origin point, Terminus point runs every line starting from the HYPACK terminus point, Alternate points alternates the direction from line to line. If Alternate points are selected, then First line direction sets the direction for the first line. The station keep time can be set at each waypoint and the thrust setting for the mission. Any previously opened mission can be replaced with the HYPACK lines, or the HYPACK lines can be appended or inserted into a previously opened mission. Click the OK button to convert the HYPACK lines to a waypoint mission. The mission will appear in the Mission Script box and in the Mission Graph.



Click the Save button to save the waypoint mission to a file. Click the Send button to send the waypoint mission to the ASV.

8.2.8 River Discharge

River discharge mode has been defined to provide a simple interface for mission definition and execution during stream gauging and river discharging measurements. The river navigation mission is defined by a series or three waypoints. Waypoint 0 (WP0) is considered the emergency recovery position. This may be the launch point or some other designated safe location for the vehicle. In the event of a fault or after normal completion of the mission the vehicle will transit to this point. Waypoint 1 (WP1) and Waypoint 2 (WP2) are used to define a transect across the river. Additional parameters which can be set are station keeping time (the amount of dwell time at each waypoint), number of transects, and estimated water speed.

A transect is defined as one segment of the mission from a waypoint to the next waypoint. The first transect of the mission is from WP1 to WP2. The second transect is from WP2 to WP1 and so on. At each waypoint during the mission a station keeping time is set. If set to 30 seconds, the vehicle will perform a station keeping function for 30 seconds at each waypoint. The number of transects along with the station keeping time defines the duration of the mission. This type of mission is commonly used during the stream gauging process. Stream gauging refers to a process for the mapping water flow velocity vectors for the cross-section of a river. The volume flow rate (Q) of the river at a specific point can be estimated using this technique.

Once the mission is defined using the River navigator the operator can save a named mission script for execution at any time in the future.

Waypoints can be entered using the set button, which reads the current vehicle coordinates (lat/long) as the selected waypoint, or by entering the lat/long waypoint coordinates manually.

8.2.9 RiverSurveyor Mode

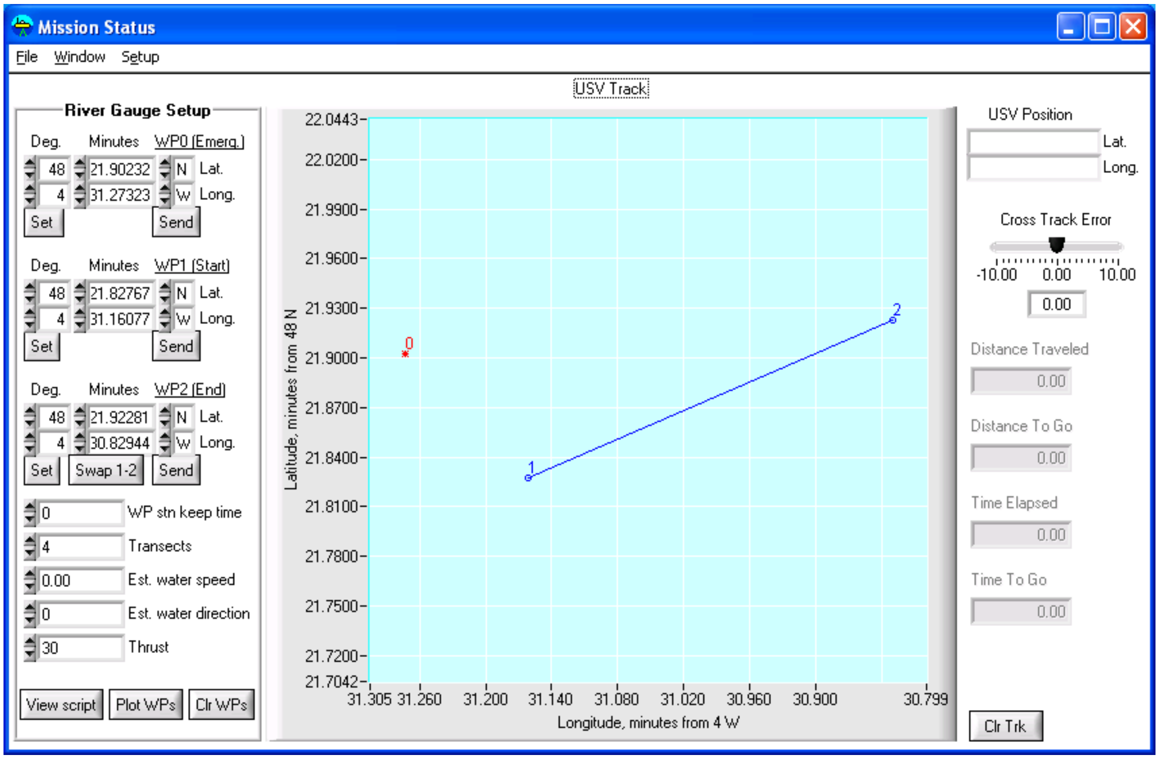
Normally a waypoint mission should be planned and created before testing, but there is a quick and easy way to test waypoint mode without the need for a planned mission, by using the Mission Status window. For this test, the user will create a waypoint mission that runs back and forth between two waypoints.

First, drive the ASV to the position for the first waypoint. Click the Set button for WP1 on the left side of the Mission Status window. WP1 is the middle of the three waypoints on the left side of the window. The ASV position will then be seen as filled in for WP1.

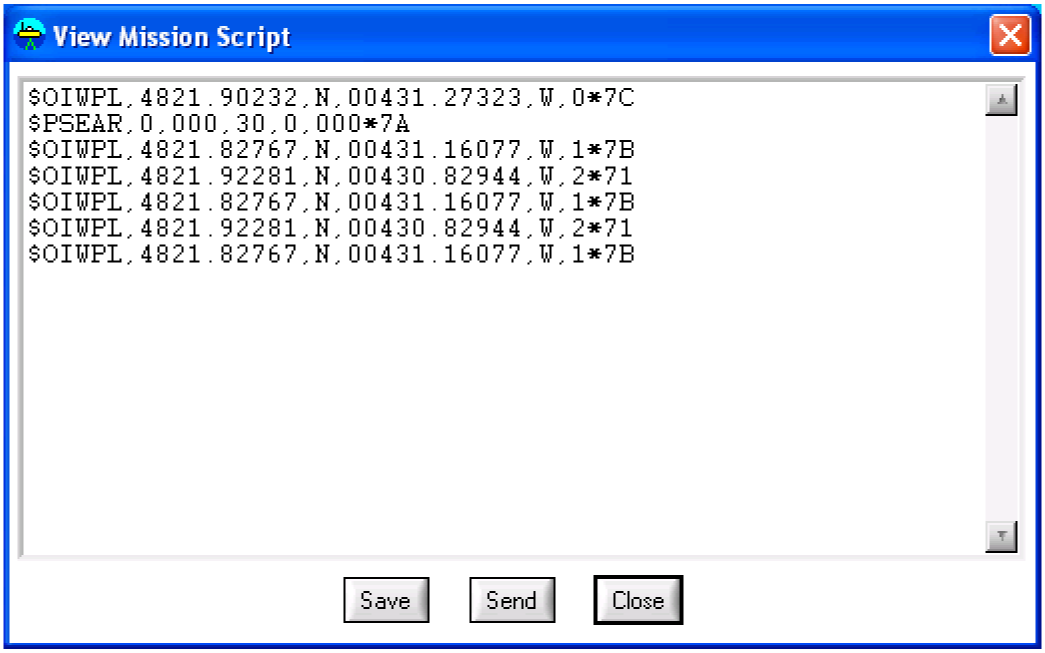
Next, drive the ASV to the position for the second waypoint. Click the Set button for WP2 on the left side of the Mission Status window. WP2 is the lower of the three waypoints on the left side of the window. The ASV position will then be seen as filled in for WP2.

Next, drive the ASV to the position for the emergency recovery position. Click the Set button for WP0 on the left side of the Mission Status window. WP0 is the upper of the three waypoints on the left side of the window. The ASV position will then be seen as filled in for WP0.

Click the Plot WPs button to see the waypoints plotted on the ASV Track graph.



Set the WP station keep time to the number of seconds for the ASV to pause each time that it reaches a waypoint. Set Transects to the number of times for the ASV to run back and forth between WP1 and WP2. Set Thrust to the throttle setting for the mission. Click the View Script button to create and display a waypoint mission for these settings.



From the View Mission Script dialog box, click the Send button to send this waypoint mission to the ASV. The Save button can also be used to save this waypoint mission to a file. Once the mission has been sent to the ASV, select Waypoint mode in the ASV Main window to start following the mission.

Watch the ASV Track graph to verify that the ASV goes to WP1, and then follows the line between WP1 and WP2. After the ASV has run between WP1 and WP2 the specified number of times, it will start station keeping at the last waypoint.

8.3 Fault Condition Table

Fault condition	Detection/ Enunciation	Response
RF Comm Loss	Detect at OIS	Pop-Up box error
Standby	TS 7800 detection	Standby
Thruster	TS 7800 detection	Standby
Heading	TS 7800 detection	Standby
Station Keeping	TS 7800 detection	Continue
Waypoint	TS 7800 detection	Continue
River navigator	TS 7800 detection	Continue
Process crash		
TS 7800	Detect at OIS Detect at TS 7800 Processor	Pop-Up box error. TS 7800 Processor will command 0 thrust. (Same error as comms link error. Possible for well-trained operator to take execute thruster mode and heading mode)
TS 7800	TS 7800 detects Fault error low to high controller process comms	Thrusters stop on loss of comms with low level process approx. .5 seconds

8.4 Mission Planning

Several methods of mission planning are available. New mission scripts can be generated using a text editor, or the text editor can be used to modify a previous mission. Additionally, a mission script can be generated automatically using the SeaRobotics mission planning GUI. The mission planning GUI allows for waypoint definition by entry of the latitude and longitude of the point or by selecting the current vehicle latitude and longitude for the waypoint. Various functions can be executed at the waypoint by selecting functions listed on the mission planning screen. When the mission has been defined, it can be sent to the vehicle for execution.

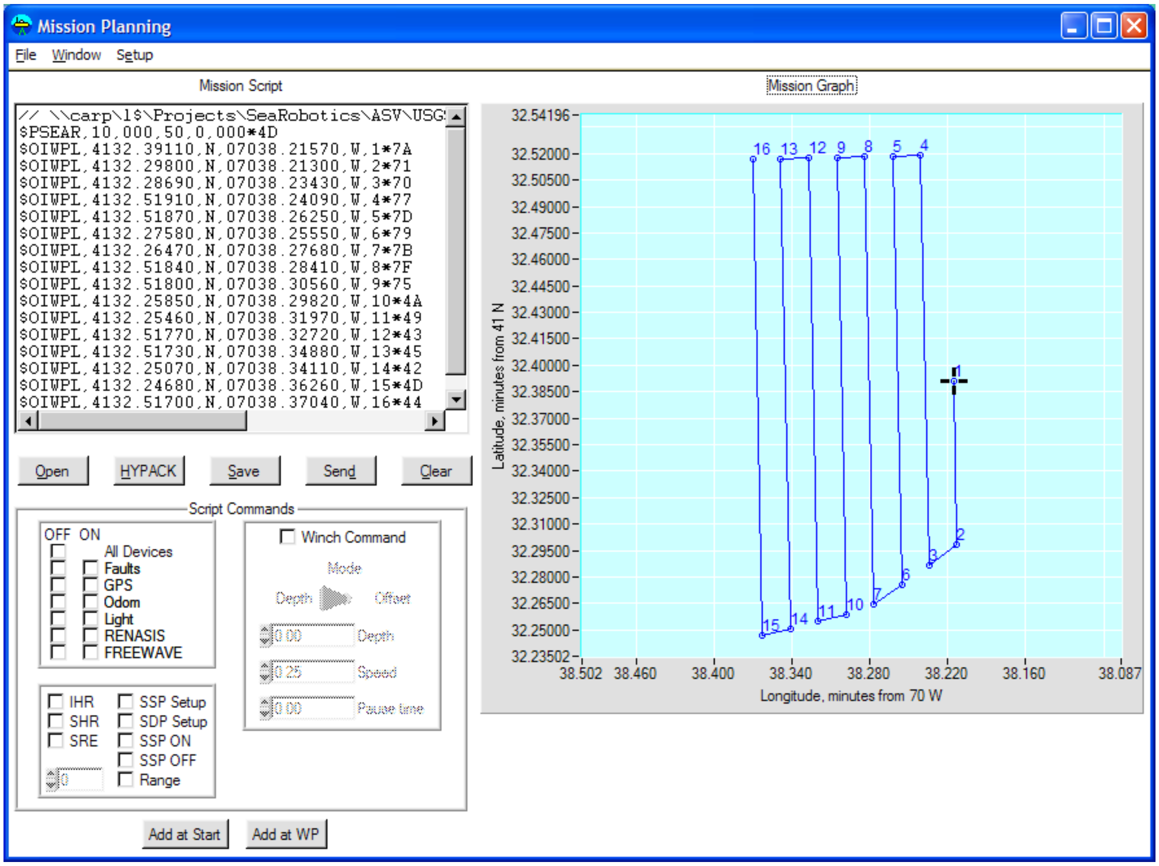
In addition to the use of the simple SRC GUI mission planner, mission planning can be accomplished using HYPACK. The HYPACK interface provides a comprehensive tool for geodetic mission planning. HYPACK allows the use of numerous chart types as backgrounds during the planning g process, along with numerous planned line generation tools. Mission planning and monitoring can be accomplished using the HYPACK Survey program module. An extensive description of the mission planning functions is available in the HYPACK manual and various tutorials are available from HYPACK.

Once a mission plan has been generated in HYPACK, the mission is stored along with the geodesy data used by the planned line file. The planned line file, which results from the HYPACK mission planning process, must be run through a conversion program which converts the waypoints from northing and easting coordinates to the latitudes and longitudes use by the SRC mission execution program. The converted planned line file is opened by the SRC mission planning GUI for the instantiation of the waypoints with various commands available on the vehicle. Once the mission has been defined, it can be sent to the vehicle for execution, or saved for execution later. When planning a mission in HYPACK and executing the mission on the ASV, care should be taken to execute the mission using transect lengths of less than 1 km. Longer transects may create discrepancies in cross track error magnitudes when monitoring the mission with HYPACK.

Mission planning can be accomplished in the following manners:

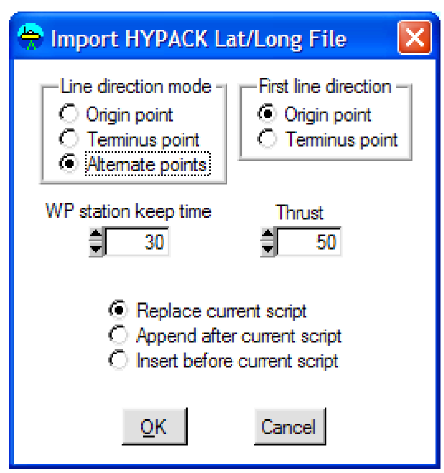
1. Define the general mission plan using Hypack Survey, complete mission plan using SRC tools
2. Define the mission using the SRC Mission Planner
3. Generate the mission as a text file in the appropriate format

The mission planning display provides a scrolling window containing the open mission script, a set of command buttons, a section which allows the entry of several mission script commands, and a plot of the waypoints/waypoint sequence described by the open mission script.



The “Add at Start” button and the “Add a WP” (waypoint) button allow the operator to define a command and its sequence to add to the mission script. **Commands which appear grayed out** are not available to the operator at the current time of with the current vehicle configuration (i.e. the winch may be removed).

The Import HYPACK Lat/Long File window is used to configure the converted HYPACK generated planned line file into a file which can be used as a mission script. A detailed description of the definition, conversion, and use of the HYPACK mission planning technique is described in the Appendix.



When the ASV enters Waypoint mode, the ASV controller starts reading lines from the mission file and executing the commands. If the command is a WPL command, it does not execute the next command until it reaches the position in the WPL command.

The one exception is if a WPL command has a waypoint ID of 0, then that position is stored as the ERP and the ASV controller goes on to the next line in the mission file.

After the last line in the mission file is executed, the ASV controller automatically enters Station Keep mode at its current location and remains there until it is commanded to do something else. While the boat is in Waypoint mode, it may be commanded to Thruster mode, Heading mode, Station Keep mode, or Go To ERP mode, and then commanded back to Waypoint mode, and it will resume the mission file where it left off. If it is commanded to Standby mode, and then back to Waypoint mode, ***it will start over*** from the first line of the mission file.

When a mission file is sent to the ASV, it is stored on the ASV and remains there until a new mission file is sent.

IMPORTANT

When the ASV is taken to a new location, the user must remember to send it a new mission file before entering Waypoint mode, AND A NEW ERP, otherwise it will try to navigate to waypoints from the last mission file!

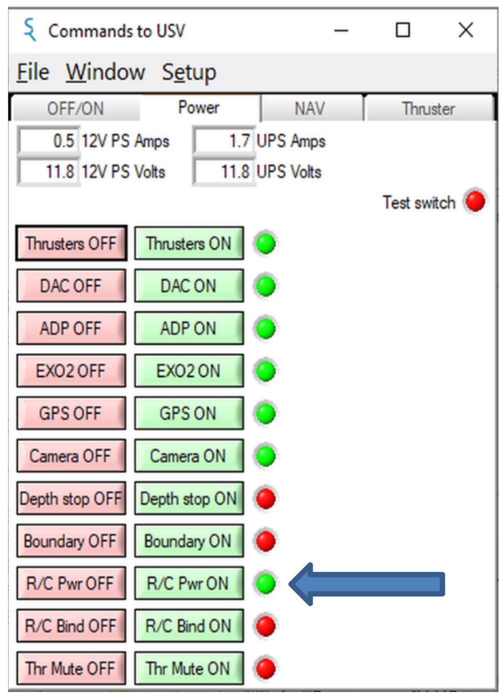
8.5 Remote Control (RC) Controller *(Option)*

When the boat is operated outside of visual range of the base station, such as during launch and recovery at a dock when the OIS is indoors or example, the RC Controller can be used. The typical usage of the RC controller will be to launch the USV, drive the USV to a safe location using Thruster or Heading modes, and then place the USV in Station Keep mode. The operator would then turn off the RC controller and go back to the OIS location to begin a mission.

The RC controller has over-riding control over the USV. When the operator takes control of the USV with the RC controller, USV control will not be relinquished until the RC operator relinquishes control back. This prevents any confusion on which device/system has control of the USV.

The standard RC controller has a range of 400 to 600 feet. If the boat is operated beyond the limit of the RC transmitter the Base Station will assume control.

The RC receiver power is ON by default. The receiver can be turned off if needed which would normally only be done if re-binding of the receiver and transmitter is required.



Selecting Modes on the RC Controller

The three operating modes on the USV are Station Keep, Thruster mode and Heading mode. There are three toggle switches on the RC controller for selecting the three operating modes.

The joystick has 6 pre-programmed functions (see illustration below):

1. Transmitter Power ON / OFF
2. Rudder LEFT / RIGHT
3. Thrust UP / DOWN
4. Thruster Mode Select
5. Heading Mode Select
6. Station Keep Mode Select

Normal RC operation would be to select an operating mode with the toggle switch and then when finished with that mode turn the toggle switch off. If an operating mode is selected on the RC controller by turning on a toggle switch and another mode toggle switch is then turned on, the second toggle switch turn on is ignored as only one mode can be active at a time.

The *Commands to ASV* page indicate which controller has USV control. In this example, the *5=RC* indicates that the RC controller is in control. If the GUI was in control, then the text would read *1=Primary*.

The GUI will always re-assume control after the RC controller is turned off.

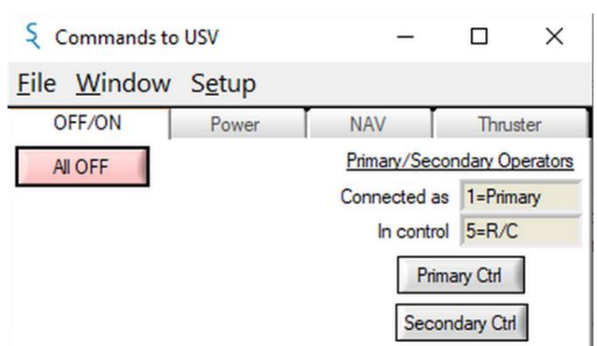


Figure 30 RC Controller

The possible switch combinations on the RC controller and the resultant control behaviors are as follows:

RC Remote Control Switch Combinations				
GUI RC Power	**RC Control Power**	**RC Mode**	**Thrust Joystick**	**Rudder Joystick**
OFF	OFF	Thruster OFF	In-Active	In-Active
		Heading OFF	In-Active	In-Active
		St. Keep OFF	In-Active	In-Active
ON	OFF	Thruster ON	In-Active	In-Active
		Heading ON	In-Active	In-Active
		St. Keep ON	In-Active	In-Active
OFF	ON	Thruster OFF	In-Active	In- Active
		Heading OFF	In-Active	In-Active
		St. Keep OFF	In-Active	In-Active
ON	ON	Thruster OFF	In-Active	In- Active
		Heading OFF	In-Active	In-Active
		St. Keep OFF	In-Active	In-Active
ON	ON	Thruster ON	Active	Active
		Heading OFF	In-Active	In-Active
		St. Keep OFF	In-Active	In-Active
ON	ON	Thruster ON	Active	Active
		Heading ON[1]	In-Active	In-Active
		St. Keep OFF	In-Active	In-Active
ON	ON	Thruster OFF	In-Active	In-Active
		Heading ON	Active	Active[2]
		St. Keep OFF	In-Active	In-Active
ON	ON[3]	Thruster OFF	In-Active	In-Active
		Heading OFF	In-Active	In-Active
		St. Keep ON	In-Active (Auto)	In-Active (Auto)

Notes:

1. If a second mode is turned on without first turning off another mode, the first mode will maintain priority. If the first mode is turned off, while the second mode is on, then the second mode will assume authority.
2. In Heading Mode, the boat maintains the heading that was stored when the mode was initially selected, much like the cruise control in a car. To adjust the heading while in Heading Mode, move and hold the joystick until the boat reaches the new desired heading and then release the joystick. Thrust is maintained manually while in Heading Mode.
3. The GUI assumes authority when the RC controller is turned OFF. If the RC controller was in Thruster or Heading Mode when it was turned off, then the GUI will automatically default to Standby Mode. If the RC controller was in station keeping mode when it was turned off, then the GUI will automatically be in station keeping mode when it assumes authority.

Station Keep Mode

Once the USV is put into Station Keep mode with the RC (and Logitech) controller the USV will stay in Station Keep mode until another mode is selected. Once the Station Keep toggle switch is turned on, the USV will enter Station Keep mode and the Station Keep toggle switch can then be turned off. Station Keep is a “latched” mode, meaning the USV will remain in station keep indefinitely until another control mode is initiated from either the GUI, Logitech or RC controller. This allows the operator to turn off the RC controller and return to the OIS to continue to the next phase of the mission. The USV will stay on location until the operator is ready to change operating modes.

Thruster mode

The USV can be driven manually when in Thruster mode by using the two joysticks on the RC controller. The left joystick controls thrust; the right joystick controls thrust angle (rudder).

Both sets of joysticks on the RC controller and the Logitech controller provide the same functionality for consistency (thrust and thrust angle). In Thruster mode, the left joystick controls forward and reverse thrust and the thrust joystick must be held in position to maintain thrust.

Once the left joystick is released and returns to the center position, USV thrust will go to zero.

When the right joystick is moved left or right, the USV direction will change direction accordingly and when the right joystick is released the USV will maintain direction but is not holding a heading. Wind or current can change the USV direction.

When the Thruster mode toggle switch is turned off the USV will revert into Standby mode (zero thrust).

Warning - If the boat is in a current, the boat will go downstream! The boat can be immediately switched into Station Keep if the USV needs to hold station.

Heading mode

Heading mode will hold the USV at a set compass heading. Even if the USV is stationary, in Heading mode the USV will rotate to hold heading. This mode is convenient at times as the operator does not need/want to steer the USV manually as in Thruster mode.

Heading mode can be useful for instance when driving the boat during recovery as the boat will drive a straight line automatically towards the ramp or cart location. In heading mode, the left joystick controls thrust and the right joystick is used to adjust the heading port or starboard. Heading is “latched” (maintained) in heading mode.

When the USV is switched into heading mode whatever the heading is *at that time* will be used. A quick “bump” of the right joystick will increment the heading a degree or two. “Bumping” the heading is useful when driving the USV towards a trailer or recovery location and only a slight heading deviation is needed as the USV approaches. Holding the right joystick continuously full left or full right will continue to change the heading. When the right joystick is released the current heading will be maintained. The thrust joystick works the same in Heading mode as in Thruster mode. Once the thrust joystick is released the thrust will go to zero.

A typical operating scenario for Heading mode would be to launch the USV off of the cart in Thruster mode, rotate the USV in the desired direction, turn off the Thruster mode toggle switch, turn on the Heading mode toggle switch and then increase thrust to the desired thrust level. The USV will drive forward at the current heading. Both heading and thrust can be modified at any time. Once the USV reaches the target location, thrust would be cut to zero, the Heading toggle switch would be turned off (USV enters Standby mode) and the Station Keep toggle switch turned on. The Station Keep switch can then be turned off and the RC controller can be powered off. The USV will now remain in Station Keep mode until another mode is selected. Typically, the USV will next be sent a mission file and the USV will be set into either Waypoint or Hypack modes and the USV will begin the mission.

Binding

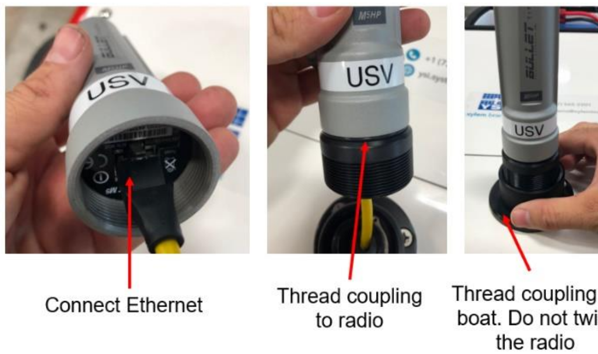
The RC controller and the RC receiver inside the USV are “mated together” or “bound” together electrically. This means that these two devices will only communicate with each other. If there happened to be multiple USV’s operating in the same area the USV’s will ignore the other RC controllers because they are not bound to each other. The binding process is done at the factory and should normally not be required again. However, should either the RC controller or RC receiver fail, or the binding between the two devices is somehow lost, the binding procedure will need to be repeated. Please refer to the appendix for the bind procedure steps.

9.0 Operations

9.1 Boat

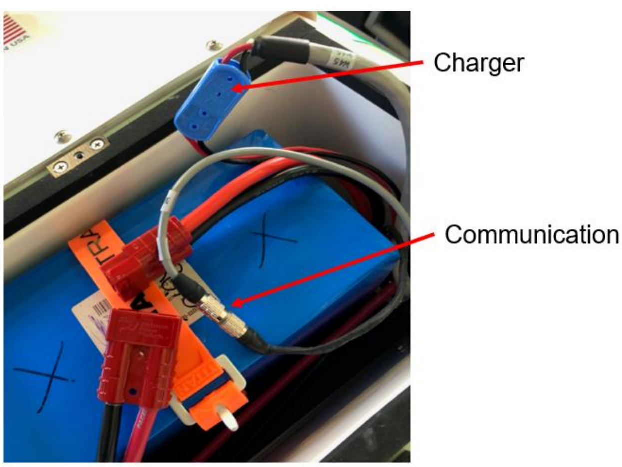
Connect Antenna

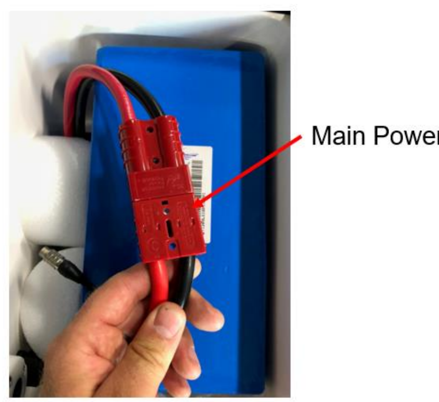
a. Remove the 5.8 gHz radio and antenna from the battery compartment
b. Screw the gray antenna into the radio. Ensure connection is tight
c. Plug ethernet cable into the bottom of the radio. Ensure connector "clicks" into position
d. Screw the radio to the mount in the sequence shown:



Connect Battery

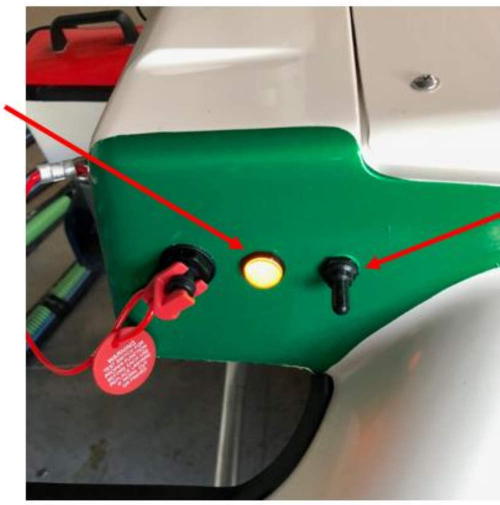
The battery should never be connected to the boat during shipping. The cables can be connected in any sequence as shown below.





Power Up

After the battery is connected, turn on the main power switch to power up the system. The amber health LED will then be illuminated continuously during the initial start-up routine. When the system has completed the start-up routine the Health LED will begin to blink at a rate of 1 pulse per second (1Hz).



NOTE: Several systems startup with the boat. These Include:

- ASV Controller
- Data Acquisition Computer (DAC)
- Camera
- INS
- SVS
- LiDAR (If installed)
- ADCP (If Installed)
- **The sonar does not power on with the boat**

9.2 OIS

IMPORTANT

Remove all cables and components from the case before applying power
DO NOT OPEN THE CASE WHILE A/C POWER IS CONNECTED TO OIS

This could result in potential shock hazard

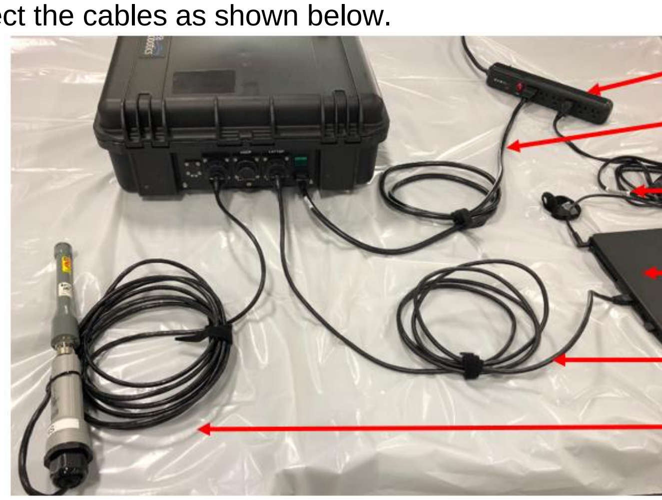
Setup

Remove the following components from the OIS case:

- Laptop
- Laptop power cable
- OIS power cable
- Ethernet cable
- Radio (with cable attached)
- Joystick
- Mouse (not supplied)

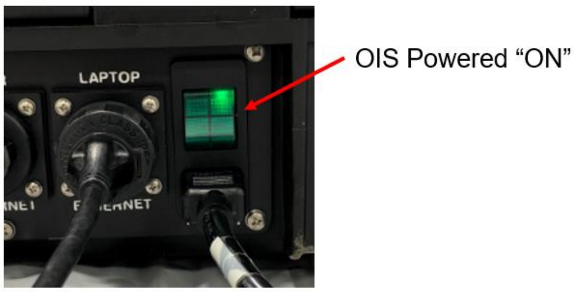
Connections

Connect the cables as shown below.



Power Up

Once connections are made *close and latch the OIS case*. Plug the OIS power and Laptop power into 110/220 A/C power and turn the OIS ON via the switch located on the back panel.



Next turn on the OIS laptop. Windows username= **searobot** password=**searobot**

Establish Communication

The controller must be woken up before starting Windows

Wake up the joystick controller by pressing the "MODE" button twice and pressing the left joystick straight down (indenting).

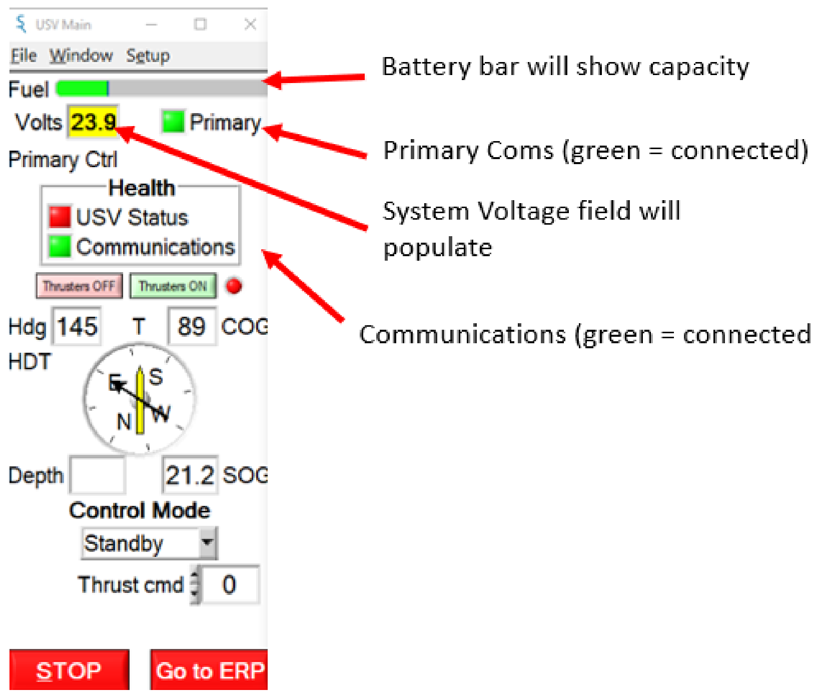
9.3 Software Preparation

Open SeaRobotics Advanced Software (SAS)

Once launched the software will automatically establish a connection to the boat.

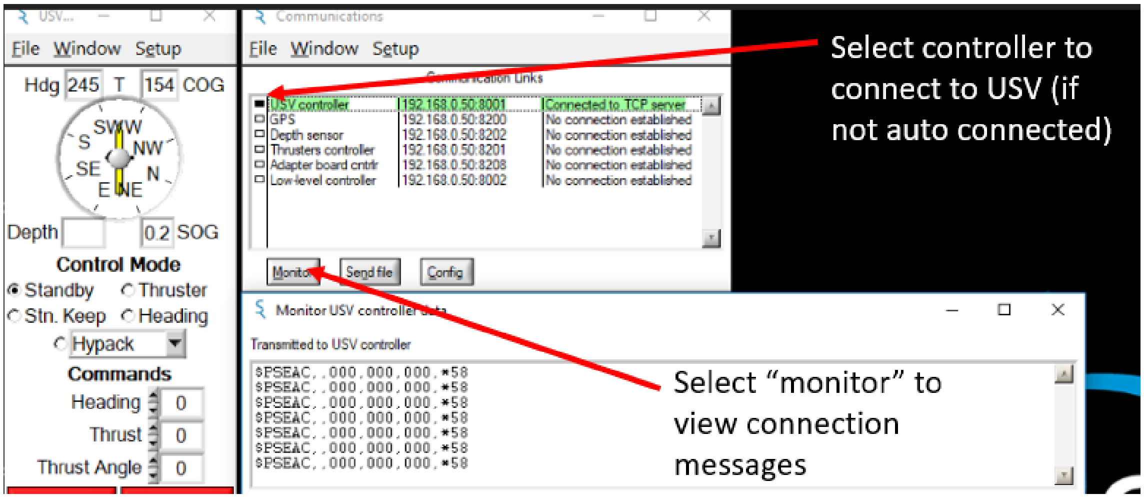
Indications the SAS software has successfully linked to the boat:

- "Primary Coms" icon will illuminate green
- "Health Communications" will illuminate green
- Battery bar will populate
- Volts field will populate.

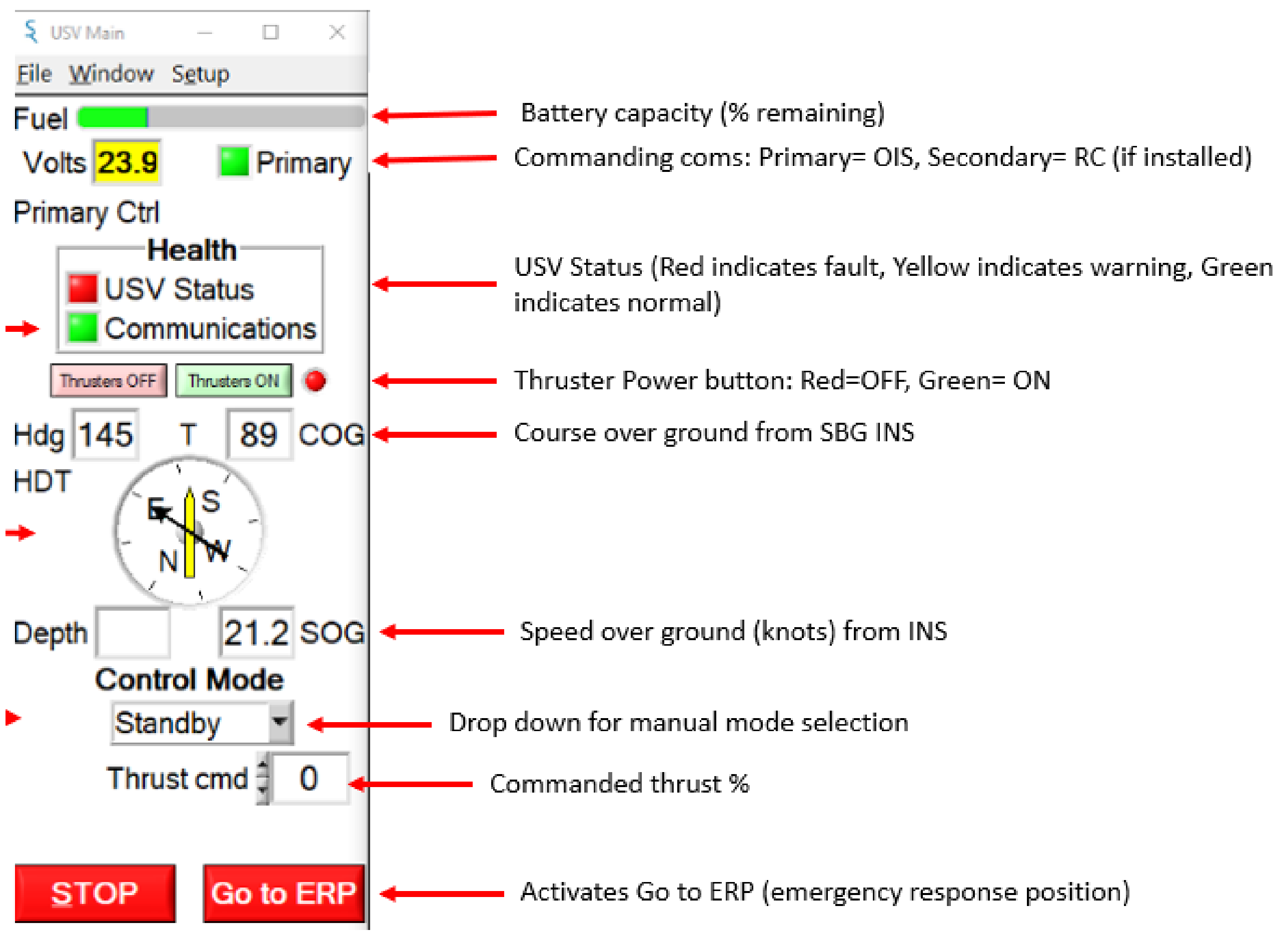


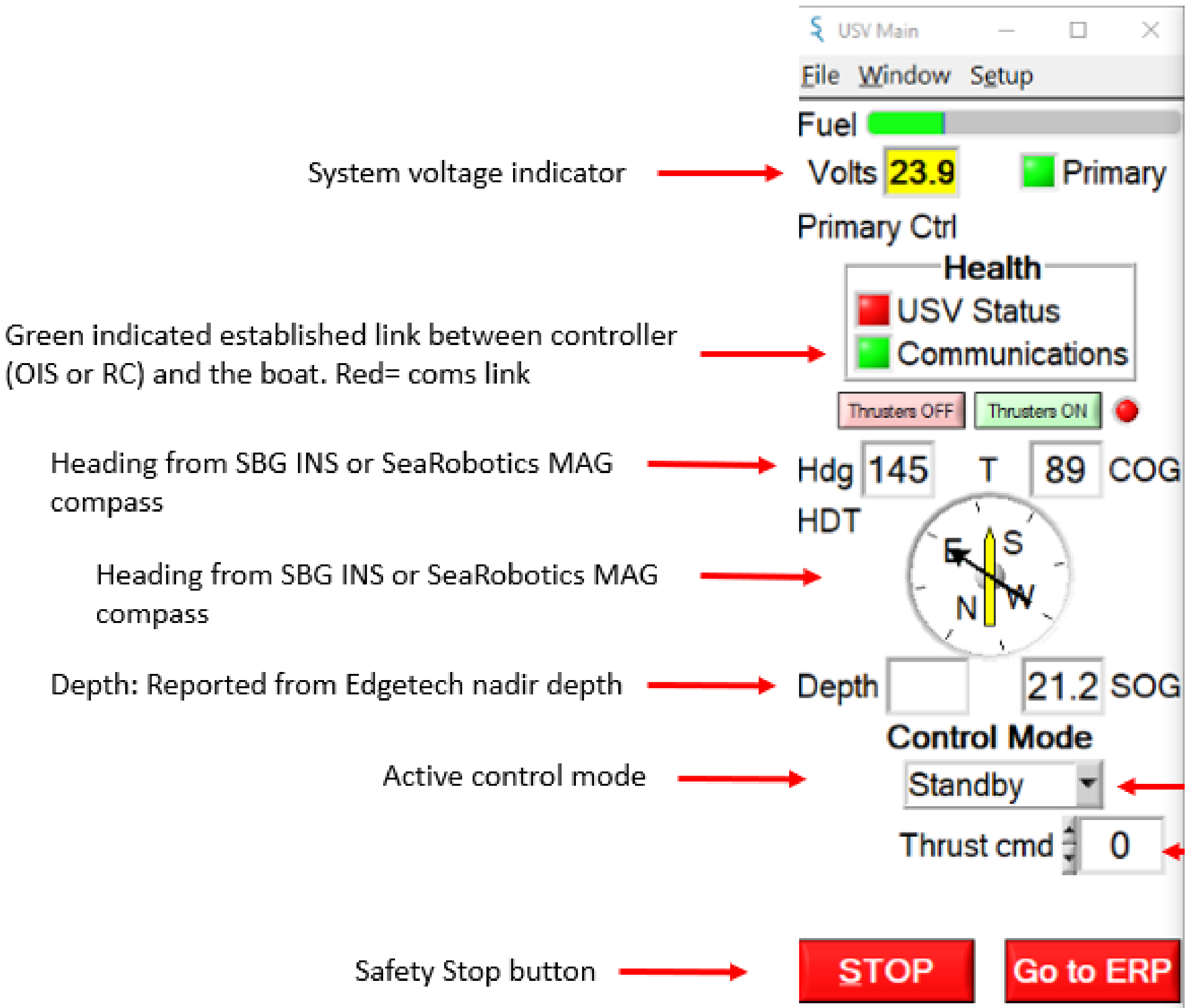
If the link is not automatically established:

1. Select Window > Communications (the Communications window will appear)
2. Select the box next to "USV Controller." This will prompt the system to connect. Selecting "Monitor" will display the messages being sent between the OIS and the boat. Once the coms are established close these windows.



Trouble Shooting Tip: If the OIS fails to connect to the boat after multiple attempts verify all Ethernet and radio connections into the OIS and laptop.





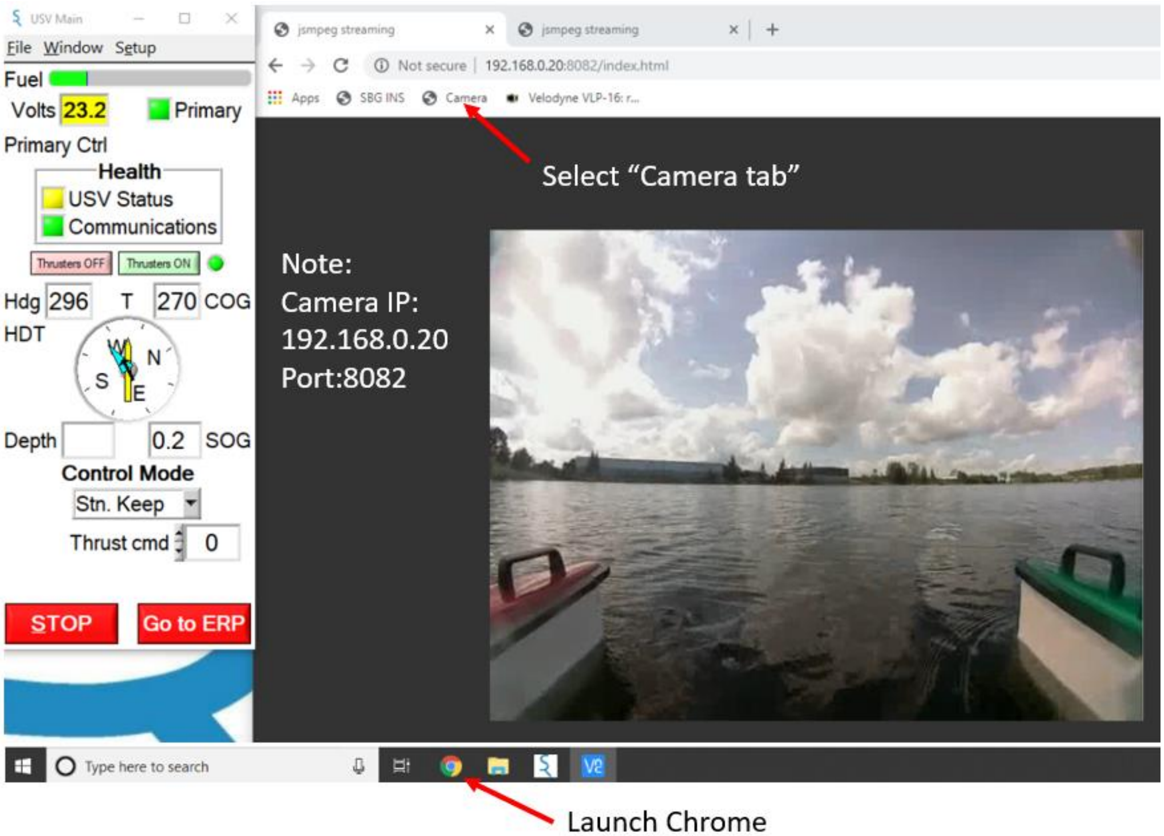
SeaRobotics Advanced Main Window

Test Communications

1. Verify that the kill switch lanyard is inserted.
2. In OIS Main window turn “Thrusters ON” Change control mode Thruster.
3. Enter “10” in the “Thrust” field of the Main window
4. Press “Enter” to send the thrust command
5. Visually ensure BOTH propellers are spinning
6. Press “**Stop**” to put the boat back into “**Standby**” and 0 thrust
7. Thrusters can also be tested with the Joystick
8. Detent the left joystick to activate “Thruster” mode
9. The top Left button will increase thrust 10% each time it is indented
10. The top Left Trigger will decrease thrust 10% each time it is indented
11. Press the **BLUE** button to put the vehicle into “**Standby**”
12. **Remove the safety Kill Switch lanyard until ready to launch**

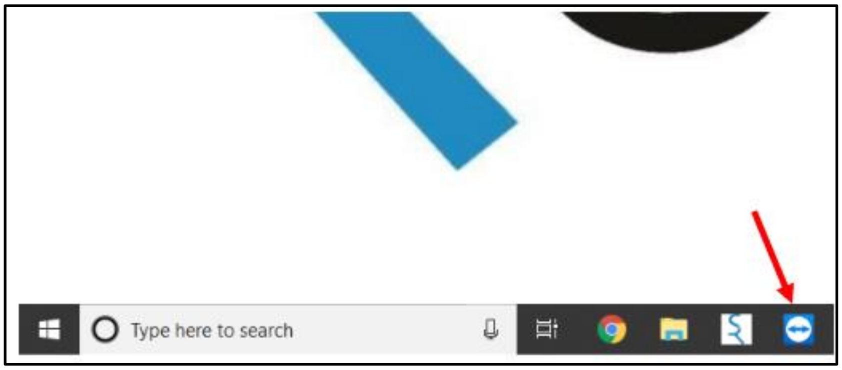
Camera

1. Open Chrome from the OIS desktop task bar
2. Select “Camera” favorite. Realtime video will load

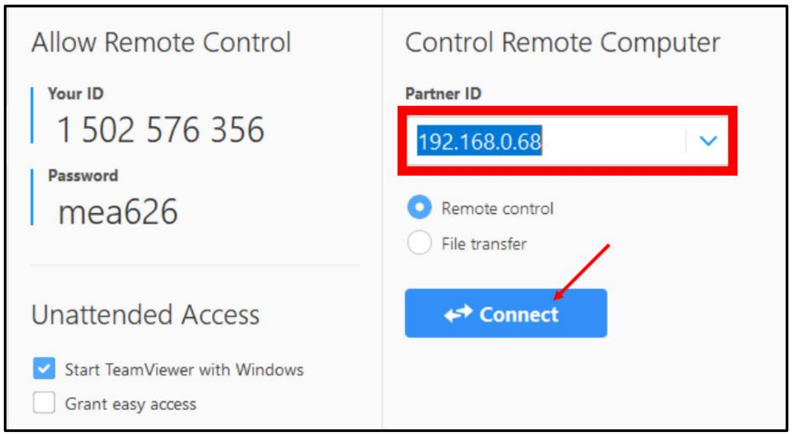


Data Acquisition Computer (DAC)

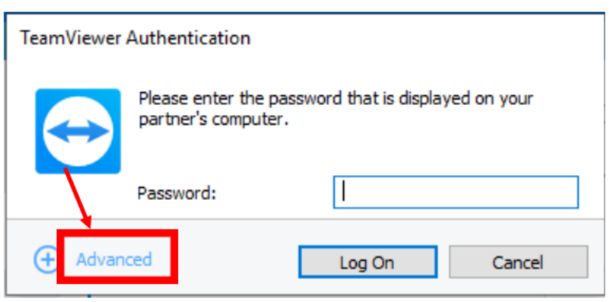
1. The DAC is powered on with the boat
2. Log into the DAC by launching TeamViewer from the Windows task bar



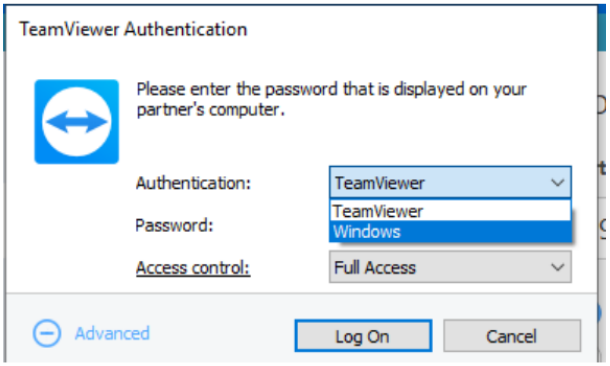
3. TeamViewer will launch. DAC IP address will be listed. Select "Connect"



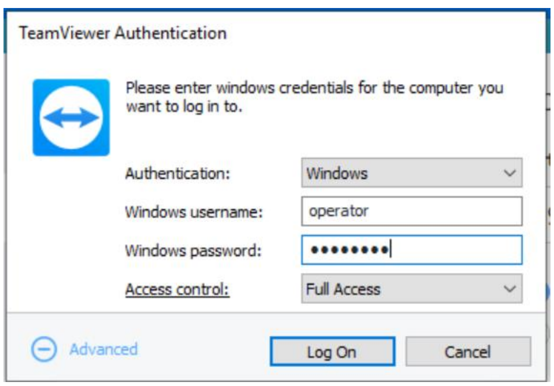
4. A password window will launch. Do not enter a password. Select "Advanced"



5. A new window will launch. Select "Windows" from the "Authentication" drop down window



6. Windows username: **operator**
7. Windows password: **searobot**



Trouble Shooting Tip: If the DAC does not initially connect this may be because it did not boot properly. Power cycle the DAC Via the Windows>Commands> POWER tab. Wait 30 seconds after turning it off to power it back on. It may take a couple minutes for the DAC to come back up. Then try reconnecting via VNC.

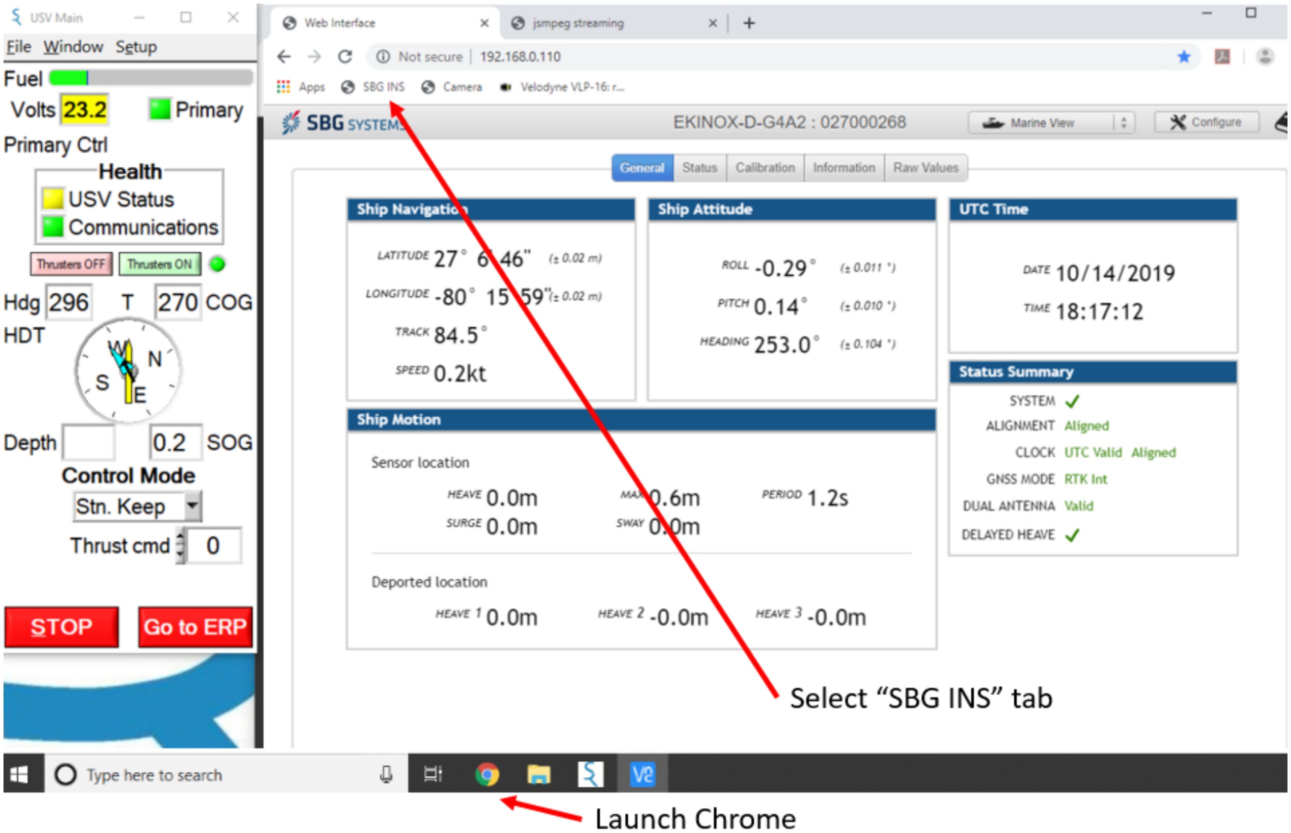
Upon login the desktop will appear as shown below.

If prompted log into Windows on the DAC. Username= **searobot** Password=**searobot**

User tip: Dedicate an external monitor to the DAC. This will help optimize screen space

SBG INS

1. The SBG EKINOX INS is powered on with the boat.
2. To verify status launch Chrome and select the “SBG INS” tab. The SBG interface will launch

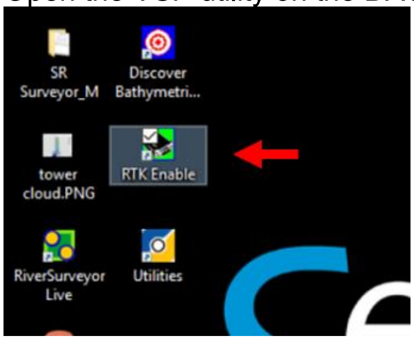


3. Note the "Status Summary" window. This indicates system status, alignment, and GNNS mode.
4. **IMPORTANT! The boat will not navigate correctly or hold station unless the antennas are aligned. Align the antennas immediately after launching the vehicle. Spin the boat on axis counterclockwise then clockwise until Alignment reads "Aligned." Once aligned the boat can be operated. Alignment can take between 3 to 20 minutes.**

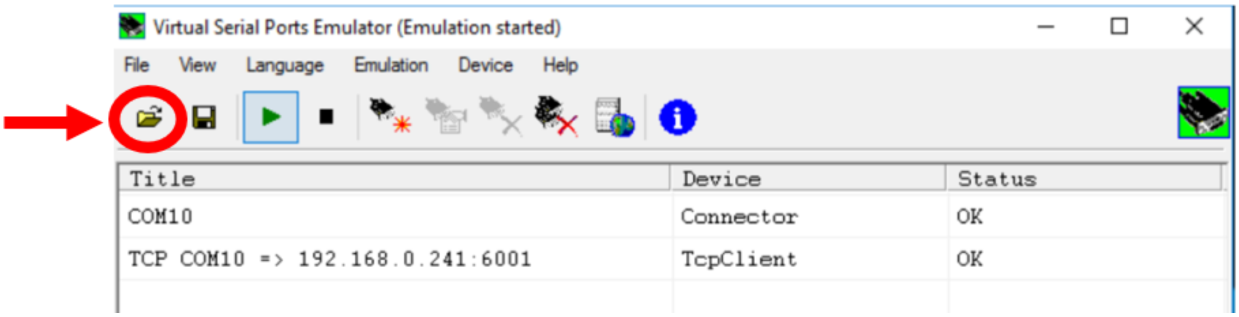
Acquiring NTRIP VRS corrections (for vehicles with cellular modem option)

When available NTRIP VRS corrections can be acquired by the SurveyorM1.8. The vehicle must be within the coverage area of the service provider to utilize this option.

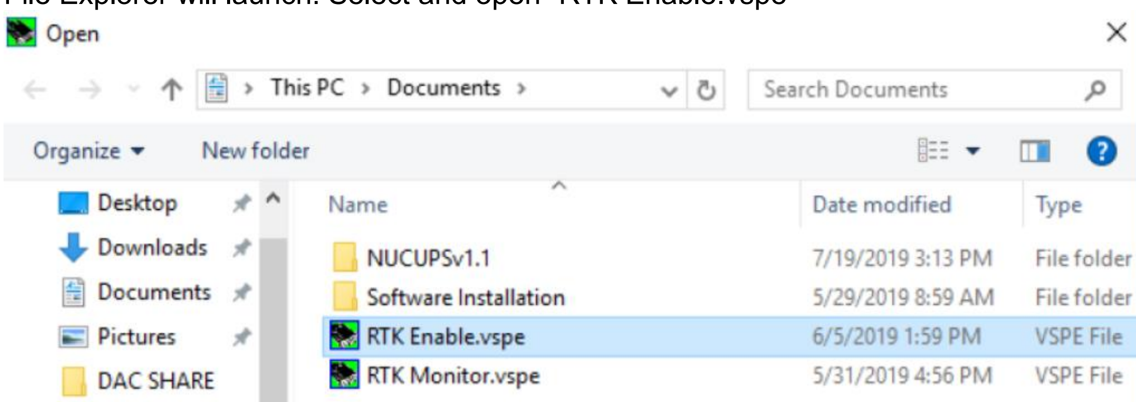
1. Open the VSP utility on the DAC desktop titled "RTK Enable"



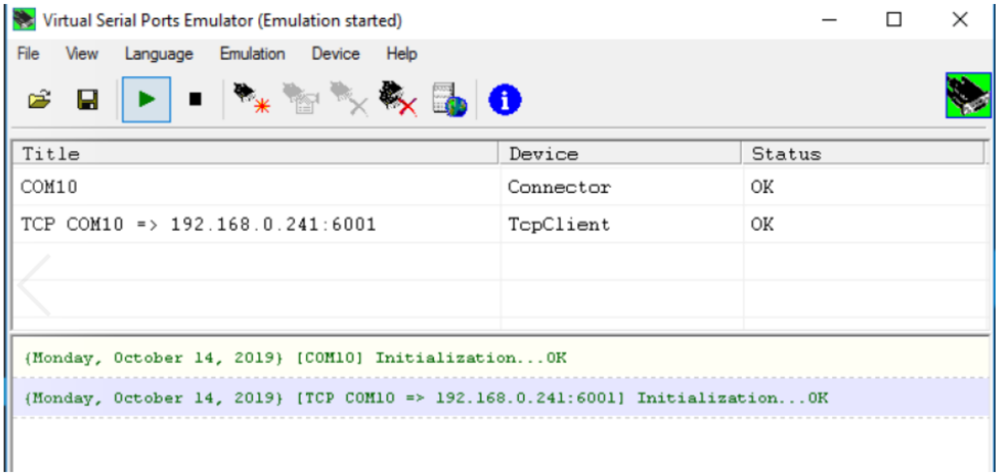
2. Once the utility launches select "Open"



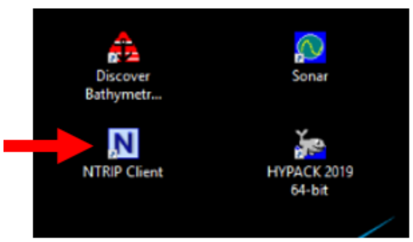
3. File Explorer will launch. Select and open "RTK Enable.vspe"



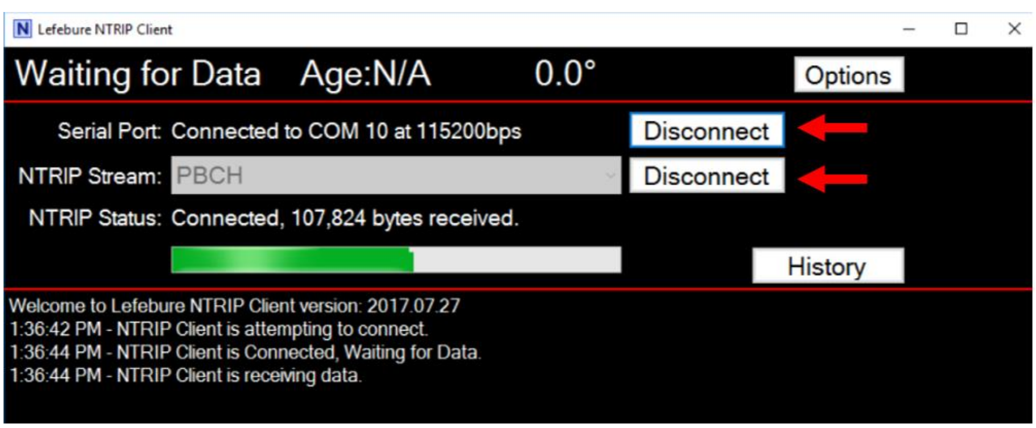
4. Once connected the utility should appear as below:



5. Minimize VSP. Leave running during survey.
6. VSP License manager will prompt. Select "No"
7. Open NTRIP client by selecting the shortcut on the DAC desktop

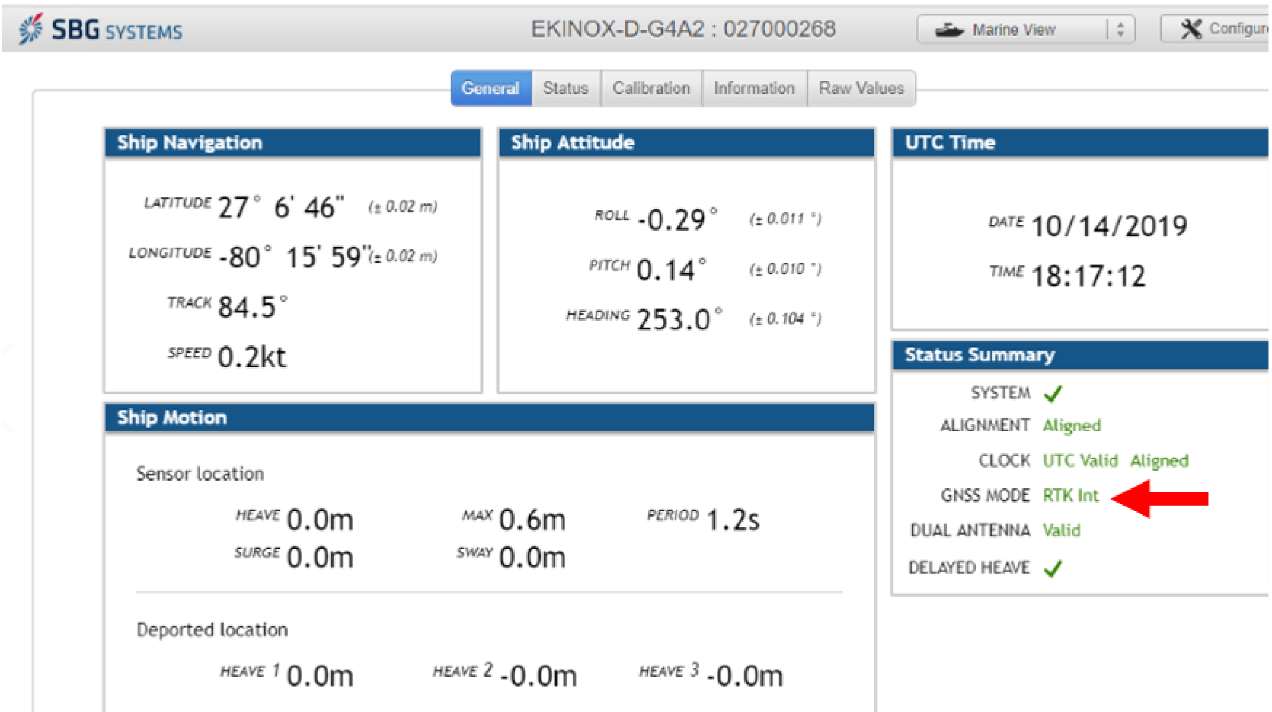


8. Once launched connect to Serial Port
9. Select NTRIP Stream (location)
10. Connect to NTRIP Stream. Once connected Serial and NTRIP status will report "Connected"



11. Minimize NTRIP. Do not close during survey

12. Launch SBG INS web interface. The Status Summary window Mode will read RTK Float or RTK Int indicating VRS reception.

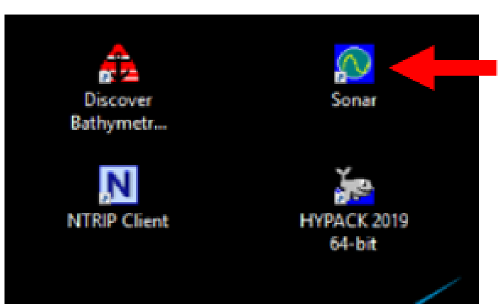


Edgetech 2205

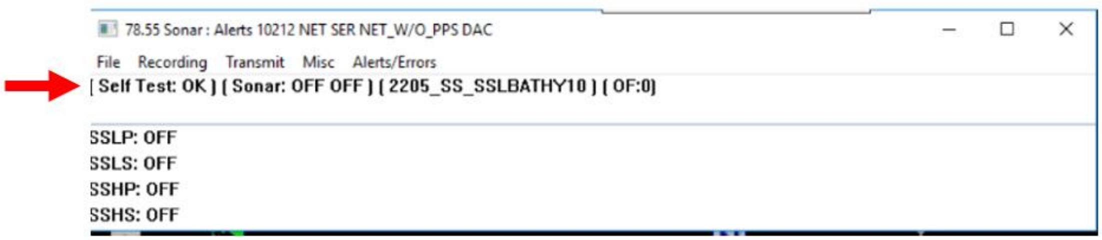
NOTE: Do not operate this sonar in air. Doing so could damage the system.

Power the sonar on while the transducers are in the water.

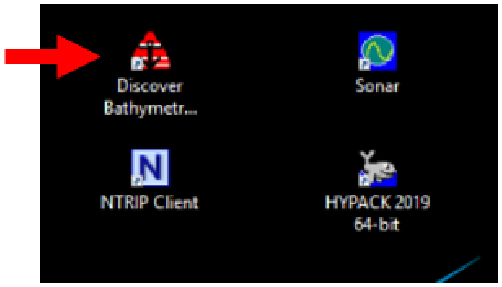
1. Using the SeaRobotics Advanced utility power on the Sonar
   a. Windows>Commands>Power>Sonar ON
   b. Wait 20 seconds for the sonar to power up
2. Open the “Sonar” shortcut on the DAC desktop



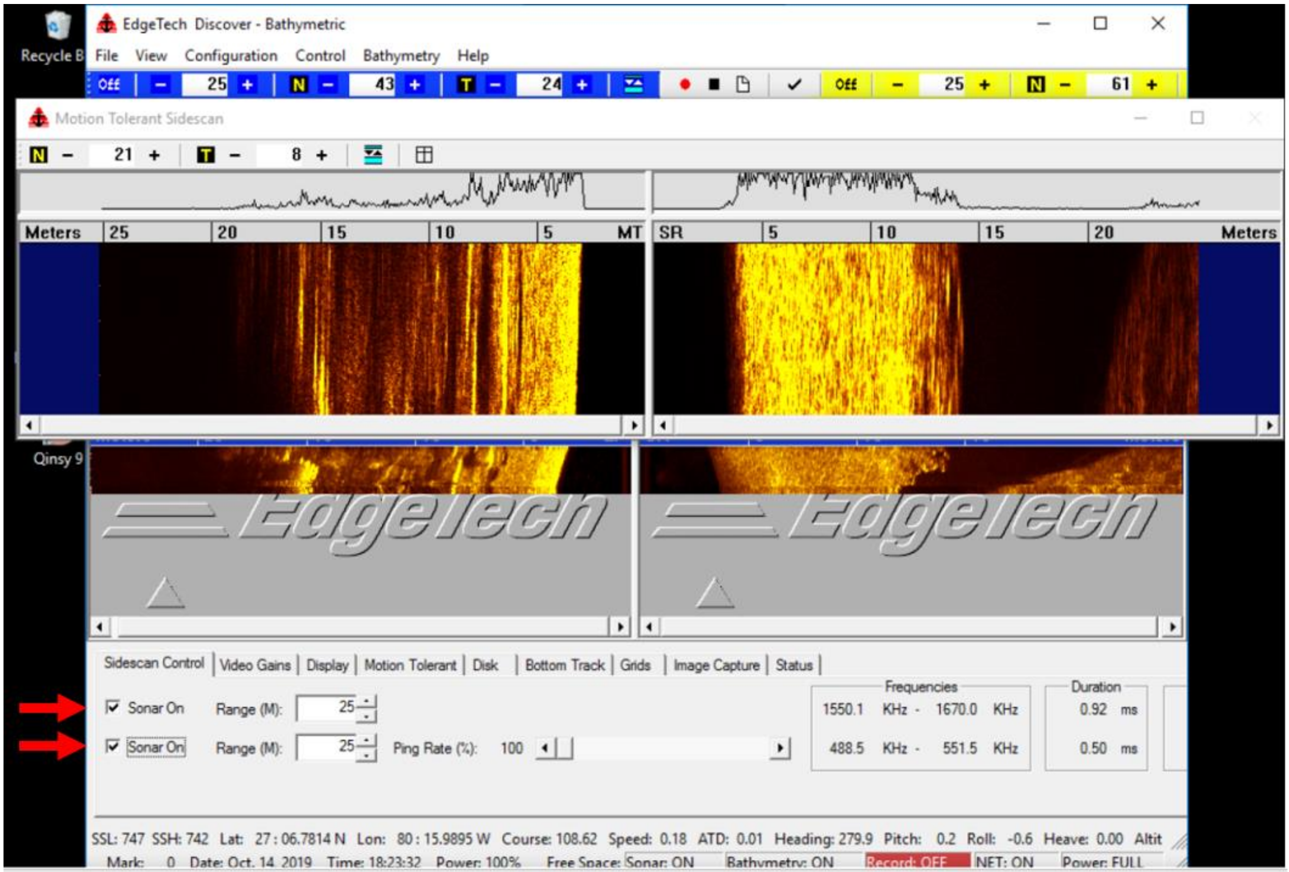
3. The Edgetech Sonar utility will automatically connect to and self-test the sonar. If connected the prompt will appear as shown reading self-test OK.



4. If the self-test fails. Not enough time was given between powering on the sonar and launching the utility. Close the utility wait 10 seconds and try again.
5. Minimize or hide this utility. Do not close it during survey.
6. Launch Discover from the DAC desktop



7. Once Discover launches toggle the two “Sonar On” boxes to enable the 1600kHz sidescan, 550kHz sidescan & 550kHz bathymetry.
8. The bathymetry turns on with 550kHz sidescan. The data bar at the bottom of Discover will state “Sonar ON,” “Bathymetry ON”
9. Sidescan waterfall will populate the windows.



10. Use Discover Bathymetry>Basic Settings> to configure sonar settings.

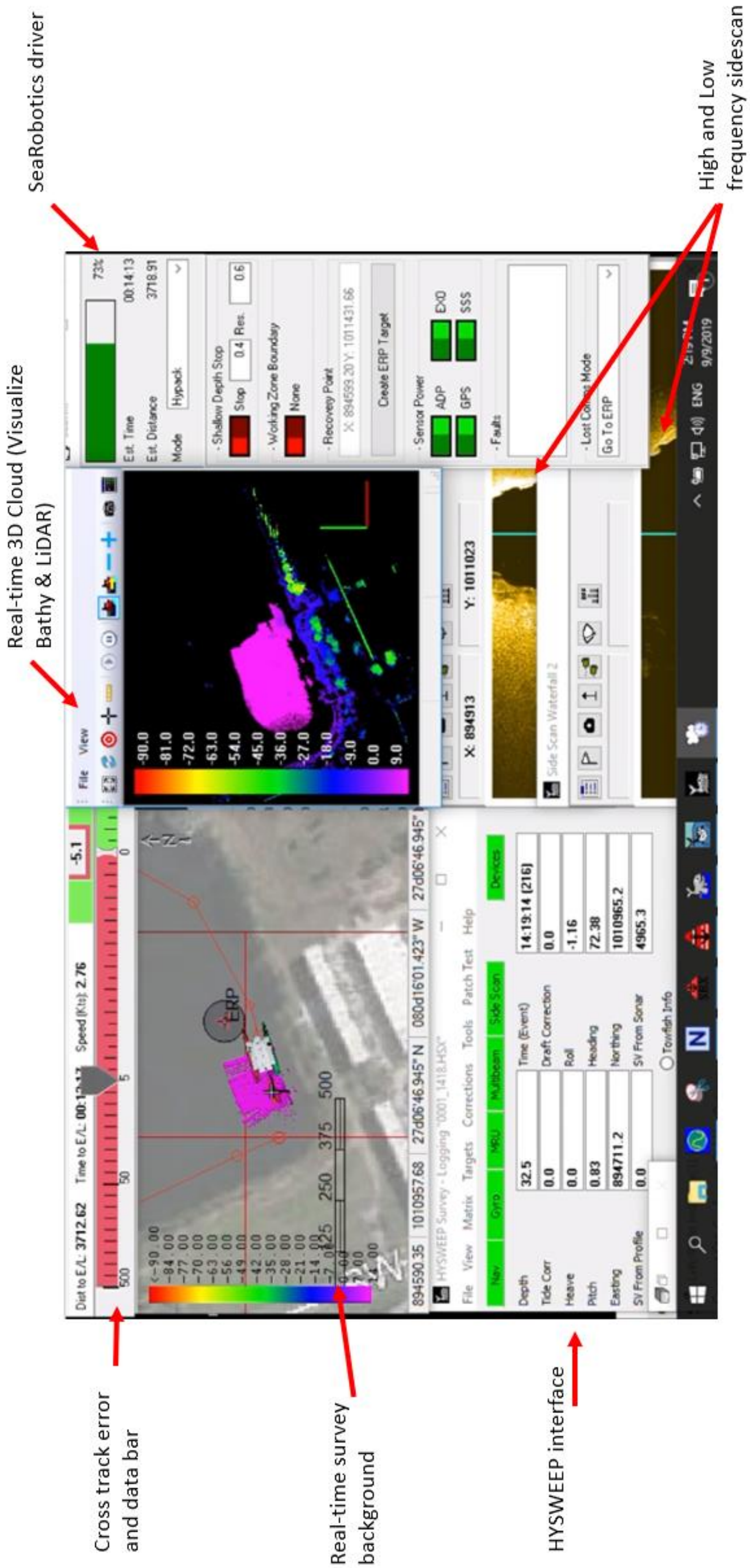
Hypack

1. Open HYPACK 2019
2. Copy project “SeaRobotics” to create new survey
3. Once survey planning is completed launch “Survey”

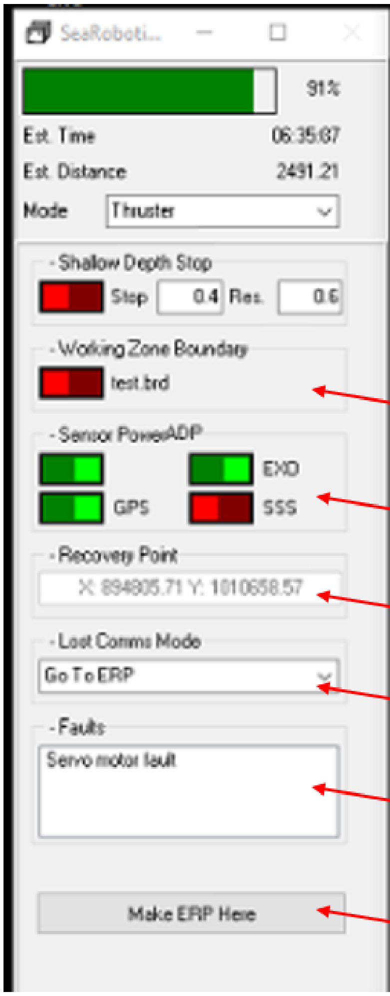
Notes:

- All hardware, com-ports, and sensor offsets are setup by default in “SeaRobotics”
- Copy this project to create all new jobs
- Change Geodesy as required for specific survey location
- Modify/ create planned line files as required for specific survey location

The windows will launch as shown below:


SeaRobotics driver
Real-time 3D Cloud (Visualize Bathy & LiDAR)
High and Low frequency sidescan
Cross track error and data bar
Real-time survey background
HYSWEEP interface

SeaRobotics HYPACK Driver Layout



Battery capacity

Time to complete survey at current speed

Selectable control modes

Shallow Depth Stop function
- Set min operating depth (m)
- Set resume depth (m)
- Button activates function (red/off, greed/on)

Working Zone Boundary function
- Button activates function (red/off, greed/on)

Power ON/OFF for sensors
- Button activates function (red/off, greed/on)

Loaded Recovery point position
- HYCAT will navigate to this point is “Go To ERP” mode is activated

Lost Comms mode
- Select action in case of lost coms: Continue, Go to ERP, Standby, Station Keep

ASV Faults display window

Select to place recover point at ASV current location

9.4 Launch Preparation

Pre-Launch

1. Set response to lost communication event in SeaRobotics OIS set DLL mode.
2. Verify all hatches are secure and watertight
3. Verify hull integrity
4. Verify all external connections are tight and secure
5. Verify HYPACK or QPS Key is installed
6. Verify props are free and clear from obstruction
7. Verify OIS base radio location and line of site to survey area

Start Mission

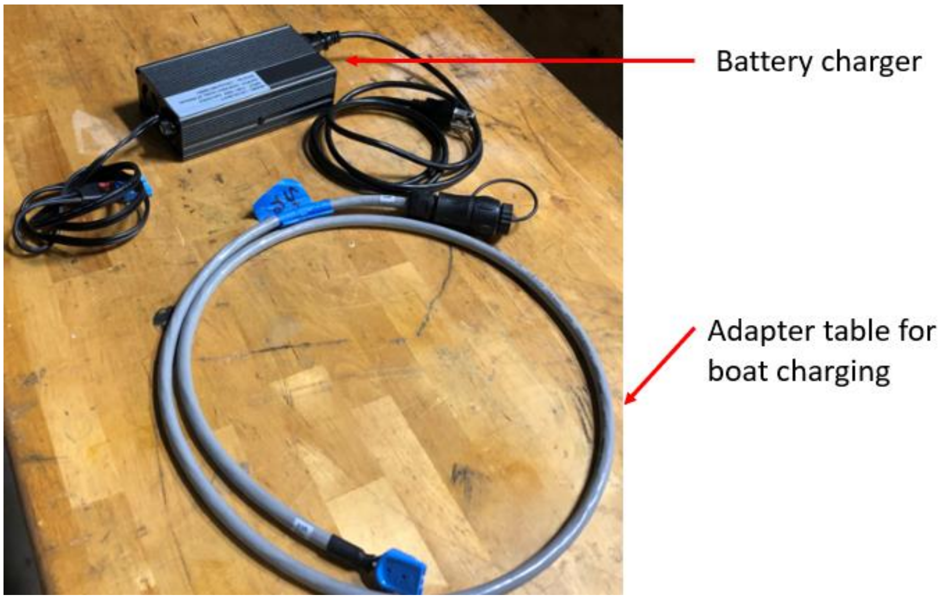
1. Connect thruster Kill Switch lanyard
2. Test thrusters (10% forward & 10% reverse)
3. Drive the boat to safe position in “Thruster” or “Heading” mode
4. Manually drive vehicle turning sharply until SBG INS antennas are aligned
5. Hold position at safe location by selecting “Station Keep Mode”
6. Power on Edgetech Sonar
7. Launch HYPACK Survey. Begin survey by selecting “HYPACK Mode”
8. The boat will hold station at end of last survey line and wait for commands

Notes:

- The boat will auto navigate to the 1st survey line
- Data-logging will auto start/stop at the beginning and end of each line
- Certain wind/current conditions may cause the boat to miss the Start/Stop gate at the end of a line. Be conscious in high wind/current conditions. Operator may want to turn off auto logging and log continually
- Operator can increment/decrement lines in real time
- Operator can change control modes at any time
- By selecting “HYPACK” mode the boat will navigate back to current survey line and continue
- It is best to run the lines in numerical order
- Discover will automatically log .jsf files when HYPACK is logging
- User discover to configure bathymetry range. HYPACK only visualizes the acquired data.
- The SeaRobotics driver will not load in survey unless there is a planned line file.

9.5 Battery Charging

An automatic battery charger and adapter cable are supplied with the ASV. Please note the battery can only be charged with the supplied charger.



There are two ways to charge the battery:

1. Onboard thru the vessels wiring
2. Externally by removing the battery from the ASV

The ASV Li-Ion battery does not have to be removed from the vessel for charging. If desired, the battery can be removed to charge. Typical charging time will be four to six hours depending on depth-of-discharge. The ASV has been internally wired to provide charging of the battery through a charge port/connector located on the aft face of the vessel. The vessel must be powered off to charge.

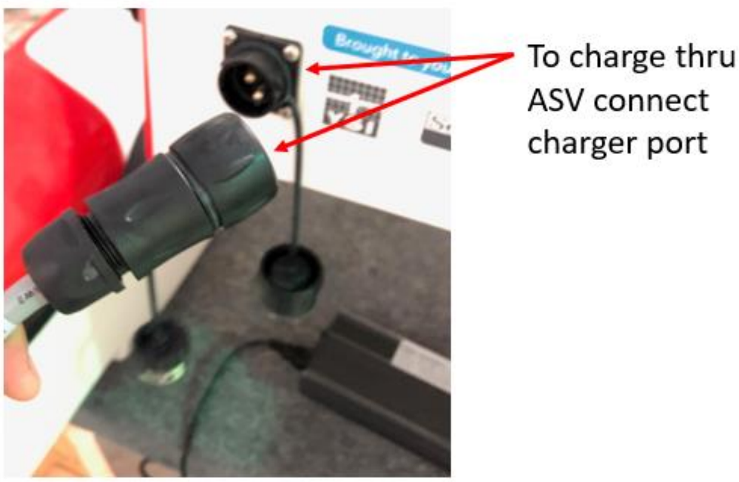
The charging system has a standard 120/220 VAC plug so the charging system can be moved anywhere a standard 120/220VAC outlet is located. The total load of the charging system is approximately 8 amps.

The charging system is automatic. It will automatically stop charging when the battery is fully charged.

CAUTION: The charger generates heat during the charge sequence. Do not rest it on fabrics, soft plastics, or near flammable items while in use. Rest on a hardwood wood table, concrete, glass, or hard floor surface.

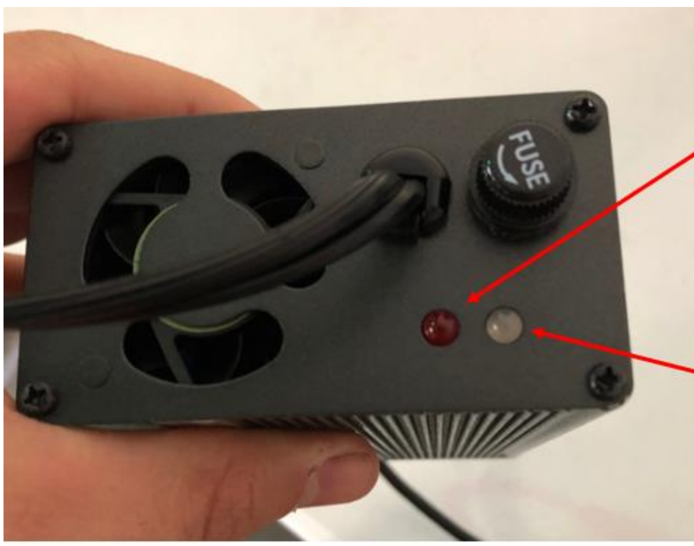
Onboard Charging

1. Ensure the ASV is powered off
2. Ensure the battery is completely connected to the ASV
3. Remove the charger port cap on the aft face of the ASV. Rotate the connector collar ¼ turn counter-clockwise to remove the cap
4. Plug the charger adapter cable (shown above) into the charger port. Lock the charger connector into place by rotating the lock collar ¼ turn clockwise.
5. Plug the adapter cable into the battery charger
6. Plug the battery charger into an A/C power source
7. Turn the charger ON. Indent the white dot on the switch located on the LED face of the charger
8. When charging the LEDs will light amber and red
9. When charging is complete the Left LED will light green
10. Once fully charged 1st disconnect the charger port at the boat
11. Turn off the charger
12. Disconnect AC power
13. Reconnect the ASV charger power cap.



External Charging

1. Power the ASV off
2. Completely disconnect the battery from the ASV (coms, charger port, & main power)
3. Remove the battery from the ASV
4. Plug the charger directly into the charge port of the battery
5. Plug the battery charger into an A/C power source
6. Turn the charger ON. Indent the white dot on the switch located on the LED face of the charger
7. When charging the LEDs will light amber and red
8. When charging is complete the Left LED will light green
9. Once fully charged 1st disconnect the charger from the battery
10. Turn off the charger
11. Disconnect AC power
12. Reinstall into the ASV



RED LED lit when discharged

-LED lit AMBER when charging
-LED lit GREEN when charged

Indent white dot to power on charger

10.0 Data Processing and Presentation

OIS Log Files

Messages between the SeaRobotics ASV application and the ASV controller communication link are stored in log files on the OIS laptop, in the directory "Documents\Searobotics \logs\".

Each time the SeaRobotics ASV application is started, it creates a new log file, named by the UTC date and time that it was started. If a log file is required for a certain period, a separate log file can be started by selecting the File menu, and then selecting Start Logging. The messages will then be logged to both files until logging to the second file is stopped.

These log files are specific to the vessels onboard health monitoring system. Hydrographic data is logged separately to an external USB drive.

ASV Log Files

Log files can also be stored on the ASV controller. They are stored in the directory: /mnt/cf_usb/data/. This directory is on a USB flash drive on the embedded computer board. By default, no messages are written to the log files on the ASV. There are two ways that log files can be stored on the ASV, either by a communication server process, or by the main control process.

These log files are specific to the vessels onboard health monitoring system. Hydrographic data is logged separately to an external USB drive.

Communication Server Log File

If the vessel is not running in HYPACK mode, there is a server process that handles communications with each of the devices on the ASV. The server process has an option to log all data received from the device that it handles. This is set up in the file: /searobot/COMM.cfg.

To log data from a device, add a file name to the end of the line for that device. The communication process will then create a file in the log file directory with the name the user wrote plus a UTC time stamp and log all data from the device to that file. For example, the line "ADP 127.0.0.1 8102 COM2 115200 ADP.log" will create the file "/mnt/cf_usb/data/ADP20090521-214257.log" and all data from the ADP will be logged to that file.

The procedure for changing COMM.cfg is similar to the procedure for changing the init.sea file, which is described in the appendix. After this file is changed, all of the ASV processes should be stopped and restarted. This can be done by logging in to the ASV controller and typing the command "/etc/init.d/asv.sh restart".

Main Control Process Log File

The main control process creates a file named "event<timestamp>. sea" when it is started. It has an option to log NMEA messages that it receives, selected by sentence ID, to that file. This is set up in the second line of the file "/searobot/STRINGS.ini" For example, a second line containing "GGA DBT" will cause all GGA and DBT sentences that the main control process receives to be logged to the file: "/mnt/cf_usb/data/event20090521-214257.sea".

The procedure for changing "STRINGS.ini" is like the procedure for changing the "init.sea" file, which is described in an appendix. After this file is changed, the main control process needs to be stopped and restarted. This can be accomplished by logging in to the ASV controller and typing the command “/etc/init.d/asv.sh reload”.

11.0 Launch & Recovery Cart

The optional lightweight cart is made of aluminum with plastic wheels and solid rubber tires for minimal maintenance. The handle is removable for easy storage.

Figure 31 Launch & Recovery Cart

12.0 Equipment Checklist

Equipment Checklist		
Item	**Check**	**Description**
5		OIS
6		OIS Power Adapter
7		Table & Chairs
8		Tripod
9		RF Radio Ethernet Cable
10		Spare Propellers and pins
11		Propeller tools
12		Rain Cover / Tarp for OIS
13		Power Strip
14		Extension Cords
15		Spare Joystick Batteries (AA)

13.0 Maintenance

13.1 Joystick Batteries

The joystick uses two "AA" batteries. When the batteries are low the mode light will blink. Spare batteries should be on hand in case the batteries need to be changed. The vessel can also be operated via the up/down/left/right arrows on the keyboard should the joystick become inoperable.

13.2 Main Lithium-Ion Battery

- Lithium-Ion batteries are also low-maintenance batteries. One of the advantages of Lithium-Ion batteries is that the batteries have no "memory effect." The batteries do not require scheduled cycling to maintain them. Even though Lithium-Ion batteries are low-maintenance, there are some steps the user can take to extend the life of the Lithium-Ion battery.
- Charge Lithium-Ion batteries fully (preferable overnight) before beginning to use the batteries
- Fully charge and discharge Lithium-Ion batteries 3-4 times to allow the battery to reach its maximum rated capacity
- Use the Lithium-Ion battery at least every 2-3 weeks
- Keep Lithium-Ion batteries fully charged when not in use
- Charge Lithium-Ion batteries regularly
- Avoid regularly running Lithium-Ion batteries too low
- Never leave Lithium-Ion batteries discharged for extended periods - the batteries do self-discharge and the charge could drop low enough to damage the battery
- Keep Li-Ion batteries out of high heat -high temperatures may cause premature battery failure
- Store Lithium-Ion batteries in a cool, dry place if they will not be used for several weeks
- The useful capacity of a Lithium-Ion battery decreases by around 10% each year. Lithium-Ion batteries also only have a useful service life of 2-3 years. These batteries begin aging immediately upon manufacture - not when they begin service. Manufacturers usually anticipate a life expectancy of 300-500 discharge cycles.

13.3 General Maintenance

IMPORTANT! NEVER SPRAY ELECTRICAL ENCLOSURES OR CONNECTORS WITH HIGH PRESSURE WATER! Remove high pressure nozzles from hoses to flush all components with low pressure fresh water after each use.

IMPORTANT! NEVER USE POWER TOOLS WHEN SERVICING THIS VEHICLE. Doing so could damage the vehicle and cause catastrophic failures. All fasteners are to be tightened completely with hand tools.

Always inspect vehicles with POWER OFF unless otherwise instructed.

Check all screws, bolts, and other fittings to keep secure. If possible, keep the vessel under cover to protect the surfaces from the effects of the sun and rain. Keep all aluminum and stainless parts clean and polished with a good metal wax. If not adequately maintained, metals on boats corrode quickly, especially in a saltwater environment. Keep the hulls of the boat clean and properly waxed. This protects the hull from deterioration from the sun and will provide better “fuel efficiency”. Fiberglass should be cleaned with fresh water and a nonabrasive soap. If necessary, a soft brush should be used to help remove debris caught in crevices. Patch any cracks that occur due to stress, age, or accident.

Inspect all electrical connections for cleanliness and tightness—corrosion is often a sign a connection may not be safe. Terminal blocks should be tightened periodically.

The majority of failures in modern day boats are caused by corroded electrical systems.

After extensive use (multiday missions) inspect hull and electrical enclosure integrity.

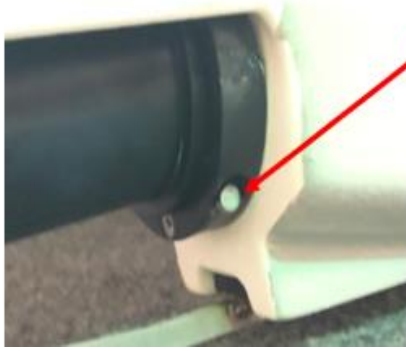
- Open all compartments and inspect for water intrusion
- NOTE! If water is present inside the vessel, power vehicle off IMMEDIATELY!
- Once powered off use towels or rags completely remove all water before powering the system back on
- Water should never be present in any compartment
- Inspect for loose or damaged internal components
- Inspect for damages hatched seals

13.4 Thruster Maintenance

IMPORTANT: DO NOT INSPECT OR SERVICE THE THRUSTERS WITH THE VEHCILE TURNED ON. FAILURE TO COMPLY COULD RESULT IN SEVERE INJURY AND DISMEMBERMENT

Before each launch inspect running gear:

- Ensure propellers and shafts are free of debris
- Ensure props locknuts and nylons washer are in place
- Ensure thruster locking bolt and nut are in place



and thruster locking pin

The thrusters require replacement of primary shaft seals every 400 hours of operation or every 18 months which ever comes first.

Operation hours are logged in the “ASV Status” window.

Replacing thruster shaft seals

1. Remove prop nut using a 10mm socket
2. Remove nylon washer, prop, and prop pin from shaft
3. Remove (2) Seal hub retaining screws and (1) grease blead screw
4. By hand physically pull the seal retainer aft removing it from the thruster

Remove all (2) machine screws and (1) sealing screw from seal retainer

Once all (3) screws are removed pull The seal retainer aft off of the thruster

Thruster with seal retainer removed

Inspect O-rings and lubricate with marine lubricant before reinstalling seal hub

Greasing the Shaft Seals

Grease the shaft log every 500 hours by first removing the grease bleed screw from the starboard side of the thruster housing. Then locate the grease fitting located on the port side of the thruster housing. Using a grease gun, fill thruster tube with grease until clean grease is seen exiting the grease bleed screw port. Once complete reinstall the bleed port screw.

DO NOT OPERATE THE VESSEL WITHOUT THE BLEED PORT SCREW INSTALLED.

Use LUCAS Marine Grease and Applicator.

14.0 Lifting & Transportation

This ASV is designed with 4 lifting handles. Only lift the ASV from the handles!

The vessel can be lifted from a single pick point using a four-leg sling configuration with the lifting handles as attachment points

The vehicle can be placed directly on the ground without damaging any sensors or running gear.

Important ASV handling Instructions

IMPORTANT! NEVER SPRAY ELECTRICAL ENCLOSURES OR CONNECTORS WITH HIGH PRESSURE WATER!

Remove high pressure nozzles from hoses to flush all components with low pressure fresh water after each use.

IMPORTANT! NEVER USE POWER TOOLS WHEN SERVICING THIS VEHICLE. Doing so could damage the vehicle and cause catastrophic failures. All fasteners are to be tightened completely with hand tools.

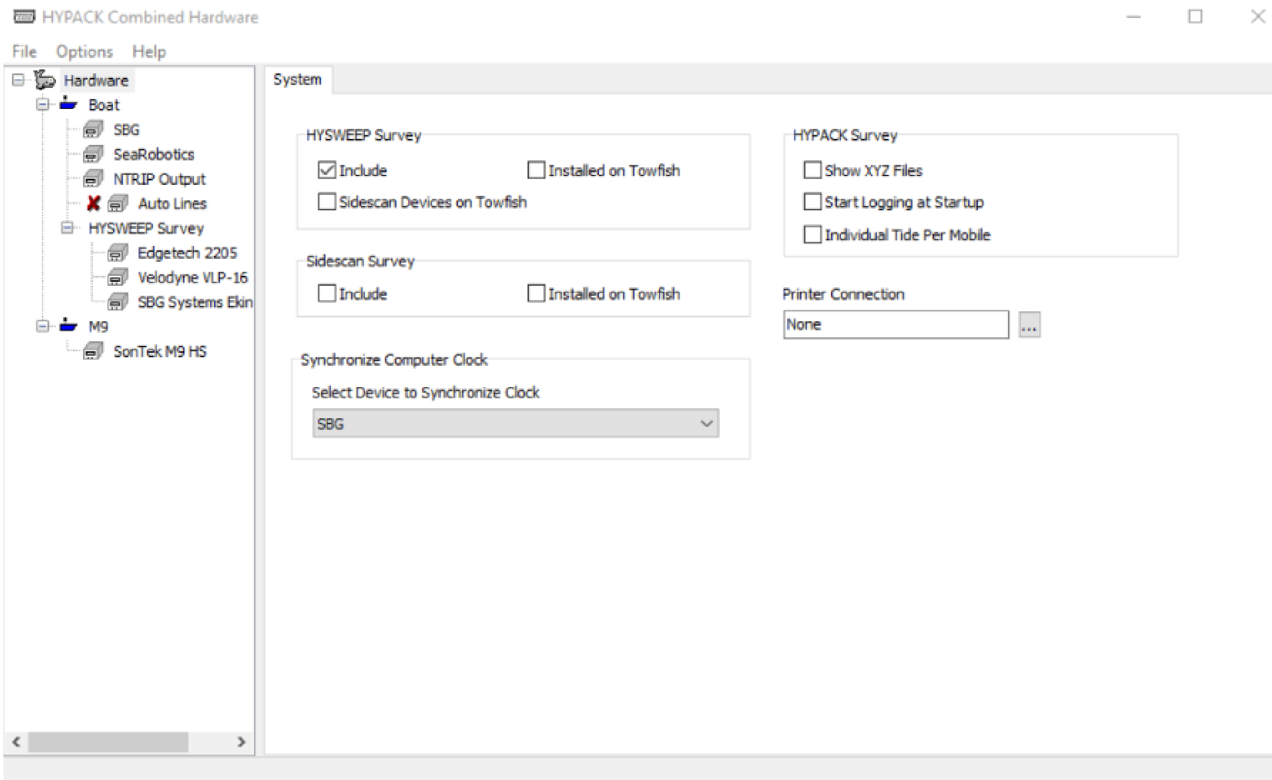
Figure 32 ASV Loaded in SUV

15.0 Spare Parts

Spares	
Item	**Description**
1	RC Transmitter (if used)
2	Main Battery
3	Thruster Assembly
4	Starboard thruster propeller
5	Port thruster propeller
6	Shaft seals (4)
7	Shaft seal removal tool
8	Motor Controller
9	Computer Stack, control computer
10	Data Acquisition Computer, with loaded hard drive
11	ADCP
12	Cables
13	Sonar circuit card stack
14	AHRS
15	Camera Controller
16	Interconnect Board
17	Ethernet Switch
18	INS
19	GNSS Antenna
20	WiFi Antenna

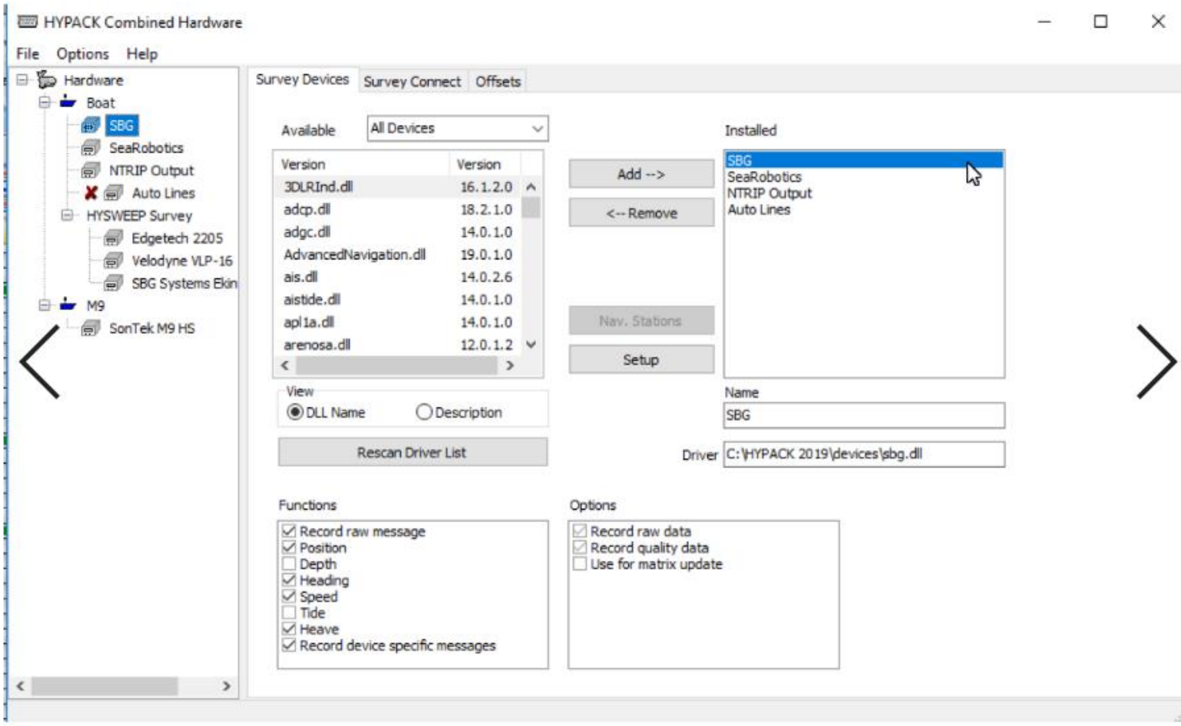
16.0 Appendix Device Interface Settings

Offset units = feet

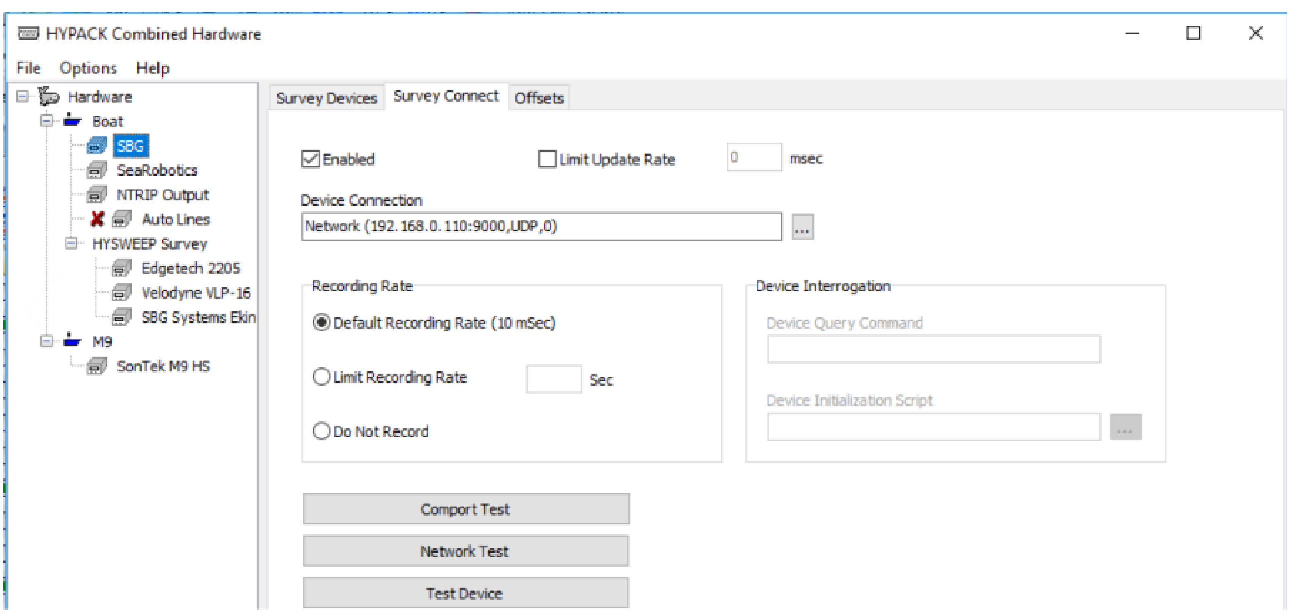


BOAT SBG Ekinox

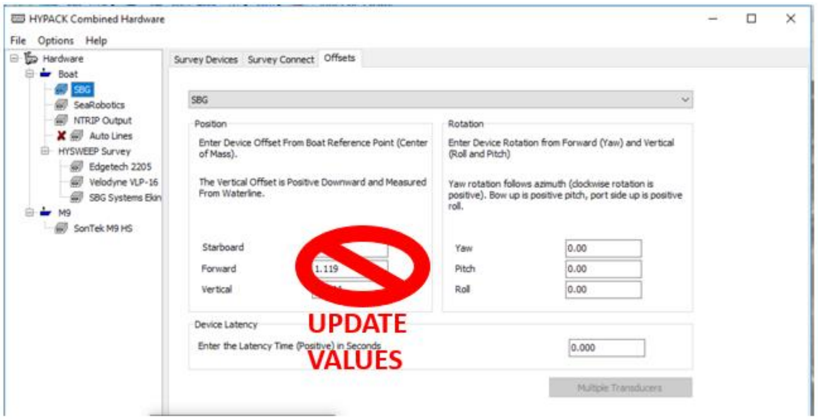
Devices



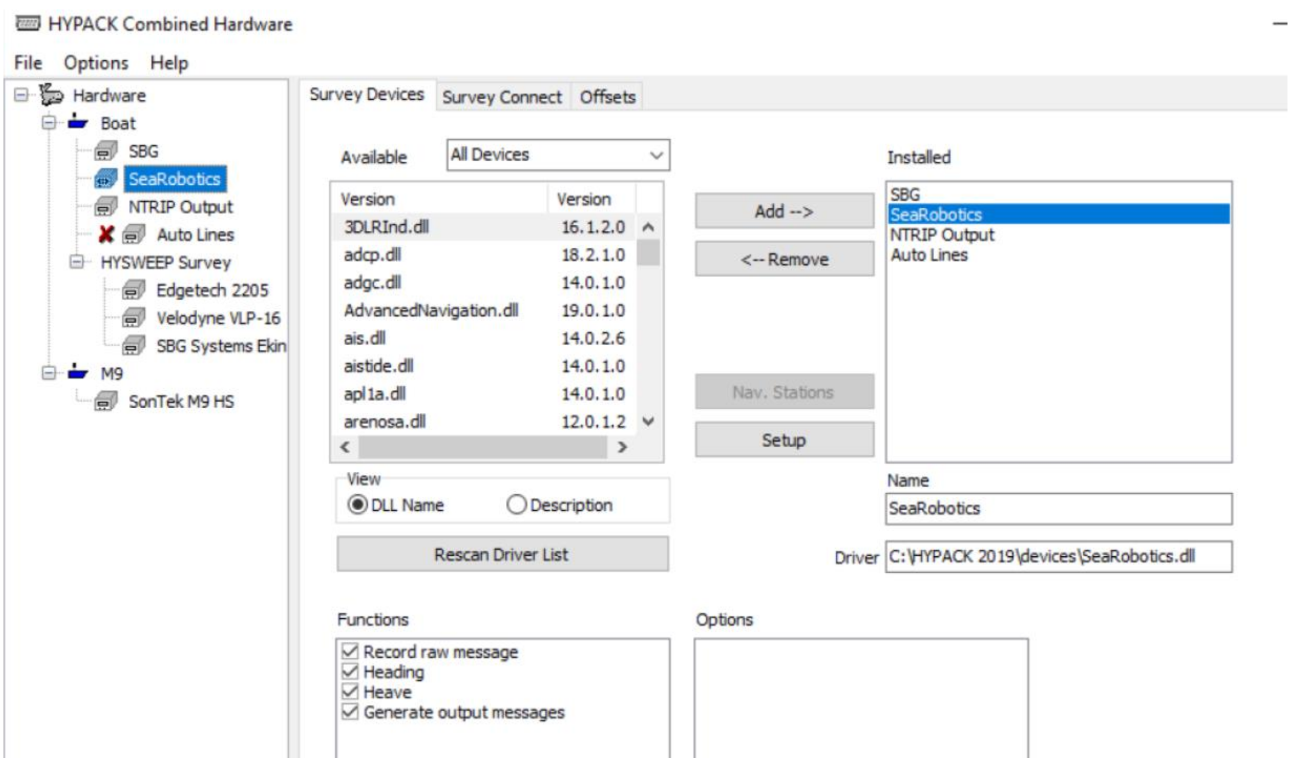
Survey Connect



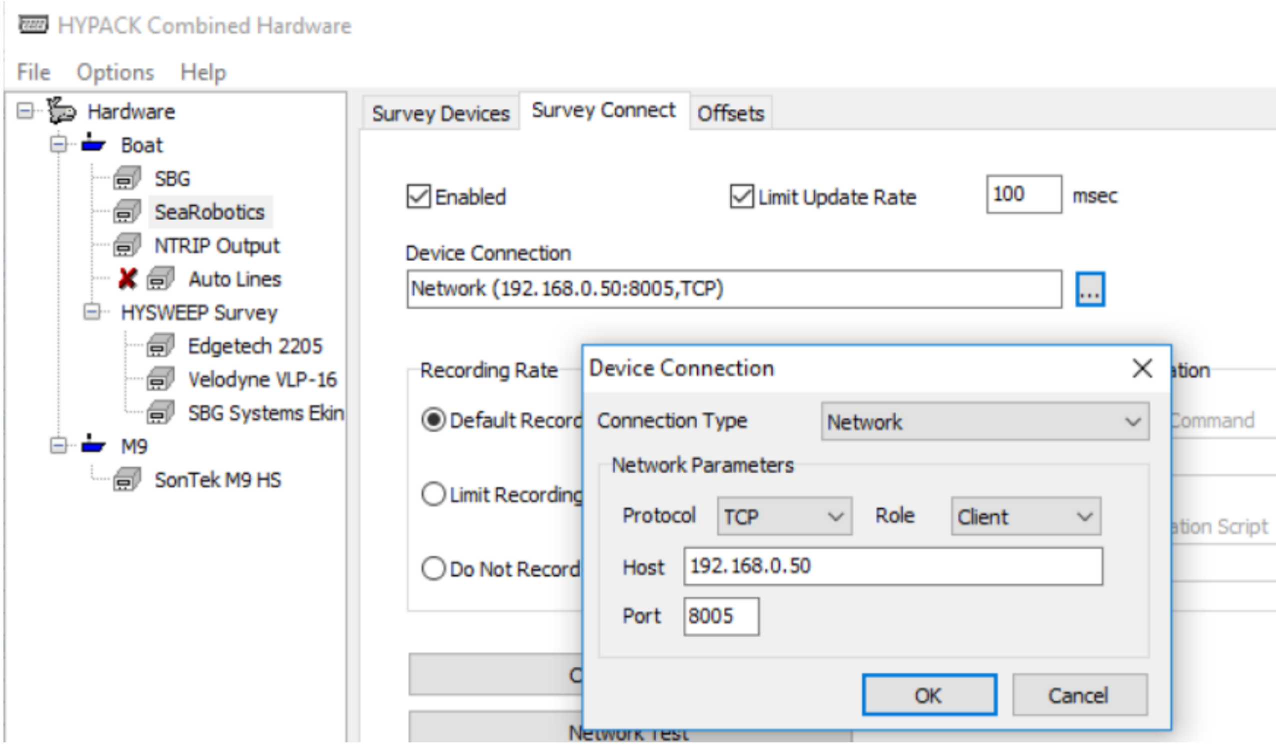
Offsets



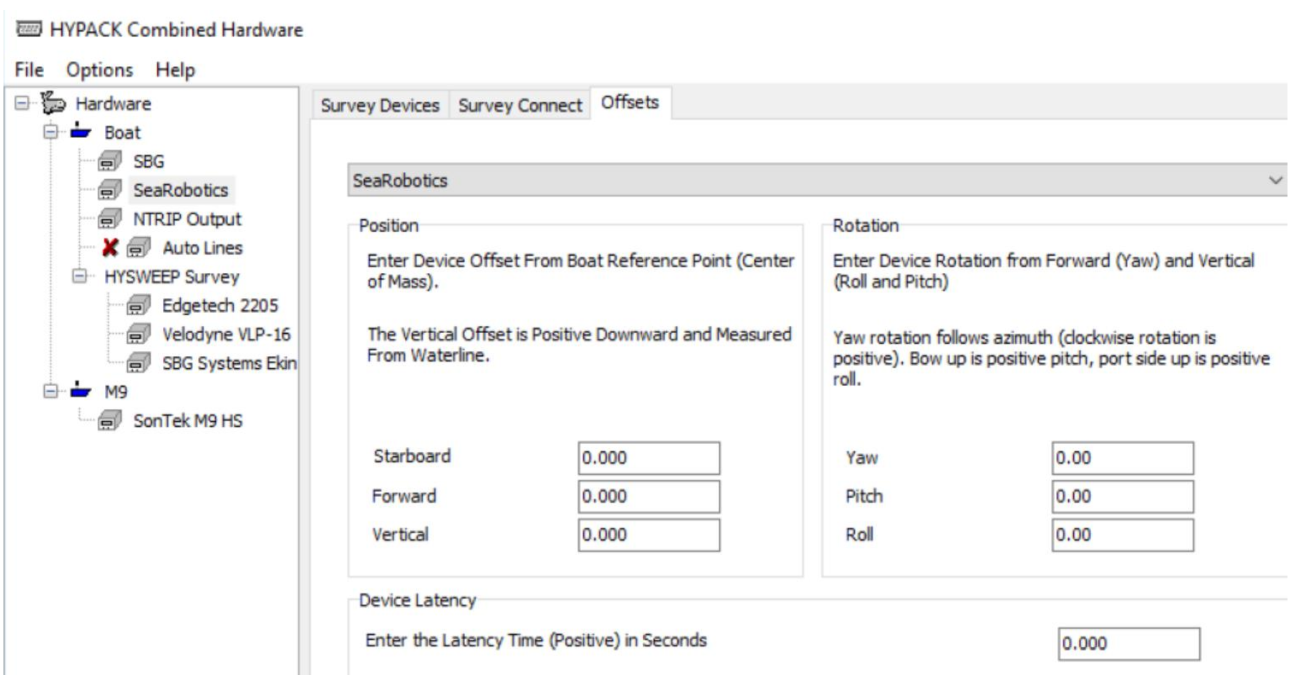
SeaRobotics dll



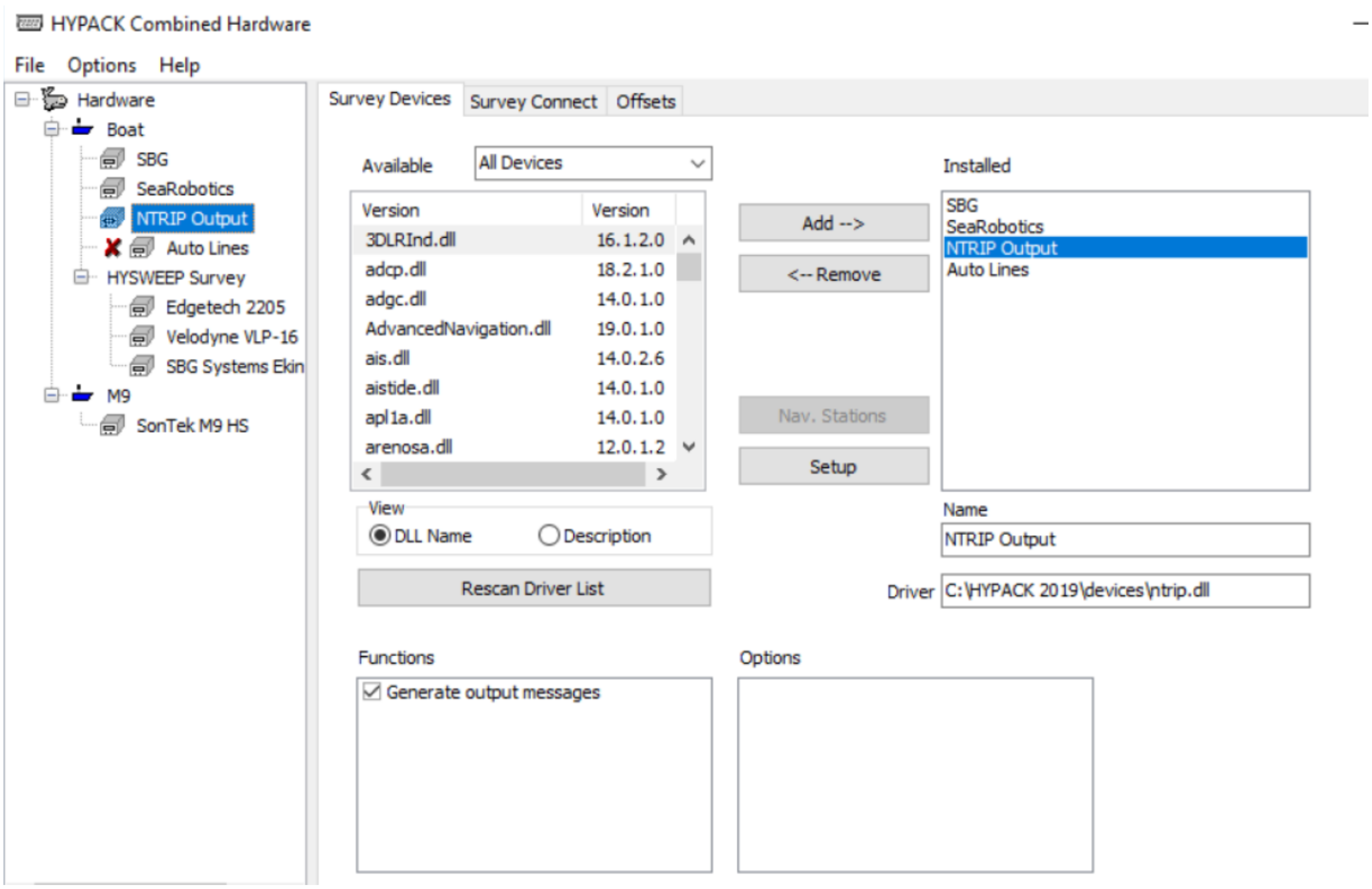
Survey Connect



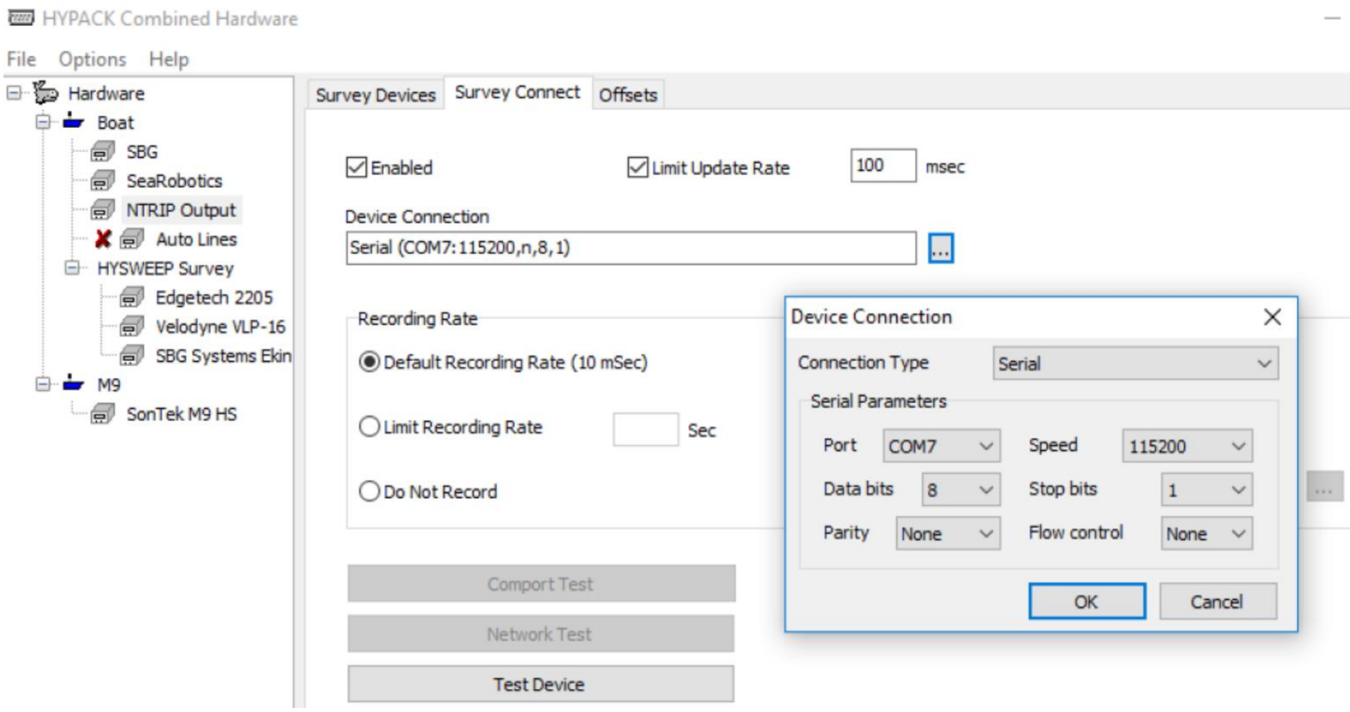
Offsets



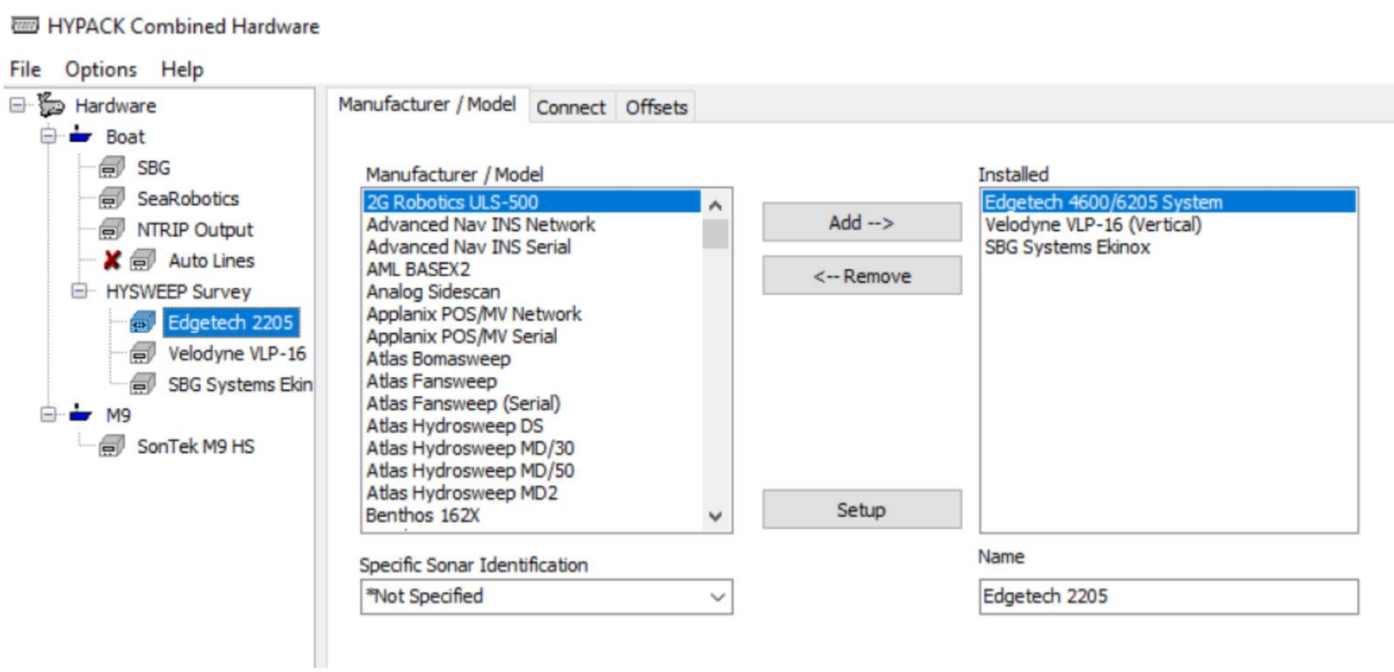
NTRIP


HYPACK Combined Hardware
File
Options
Help
Hardware
Boat
SBG
SeaRobotics
NTRIP Output
Auto Lines
HYSWEEP Survey
Edgetech 2205
Velodyne VLP-16
SBG Systems Ekin
M9
SonTek M9 HS
Survey Devices
Survey Connect
Offsets
Available
All Devices
Installed
Version
Version
3DLRInd.dll 16.1.2.0
adcp.dll 18.2.1.0
adgc.dll 14.0.1.0
AdvancedNavigation.dll 19.0.1.0
ais.dll 14.0.2.6
aistide.dll 14.0.1.0
apl1a.dll 14.0.1.0
arenosa.dll 12.0.1.2
Add -->
<-- Remove
Nav. Stations
Setup
SBG
SeaRobotics
NTRIP Output
Auto Lines
View
DLL Name
Description
Rescan Driver List
Name
NTRIP Output
Driver
C:\HYPACK 2019\devices\ntrip.dll
Functions
Generate output messages
Options

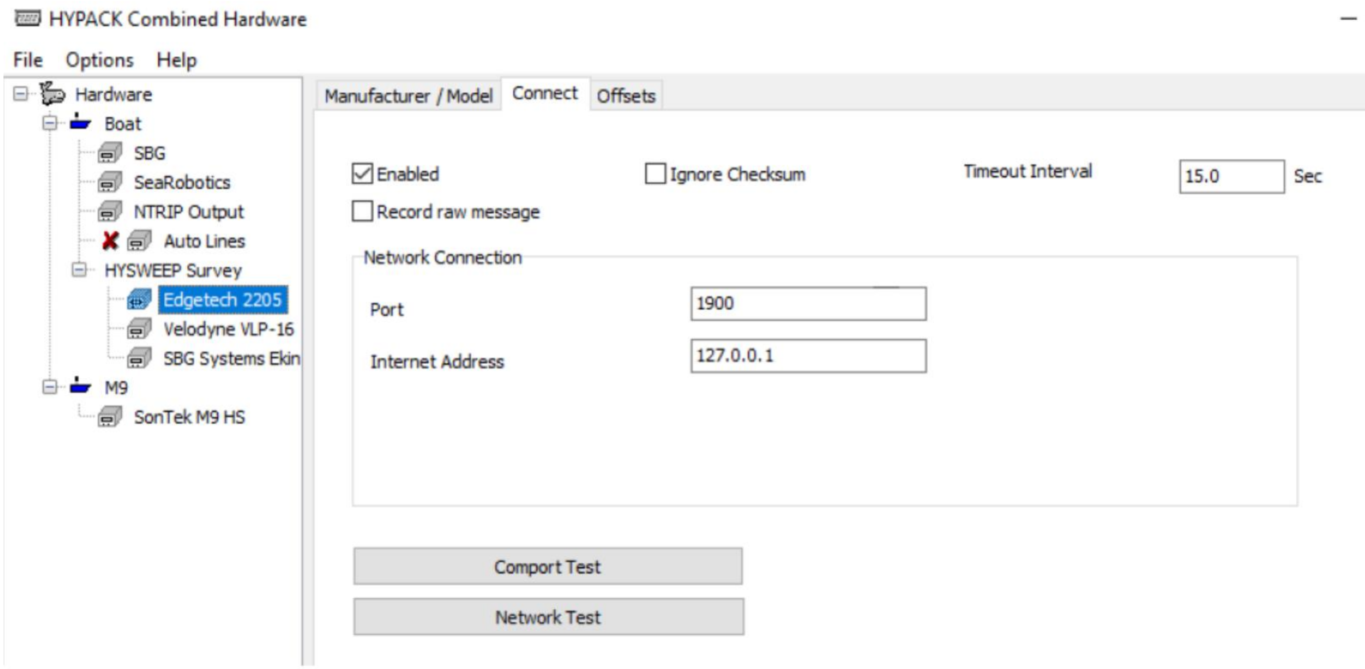
Survey Connect



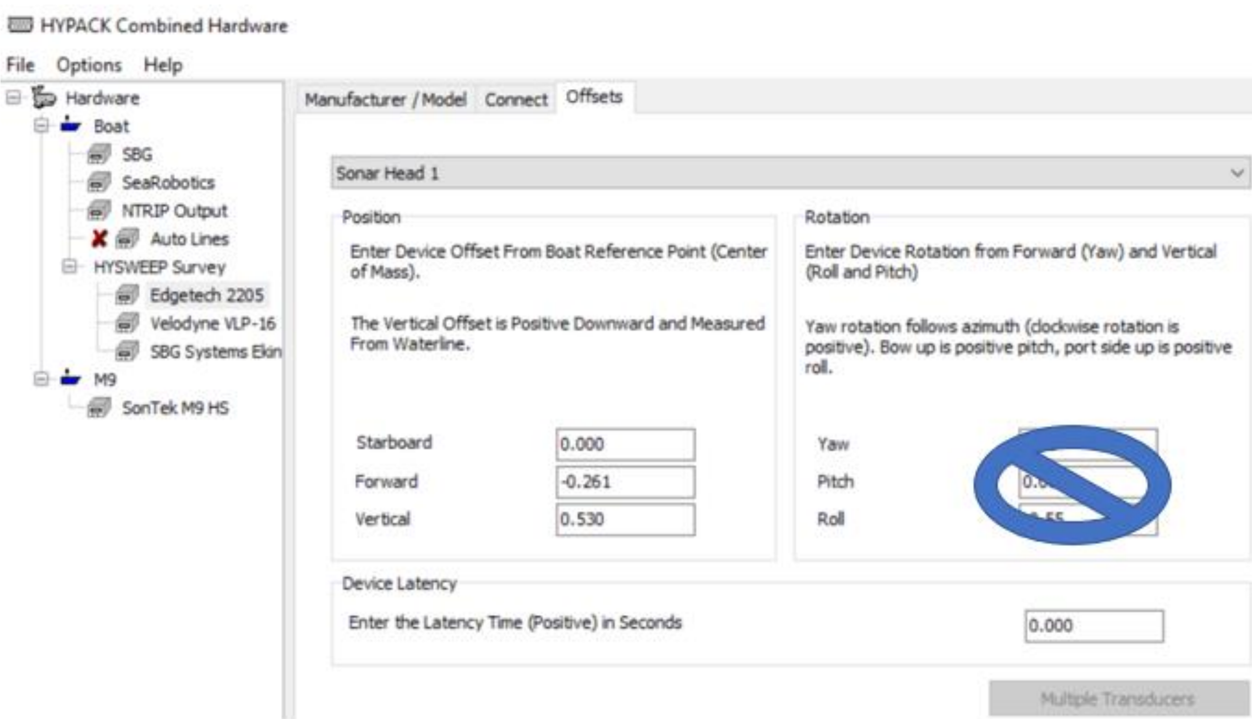
HYSWEEP Edgetech 2205



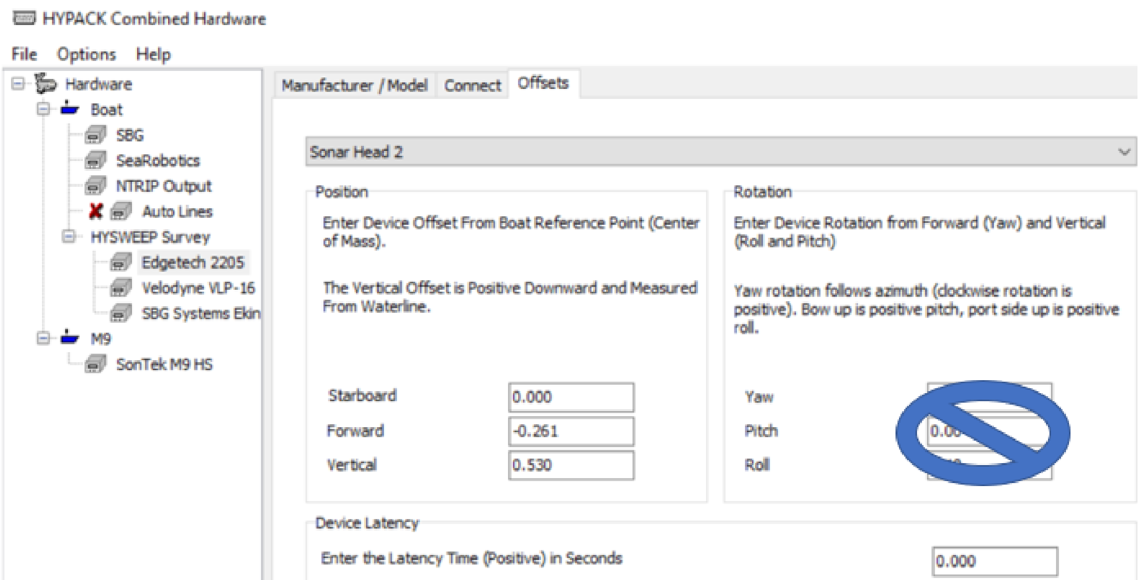
Survey Connect



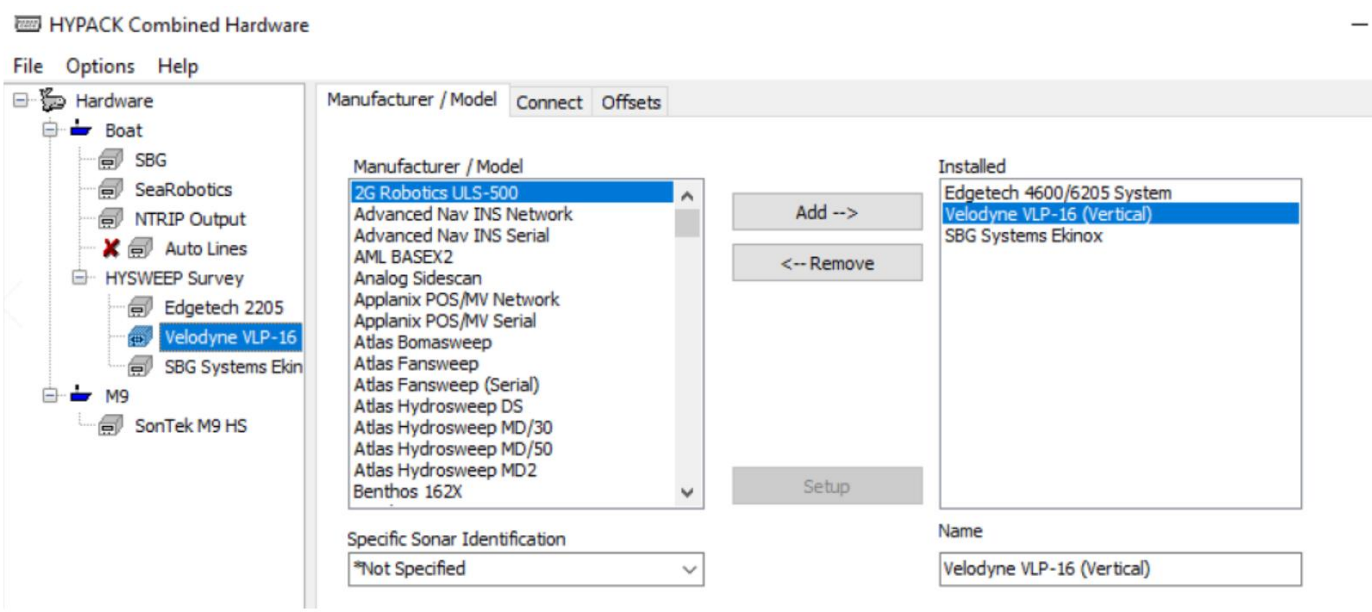
Offset Sonar Head 1



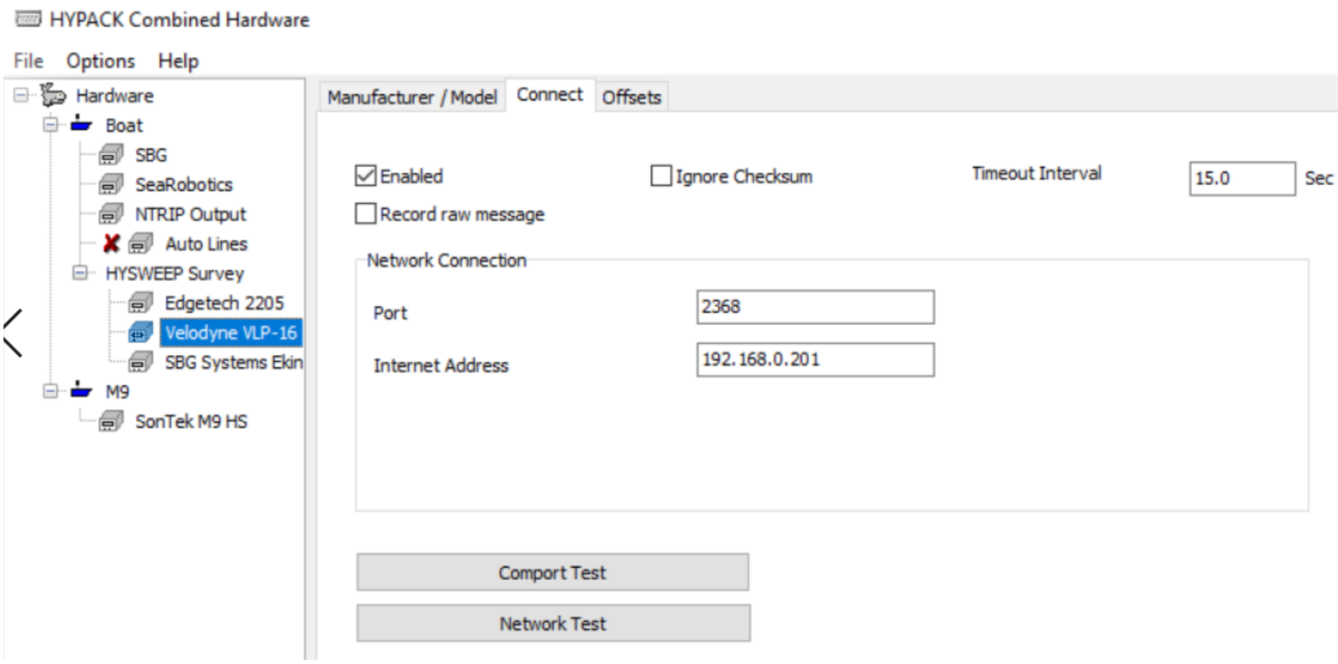
Offset Sonar Head 2



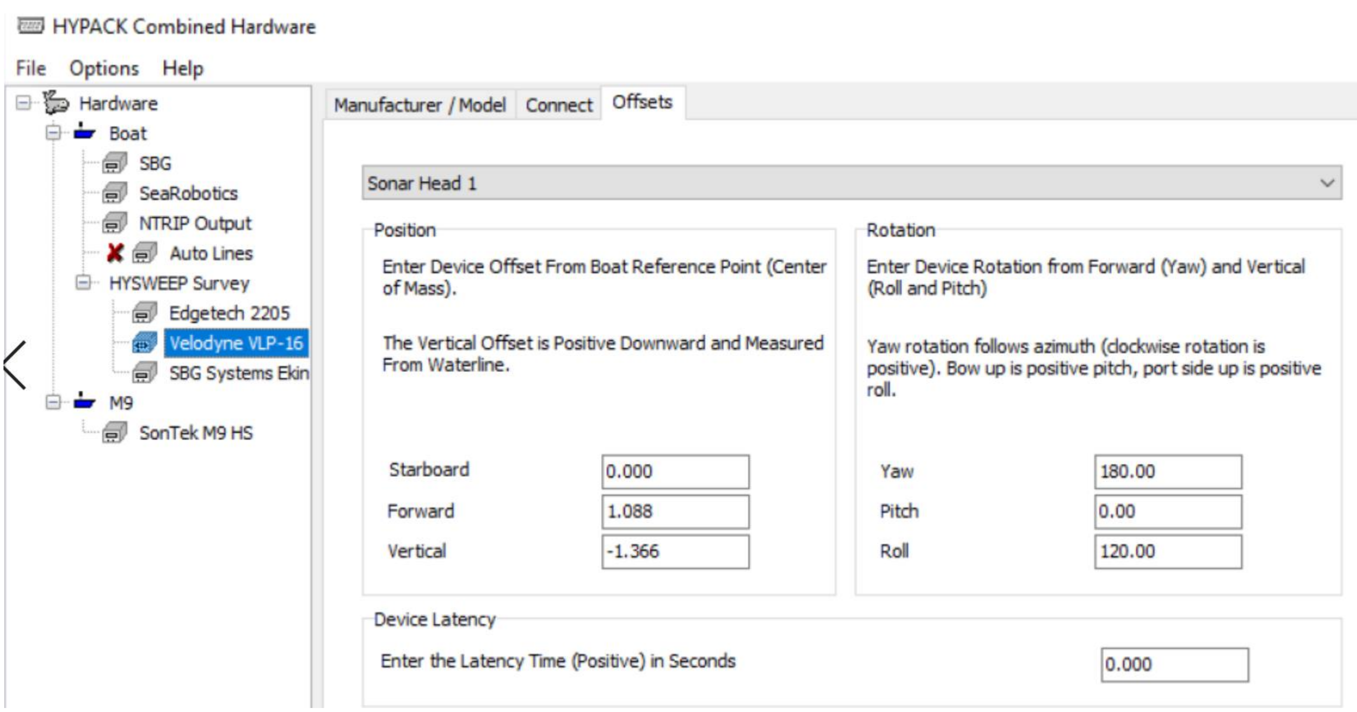
HYSWEEP Velodyne LiDAR



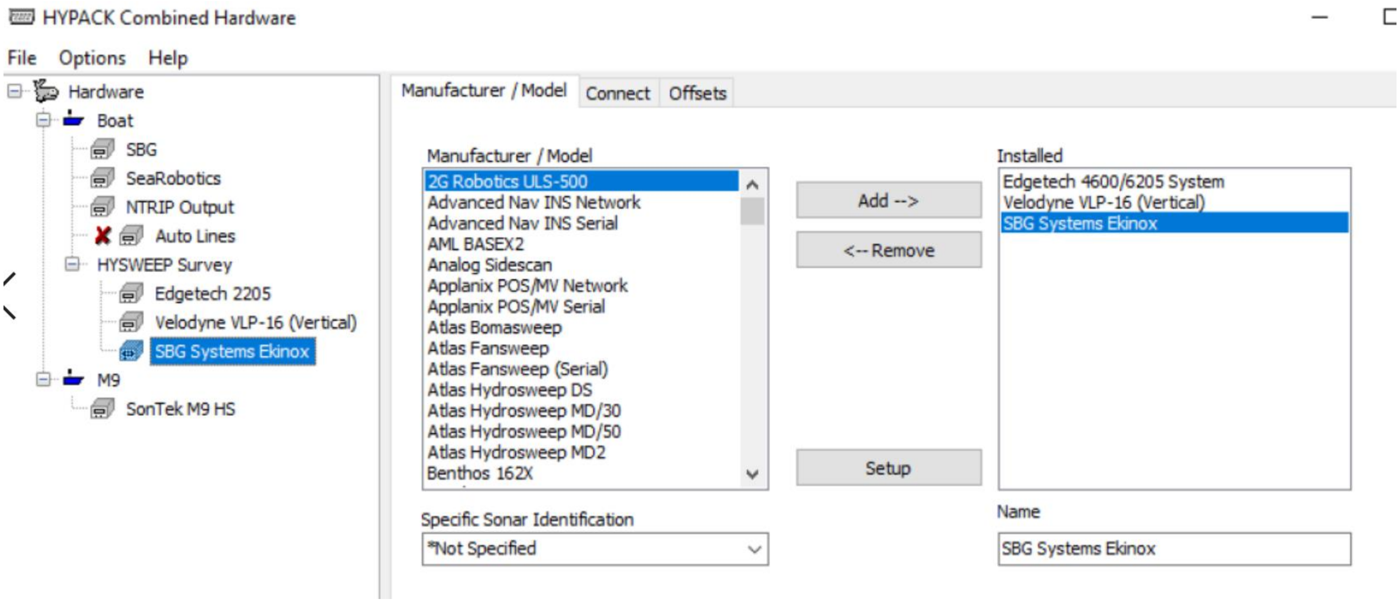
Survey Connect



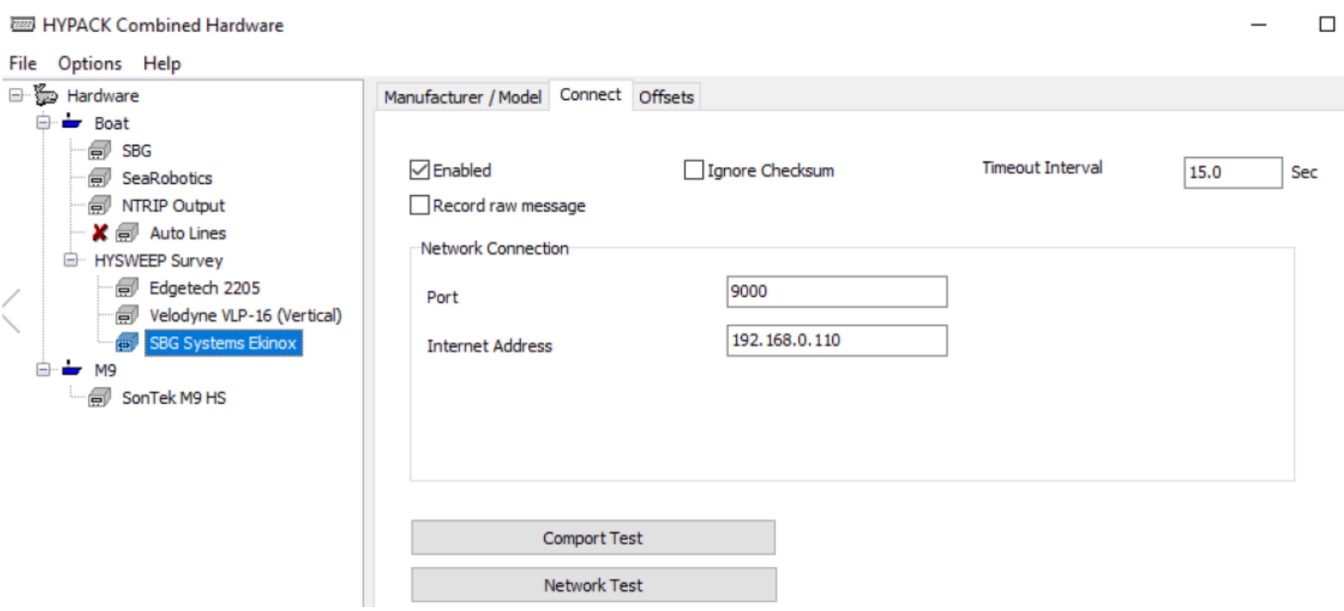
Offsets



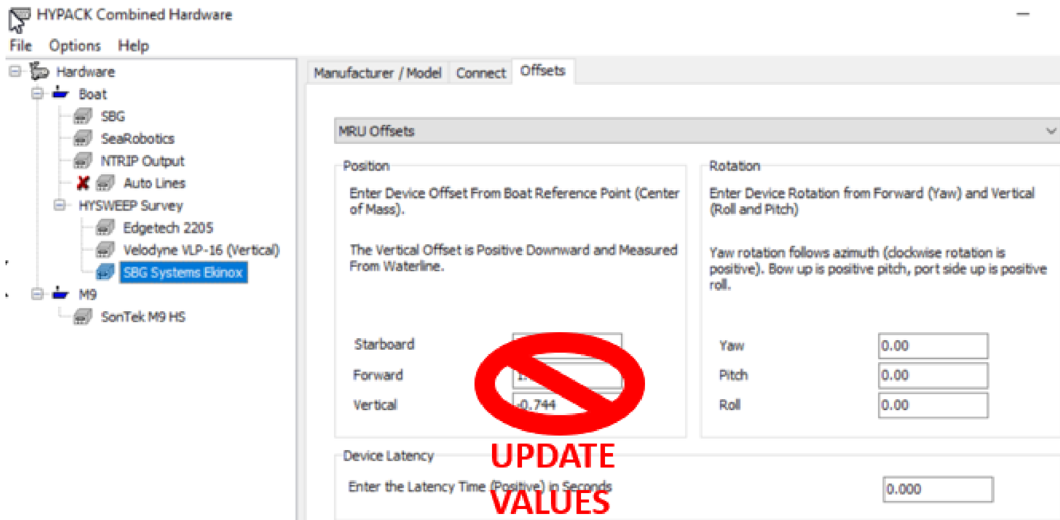
HYSWEEP SBG



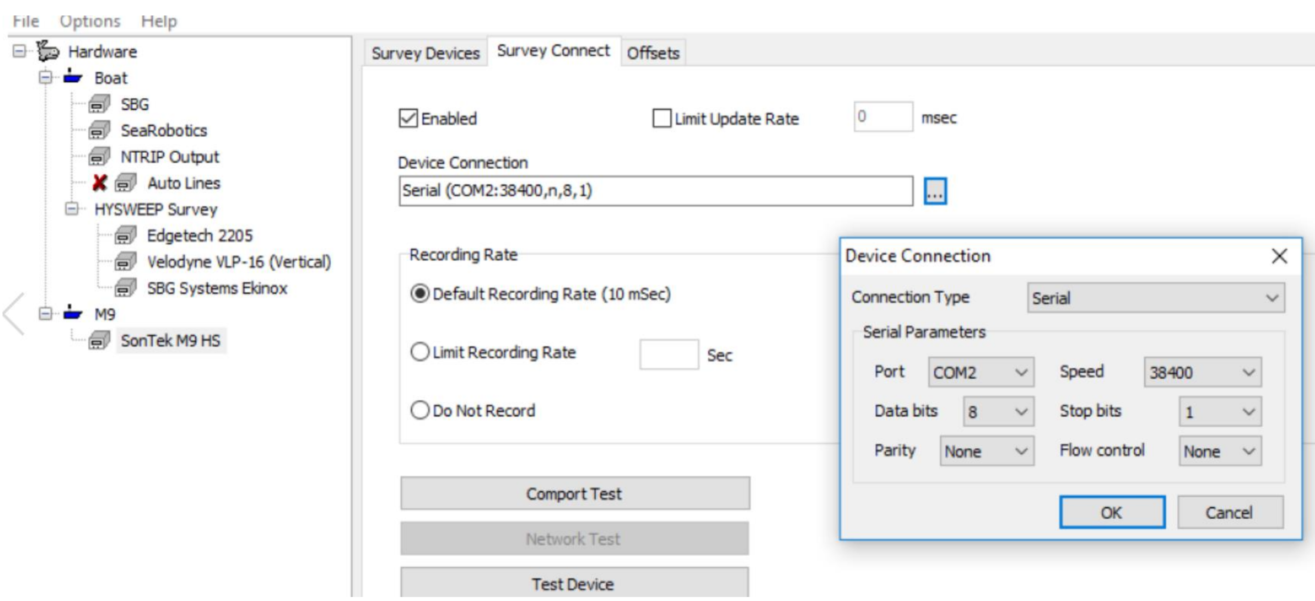
Survey Connect



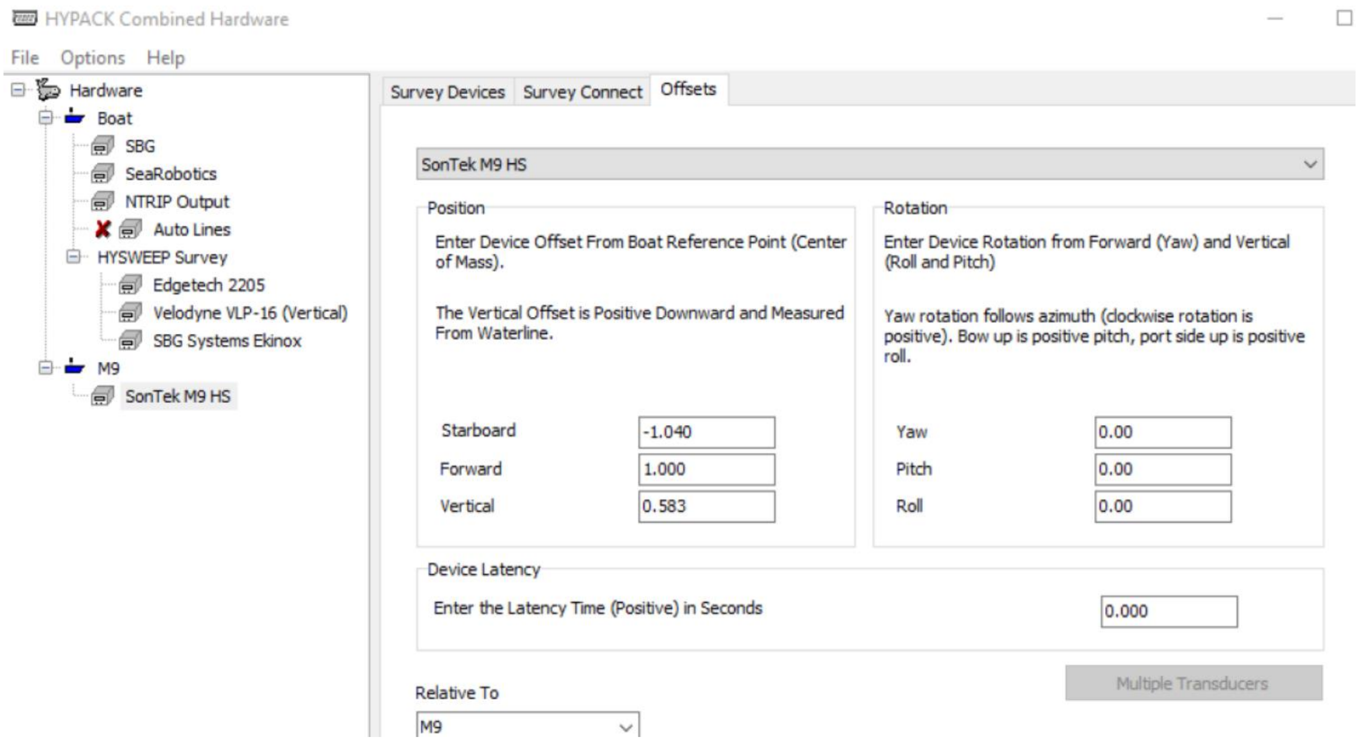
Offsets



Sontek M9

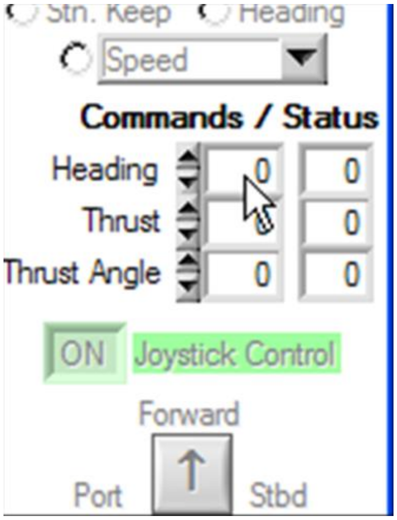


Offsets

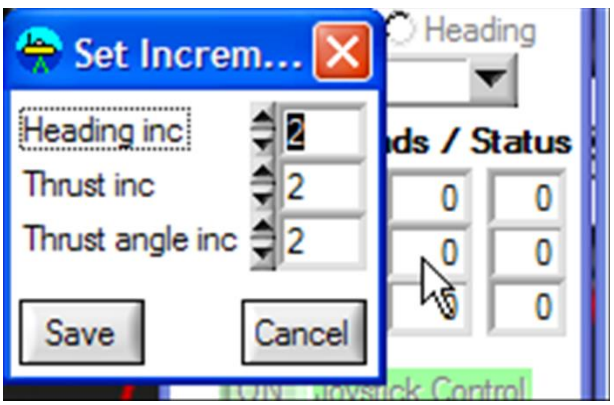

HYPACK Combined Hardware
File Options Help
Hardware
Boat
SBG
SeaRobotics
NTRIP Output
Auto Lines
HYSWEEP Survey
Edgetech 2205
Velodyne VLP-16 (Vertical)
SBG Systems Ekinox
M9
SonTek M9 HS
Survey Devices
Survey Connect
Offsets
SonTek M9 HS
Position
Enter Device Offset From Boat Reference Point (Center of Mass).
The Vertical Offset is Positive Downward and Measured From Waterline.
Starboard -1.040
Forward 1.000
Vertical 0.583
Rotation
Enter Device Rotation from Forward (Yaw) and Vertical (Roll and Pitch)
Yaw rotation follows azimuth (clockwise rotation is positive). Bow up is positive pitch, port side up is positive roll.
Yaw 0.00
Pitch 0.00
Roll 0.00
Device Latency
Enter the Latency Time (Positive) in Seconds 0.000
Multiple Transducers
Relative To
M9

17.0 Appendix Joystick Setup

Heading, thrust and thrust angle can be changed *incrementally* using both the joystick (buttons #5,6,7,8) and the left/right/up/down arrows on the keyboard. (The “X” and “Y” axis joystick levers make *proportional* changes based on the joystick settings.) The incremental values can be changed as deemed necessary by the operator.

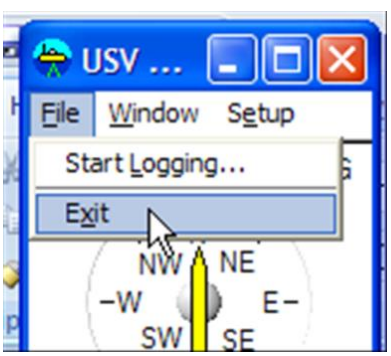


The operator may want to make large thrust angle increments if the vessel is in open water but may want very small increments when the vessel is in a harbor with a lot of boat traffic. To change any of the three values, right click on any of the three boxes (heading/Thrust/Thrust Angle) and a new screen will pop up titled “Set Increments”.



Either type the desired value in the appropriate box or click on the up/down arrows on the left side of the boxes.

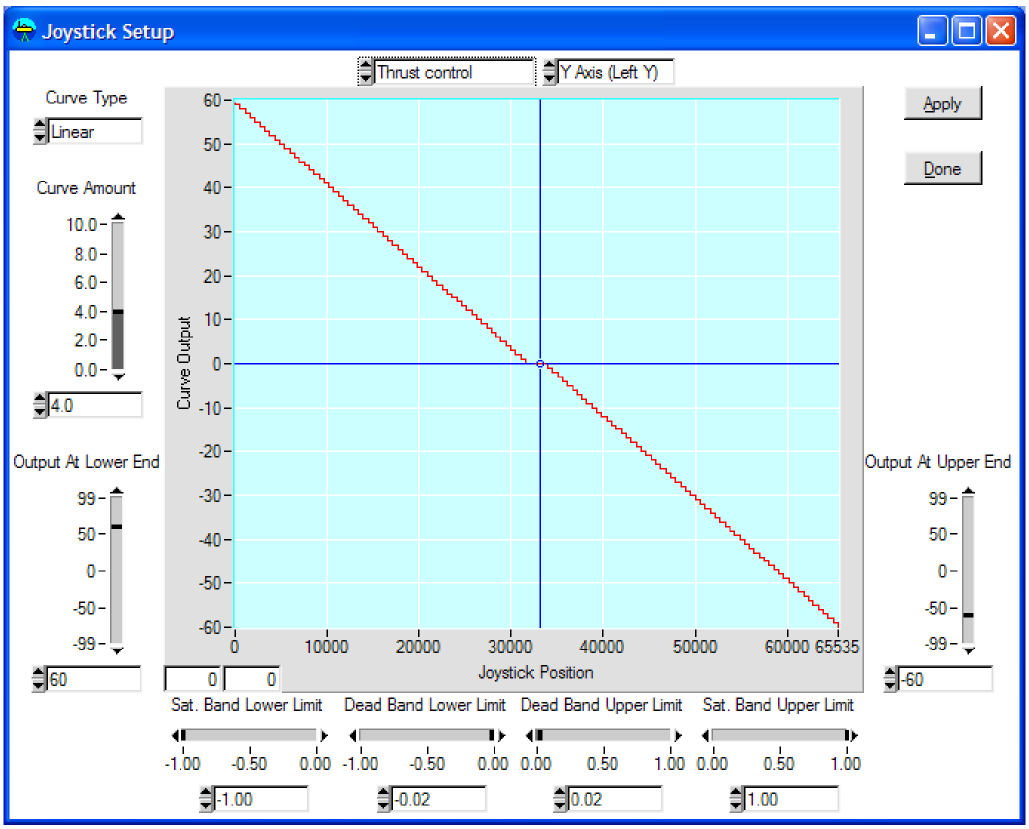
The setting will be saved once the ASV main software is properly exited.



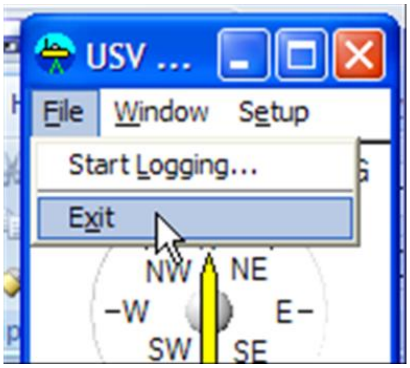
Joystick Setup Display

The joystick setup display is provided for the operator who wishes to modify the operation of the joystick. In certain instances, the operator may require finer control of the vehicle at very low speeds which requires changing the shape of the joystick response curve.

Normally only the “Y” axis (thrust) and “X” axis (differential steering) will be changed. If the maximum thrust level needs to be adjusted, the “Output at Lower End” setting would be updated. In the screen below the maximum thrust level at the “Lower End” is set to “60”. To change the maximum reverse thrust level change the value in the box “Output at Upper End” (retain the negative sign).



After the settings are updated, press the “Apply” button to test the settings on the screen with the joystick, then press “Done”.



The settings will be lost if the ASV main screen is not closed properly. Before shutting down the computer, close the ASV application by either pressing the red “**X**” or press “File > Exit”. The new settings will then be written to the “.ini” file and will be loaded on start-up.

Logitech Joystick Button Functions

There are several functions that can be assigned to joystick buttons. These functions are modified in the SeaRobotics ASV configuration file “asvois.ini”

Joystick button functions are set in the [joystick] section of the file. The general format of a joystick button function is button x = “function string” where x is a number from 1 to 12, and “function string” is one of the strings below.

Here are the functions that can be assigned to joystick buttons:

"standby mode" – put ASV in Standby mode

"thruster mode" – put ASV in Thruster mode

"heading mode" – put ASV in Heading mode

"speed mode" – put ASV in Speed mode

"station keep mode" – put ASV in Station Keep mode

"go to ERP mode" – put ASV in Go to ERP mode

"waypoint mode" – put ASV in Waypoint mode

“Hypack mode” – put ASV in Hypack mode

“hold” – ignore axis movement while button is depressed

“up arrow” – increment thrust/speed

“down arrow” – decrement thrust/speed

“right arrow” – increment heading/thrust differential

“left arrow” – decrement heading/thrust differential

"decrement winch" – bring winch in one decrement

"increment winch" – let winch out one increment

"stop winch" – stop winch motion

"zoom in" – zoom in camera

"zoom out" – zoom out camera

To see the location of the "asvois.ini" file select Setup->About.

If this file is edited, the main ASV control program must be closed.

Joystick button functions are set in the [joystick] section of the file. The general format of a joystick button function is button x = “function string” where x is a number from 1 to 12, and “function string” is one of the strings below.

By default, eight button functions are presently defined by SRC.

This is the code in the “ini” file for programming the eight buttons:

[joystick]

button 1 = "standby mode"

button 3 = "station keep mode"

button 5 = "up arrow"

button 6 = "right arrow"

button 7 = "down arrow"

button 8 = "left arrow"

button 10 = "hold"

button 11 = "thruster mode" (Press button down)

max errors = 50

poll interval = 0.1

thrust diff high = 30

thrust diff low = -30

thrust rate = 20

[joystick heading rate control]

axis = 2

curve base = 0

curve type = 0

high = 60

low = -60

lower dead band = -0.02

lower sat band = -1

upper dead band = 0.02

upper sat band = 1

[joystick speed control]

axis = 1

curve base = 0

curve type = 0

high = -50

low = 50

lower dead band = -0.02

lower sat band = -1

upper dead band = 0.05

upper sat band = 1

[joystick thrust angle control]

axis = 2

curve base = 0

curve type = 0

high = 40

low = -40

lower dead band = -0.02

lower sat band = -1

upper dead band = 0.02

upper sat band = 1

[joystick thrust control]

axis = 1

curve base = 0

curve type = 0

high = -50

low = 50

lower dead band = -0.02

lower sat band = -1

upper dead band = 0.05

upper sat band = 1

18.0 Appendix RC Transmitter & Receiver Setup

Transmitter / Receiver Binding

The receiver inside the boat must be "bound" to the transmitter during the initial start-up of the system at the factory. This procedure is called "binding" and may need to be repeated should the RC receiver and RC transmitter become unbound.

Note that "RC Power" is normally on by default when the boat is powered up.

1. Turn off the transmitter
2. Turn off "RC Power" on the GUI
3. Turn on "BIND" on the GUI
4. Delay a couple of seconds
5. Turn On "RC Power" on the GUI (the receiver is now in Bind mode)
6. On the Transmitter, press and hold "BIND" and turn the power on (this puts the transmitter into Bind mode)
7. Wait until the transmitter emits 2 high pitch beeps
8. Release the "BIND" button on the transmitter
9. Turn off the "BIND" on the GUI

New Transmitter Setup

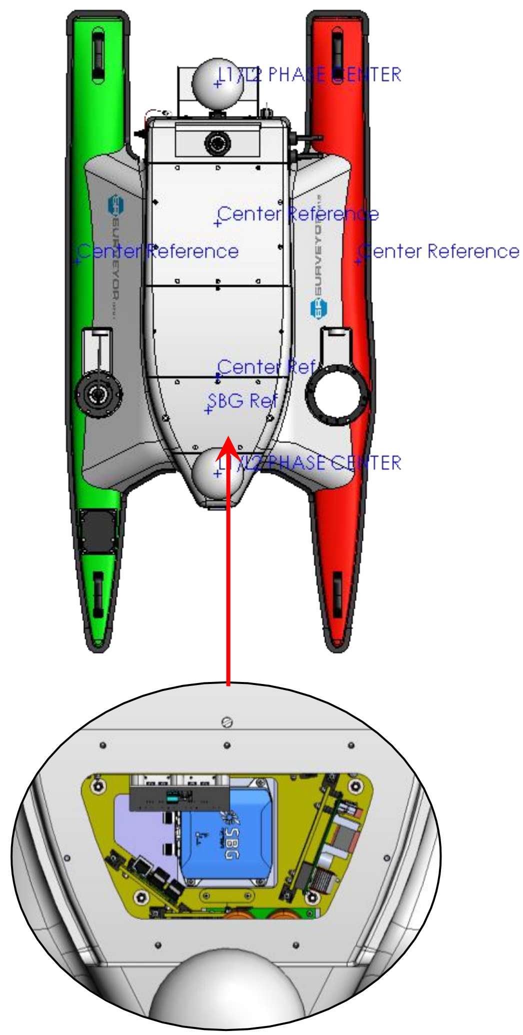
If a new transmitter is purchased it must be purchased with an interface cable and programming dongle so that the SRC presets can be loaded for the proper configuration. The file is included in the software library on the OIS laptop. Follow the instructions provided with the transmitter for loading the file.

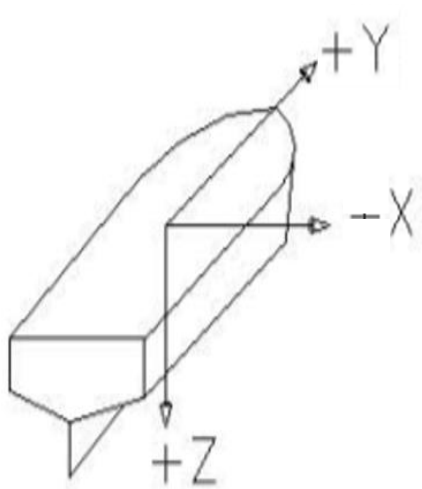
19.0 Appendix Survey Sensor Offsets

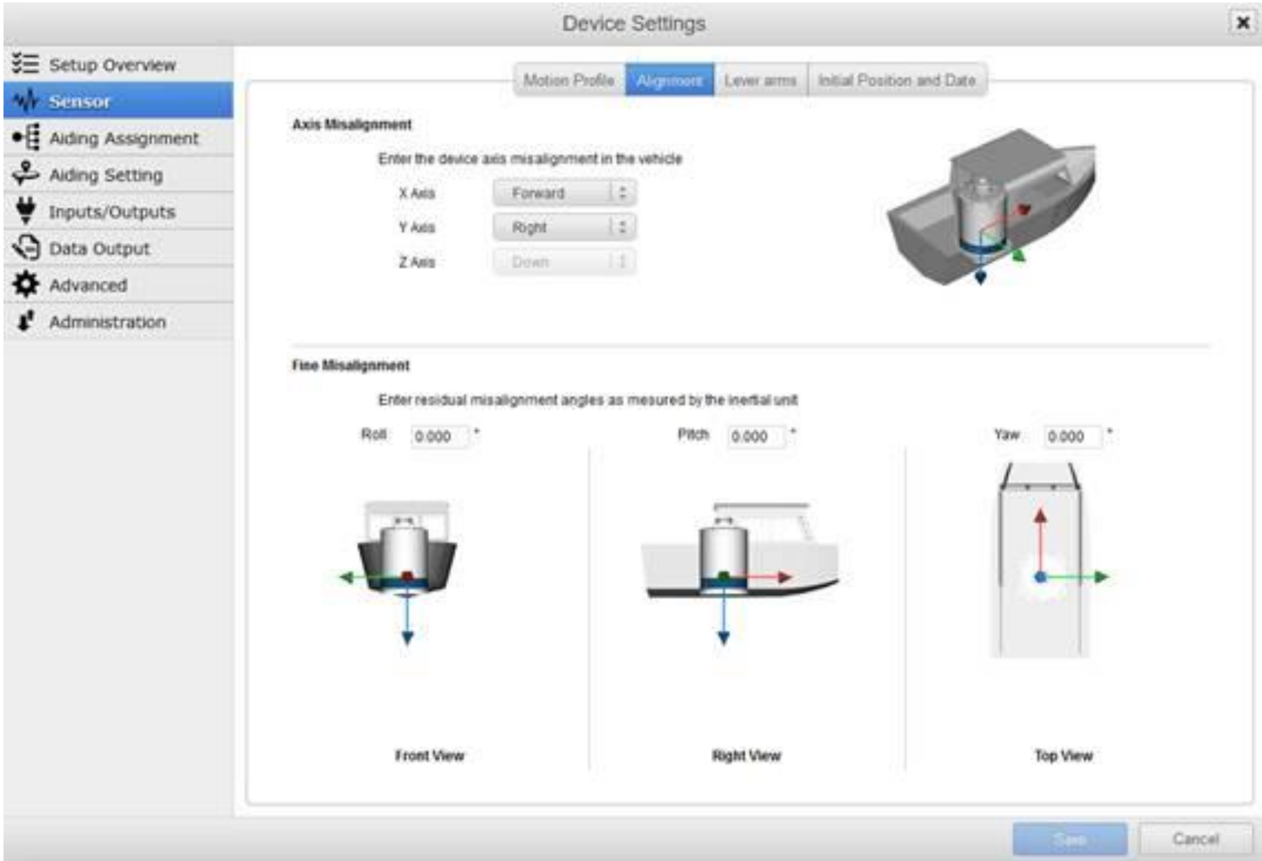
The origin for the sensor offsets is on the top of the IMU. The coordinate system is shown in the figure below. This system has been adopted due to the fact that the IMU is rotated 90 degrees in order to accommodate the connectors.

The screen shot of the SBG utility shown below demonstrates how the reference axes are setup and the data is entered for each sensor.

ASV Surveyor Default Sensor Offsets (mm)			
Sensor	**X**	**Y**	**Z**
SBG – Top (origin)	0	0	0
GPS – Forward	27.2	177.7	-202.0
GPS – Aft	27.6	-922.3	-202.0
SSS – Starboard	-369.6	-420.3	398.8
SSS – Port	424.0	-420.3	398.8
SBP – Transmitter	27.2	-95.9	362.8
SBP – Receiver	27.2	-527.7	365.4
LIDAR	27.2	-9.0	-202.0
Center of Gravity	36.0	-341.0	27.0
Waterline	0	0	248.5





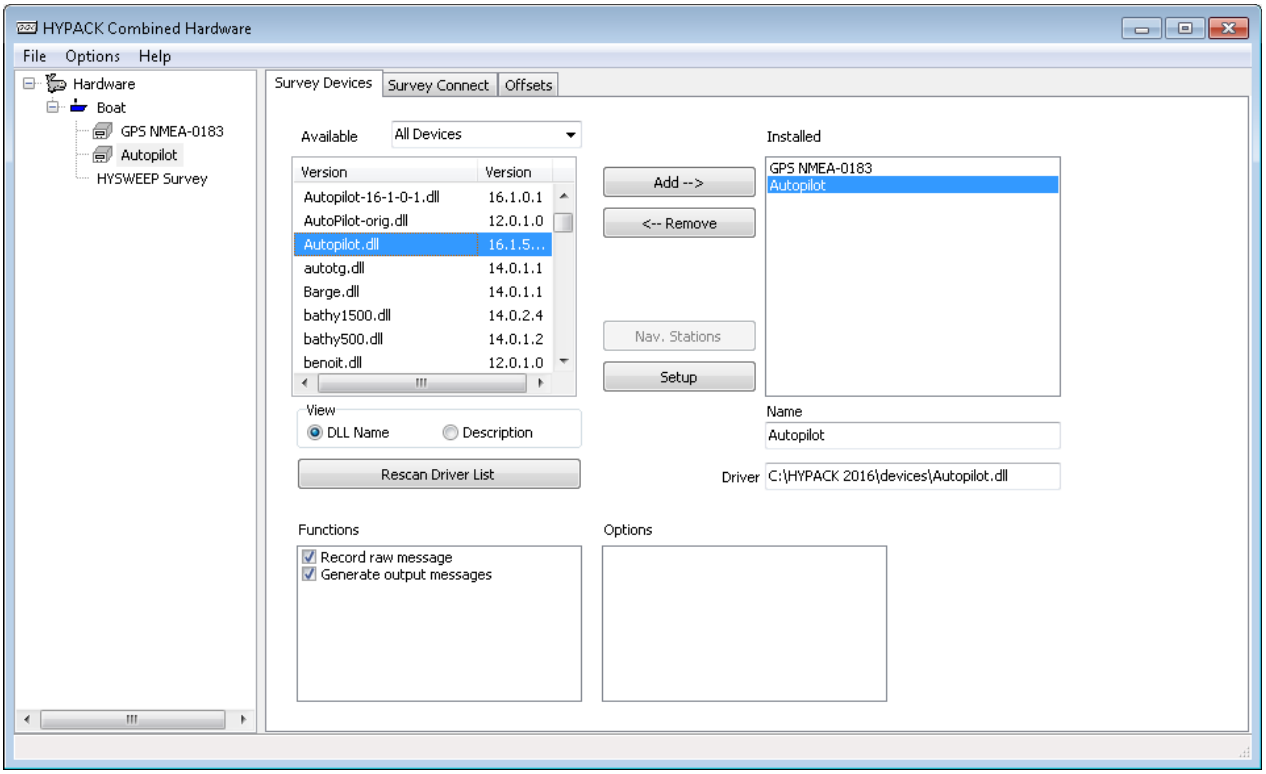


Device Settings
Setup Overview
Sensor
Aiding Assignment
Aiding Setting
Inputs/Outputs
Data Output
Advanced
Administration
Motion Profile
Alignment
Lever arms
Initial Position and Date
Axis Misalignment
Enter the device axis misalignment in the vehicle
X Axis
Forward
Y Axis
Right
Z Axis
Down
Fine Misalignment
Enter residual misalignment angles as mesured by the inertial unit
Roll
0.000
Pitch
0.000
Yaw
0.000
Front View
Right View
Top View
Save
Cancel

20.0 Appendix HYPACK Setup

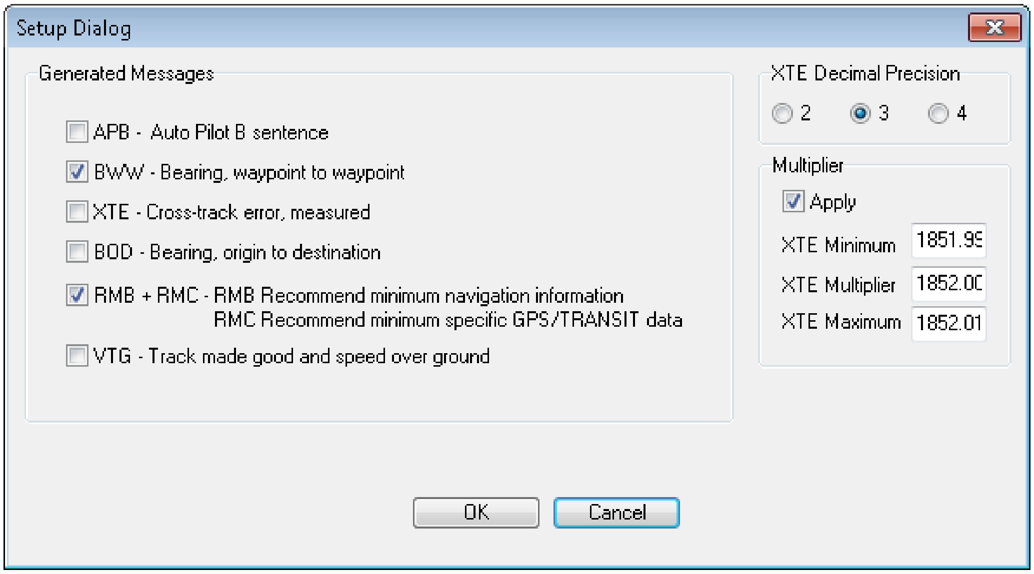
There is a file on the ASV controller named /searobot/COMM.cfg, which contains a line that reads "NMEA 127.0.0.1 8005". This sets up a communication link to receive messages from HYPACK Survey, on the ASV controller at TCP port 8005. If this line is not already present in COMM.cfg, then it should be added. See the ASV User Manual for instructions on how to use WinSCP to edit files on the ASV controller.

In Hypack Control Mode, the ASV controller navigates based on two messages from HYPACK Survey, BWW and RMB. The HYPACK driver Autopilot.dll provides these messages. In HYPACK Hardware, add Autopilot.dll to the installed devices.



Note that the driver version must be 16.1.4.0 or later. Earlier versions will not work properly.

Select the Setup button to open the Setup Dialog.



Select the messages “BWW” and “RMB”.   The other messages should be unchecked.

The “XTE” value is normally in nautical miles; however, it should be in meters for the ASV controller.

Set the “XTE Multiplier” to **1852** to convert nautical miles to meters.

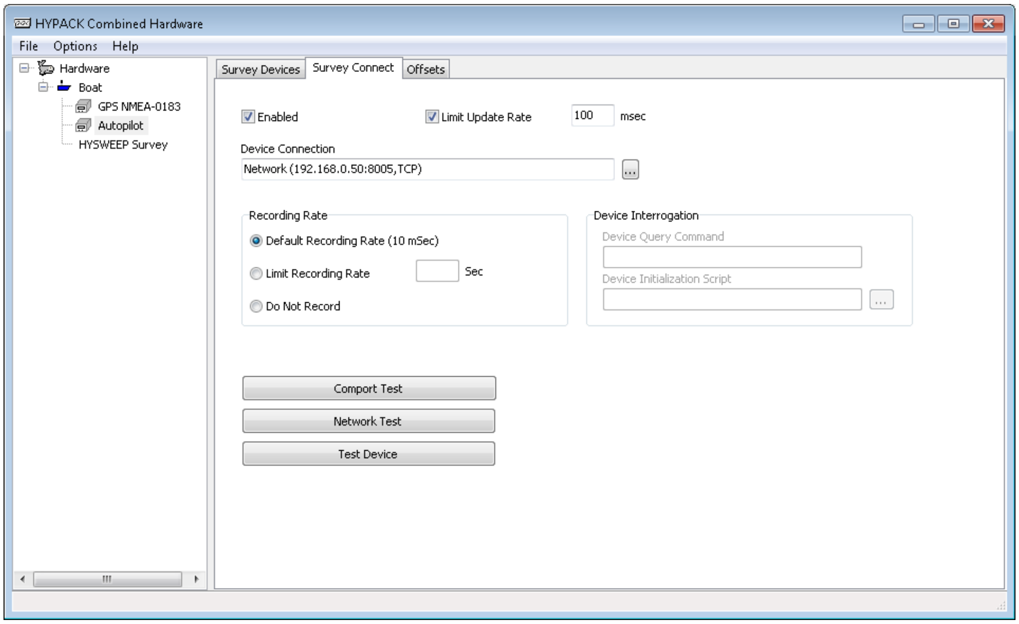
Set the “XTE Minimum and Maximum” to **1851.99** and **1852.01** to ensure that the Multiplier stays near **1852**.

Ensure that “Apply” is checked.

Set the “XTE Decimal Precision” to **3**.

Select the OK button to save the setup.

Next, select the Survey Connect tab for the Autopilot device.

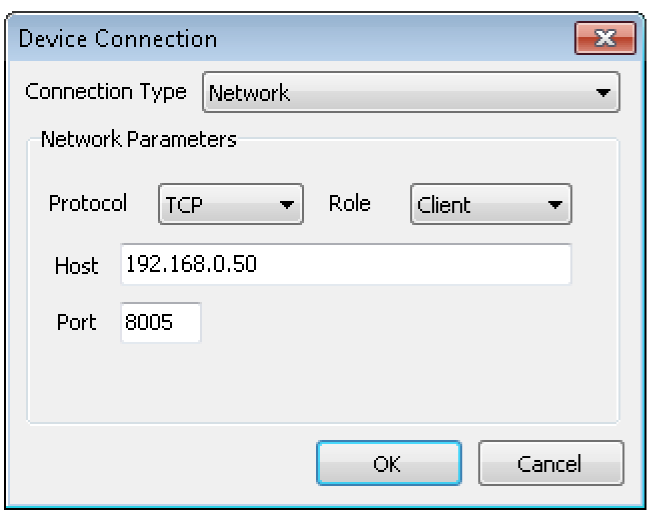


Ensure that “Enabled” is checked.

Limit Update Rate is checked, and set to **100** msec.

This will send messages to the ASV controller every 100 msec, a rate of 10 Hz.

Select the “…” button next to Device Connection to open the Device Connection dialog.



Set “Connection Type” to **Network**, “Protocol” to **TCP**, and “Role” to **Client**.

Set “Host” to the IP address of the ASV controller, normally **192.168.0.50**, and “Port” to **8005**.

Select the OK button to save the setup.

In HYPACK Hardware, save the setup and exit. The next time that HYPACK Survey runs, it will now send Autopilot messages to the ASV controller.

The ASV controller can now be set to navigate per the Autopilot messages from HYPACK Survey, using the SeaRobotics ASV GUI.

21.0 Appendix SeaRobotics Grapher Utility

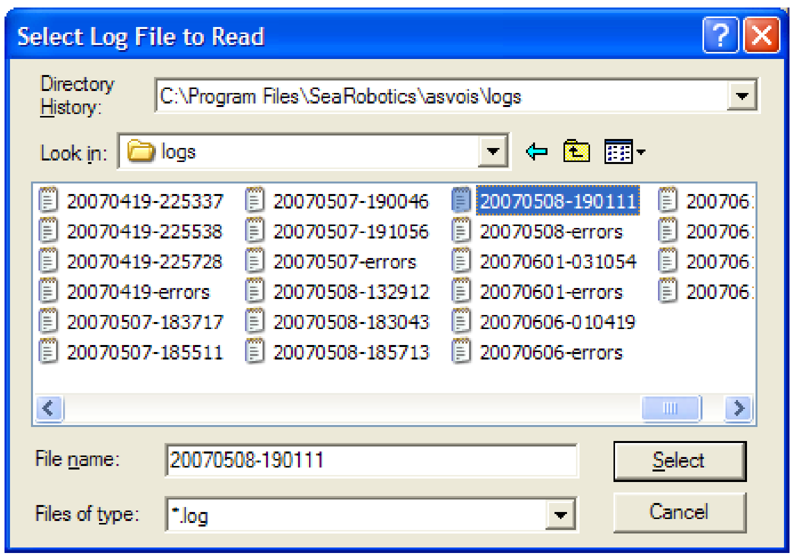
SeaRobotics Grapher Overview

There is a program installed on the OIS computer for simple graphing of data from ASV log files, called SeaRobotics Grapher. This is just a simple plotting program that allows an operator to view the data but does not have the capabilities of a more sophisticated graphing package.

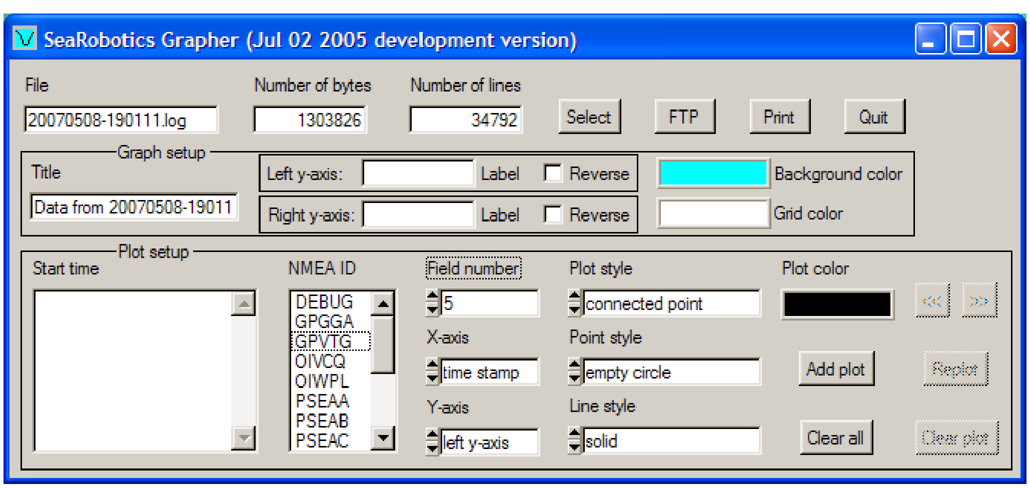
SeaRobotics Grapher can read data fields from NMEA sentences and create plots of the data from those fields. This allows an operator to create plots from the OIS communication log files, and from the log files stored on the ASV USB flash drive.

Quick Start Guide

When the SeaRobotics Grapher is opened, a Select Log File window is displayed.

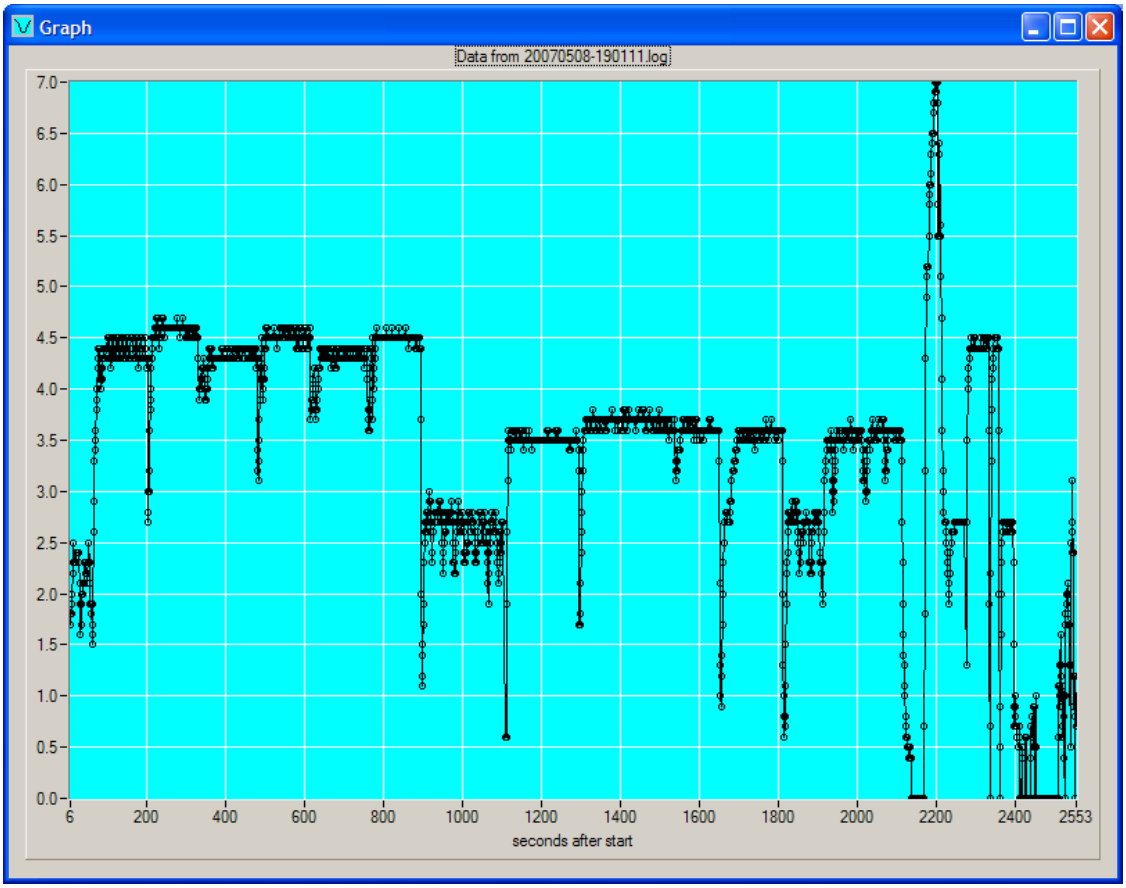


Use this window to find and select the log file to open. Once a file is selected, SeaRobotics Grapher will scan the file and list all of the NMEA IDs that it finds in the file. This may take a minute for a large file.



To create a plot, first select the NMEA ID to get the plot data from. Next, select the Field number for that NMEA ID to get the plot data from. For example, field 5 in the GPVTG sentence is the speed over ground, in knots, from the INS receiver. Next, click the Add plot button, and the data will be plotted. It may take a minute to read and plot the data from a large file.

The Graph window can be maximized to get a more detailed look at the data. A zoom and pan



feature are also available in the graph. Click the Help button in the upper right of the Graph window for zoom and pan help.

Reference Guide

The SeaRobotics Grapher window is divided into three parts. The top part has information and actions related to the log file. The middle part controls the overall Graph setup. The bottom part controls each individual Plot setup.

Log file

File displays the name of the log file.

Number of bytes displays the size of the log file in bytes.

Number of lines displays the size of the log file in lines.

The **Select** button is used to select a new log file.

The **FTP** button runs the ftp program in a Command Prompt window and executes ftp commands from the file getlogs.ftp. At one time, this was used to transfer files from the ASV computer to the OIS computer, but its use is no longer recommended. WinSCP should be used for file transfers.

The **Print** button prints the current graph.

The **Quit** button exits SeaRobotics Grapher.

Graph setup

Title sets the graph title. By default, it is filled in with the log file name.

Left y-axis: and **Right y-axis:** have two settings each.

Label sets the axis label in the graph.

Reverse reverses the axis direction in the graph.

Background color sets the graph background color.

Grid color sets the graph grid color.

Plot setup

Start time displays all the “start @” lines found in the log file. These normally appear only in the ASV event log file. The user can select which start time to begin reading plot data from.

NMEA ID displays all the NMEA IDs found in the log file. The user can select which NMEA ID to get plot data from.

Field number sets which data field of the selected NMEA ID to get plot data from. See the OIS-ASV Interface document for information on the data fields in the NMEA sentences.

X-axis selects the x-axis for the plot. There are three options.

index plots each point by its index number. The first point has index zero, the second point has index one, etc.

line number plots each point by its line number in the log file. The first line in the file is line number one.

time stamp plots each point by its time stamp in the log file. Time stamps are normally in seconds since the log file was started.

Y-axis selects either the left or right y-axis for the plot.

Plot style selects from a number of different plot styles.

Point style selects from a number of different point styles for the plot. It may not apply for some plot styles.

Line style selects from a number of different line styles to connect the points in the plot. It may not apply for some plot styles.

Plot color sets the plot color.

The **Add plot** button adds a new plot to the graph with the current plot setup.

The **Clear all** button clears all the plots from the graph.

The **<<** and **>>** buttons appear when there are multiple plots on the graph. They select the previous and next plot, respectively, of all the plots on the graph, for the Replot and Clear plot buttons to operate on.

The **Replot** button clears and re-plots the selected plot, using the current plot setup.

The **Clear plot** button clears the selected plot from the graph.

Drive to Recovery Point

After collecting data at the end of the last mission, use Thruster mode or Heading mode to drive the ASV to the recovery point, if necessary.

22.0 Appendix APM Mission Planner

Overview

APM Mission Planner is a Windows application that can create waypoint-based missions. It is a free, open-source application that was originally developed for unmanned air vehicles. Missions can be created with simple point-and-click waypoint entry on Google or other maps. Mission files can be saved from APM Mission Planner and then opened with the SeaRobotics ASV GUI. The SeaRobotics ASV GUI will convert the APM Mission Planner mission file to a SeaRobotics mission script, which can then be saved to a file or sent to the ASV.

See http://planner.ardupilot.com/ for more information about APM Mission Planner.

Installing APM Mission Planner

APM Mission Planner should already be installed on the OIS PC. If not, go to http://ardupilot.com/downloads/?did=82 to download the APM Mission Planner Installer.

See http://planner.ardupilot.com/wiki/common-install-mission-planner/ for installation instructions.

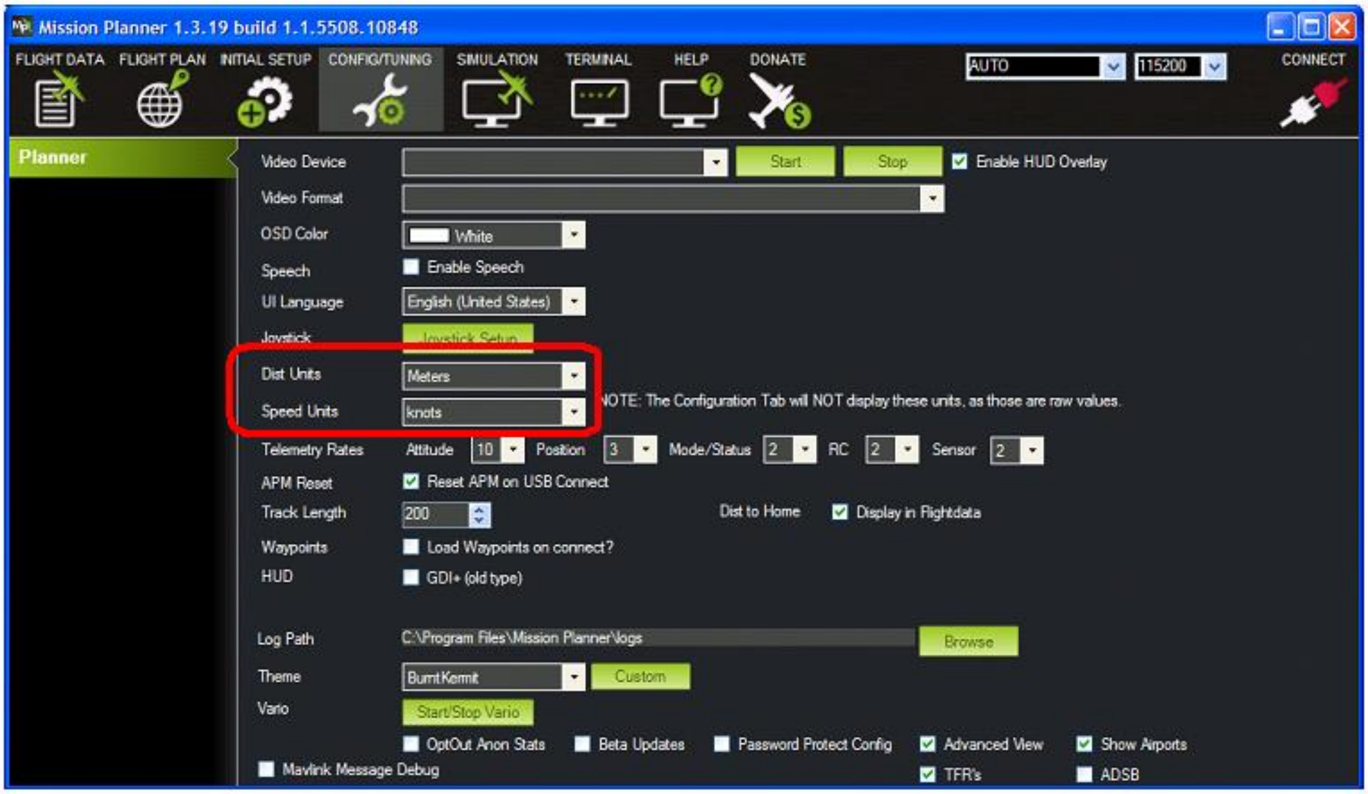
Using APM Mission Planner

See http://planner.ardupilot.com/wiki/common-planning-a-mission-with-waypoints-and-events/ for instructions on planning a mission with APM Mission Planner.

There are a few specific things that the user should do when using APM Mission Planner to create mission files that will be converted to SeaRobotics mission scripts.

Config

The first time that APM Mission Planner runs, select CONFIG/TUNING to set configuration values.



Set “Dist Units” to Meters and “Speed Units” to knots, as shown above.

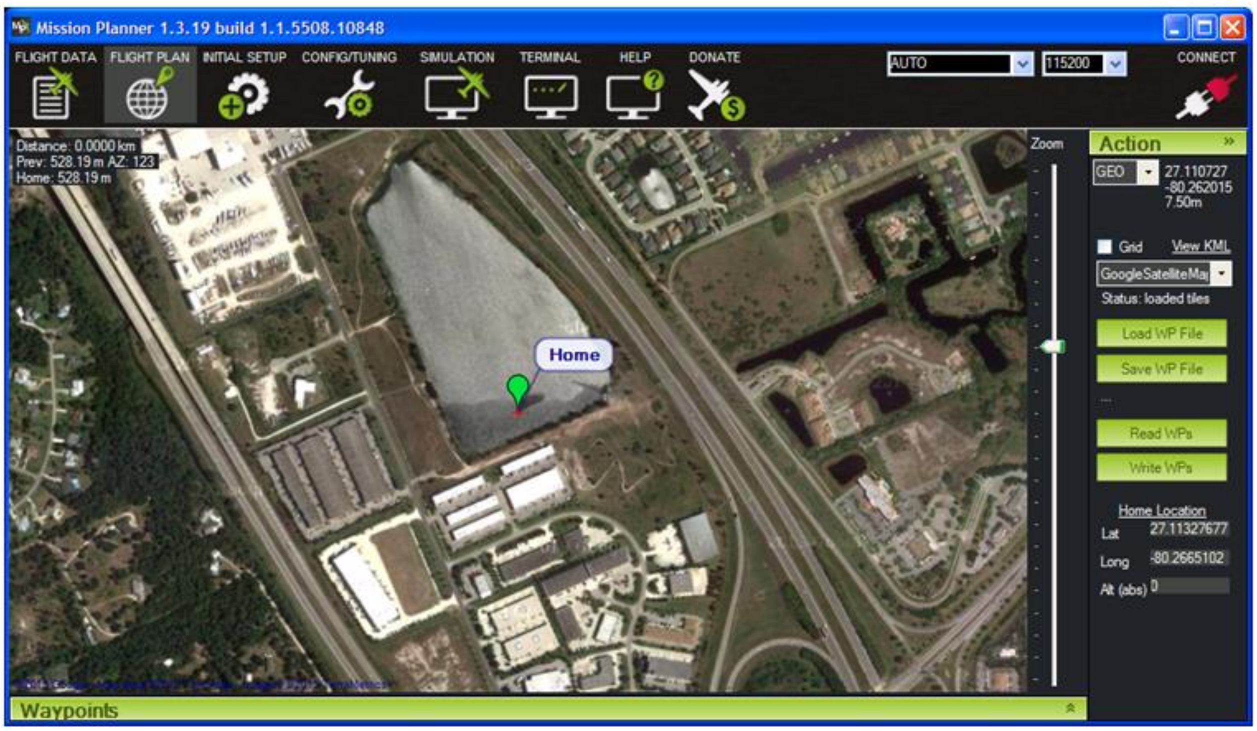
Flight Plan

Select “FLIGHT PLAN” to create a mission with APM Mission Planner.

Home Location

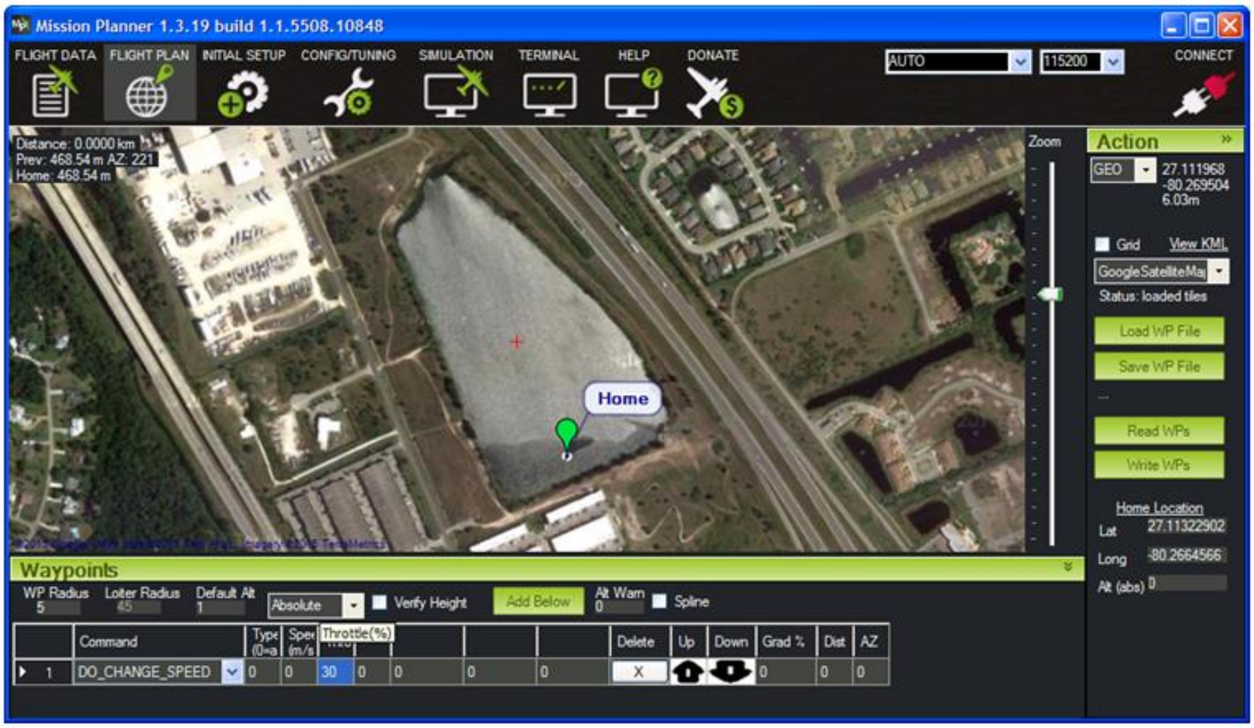
It is not necessary to set a Home Location. If a Home Location is set, it will appear at the beginning of the SeaRobotics mission script as waypoint 0, which is the ERP.

To set a Home Location, click on the Lat or Long value below Home Location, and then click on the map to set the Home Location.



DO_CHANGE_SPEED Command

The first command in a mission should be a DO_CHANGE_SPEED command, to set the initial throttle value for the mission. This command must appear before the first waypoint command otherwise the ASV will not be able to get to the waypoint.

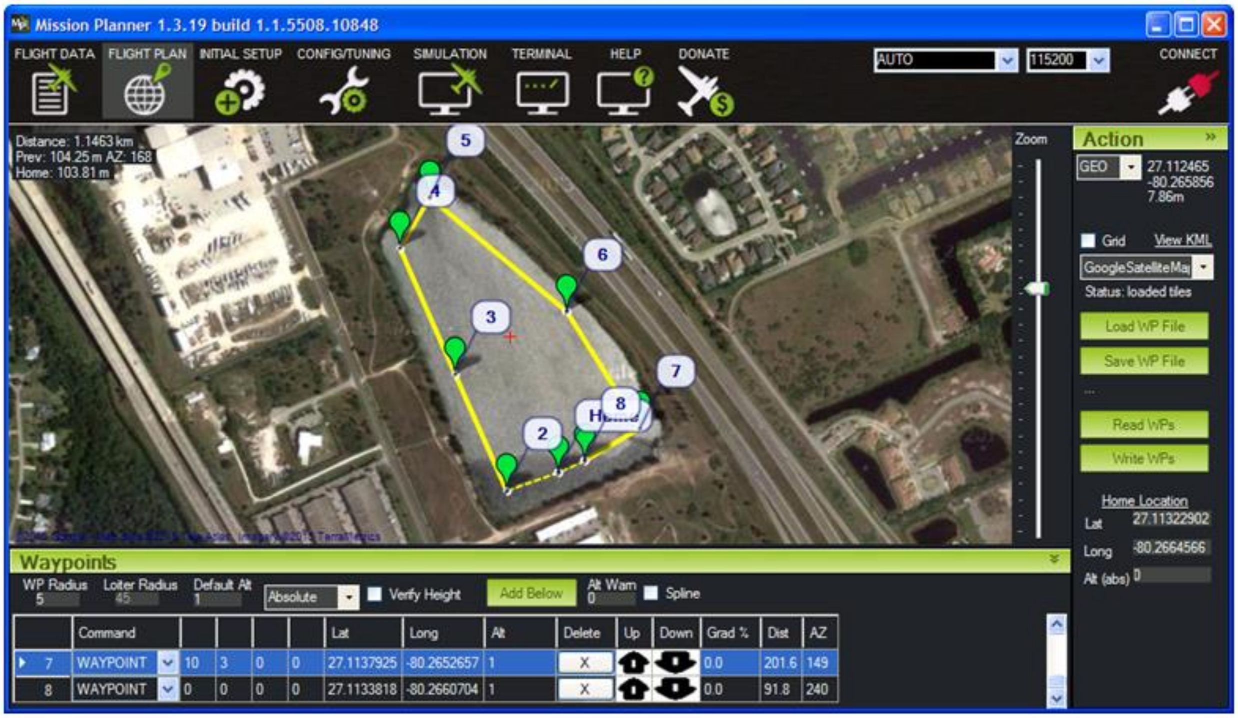


Click on the chevron at the right end of the Waypoints bar to display the waypoint details. Then click the “Add Below” button to add the first command. Use the dropdown menu below the Command column to select DO_CHANGE_SPEED. The column heading for the third parameter will change to Throttle (%). Enter the desired throttle value in the third parameter box.

This command may be used anywhere in the mission to change the throttle value.

WAYPOINT Command

Once a throttle value is set, point and click on the map to create waypoints. Also, the right-click menu can be used to automatically create waypoints, as described in the APM Mission Planner mission planning instructions.

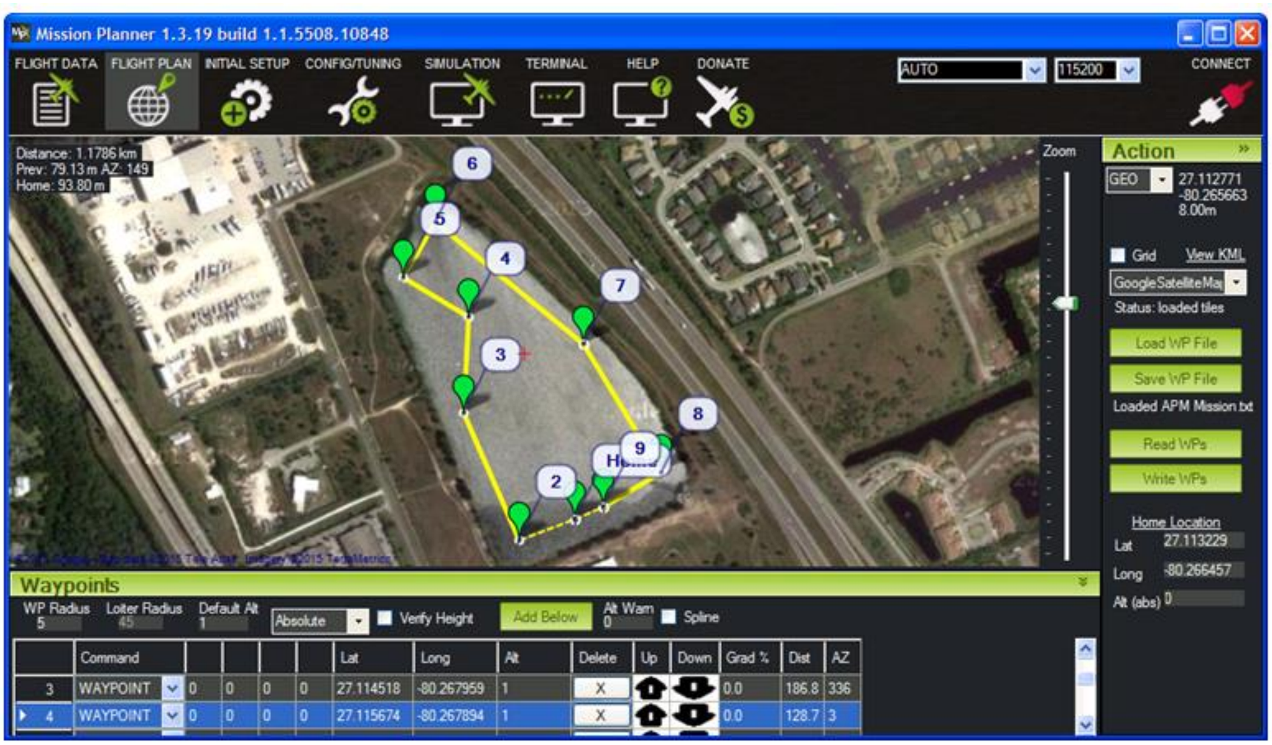


In the WAYPOINT commands, the first parameter sets the number of seconds to hold at that waypoint. The ASV will station-keep for that period before continuing. If the second parameter is greater than zero, then it sets the radius in meters to attain that waypoint. If the second parameter is zero, then the radius remains as previously set. In the image above, the ASV will station-keep for 10 seconds when it reaches waypoint 7, before continuing on to waypoint 8. The ASV will use a radius of 3 meters to attain waypoint 7 and will continue to use a 3-meter radius for waypoint 8.

The ASV software ignores the altitude value in the seventh parameter of the command.

DO_SET_HOME Command

DO_SET_HOME is an optional command that may be used anywhere in the mission to set a new ERP.



First, right-click on the map and select “Insert Wp” to insert a new waypoint at the location for the new ERP.

In the image above, waypoint 4 was inserted to become the new ERP after waypoint 3 is reached.

Then change the command from WAYPOINT to DO_SET_HOME. The waypoint will disappear from the map display, but the command will remain in the mission.

DO_SET_RELAY Command

DO_SET_RELAY is an optional command that may be used anywhere in the mission to set a relay state on the ASV.

Click the Add Below button to add a command, and then change the command to DO_SET_RELAY. The first parameter sets the relay number, and the second parameter sets the relay off (0)/on (1). In the image above, the ASV will turn on relay 13 after it reaches waypoint 2.

Save WP File

When the mission plan is complete, click the “Save WP File” button to save the mission to a file.

Loading a Mission

23.0 Warranty & Repair

12 Month Warranty

SeaRobotics Corporation ("SeaRobotics ") has a strong commitment to the high quality in the production of our products, and to provide industry leading after-sales support for our customers. Every system (Product) is covered by a warranty to the original owner (OWNER) that such Product conforms to their specifications and is free from defects in materials or workmanship with the exception of those outlined in the Limitations and Exclusions section contained herein.

The duration of this warranty is 12 months from the date of acceptance at SeaRobotics, whether or not use starts from that date.

This warranty is extended to the original OWNER of the Product and is not transferable. This warranty provides for the repair or replacement, at our factory, of the defective Product. If a component is found to be defective during the period of this warranty, SeaRobotics reserves the right to repair or replace the defective component at its own discretion. On-site warranty repair is available at additional cost but is not covered by this limited warranty. In no event shall SeaRobotics be liable for more than the original purchase price of the defective Product. Except as disallowed under state law of certain states, in which case only this sentence shall not apply, in no event, whether as a result of breach of contract, indemnity, warranty, tort, strict liability or otherwise, shall SeaRobotics or their employees or affiliates be liable for any special, consequential, incidental or exemplary damages including, but not limited to, loss of profit or revenues, loss of data, loss of use of any associated equipment, damage to associated equipment, cost of capital, cost of substitute products, facilities, downtime cost, or claims of customers of the Owner for such damages.

Limitations and Exclusions

This limited warranty does not cover:

Damage caused by improper use, improper maintenance, incorrect reassembly or accidental damage.

Items subject to normal wear including but not limited to; view ports, illumination components, outer shells, O-rings, batteries, protective bumper frame, tether and propellers unless found to be defective in workmanship or materials.

Modification or alterations made to the product without prior authorization from SeaRobotics

Damage due to incorrect power connection as described in the User's Manual

Damage or failure that is caused during shipment or by acts of God, acts of war, or other such similar or dissimilar occurrences beyond either party's control.

SeaRobotics makes no warranties regarding third-party products. However, SeaRobotics shall assign to OWNER any transferable manufacturers' warranties covering third-party products delivered with the Product. OWNER shall bear the responsibility of completing and returning manufacturers' warranty registration cards for such third-party warranties. SeaRobotics will aid OWNER, when required, to facilitate the performance of third-party warranties but bears no responsibility for such third party's performance.

Shipping and Return Material Authorization (RMA)

Immediately upon identifying a problem which you believe to be subject to this limited warranty, you must request warranty service by contacting SeaRobotics or your local distributor. All requests for warranty service must be authorized by SeaRobotics prior to return of the Product. You must work with our technical support staff to help diagnose the problem. This may include performing routine diagnostic procedures. The technician can determine if the problem can be resolved over the telephone or if return for repair is required. Upon determining that the product may have a defect under the terms of the limited warranty, and that return to the repair facility is required; SeaRobotics will issue a Return Merchandise Authorization (RMA) number which must be clearly indicated on each item returned for service and the address to which the Product must be sent.

Do not return the Product to SeaRobotics prior to the receipt of the RMA number. The Product must be shipped in their original shipping containers and packing material or otherwise adequately packed for shipment, and the RMA number must appear clearly on the outside of the package. If the product is damaged during shipment or received in inadequate packaging, this warranty may not apply.

The OWNER is solely responsible for the cost of shipping to and from the authorized SeaRobotics Warranty Center. Contact SeaRobotics for your closest Warranty Center to help reduce the distance the Product must be delivered. In all cases the OWNER bears all risk of loss related to the Product during shipment and should consider insuring the shipment both to and from SeaRobotics. If SeaRobotics is unable to repair the Product to conform to the warranty within a reasonable time, SeaRobotics has the option to deliver a comparable replacement unit(s) or refund the original purchase price. All new Products sold by SeaRobotics are subject to the terms of this warranty. Used and refurbished Products are covered by this warranty only by prior written agreement and on a case-by-case basis.