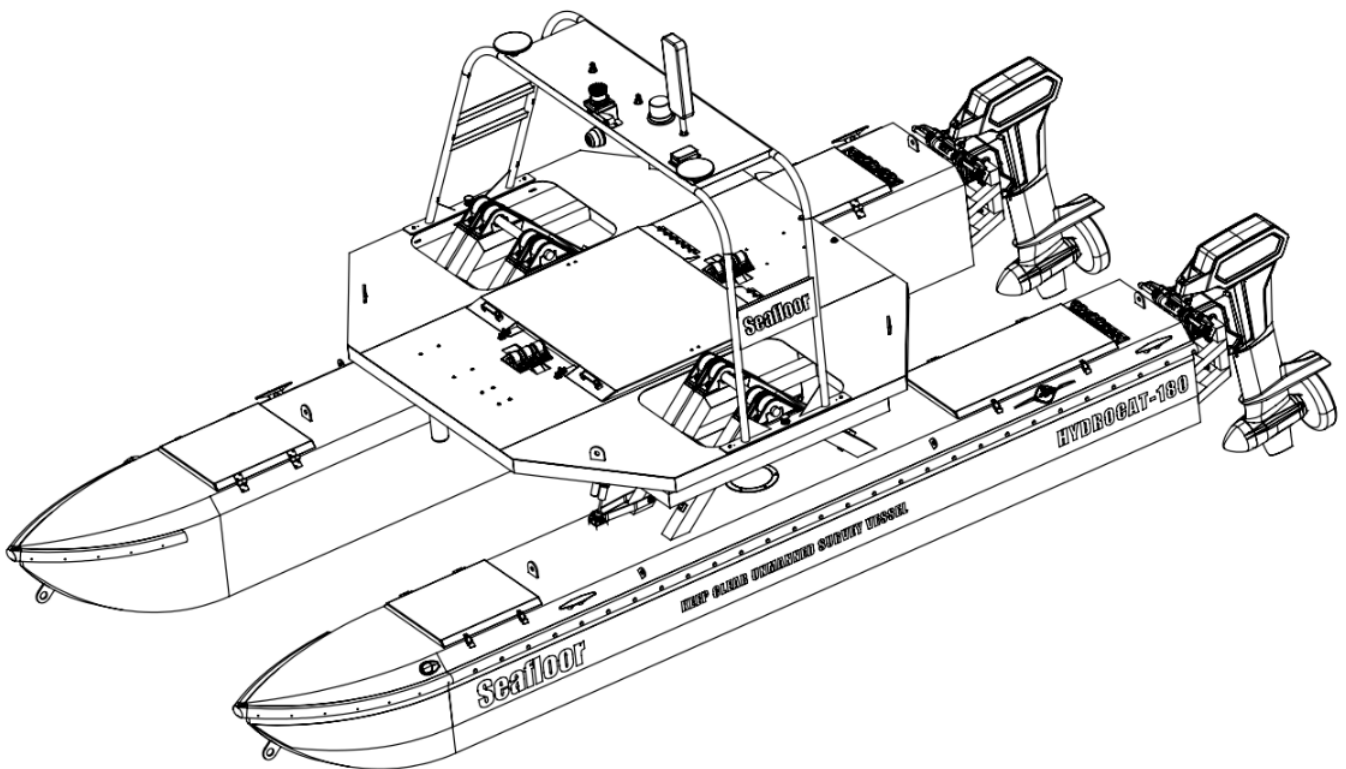


# HydroCat™ 180

User and Technical Manual

Seafloor Systems, Inc



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# 1 Introduction

## 1.1 System Overview

Welcome to the Seafloor Systems HydroCat™ 180 manual. This document provides an overview of the key features and functionalities of our cutting-edge Uncrewed Survey Vessel (USV) designed for hydrographic surveying and marine mapping applications. The HydroCat™ 180 offers advanced hydrographic surveying capabilities, autonomous operation, flexible payload options, and real-time data viewing. The HydroCat™ 180 features a robust hull and propulsion system, a sophisticated navigation and control unit and reliable communication systems. This manual is for hydrographic surveyors, marine scientists, and technical personnel involved in underwater mapping and surveying tasks using the HydroCat™ 180.

## 1.2 Terms And Acronyms

ANP	AutoNav Plus
ASV	Autonomous Survey Vessel
Bow	Front or forward part of the vessel
CAA	Collision Avoidance Assist
CCW	Counter-Clockwise
CW	Clockwise
ESC	Electronic Speed Controller
FAQ	Frequently Asked Questions
GND	Ground (Voltage)
GNSS	Global Navigation Satellite System
GPS	Global Position Satellites
HDPE	High Density Polyethylene
HLP	Hydrolite Plus
HUD	Heads Up Display
LED	Light Emitting Diode
LiPo	Lithium Polymer Battery
Motor	Center electronic part of the Thruster
MBES	MultiBeam Echosounder
NMEA	National Marine Electronics Association
PoE	Power over Ethernet
Port	Left side of vessel - facing towards bow
Prop	Propeller
RCU	Remote Control Unit
RCV	Remote Controlled Vessel
RDP	Remote Desktop Protocol, Remote Desktop Connection
Receiver, RCVR	Receiver for the Transmitter
RSSI	Received Signal Strength Indicator
RTK	Real Time Kinematic
RTL	Return to Launch
Rx	Receive
SBES	Single Beam Echosounder
Servo Thruster	Servo Thruster Assembly
SOC	State of Charge
Starboard	Right side of vessel - facing towards the bow
Stern	Rear or aft part of the vessel
SVP	Sound Velocity Profiler
SVS	Sound Velocity Sensor
Thruster	Thruster assembly with prop
Transmitter	Transmitter also known as Radio Control Unit
Tx	Transmit
USV	Uncrewed Survey Vessel
VDC	Voltage - Direct Current
VAC	Voltage - Alternating Current

**Information**

Information banner is to notify useful information for operator.

**Caution**

Caution banner is provide important information that if disregarded may result in accidental misuse or damage to the system.

**Important Alert**

Important Alert is to provide important information that if disregarded may prove harmful to personnel or equipment.



### 1.3 System Specifications

Survey Speed	2.5-4 knots (1.3-2m/s)*
Top Speed	9.7 knots (5m/s) Sonar Pole Up
Length	18ft (5.5m)
Width	8.5ft (2.5m)
Draft	2.4ft (0.74m)
Air Draft	7.5ft (2.3m)
Hull Material	Corrosion Resistant Aluminum
Hardware	316 Stainless Steel
Weight (Base Boat)	1700lbs (725kg)
Payload	800lbs (365kg)
Trailer Towing Weight	3000lbs (1361kg) (Base Boat and Trailer)
Power	48VDC Drivetrain and 12VDC Payload
Drivetrain Battery Setup	Specs based on 3 per pontoon (2 per pontoon default setup)
Battery Endurance	10 hours at Survey Speed
Thruster	2x Electric Outdrives
Steering	Hydraulics
Communication Range	Line of Sight, Up to 1km (Conditions Dependent)
Remote Control Voltage Range	6-8.5VDC
Remote Control Long Range Battery	2S LiPo
Remote Control Range	Line of Sight, Up to 1.2 miles (2km) (Conditions Dependent)
Shore Power Requirements	100-240VAC for PoE
Sea State	Beaufort Sea State 4 and Below (Figure 103)
Operating Air Temperature	14°F – 113°F (-10°C – 45°C)
Operating Water Temperature	28.4°F – 96.8°F (-2°C – 36°C)

\*Speed in ideal conditions. Refer to Survey Endurance Chart 3.5.

### 1.4 System Limitations

To limit potential damage to the HydroCat™ 180, it is not recommended to use the USV in the following conditions:

- Colder environments can lead to decreased battery capacity and shorter endurance compared to what is indicated on the endurance chart. (Refer to 3.5)
- Range outside of 1.2mi (2km) line of sight. (Greater than 1.2mi (2km) with advanced Comms kit)
- Charging: On land only. No equipment leakage circuit interrupter (ELCI) protections for on water charging.
- Weather Conditions: Do not use USV in adverse weather. Thunderstorms, lightning, hurricanes, monsoons, extreme heat, strong current, strong winds, heavy rain, etc.
- Collision Avoidance Assist (CAA) - **Optional Add On**: Limited effectiveness in adverse weather. Fog, rain heavy spray will affect range. CAA range is 25m in perfect conditions. CAA is a man in loop system.

### 1.4.1 Water Towing

Caution

Props must be out of the water or held in place. Thrusters do not have hydrogeneration protection.

Caution

If towing is required, keep tow speed below 10 knots (5m/s). Towing faster than 10 knots (5m/s) or too fast for sea conditions may cause equipment damage, or water to enter, or flooding/swamping/sinking of HydroCat™ 180.

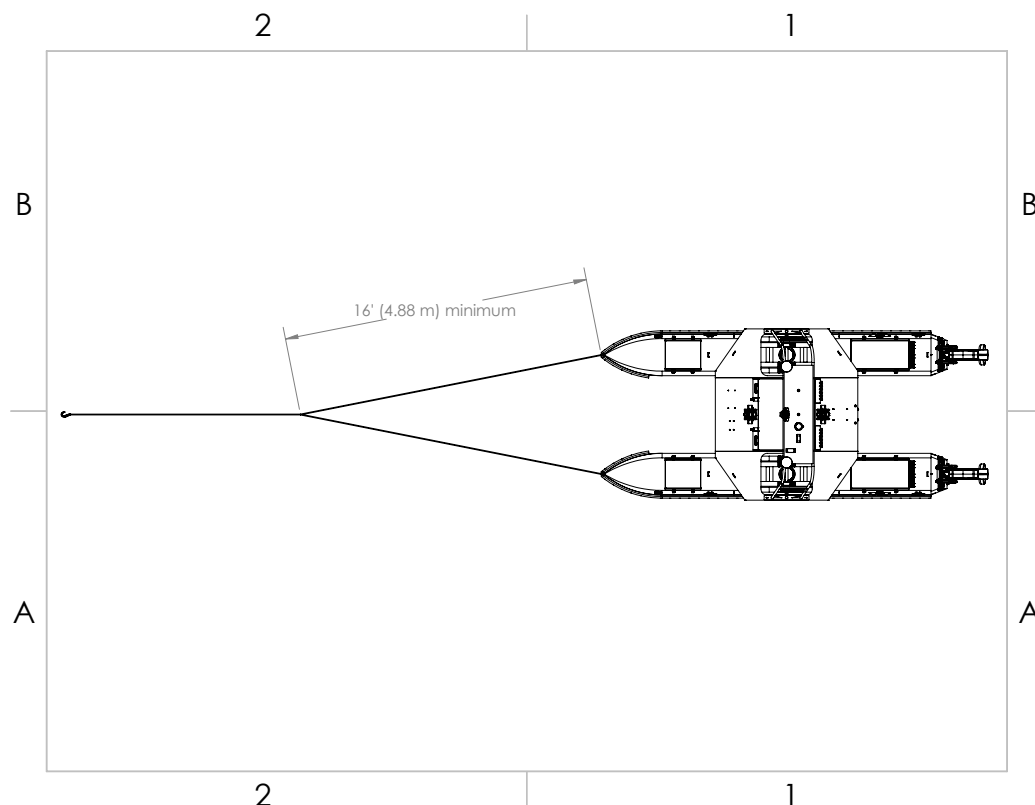


Figure 1: Towing Harness

### 1.5 Warranty

Seafloor Systems, Inc. is committed to upholding the highest standards of quality, reliability, and durability in its products. We provide a warranty to the original purchaser or purchasing agency, guaranteeing that each HydroCat™ 180 will be free from defects in materials or workmanship for a duration of one year from the date of shipment.

The warranty provided does not cover defects resulting directly or indirectly from misuse, negligence, accidents, repairs, or alterations conducted outside of our facilities. It also does not cover the utilization of the HydroCat™ 180 for purposes other than water measurements, or pairing it with instruments exceeding a weight of 800lbs (362.9kg).

Seafloor assumes no responsibility for the loss of boats, instruments, damage to property, or any injury or fatality associated with the utilization of its products or any products that may be included or utilized in conjunction with Seafloor products. Seafloor's warranty does not extend to third-party products sold by Seafloor, which may encompass items such as GPS devices, depth sounders, and other supplementary equipment.

All warranty-related services are carried out from Seafloor's facility in El Dorado Hills, California, U.S.A.

## 1.6 Technical Support

Seafloor Systems, Inc. provides comprehensive customer support through both an online support system and a phone support system during regular business hours. For assistance outside of standard business hours, support is available by appointment.

**If your HydroCat™ 180 was purchased through an authorized dealer, we kindly request that you contact your dealer's designated point of contact for immediate support and assistance.**

To submit a support request, please fill out our support form on our website [www.seafloor.com](http://www.seafloor.com) via the big green button. You may also email us at [support@seafloor.com](mailto:support@seafloor.com). Please include as much information as possible:



- Your Name and Company
- Where you purchased the system
- Purchase Order number
- Serial number of the system
- In-depth explanation of the issue
- Any helpful pictures of the issue

Upon submitting your support request through our website or emailing us, a case will be automatically generated in our support system. One of our support representatives will reach out to you to assist with your inquiry or issue within 48 hours. Please note that this response time does not include weekends.

- Support: [www.seafloor.com](http://www.seafloor.com)
- Support Email: [support@seafloor.com](mailto:support@seafloor.com)
- Phone (PST/PDT): +1 530-677-1019 (Business Hours: Monday - Friday, 0700-1530)
  - Option 2 for Support
    - \* Option 1 for USV Support
    - \* Option 2 for Single Beam Support
    - \* Option 3 for Multibeam Support

## 2 Safety

### 2.1 Battery Safety

Please read through these instructions carefully before you operate the HydroCat™ 180.

#### Important Alert

**Danger to life from electric shock. Contact with uninsulated or damaged parts can result in severe physical injuries.**

- Avoid touching contacts.
- Do not undertake any repair work whatsoever on Power 48-5000 pontoon batteries.
- Never touch scuffed or severed wiring or obviously defective components.
- If you notice a defect, immediately switch off the battery.
- Avoid contact with electrical components in water.
- Prevent mechanical forces from working on the batteries and cables.
- Never charge damaged batteries.
- Do not use the system near flammable gasses, solvents, or vapors.
- Anyone with a cardiac pacemaker must maintain a distance of at least 20in (50cm) from the Power 48-5000 and from the chargers.
- Keep the batteries away from heat sources.
- Do not store flammable objects near the batteries.
- Remove metal jewelery and wristwatches before you start work on batteries or in their vicinity.
- Always put down tools and metal objects without making contact with the batteries.
- When connecting the battery, ensure correct polarity and secure connections.
- Battery terminals must be clean and free of corrosion.

#### Important Alert

**Never open the batteries.**

### 2.2 Battery Charging Safety

#### Important Alert

**Failure to follow any of the instructions and safety warnings contained within this document may cause irreversible damage to the battery pack.**

#### Information

Due to shipping regulations, batteries are not shipped fully charged. All battery packs should be fully charged prior to first use.

#### Pontoon and Gimbal batteries:

- Always use a Torqeedo approved charger specifically designed for lithium ion batteries. Never use NiCD, NiMH, LiPo chargers to charge lithium ion batteries. (Refer to 3.8)

- Do not charge any type of battery on or near any flammable materials including in or near your vessel.
- Never leave batteries unattended while charging. While batteries are charging they MUST remain under constant observation so that you may react quickly should any problems arise.
- Ensure proper ventilation when batteries are charging.

### **RCU Long Range Module Battery (Lithium Polymer (LiPo)):**

- LiPo batteries, 2S and greater, feature a separate balancing plug that isolates each cell in a pack and allows each to be charged and monitored independently. This ensures that all cells charge equally and discharge at the same rate during use. Never charge a 2S or greater LiPo battery without connecting the balance lead to the charger. Always balance charge a 2S or greater LiPo battery.
- Charge each battery pack individually. Never charge battery packs in series. Charging packs in series may result in improper charger cell recognition, improper charging rate, and overcharging that may lead to a fire. We recommend using a LiPo balance charge when charging your LiPo batteries. (Refer to 3.8)
- Always check to make sure that your LiPo charger settings match those listed on the battery pack label. Refer to the battery label for the proper cell count and 1C charging amperage settings.

## **2.3 Vessel Safety**

### Important Alert

Working with electricity in water environments requires utmost caution and adherence to safety protocols. Here are some important safety guidelines when using the HydroCat™ 180:

- **Electrical Safety:** Exercise extreme caution when dealing with electricity in water. Avoid exposed wires and electrical circuits to prevent electrical shock hazards.
- **Propeller (Prop) Safety:** Keep body parts away from the thruster inlet and outlet to prevent injuries.
- **Operating Conditions:** Avoid operating the thrusters for extended periods outside of the water. The thrusters rely on water for cooling and operating them dry can result in increased heat build up and potential damage.
- **Environmental Considerations:** While the thrusters can handle saltwater and sandy environments, it's crucial to avoid sucking debris into the thruster. Steer clear of plants, weeds, and other aquatic debris to prevent damage.
- **Battery Safety:** Never leave batteries powered on while the HydroCat™ 180 is unattended. Always power off all batteries immediately after use.

Adhering to these safety guidelines is crucial for the safe and effective operation of the HydroCat™ 180 and to prevent accidents or damage to the equipment. Always prioritize safety when working with water-based electrical equipment.

### 3 System Operation

#### 3.1 HydroCat™ 180 Assembly

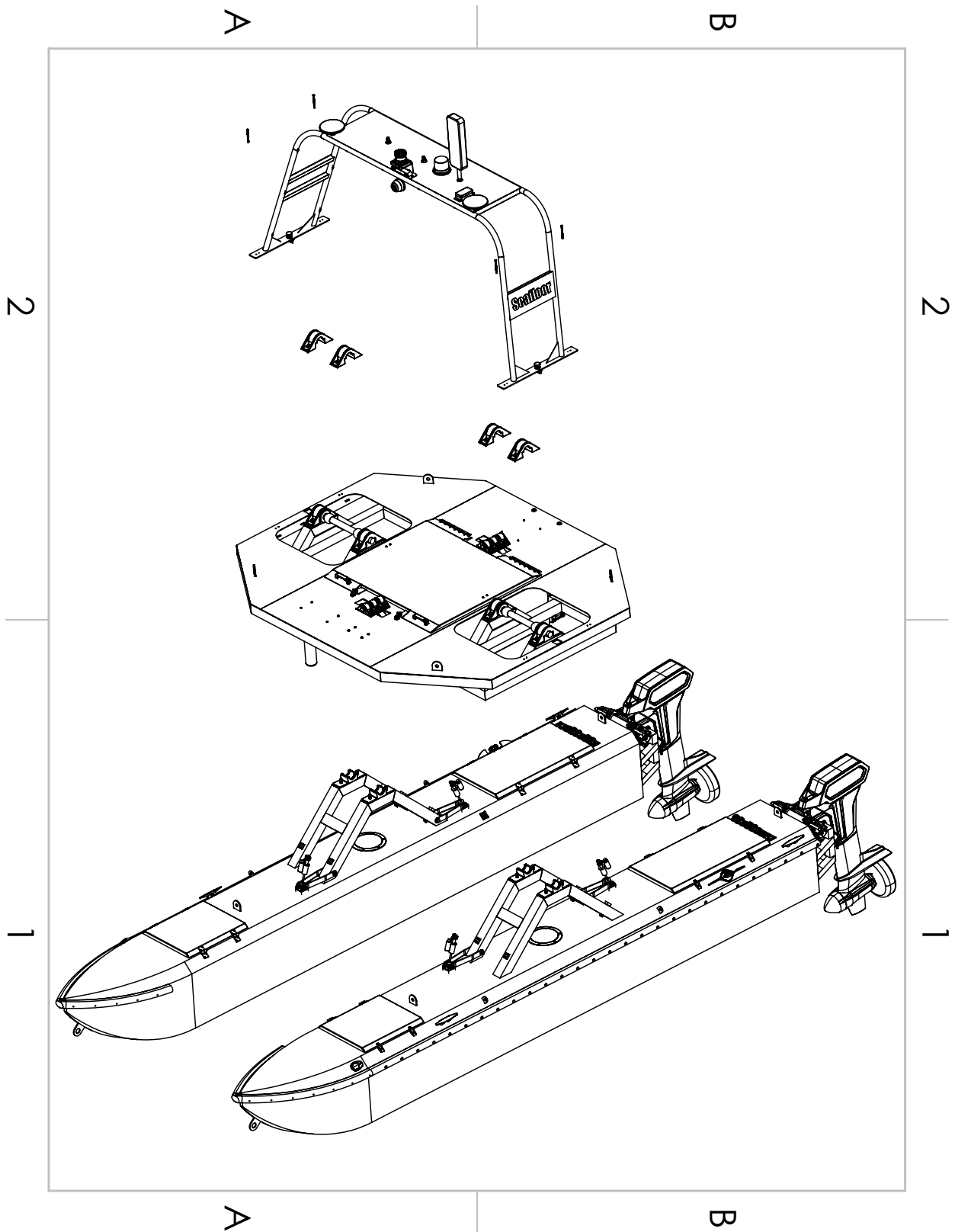


Figure 2: Assembly Overview

Tools Required(Not Supplied):

- QTY 2 - Lifting straps, 2k lbs (907 Kg) limit each, 20ft (6m) length
- QTY 4 - D-Ring shackles
- Ratcheting socket wrench
- 22mm Deep socket
- 3/4" Socket
- 3/4" Open ended wrench

Hardware Required(Supplied):

- Gimbal Bearings:
  - QTY 8 - M14 Nyloc
  - QTY 8 - M14 Washer
- Pitch Shocks:
  - QTY 4 - 1/2-13 x 3" Long Hex Bolt
  - QTY 8 - 1/2" ID, 1.25" OD Washers
  - QTY 4 - 1/2-13 Thin Nyloc
  - QTY 8 - 1/2" Acetal Sleeve Bearing

Assembly:

1. Connect actuator control box power cable(Cable H). (Figure 107)
2. Attach lifting straps in an X pattern to cross the entire gimbal.
  - Be mindful that there is enough length in the straps to clear the tower.
3. Secure the shackles to the gimbal lifting points(Figure 9) and lifting straps.
4. Spread the pontoons 4' (1.2m).
5. Lift the gimbal onto pontoons. The pitch axis rod will sit into each rod cradle on the pontoons.

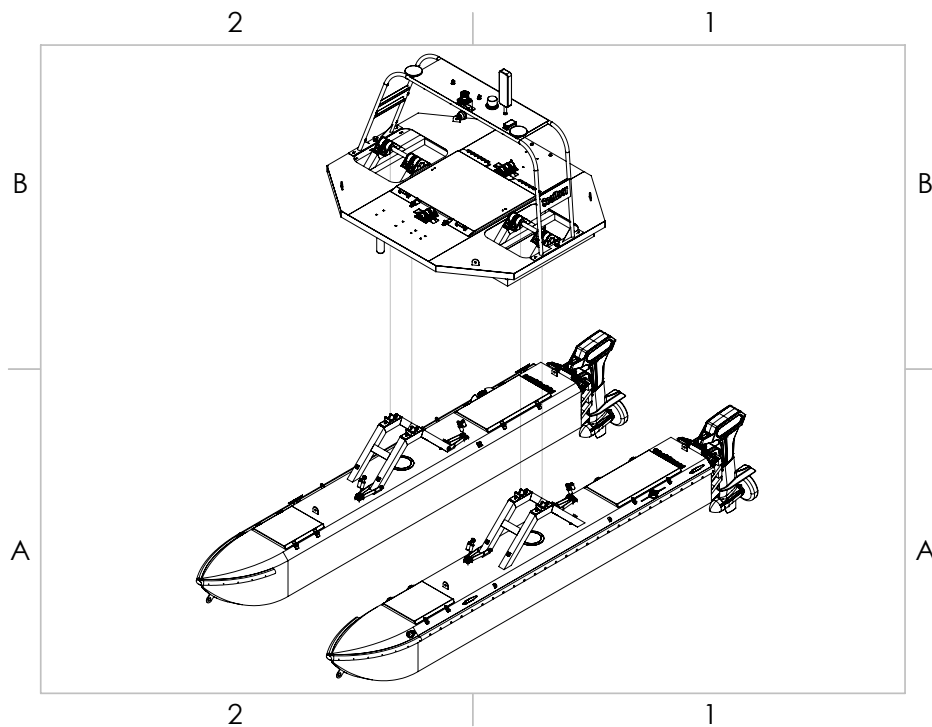


Figure 3: Gimbal Installation

6. Once the gimbal is in position, install the bearing top clamp.

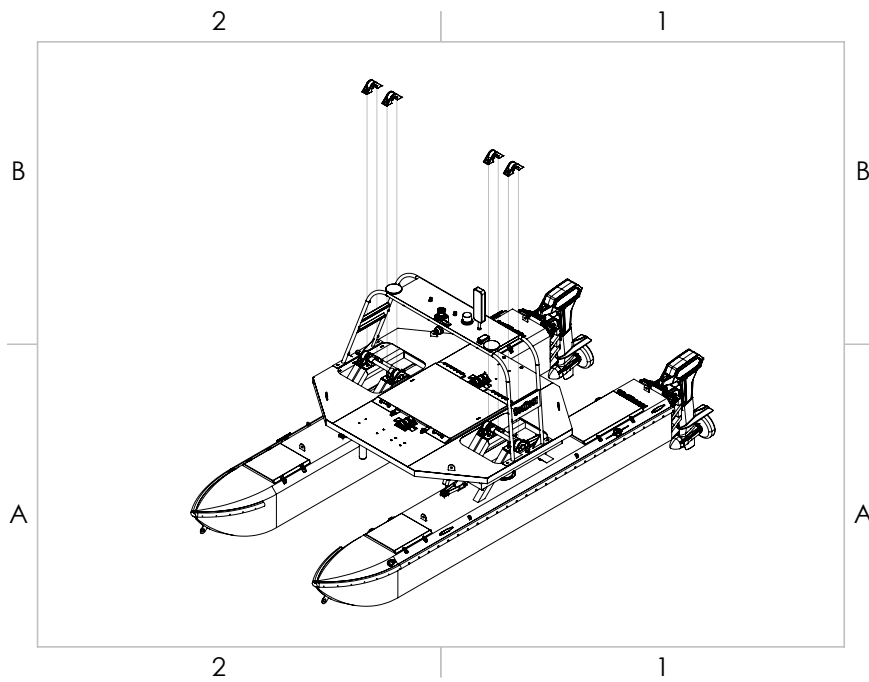


Figure 4: Top Clamp Installation

7. Install the M14 hardware to secure the bearing top clamp. Do not tighten yet.

8. Install shock hardware:

- Installation order: Bolt, Sleeve Bearing, Shock, Sleeve Bearing, Washer, Nyloc.

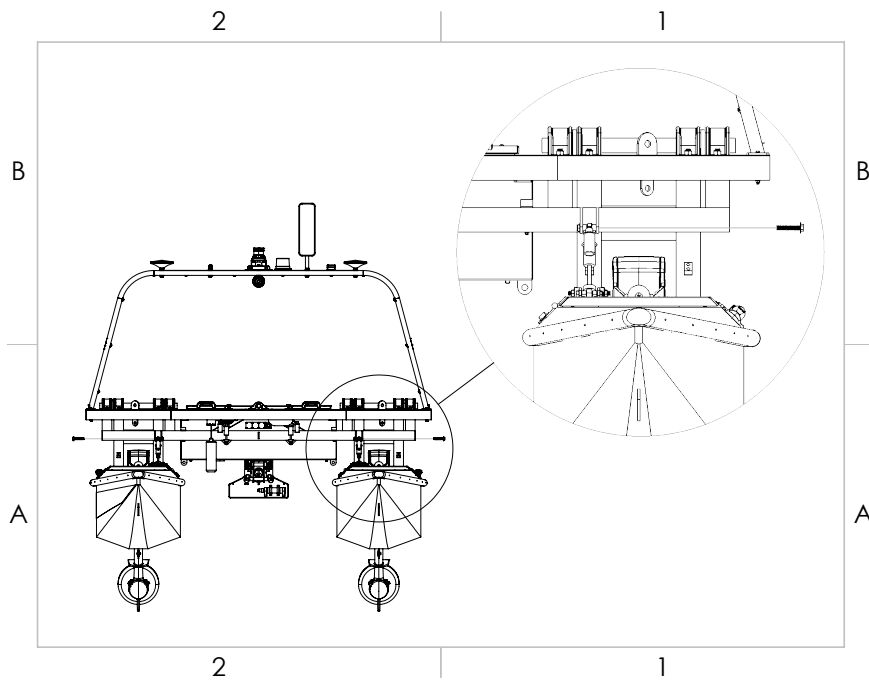


Figure 5: Shock Installation

9. Tighten all recently installed hardware.



10. Slip the cold shrink over both pontoon data cables.(Cable KK).
11. Connect the two gimbal to pontoon data cables(Cable KK). (Figure 109)
12. Pull cold shrink tab while holding the cold shrink over the connector.

### 3.2 What's Included

Item	Quantity	Description	Image*
HydroCat™ 180	1	HydroCat™ 180 USV	
HydroCat™ 180 Trailer (OPTIONAL)	1	Fitted for HydroCat™ 180	
Power 48-10000 Fast Charger	2	Chargers for pontoon batteries	
Shoreside Antenna	1	Paired to HydroCat™ 180 Antenna	
Shoreside PoE	1	To power Shore Side Antenna	
10ft Ethernet Cable	1	To be used with Shoreside PoE and Shoreside Antenna	
Remote Control Unit (RCU)	1	Remote Control Unit for HydroCat™ 180	
USB Charging Cable	1	Charging Cable for RCU	
Long Range Module	1	Used with RCU for extended range	

2S Lipo Battery	1	Used with Long Range Module	
LiPo Charger	1	Charger for the 2S LiPo Battery	
AML3 Adapter	1	To adapt the AML3 SVP to work with the SmartCast	
Voltage Tester	1	To measure the 2S LiPo voltage	
USB Drive	1	Loaded with software, drivers, and manuals	
DB9 Null Modem	1	Swaps Tx and Rx, usually orange in color	
DB9 Gender Changer	1	Male to Male DB9 gender changer, usually yellow in color	
USB to Serial Adapter	1	For devices that do not have a DB9 port	

Table 3: What's Included

\*Please note that images provided are for illustrative purposes only and may not precisely represent the delivered product. Seafloor Systems reserves the right to modify any product at its discretion.

### 3.3 System Overview Diagram

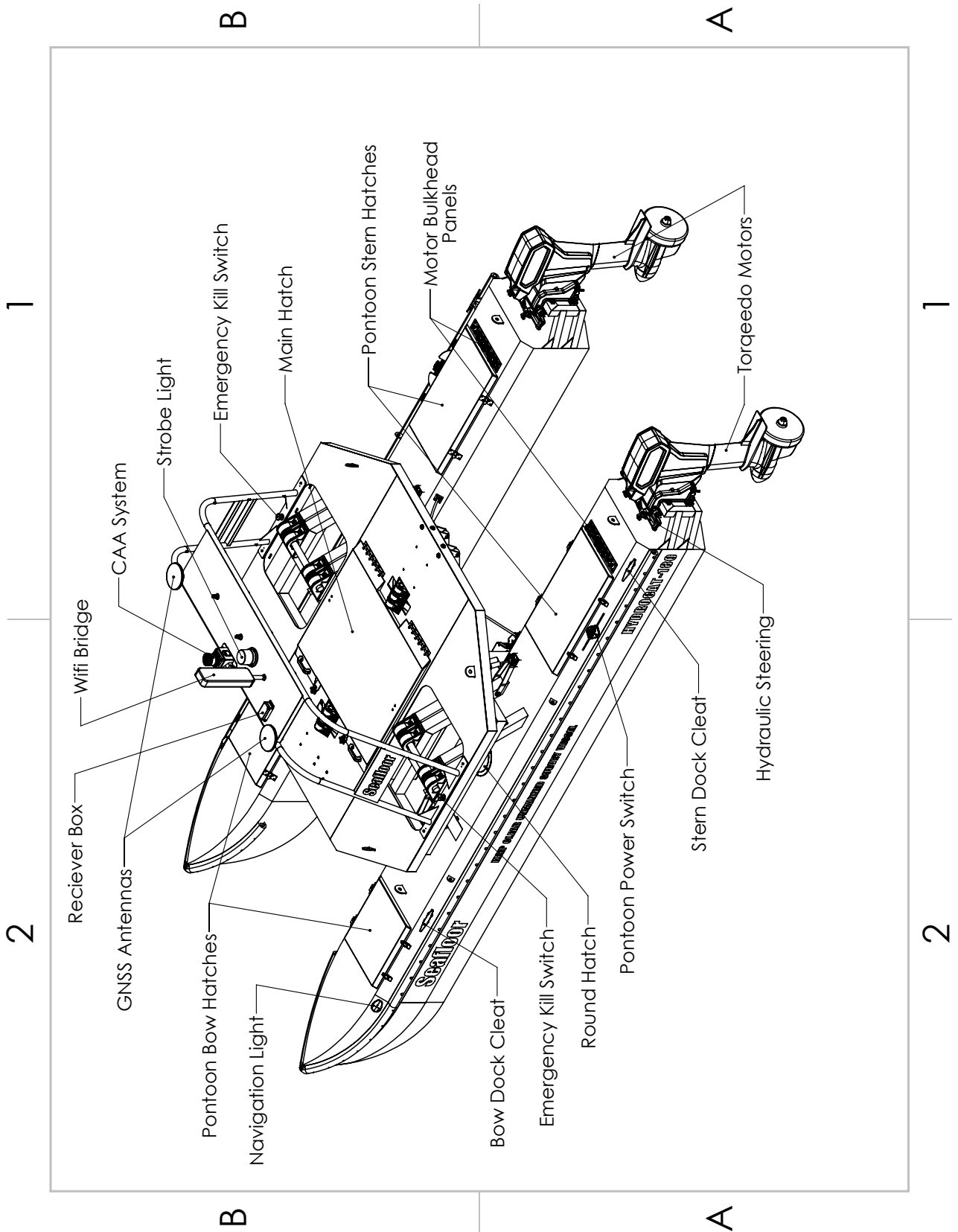


Figure 6: HydroCat™ 180 System Overview

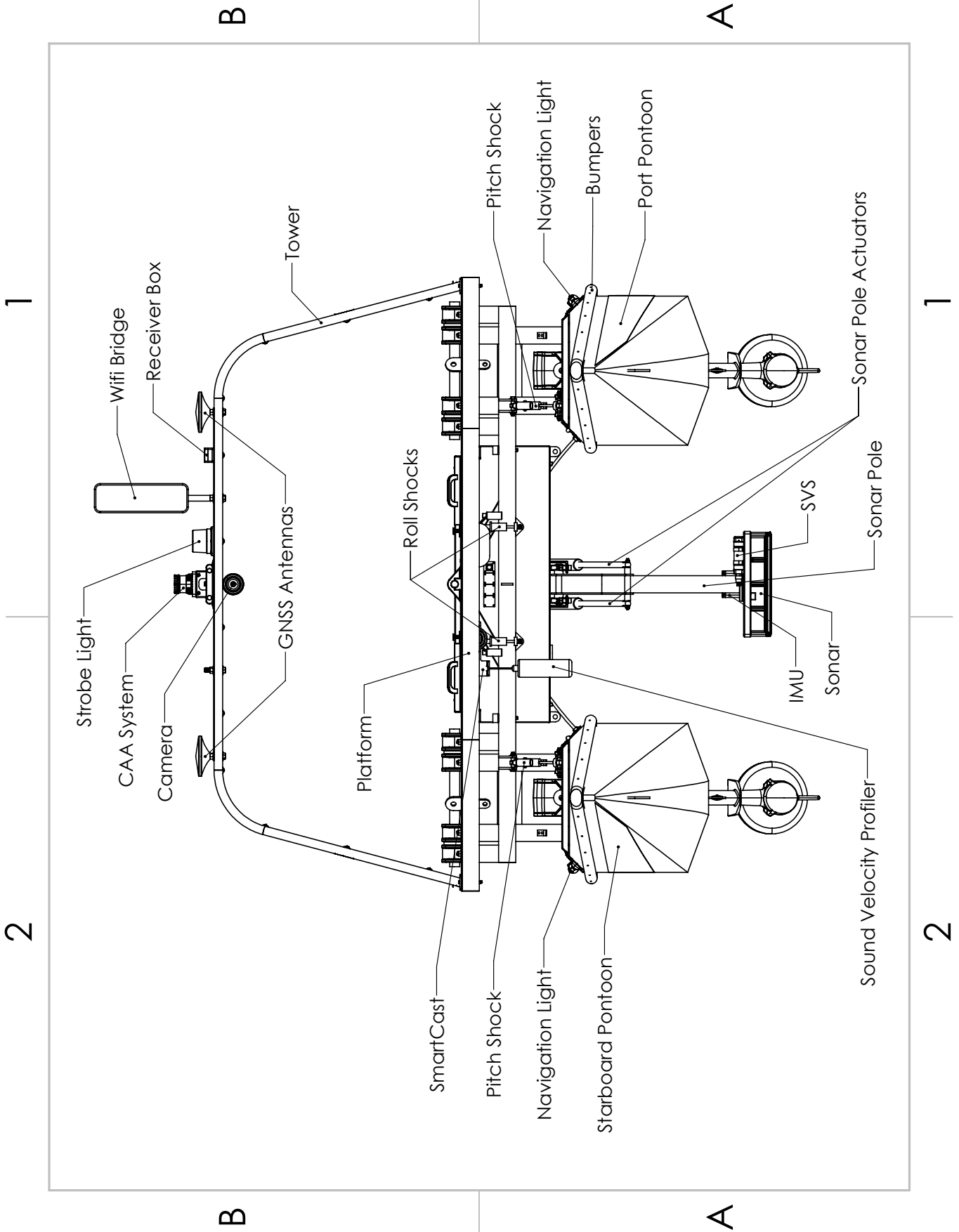


Figure 7: HydroCat™ 180 Front View

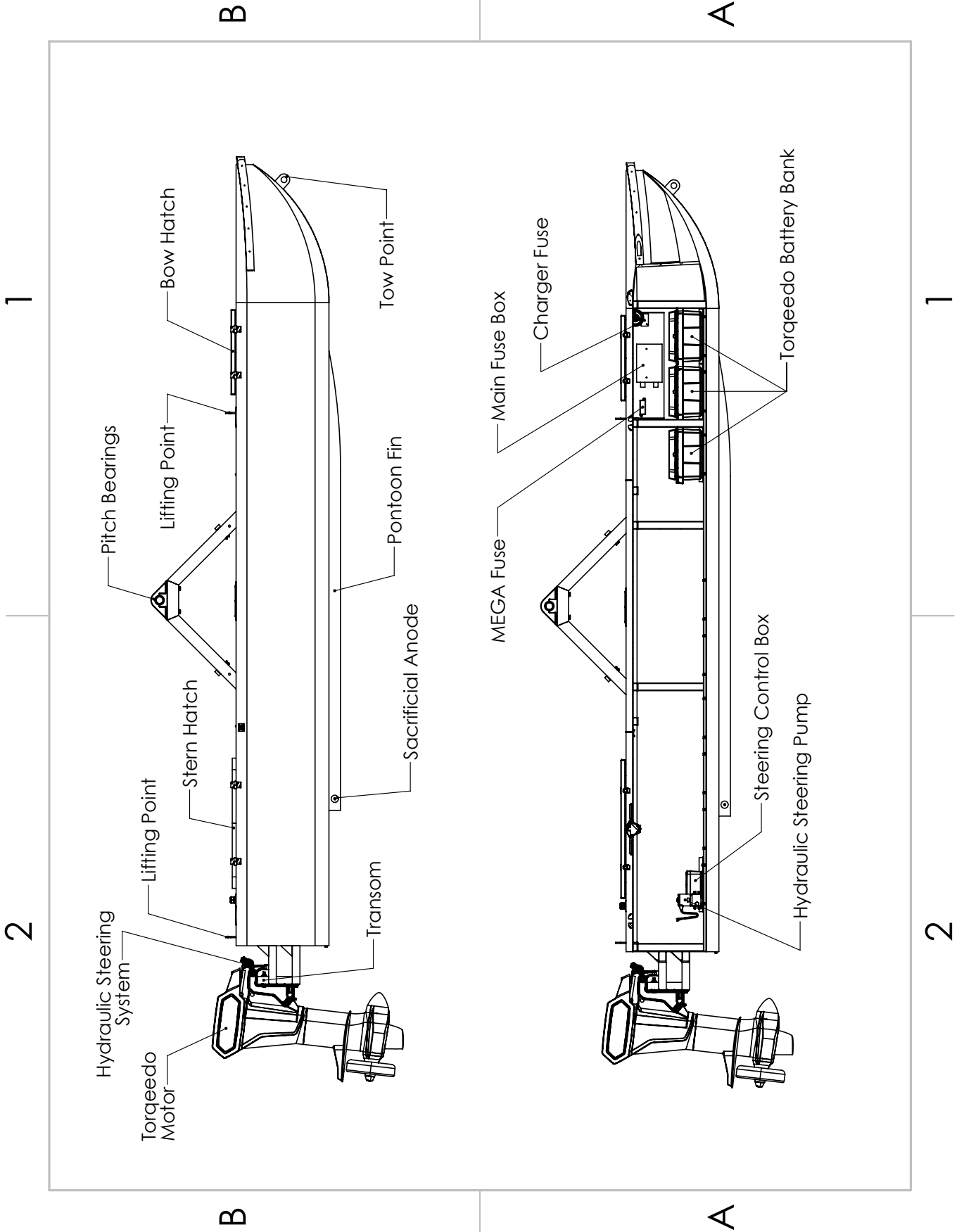


Figure 8: HydroCat™ 180 Pontoon

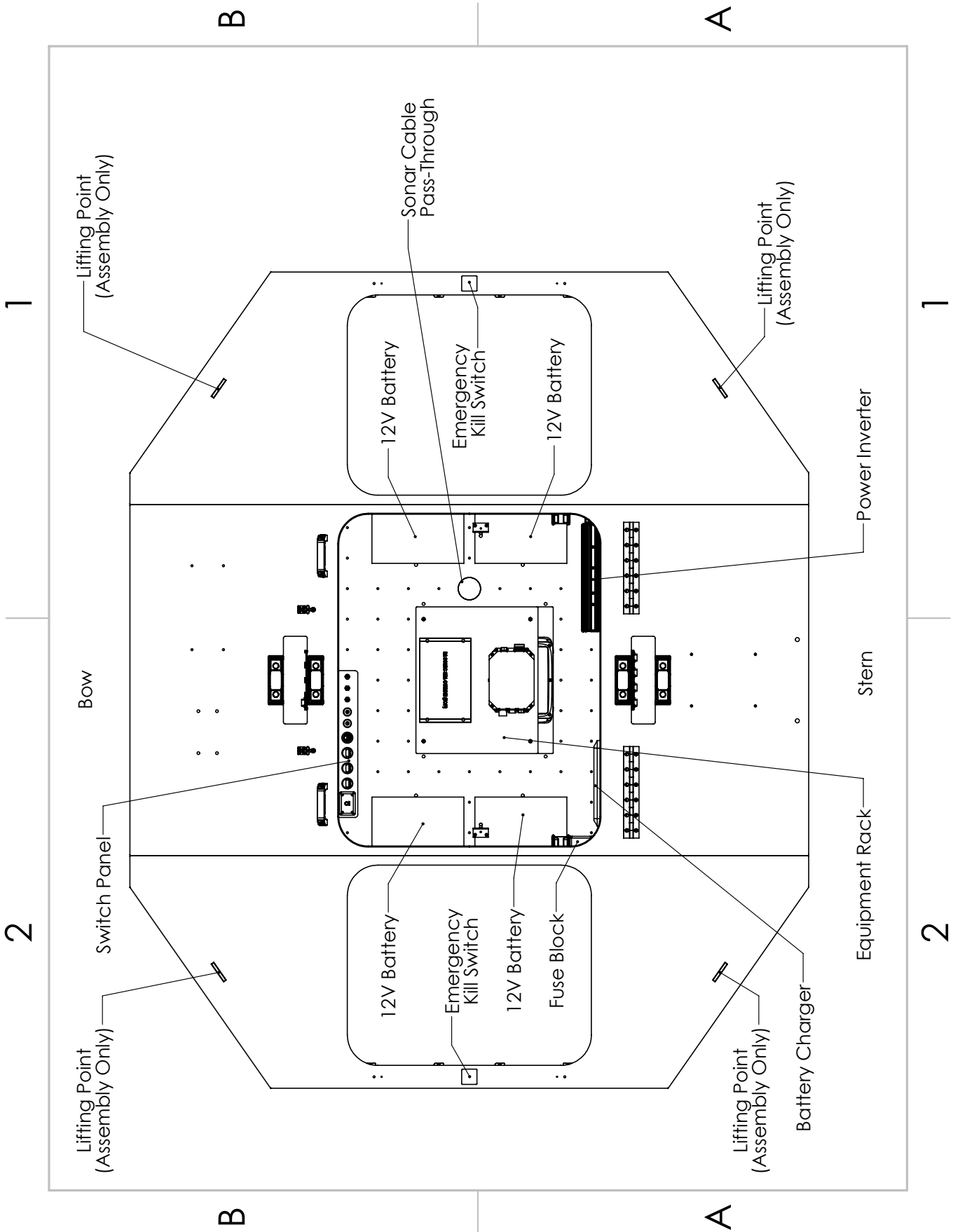


Figure 9: HydroCat™ 180 Gimbal Deck

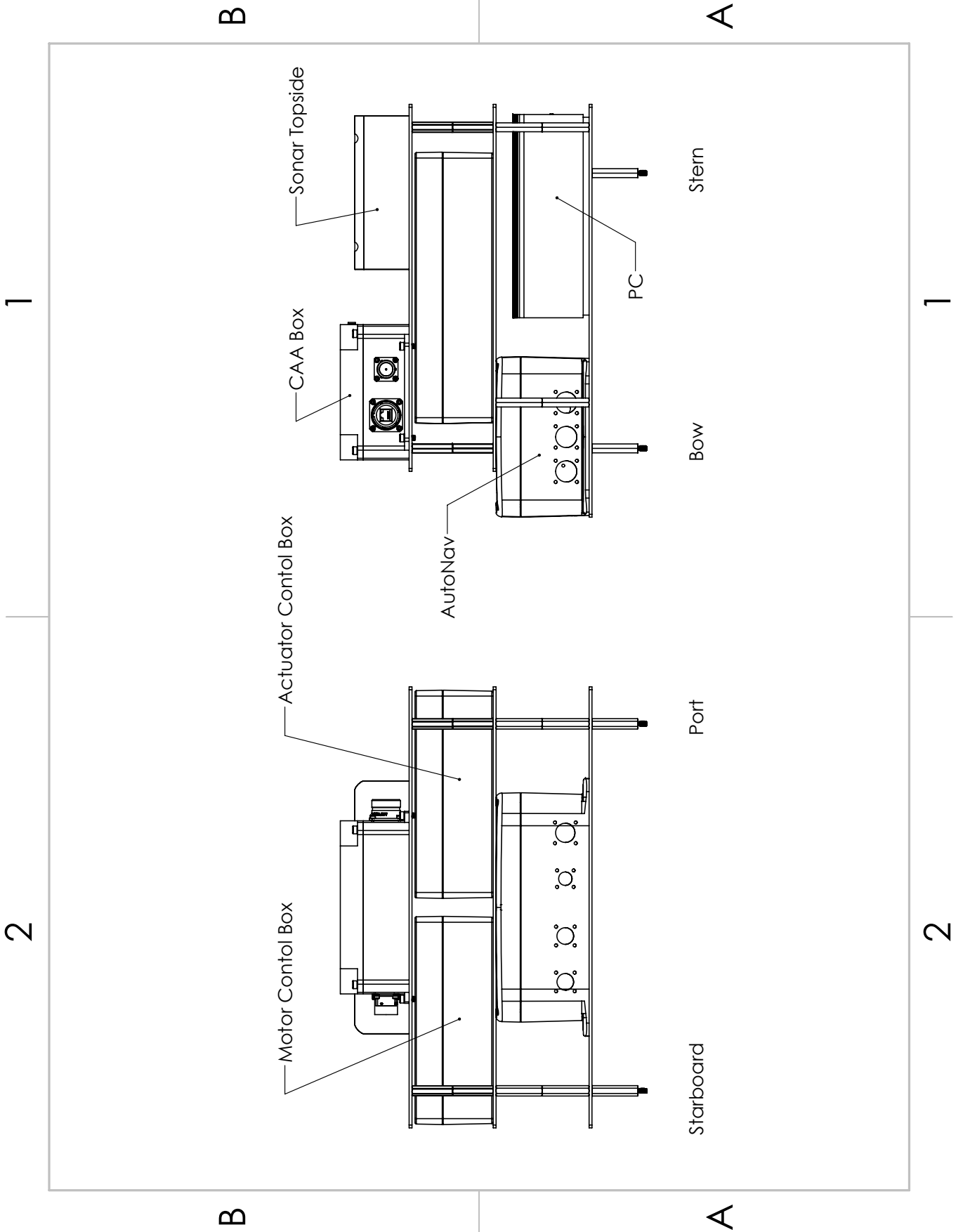


Figure 10: HydroCat™ 180 Payload

### 3.4 HydroCat™ 180 Control Layout

#### Gimbal:

1. SmartCast Manual Override Switch
  - Switch towards stern - lowers SVP
  - Switch towards bow - raises SVP
2. Sonar Pole Manual Override Switch
  - Switch towards stern - lowers Sonar Pole
  - Switch towards bow - raises Sonar Pole
3. CAA Power Switch
  - Switch towards stern - CAA powered on
  - Switch towards bow - CAA powered off
4. Starboard Pontoon Power Button
5. Port Pontoon Power Button
6. Gimbal Power Switch
7. Starboard Pontoon Battery Voltage Monitor
8. Gimbal Battery Voltage Monitor
9. Port Pontoon Battery Voltage Monitor
10. Inverter Power Button

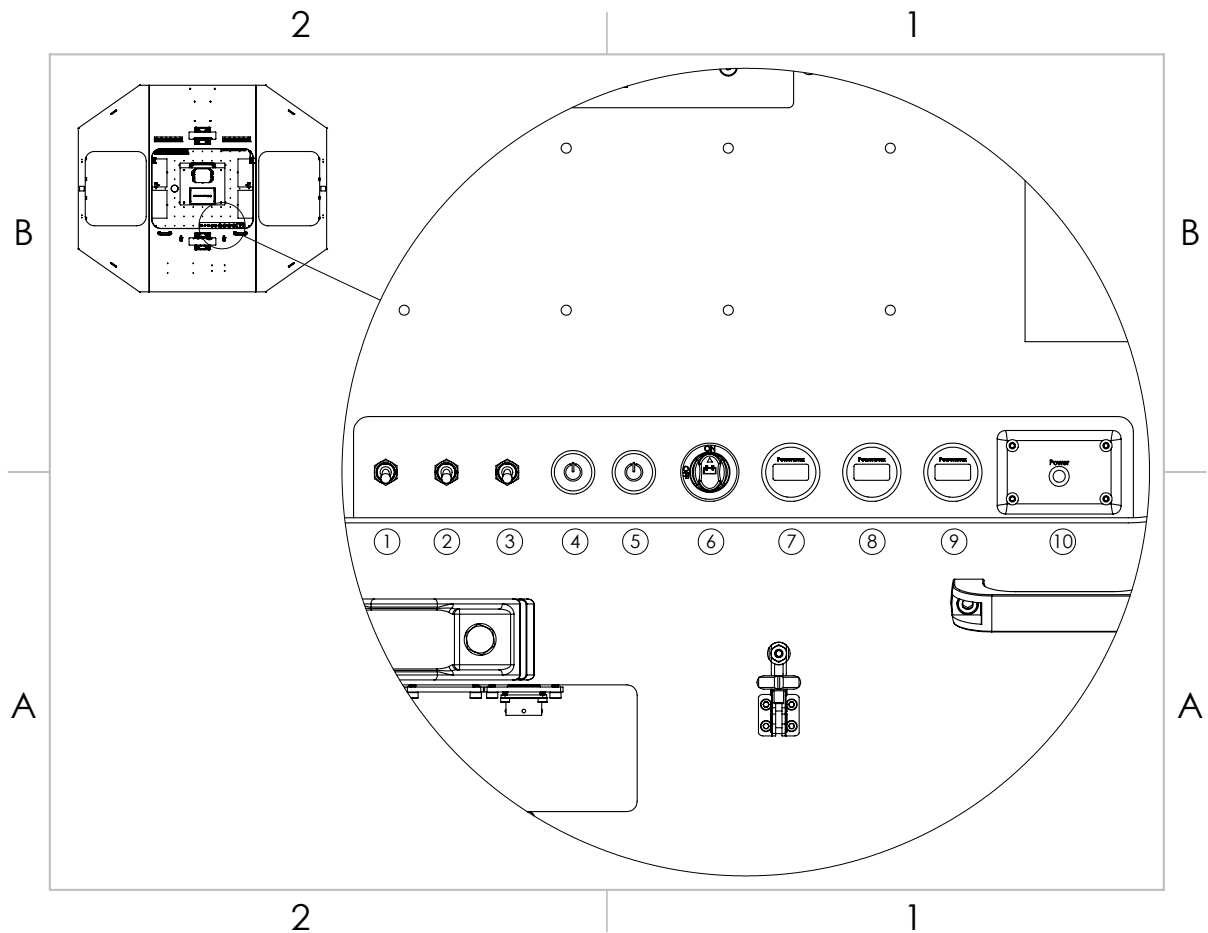


Figure 11: Control Layout



## Thruster Bulkhead Panel

### Port:

1. Thruster Trim Switch
  - Switch up - Thruster Up
  - Switch down - Thruster down
2. Thruster Trim Communication Cable
3. Thruster Communication Cable
4. Positive Thruster Battery Cable
5. Negative Thruster Battery Cable
6. Hydraulic Steering Communication Cable
7. Hydraulic Hose
8. Hydraulic Hose

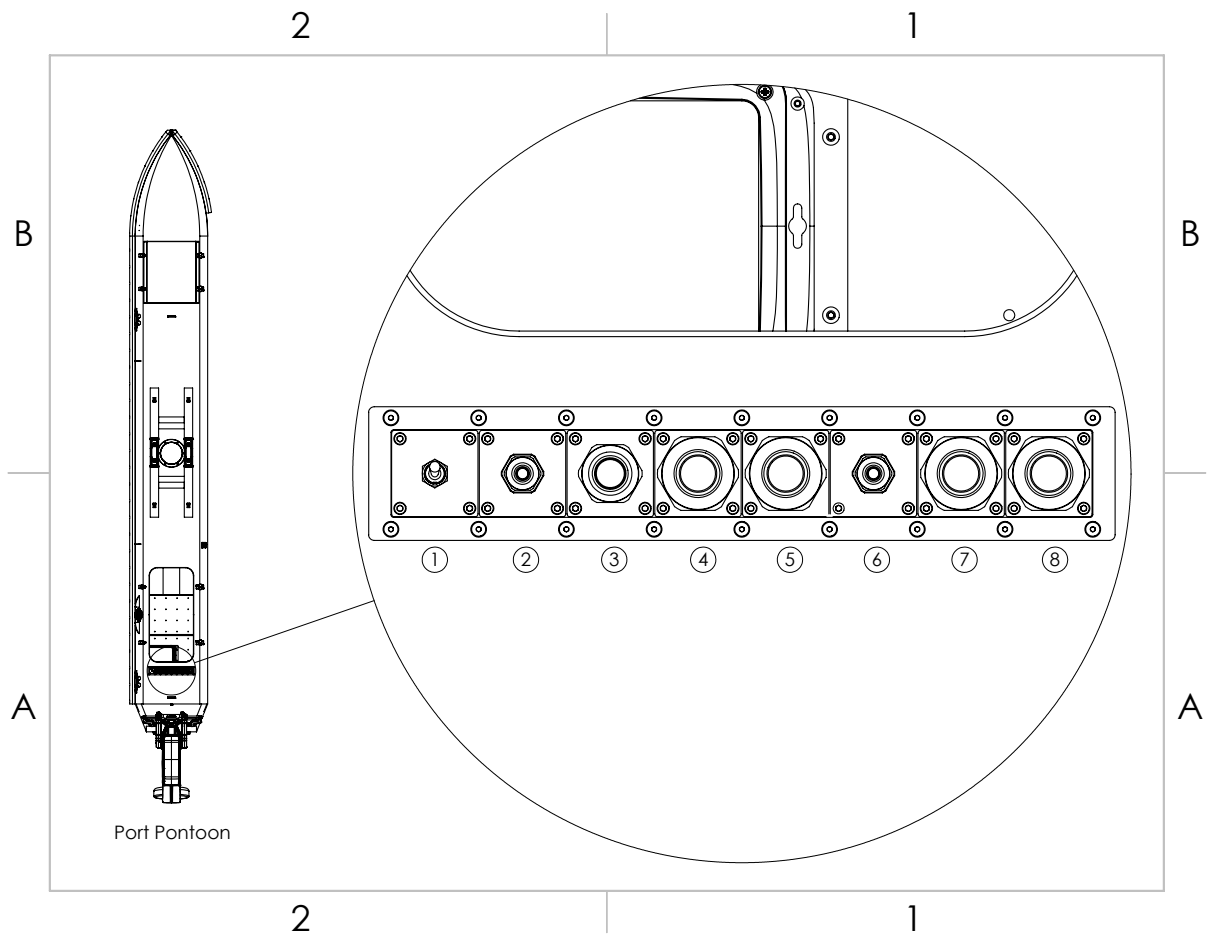


Figure 12: Port Thruster Bulkhead Panel

**Starboard:**

1. Thruster Trim Switch
  - Switch up - Thruster Up
  - Switch down - Thruster down
2. Thruster Trim Communication Cable
3. Thruster Communication Cable
4. Positive Thruster Battery Cable
5. Negative Thruster Battery Cable
6. Hydraulic Steering Communication Cable
7. Hydraulic Hose
8. Hydraulic Hose

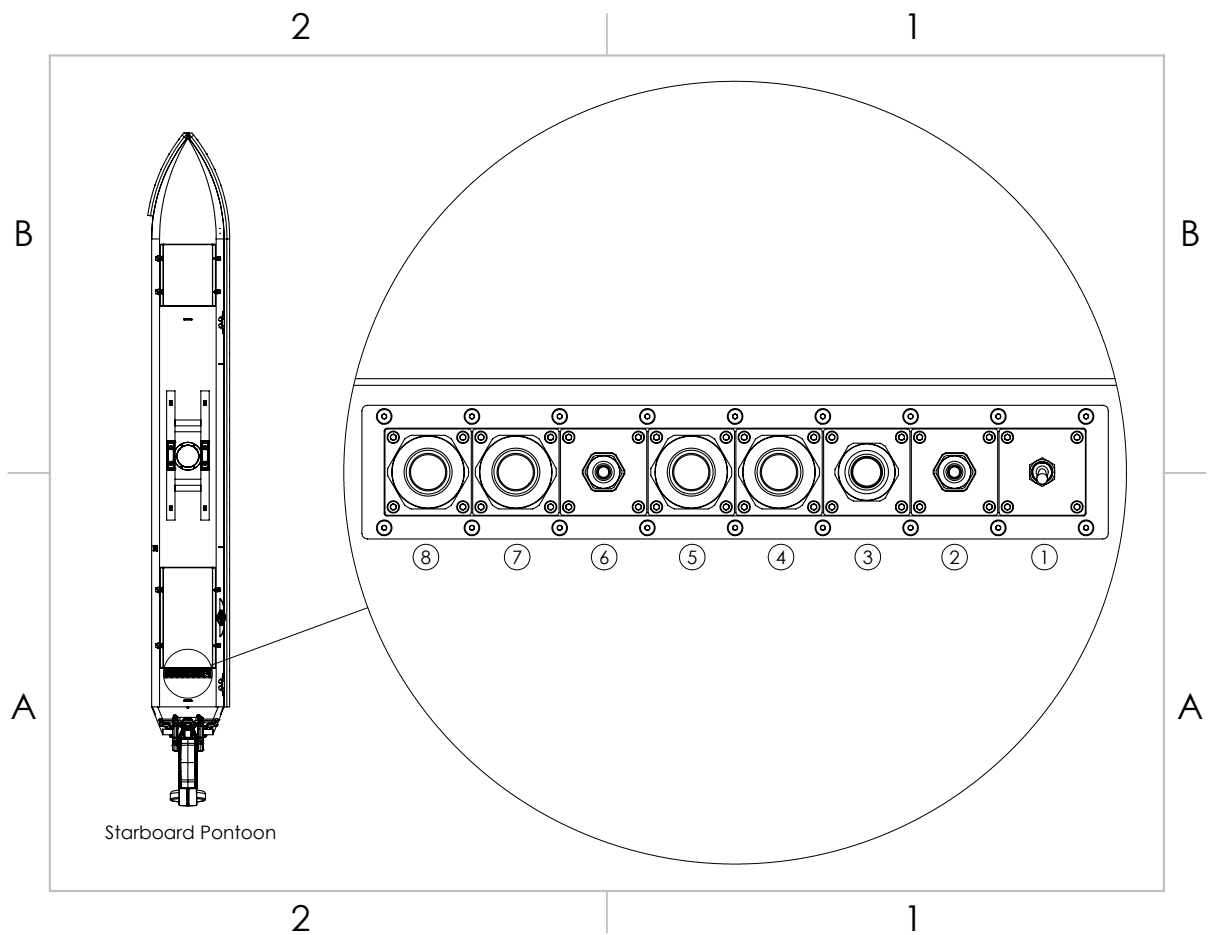


Figure 13: Starboard Thruster Bulkhead Panel

## Gimbal Bulkhead Panels

### Rear:

1. Port Pontoon Cable
2. Port Sonar Pole Actuator
3. Starboard Sonar Pole Actuator
4. Starboard Pontoon Cable

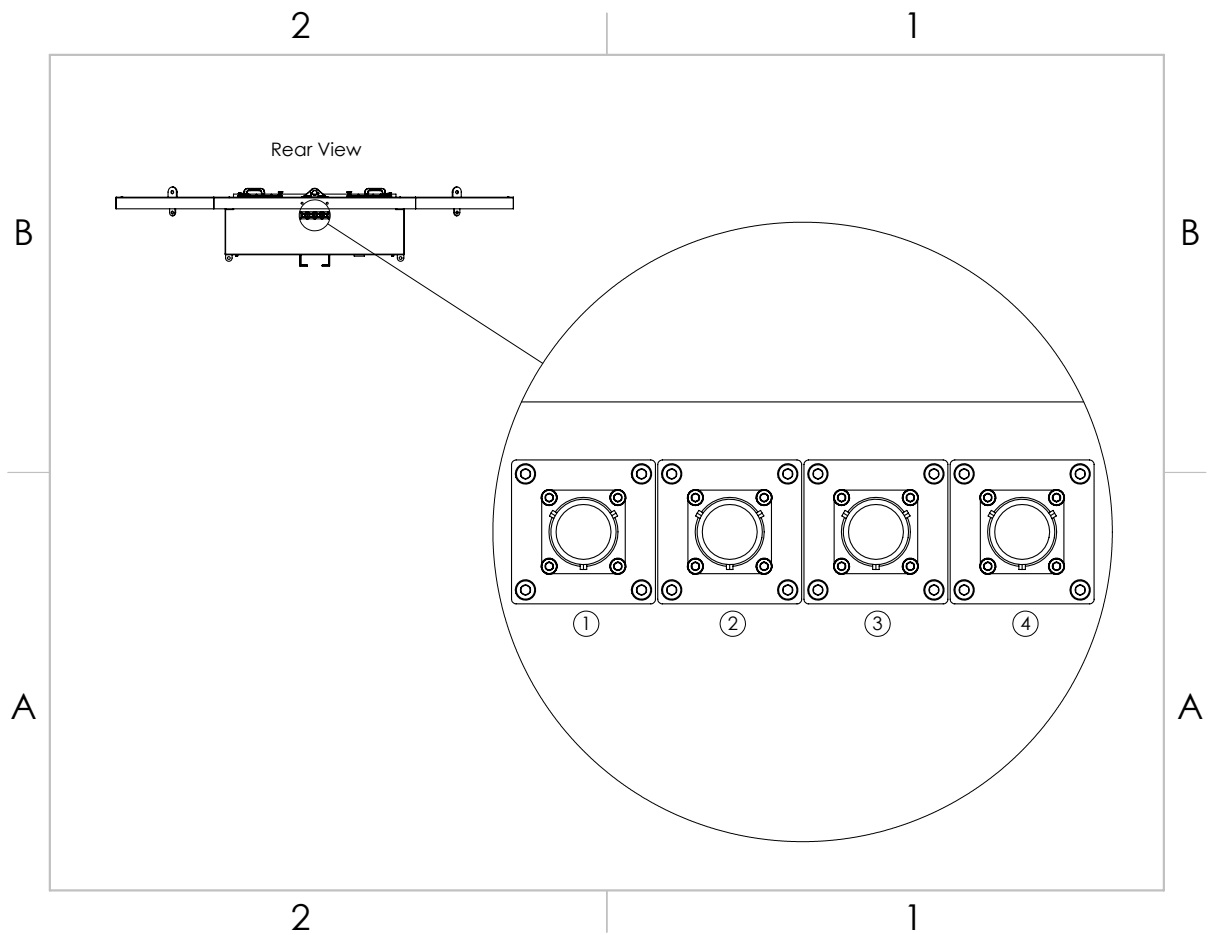


Figure 14: Gimbal Rear Bulkhead Panel

**Front:**

- 1. Unused
- 2. Unused
- 3. Unused
- 4. SmartCast

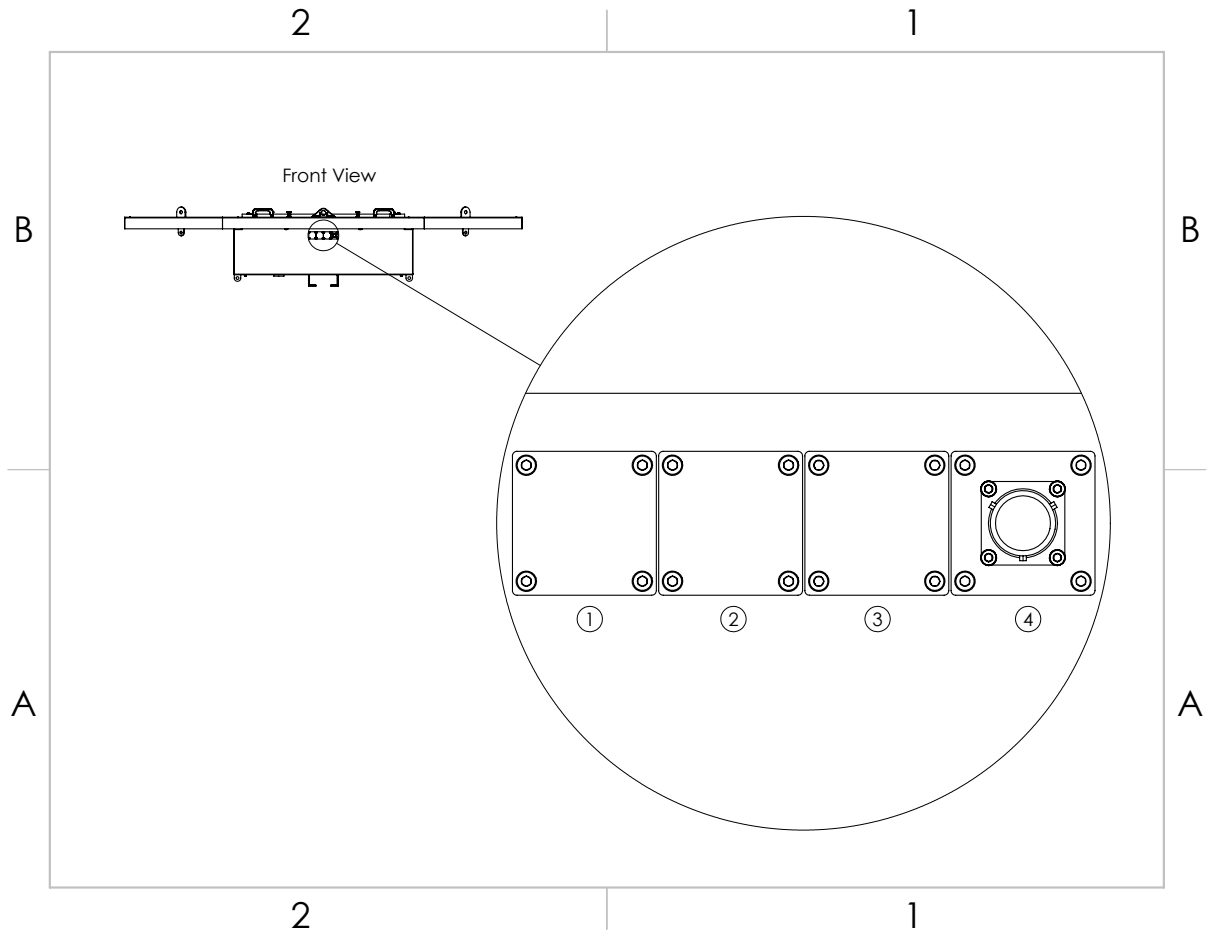


Figure 15: Gimbal Front Bulkhead Panel

### 3.5 HydroCat™ 180 Endurance Chart

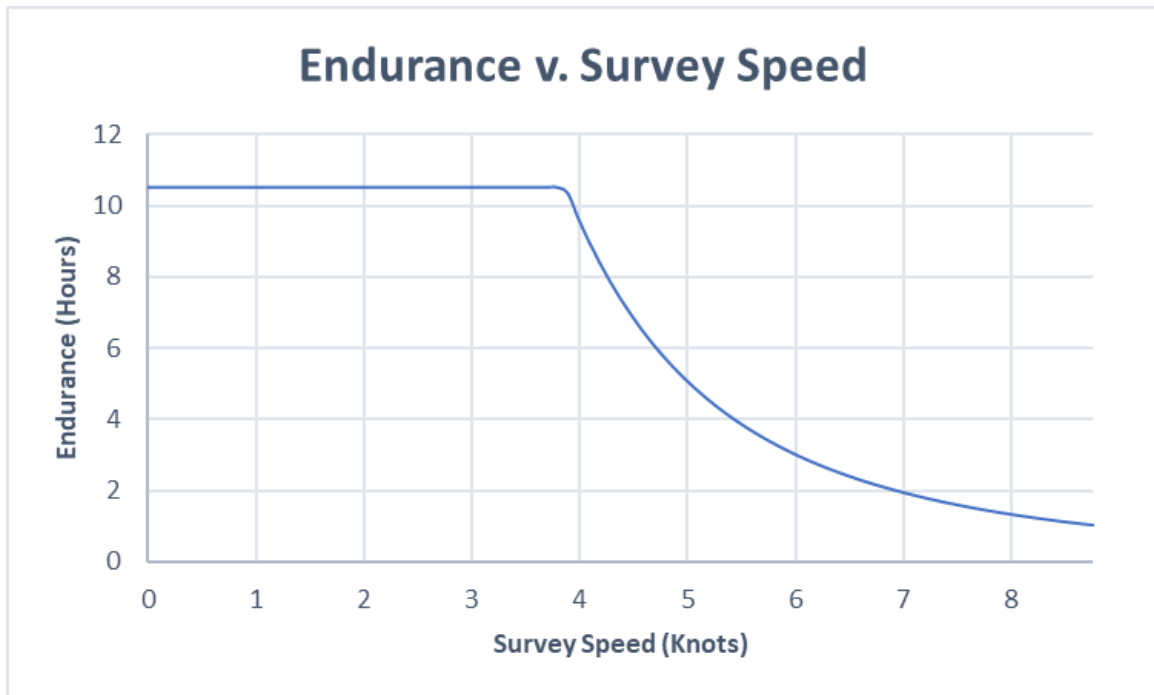


Figure 16: HydroCat™ 180 Endurance Chart

Payload batteries have an estimated 10 hours of endurance. (Conditions dependant, refer to 1.4)

### 3.6 Remote Control Unit (RCU)

The HydroCat™ 180 is controlled by a Taranis Q-X7 Access Transmitter.

#### Information

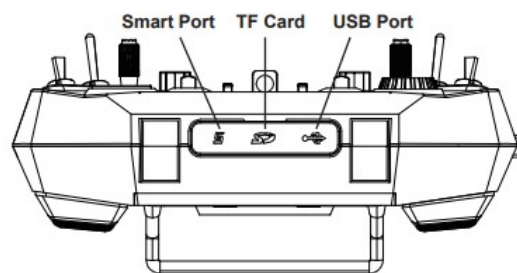


Figure 17: Bottom View

#### To charge the battery:

- Open bottom dust cover to reveal USB mini port.
- Connect supplied USB mini cable.
- Connect USB A into a suitable charger source. (5VDC at 2amps)

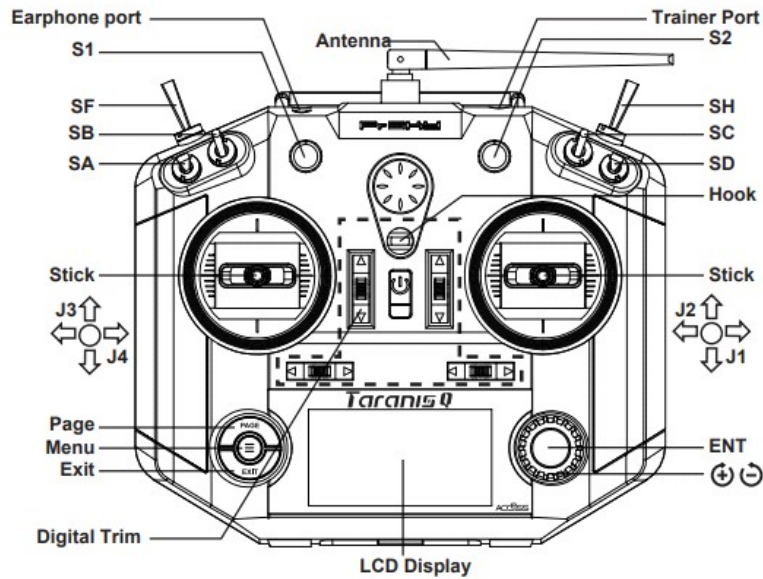


Figure 18: RCU Front View

### Remote Control Unit Functions

Power (Not labeled - Right below Hook)	Press and hold Release when the fourth loading dot appears - to power on Release when the last loading dot shows - to power off
J1/J2	Throttle (Up/Down Skid Steering (Left/Right)
J3/J4	Hydraulic Steering (Left/Right)
S1	Volume Clockwise to turn up Counter-Clockwise to turn down
S2	Manual SmartCast ( <b>Default Position - Straight Up</b> ) Clockwise to spool out Counter-Clockwise to spool in
SA	Arm (Up) (+ SH down/pull) Unused (Center)( <b>Default Position</b> ) Disarm (Down) (+ SH down/pull)
SB	Loiter (Up) Unused (Center)( <b>Default Position</b> ) Unused (Down)
SC	Pole Up (up) Stop (center)( <b>Default Position</b> ) Pole Down (down)
SD	Unused
SF	Manual (Up) (Push)( <b>Default Position</b> ) Auto (Down) (Pull)
SH	Unused (Up)( <b>Default Position</b> ) Send Command (Down) (Pull) Hold for 5 seconds. To <b>Arm</b> SA up + SH down To <b>Disarm</b> SA + SH down
Digit Trims	Unused
Earphone Port	Unused
Trainer Port	Unused
Module Bay	Long Range Module Connects here (Refer to Figure 19)
Battery Cover	RCU Internal Battery Location (Refer to Figure 19)

Table 4: RCU Functions

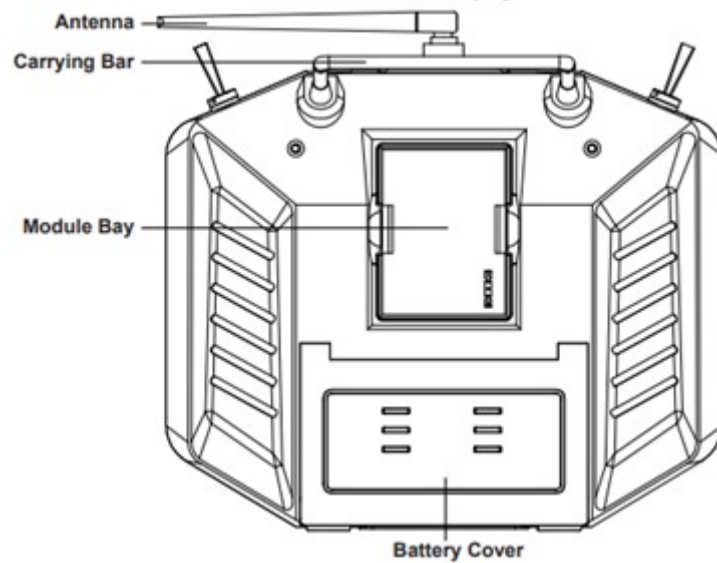


Figure 19: Back View

### Important Alert

For safety you must arm the HydroCat™ 180 to allow the thrusters to function. Always disarm or power off the vessel when working near the props.

#### **To arm the HydroCat™ 180:**

Move SA switch up and hold SH down for 5 seconds. See Figure 18

#### **To disarm the HydroCat™ 180:**

Move SA switch down and hold SH down for 5 seconds. See Figure 18

### 3.7 Voltage Tester

#### Information

Max voltage of a 2S battery is 8.4VDC.

#### **Connecting to a Voltage Tester:**

1. Connect the balance cable connector to the voltage tester.
2. Due to the versatile nature of the voltage tester, it may take a few configurations to connect correctly.



Figure 20: LiPo Voltage Tester

3. The voltage tester will cycle from overall voltage to each cell voltage.
4. It is recommended to check every battery prior to operation.

## 3.8 Battery Charging

### 3.8.1 Pontoon Charging

#### Information

You can charge the pontoon batteries and gimbal batteries at the same time. It is not recommended to operate any installed equipment while the batteries charge.

#### Important Alert

Never leave batteries unattended while charging. Batteries on charge MUST remain under constant observation so that you may react quickly should any problems arise.

#### Caution

Pontoon battery voltage minimum is 39V. DO NOT DISCHARGE BELOW 39V. Battery discharged below 36VDC requires it to be sent in for service.

#### Caution

### Charging Pontoon Batteries:

To Connect:

1. Start with the HydroCat™ 180 fully powered off.
2. Connect Fast Charger output connector into the pontoon charging connector.





Figure 21: Charging Connector - Power

3. Remove waterproof signal cable cap. Do NOT lose it.
4. Connect Fast Charger data cable into pontoon signal cable.

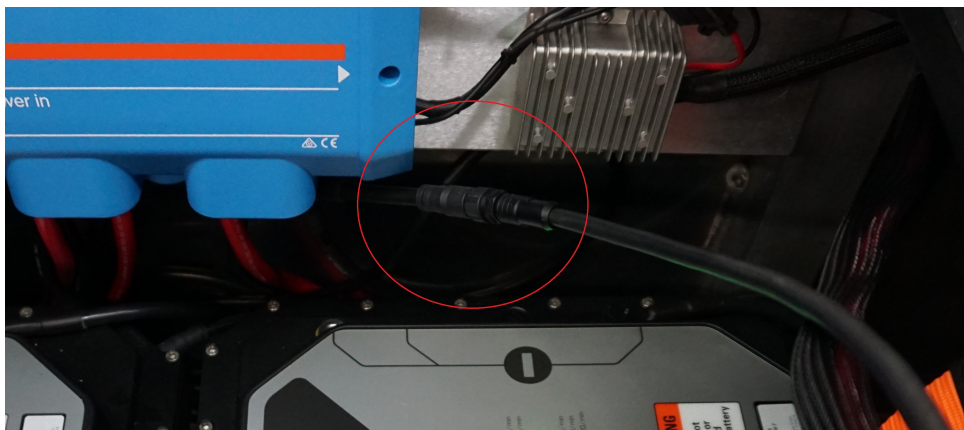


Figure 22: Charging Connector - Data

5. Switch off the pontoon battery switch. (Figure 6)
6. Power on the pontoon batteries. (Figure 11)
7. Connect Fast Charger to AC power. 100-240VAC/50-60Hz
8. Repeat for the opposite side.
9. Charging complete when charger switches to standby mode.

To Disconnect:

1. Disconnect Fast Charger from AC power.
2. Disconnect Fast Charger signal cable from the pontoon signal cable.
3. Attach pontoon signal cable cap.

4. Disconnect Fast Charger output connector from the pontoon charging connector.
5. Repeat for the opposite side.

**Caution**

Charger will show three dots if the batteries are above 49V. They cannot be topped off.

**Technical Data**

Property	Value
AC Input	100-240VAC
Rated Voltage	44.4V
Final charging voltage	50V
Final discharging voltage	36V
Maximum voltage at the terminals	50V
Maximum discharge current	200A
Ambient temperature, storage	-13°F to 140°F (-25°C to +60°C)
Ambient temperature, charging	32°F to 122°F (0°C to +50°C)
Ambient temperature, discharged	14°F to 122°F (-10°C to +50°C)
Usable Energy	5000 Wh
IP Protection class	IP67
Max. output power	2900 Watt at 240VAC 1400 Watt at 100VAC
Charging Time	About one hour and 45 minutes per battery per side at 240VAC About three and a half hours per battery per side at 100VAC

Table 6: Pontoon Charger Technical Data

### 3.8.2 Gimbal Charging

**Information**

You can charge the pontoon batteries and gimbal batteries at the same time. It is not recommended to operate any installed equipment while the batteries charge.

**Important Alert**

Never leave batteries unattended while charging. Batteries on charge MUST remain under constant observation so that you may react quickly should any problems arise.

**Caution**

Recommended power off at 11.6VDC. Minimum gimbal voltage requires 9.5VDC. If continually running gimbal batteries to 9.5VDC, battery life will diminish quicker.

#### Charging Gimbal Batteries:

1. Start with the USV fully powered off.
2. Connect the NOCO genius charger into an AC power source. 100-240VAC/50-60Hz
3. Verify each channel is set to AGM 12V. Use the channel button to change if needed.
4. Refer to Figure 9 for charger location.



Figure 23: NOCO Battery Charger

5. Charging complete when each channel has a solid green Light Emitting Diode(LED).
6. Disconnect AC power source when all channels are fully charged.

### Technical Data

Property	Value
AC Input	100-240VAC
Rated Voltage	12V
Final Charging Voltage	14.8V
Maximum Voltage At The Terminals	14.8V
Maximum Charge Current	10A
Ambient Temperature, Charging	-4°F to 122°F (-20°C to +50°C)
IP Protection Class	IP68
Max. Output Power	150 Watt per channel
Charging Time	About 7 hours per channel

Table 8: Gimbal Charger Technical Data

### 3.8.3 Long Range Module Battery Charging

#### Important Alert

Never leave batteries unattended while charging. Batteries on charge **MUST** remain under constant observation so that you may react quickly should any problems arise.

#### Caution

Max voltage of a 2S battery is 8.4VDC.

#### Caution

### Charging LiPo Battery: with E4 Cube Balance Charger

1. Using the supplied voltage tester, verify each cell is above 3.2V, below 4.2V, and within 10% of each other.
2. Plug the E4 Cube charger into an AC 100-240VAC/50-60Hz outlet. Note that the battery is not connected to the charger currently.

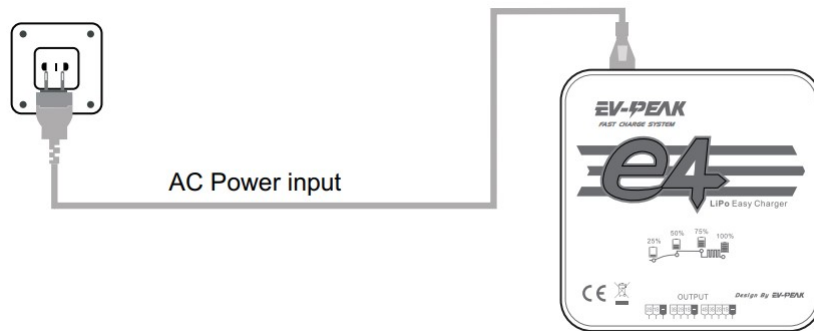


Figure 24: Cube Balance Charger Power

3. Charger will run a self-check. Wait for LED 1, 3 and LED 2, 4 to blink alternately before proceeding.
4. Connect the 2S 7.2V LiPo battery balance cable to the 2S (left) port.

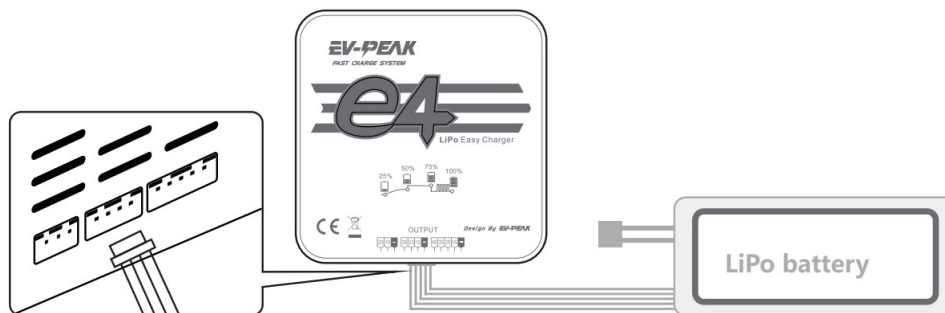


Figure 25: Cube Balance Charger Connection

5. After connecting the battery, the LED will blink and indicate the battery capacity percentage.
  - First LED indicates 25% capacity
  - Second LED indicates 50% capacity
  - Third LED indicates 75% capacity
  - Fourth LED indicates 100% capacity
  - Four LEDs will always be on when the battery is fully charged
6. When the battery is fully charged, disconnect the AC power first. Then disconnect the LiPo battery.

### Technical Data

Property	Value
AC Input	100-240VAC
Rated Voltage	2S - 4S
Maximum charge current	4A
Charge Mode	Balance

Table 10: E4 Cube Balance Charger Technical Data

### 3.9 HydroCat™ 180 Power On Procedure

#### Information

#### Important Note:

- Shut down pontoon batteries at 39VDC. (Refer to 1.4)
  - Recommended to shutdown gimbal batteries at 11.6VDC. (Refer to 1.4)
  - Voltage can be viewed on the Voltage Sensor. (See Figure 50 and 3.4 for internal Voltage Displays)
1. Power on the RCU. (Refer to 3.6)
  2. Verify all switches are in their default locations and the right joystick is center. (Refer to 3.6)
  3. Verify both kill switches are pulled up. (Refer to Figure 6 and 9)



Figure 26: Kill Switch

4. Power on gimbal switch. (Figure 11)
5. Power on both pontoon buttons. (Figure 11)
6. Power on both pontoon switches. (Figure 6)



Figure 27: Pontoon Shutoff Switch - On

7. Arm the HydroCat™ 180 with the RCU. (Refer to 3.6)
8. Verify throttle and steering function correctly.
9. Secure all hatches before launching vessel.

### 3.10 Sonar Pole Actuators

#### Information

The Sonar Pole Control Box, depicted in Figure 10, is equipped with a persistent memory. It remains powered continuously through the gimbal batteries, even when the Gimbal Power Switch is powered off. In the event of a power loss while the Sonar Pole is in the down position, manual resetting of the actuators will be required. (Refer to 5.4)

#### Information

Sonar Pole Manual Override Switch can be used at anytime. The RCU knob can only be used if the Gimbal or Port Pontoon are powered.

Use SC switch on RCU (Refer to 3.6) to move the actuators up and down.

- 'Up' makes the actuator raise the sonar system out of the water.
- 'Center' stops the actuator.
- 'Down' makes the actuators lower the sonar system into the water.
- Ensure the sonar pole is in the full down position for survey operation.

#### Caution

If you have powered off the HydroCat™ 180 before raising the Sonar Pole back to its travel position, use the Sonar Pole Manual Override Switch to raise the Sonar Pole.

### 3.11 Shoreside Setup Communications

#### Information

- Let the Ethernet ports and Bridge Antennas initialize before connecting through Remote Desktop. If not given enough time, the connection will attempt to initiate and fail.
- It is not recommended to use an Ethernet to USB adapter.
- If multiple Seafloor Systems vessels are operating in the same zone. Please contact Seafloor Systems to modify Bridge settings.

#### Information

### Hardware setup:

1. Connect the 10ft(3m) Ethernet cable into the Shoreside Bridge Antenna.
2. Connect the other end of the Ethernet cable into the PoE adapter.
3. Connect the PoE Ethernet adapter into the shoreside laptop being used to remote into the Hydro-Cat™ 180.
  - Shoreside laptop supplied by customer and recommended to have an Ethernet port.
4. Connect the barrel connector from the power adapter into the PoE adapter.
5. Plug the power adapter into an AC source. 100-240VAC/50-60Hz



Figure 28: Shoreside Hardware Setup

## Software setup (Windows 11):

1. Right click the WiFi icon on the taskbar.

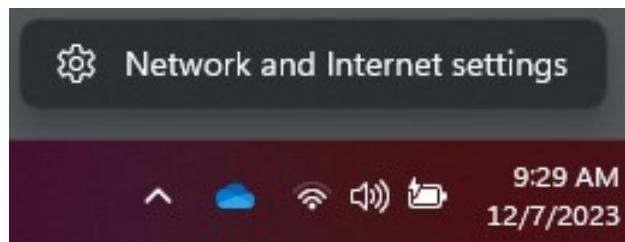


Figure 29: Network And Internet Settings

2. Open Network and Internet Settings.
3. Open Advanced Network Settings.



Figure 30: Advanced Network Settings

4. Open More Network Adapter Options.

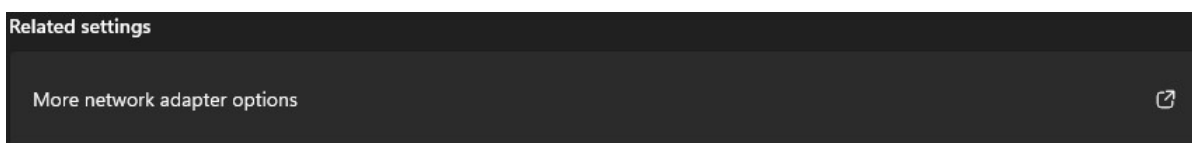


Figure 31: Network Adapters

5. Right click on the Ethernet port with the description "Unidentified Network" and select Properties.

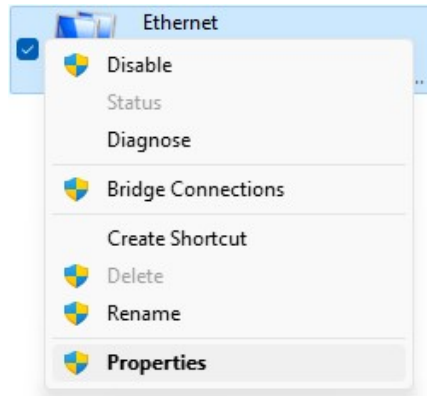


Figure 32: Ethernet Properties

6. Double click "Internet Protocol Version 4 (TCP/IPv4)".



Figure 33: Internet Protocol



7. Change the follow settings:

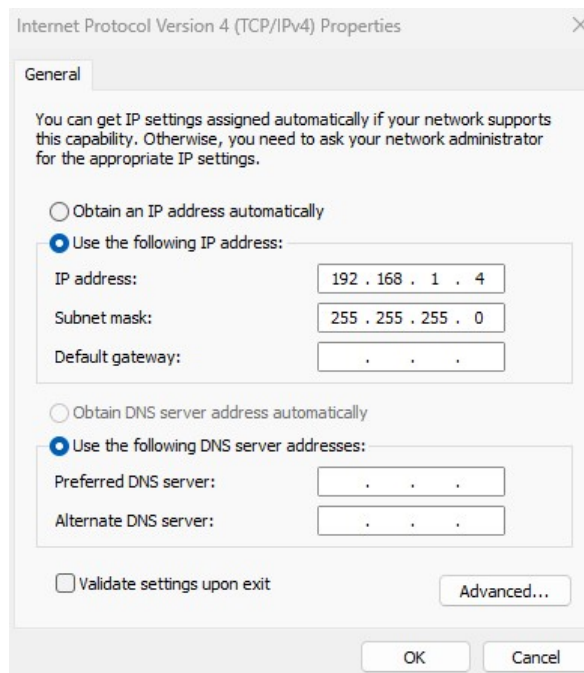


Figure 34: Ethernet Settings

- Use the following IP address:
  - IP address: 192.168.168.4
  - Subnet mask: 255.255.255.0
- Leave Preferred DNS and Alternate DNS servers blank.

### To Login:

1. Search "Remote Desktop" in the windows task bar and select it.

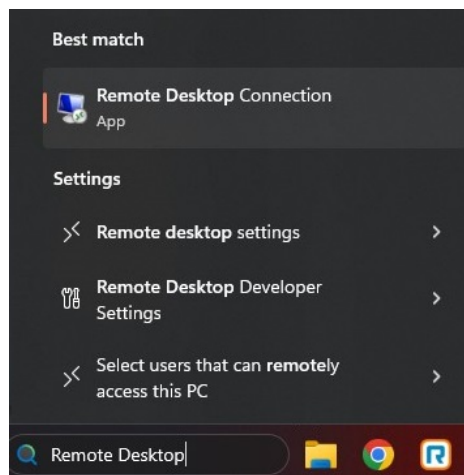


Figure 35: Taskbar Search

2. Type in 192.168.1.8 for the Computer.
3. Using "Show Options", change User name to "HydroCat".

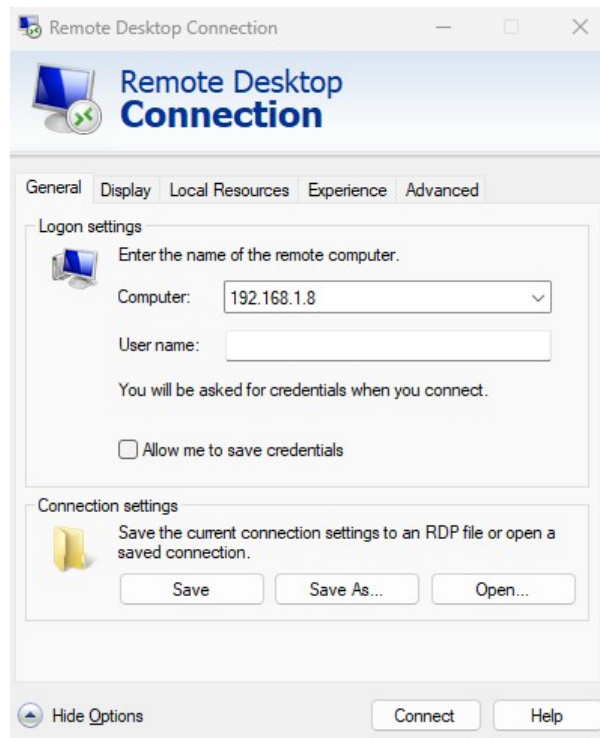


Figure 36: Remote Desktop Connection

4. Click Connect.
5. Password is "Seafloor".

## 3.12 Manual Operation

HydroCat™ 180 is a skid steered vessel with additional hydraulic steering. The right joystick manages both throttle and steering, while the left joystick solely specifically controls hydraulic steering. It's essential to have either forward or reverse thrust engaged when solely using hydraulic steering.

- Adjust speed using the RCU's throttle control: push forward for forward motion, pull back for reverse, and center for neutral.
- To turn left, move the right joystick to the left while pushing it forward. For a right turn, move the right joystick to the right while pushing it forward.
- When utilizing hydraulic steering, steer left by pushing the left joystick left while controlling throttle with the right joystick. Similarly, steer right by pushing the left joystick right while managing throttle with the right joystick.
- Familiarize yourself with the controls in a safe area to get a feel for the boat's responsiveness.
- Be mindful of the apparent opposite steering when the HydroCat™ 180 is headed toward you.

## 3.13 Autonomous Operation

### 3.13.1 Mission Planner

#### Information

Seafloor System's AutoNav™ requires three NMEA input GPS strings. GPS/GNSS system not provided by Seafloor, will need to be configured to output the required NMEA strings.

- GGA, RMC, HDT at 5Hz with a GP Talker ID(Prefix) at 57600 baud rate. RS232 Protocol with DB9 connector. USB to DB9 adapter do not work.
- Example:
  - \$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,\*47
  - \$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W\*6A
  - \$GPHDT,139.23,T\*25

#### Caution

**Important:** The AutoNav™ navigates using GPS waypoints, users should toggle to Manual mode to avoid objects and always maintain line of sight

AutoNav™ does have a Return to Home(Launch) function, it is not enabled on the RCU. To activate in Mission Planner, navigate to the Data tab and below the Heads Up Display (HUD). On the Actions tab, click RTL. (Return to Launch)

#### Caution

Below will show you how to setup a mission in Mission Planner. However, it's important to note that a mission can be started one of two ways.

- RCU - using the SF switch. (Refer to 3.6)
- Software - Mission can be started via HUD Actions.

*If started with software, the toggle switch will be in "Manual". To stop the survey, you must toggle the switch to "Auto" then back to "Manual". Same goes for the opposite scenario.*

#### Information

Internet connection is required to view satellite background images.

## Caution

Do not assume satellite images of water level are correct. Always drive the perimeter with the HydroCat™ 180.

### Mission Planner:

1. Open Mission Planner.
2. Connect to the AutoNav™.

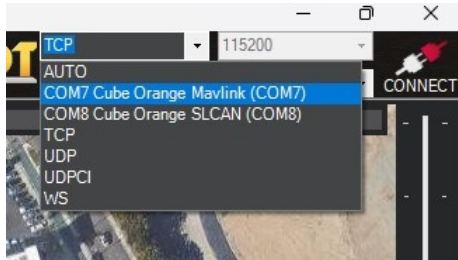


Figure 37: COM Port

- Choose Mavlink COM port
  - 115200 baud rate
3. Click PLAN.
  4. Find your survey area.
  5. Click the circled polygon in the top left and select 'Draw a Polygon'.

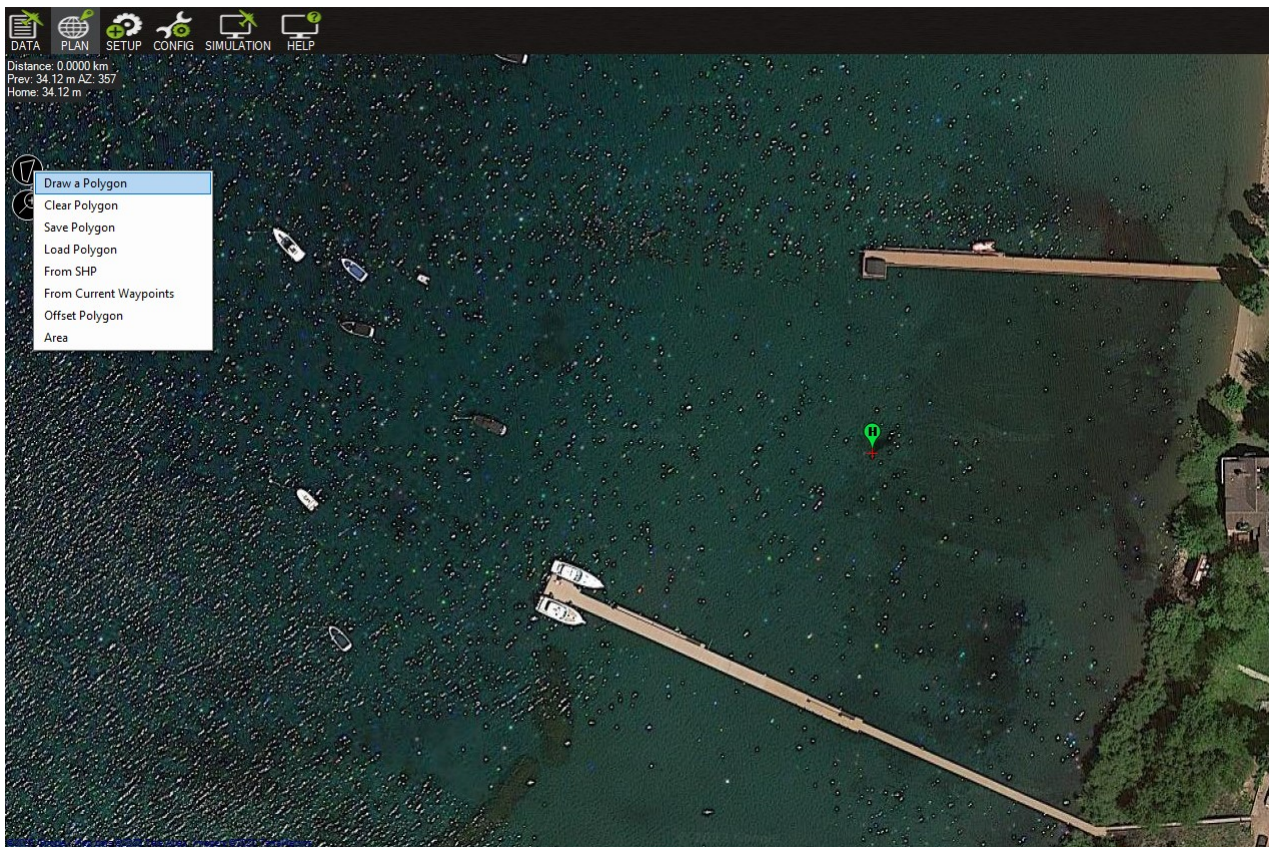


Figure 38: Polygon Select

6. Click on the survey area to define the borders of the survey. Use mouse to drop red polygon points to outline survey area.
  - Give enough distance for tides. Can also manually drive the HydroCat™ 180 to desired location and drop polygon points at each extent.
7. Right click survey area. Highlight 'Auto WP' and select 'SimpleGrid'.

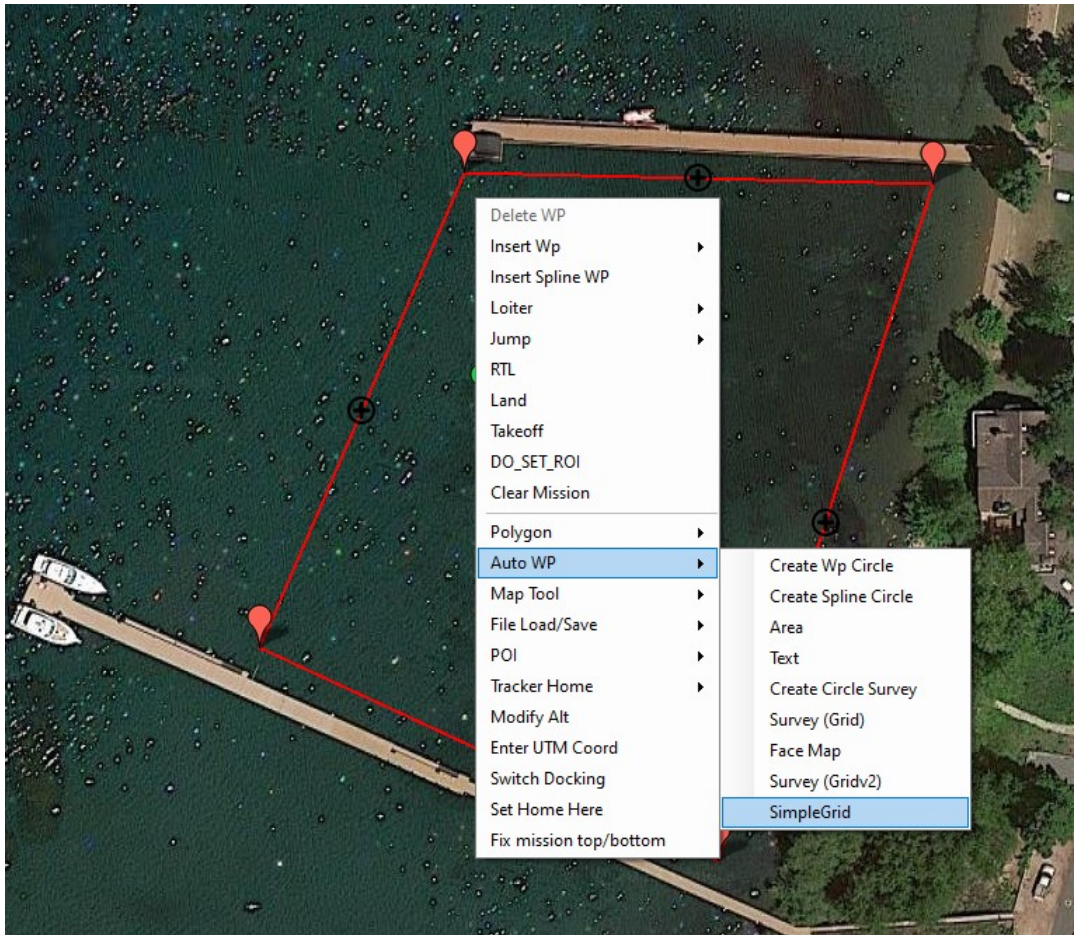


Figure 39: SimpleGrid Select

Altitude	Leave as is
Angle	Change the angle of the survey
Line spacing	Distance between lines, dependant on your swath width
Spacing inline	Increase until only start/end are present
Overshoot	Leave as is
Overshoot	Leave as is
Speed	Drop down to survey speed or delete later
Start From	Leave as is

Table 11: SimpleGrid Settings



Figure 40: SimpleGrid Settings

8. Delete the first command, speed change.

	Command	Delay				Lat	Long	Alt	Frame	Delete			Grad %	Angle	Dist	AZ
1	DO_CHANGE_SPEED	1	1	0	0	0	0	0	Relative	X			0	0	0	0
2	WAYPOINT	0	0	0	0	39.0882645	-119.9410	100	Relative	X			259.8	168.9	107.2	356

Figure 41: Delete DO\_CHANGE\_SPEED

- By deleting it will revert back to default survey speed.

9. Click 'Write' on the right panel.



Figure 42: Write Mission

- This will save the mission to the AutoNav™. It will stay saved until a new mission has been overwritten.

10. Using the RCU SF switch to toggle USV into Auto mode and run mission.

### Important Alert

**Be aware, if your USV does NOT have CAA installed or installed but not powered on, the USV will head directly to the location where it was first armed. If there are objects in the way or it was armed on shore, the boat may run aground.**

### 3.13.2 Hypack

#### Information

Seafloor System's AutoNav™ requires three NMEA input GPS strings. GPS/GNSS system not provided by Seafloor, will need to be configured to output the required NMEA strings.

- GGA, RMC, HDT at 5Hz with a GP Talker ID(Prefix) at 57600 baud rate. RS232 Protocol with DB9 connector. USB to DB9 adapter do not work.
- Example:
  - \$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,\*47
  - \$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W\*6A
  - \$GPHDT,139.23,T\*25

#### Caution

**Important:** The AutoNav™ navigates using GPS waypoints, users should toggle to Manual mode to avoid objects and always maintain line of sight. AutoNav™ does have a Return to Home(Launch) function, it is not enabled on the RCU. To activate in Mission Planner, navigate to the Data tab and below the HUD. On the Actions tab, click RTL. (Return to Launch)

#### Caution

Below will show you how to setup a mission in Hypack. However, it's important to note that a mission can be started one of two ways.

- RCU - using the SF switch. (Refer to 3.6)
- Software - using Start Mission button.

*If started with software, the toggle switch will be in "Manual". To stop the survey, you must toggle the switch to "Auto" then back to "Manual". Same goes for the opposite scenario.*

#### **Hardware Setup:**

1. Open Hypack.
2. Open Hypack Hardware Setup.
3. Right click Hardware to add a Mobile.

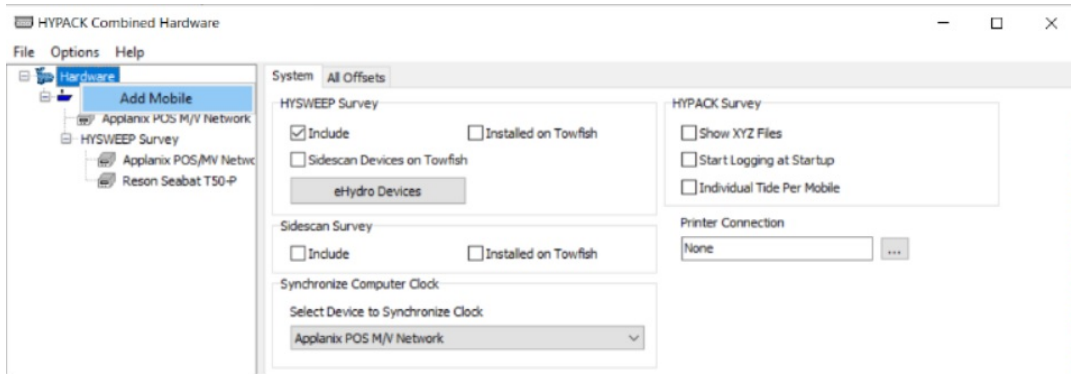


Figure 43: Add Mobile

4. Under the new Mobile, add Mavlink driver.

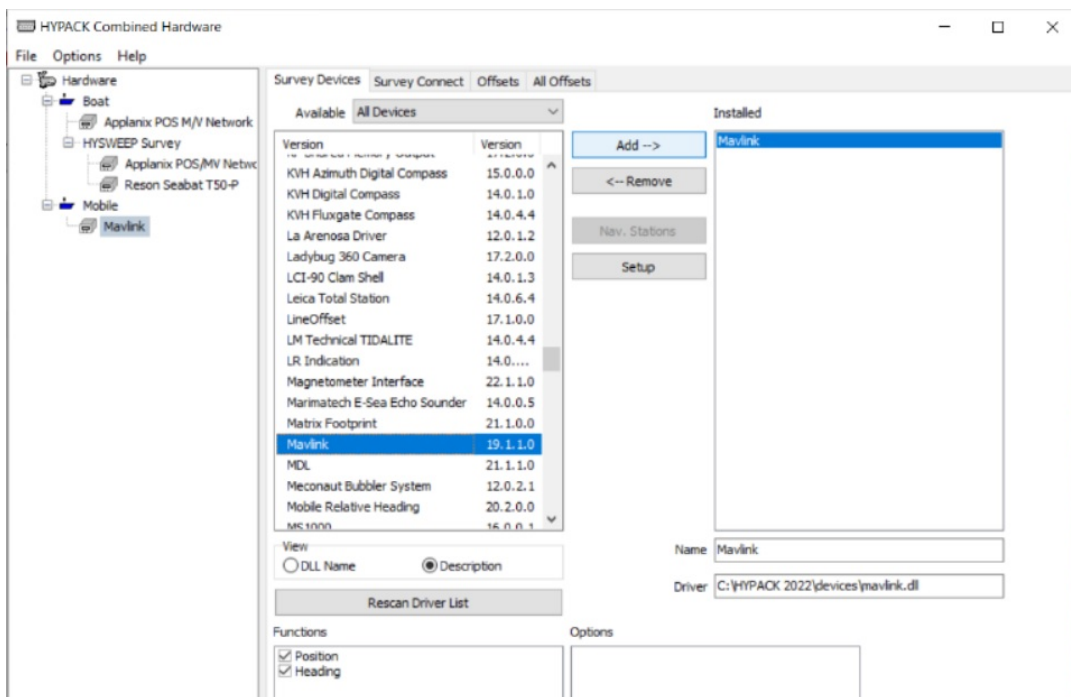


Figure 44: Add Mavlink Driver



5. Device Connection is Serial.

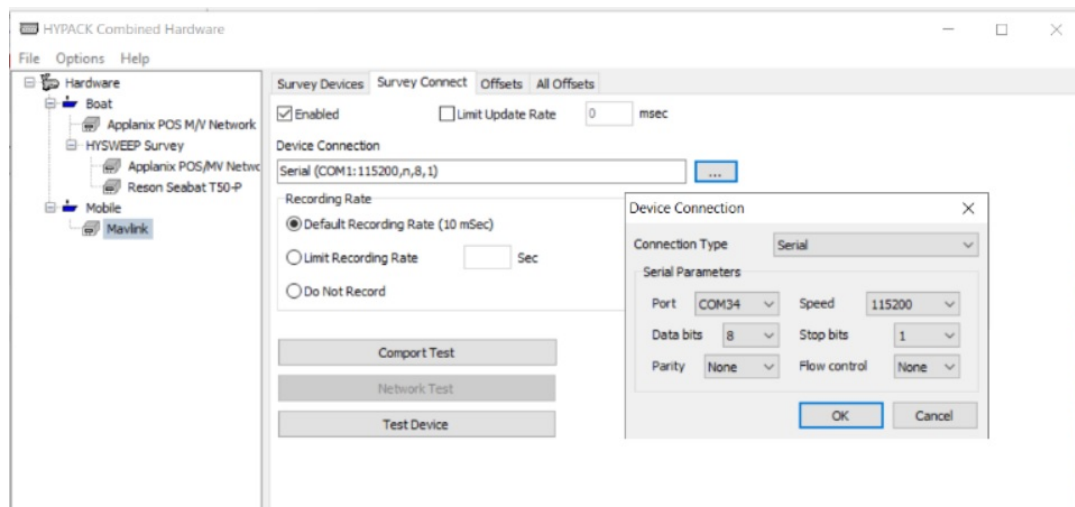


Figure 45: Set COM Port

6. Set COM number. Can be verified in Device Manager.

7. Set Baud Rate to 115200.

8. Use the Comport Test to verify data is coming through the selected COM port.

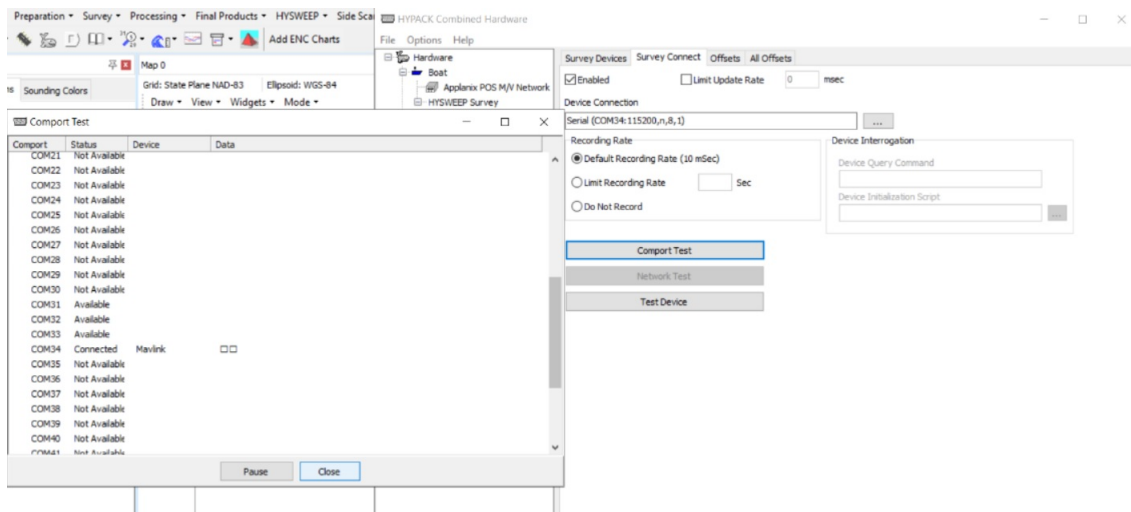


Figure 46: COM Test

## Line Planning:

1. Create the line plan using Hypack's standard Line Plane Editor.

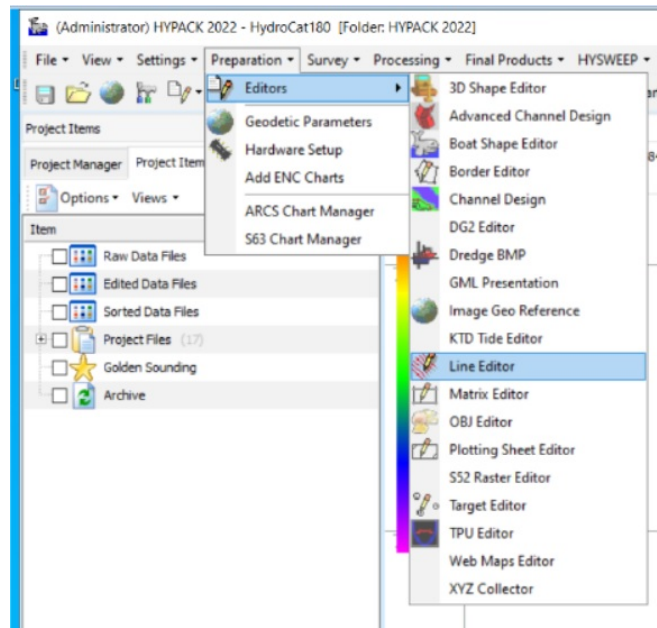


Figure 47: Line Editor

2. Right click every other line and select Reverse Order.

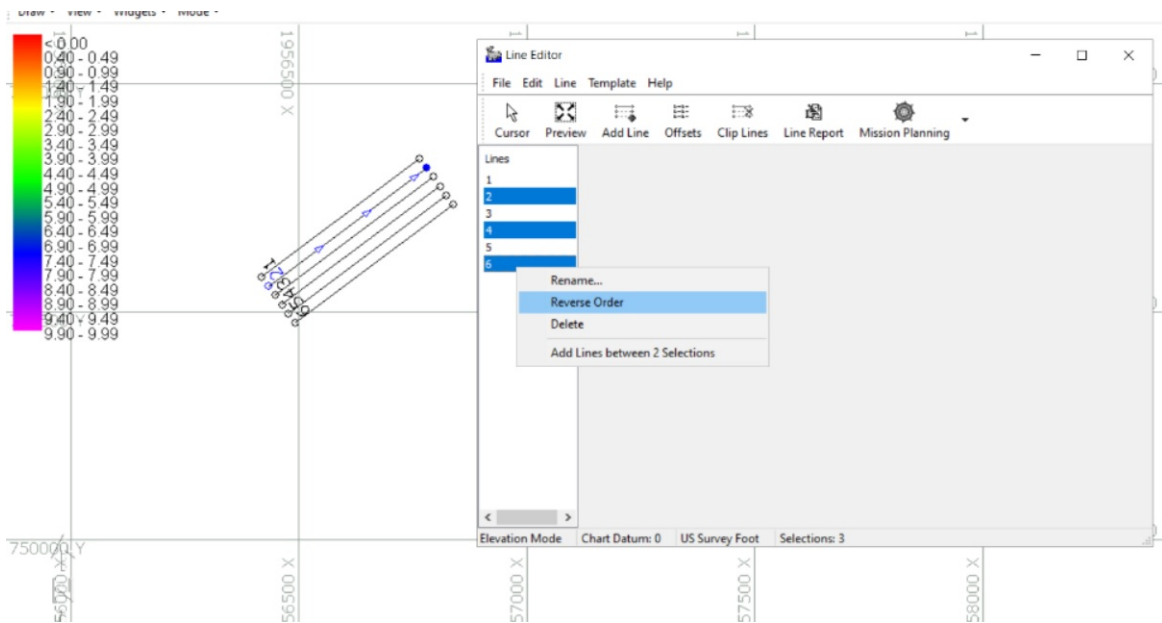


Figure 48: Reverse Every Other Line

3. Start Hypack Survey/Hysweep.
4. Mavlink Driver will say Armed or Unarmed. USV must be Armed to Start Mission.

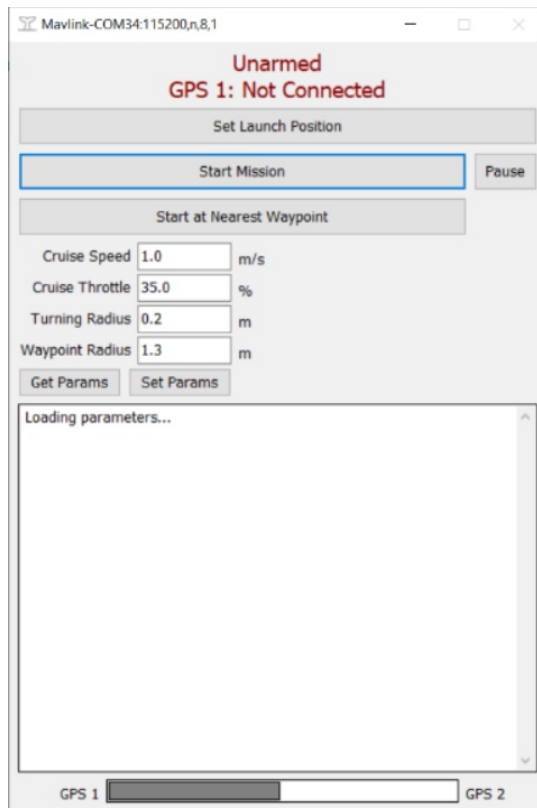


Figure 49: Mavlink Driver Control

- If the status flashes between Armed/Disarmed, it's a bug. System is Armed.

5. Using the Mavlink Driver, you can toggle Auto mode by selecting Start Mission.

#### Mavlink driver button functionality:

- Start Mission
  - The HydroCat™ 180 will navigate the current line file.
  - 'Stop Mission' will appear once 'Start Mission' is selected.
- Stop Mission
  - Click 'Stop Mission' to end line navigation.
- Pause
  - Once the Mission is started use the 'Pause' to regain manual control.
  - 'Resume' will appear once 'Pause' is selected.
- Return to Launch
  - The boat will take a straight line back to where it was last armed.
  - Make sure the boat has an unobstructed path if using this function.

Mavlink driver window will say 'Flight mode set successfully' when each button is selected.

### 3.14 SmartCast Operation

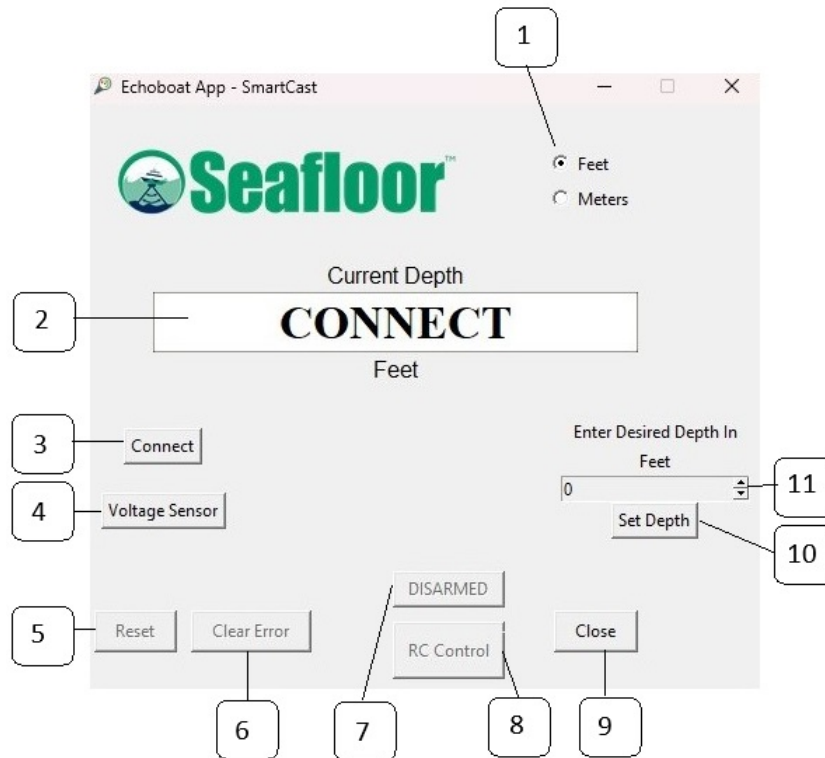


Figure 50: SmartCast GUI Layout

#### Button Labels:

1. Units: Select the units the system will use; feet or meters.
2. Screen: Displays the current position/depth of the sensor(SVP).
3. Connect: Connect SmartCast software to the SmartCast hardware.
4. Voltage Sensor: Displays the HydroCat™ 180 voltage.
5. Reset: Used when the system is armed to bring the sensor home and reset the current position to zero.
6. Clear Error: Used to clear the continuous error caused by the sensor getting stuck on an object underwater.
7. DISARMED: Used to arm/disarm the SmartCast for casting.
8. RC Control/Cast: Displays 'RC Control' when the system is not armed and is used to send a cast when the system is armed.
9. Close: Closes App.
10. Set Depth: Used to confirm the value set in Desired Depth (11).
11. Desired Depth: Use the arrows to change the depth of the cast.

#### Information

The SmartCast has 100ft (30m) of rope. Is it recommended to drop the sensor a maximum of 90% of the depth. As to not get the sensor stuck on the ground.

### Caution

Must have an SVP attached prior to manual or automated operation.

### Manual SmartCast Operation with Override Switch:

1. Power on the gimbal.
2. Using the SmartCast Override Switch: (Figure 11)
  - (a) Switch towards stern of HydroCat™ 180 lowers SVP
  - (b) Switch towards bow of HydroCat™ 180 raises SVP

### Information

When raising or lowering SmartCast rope without an SVP, it is essential to apply tension to the rope to minimize the risk of tangling.

### RCU SVP Cast Operation:

1. Power on the RCU. (3.6)
2. Power on the HydroCat™ 180.
3. Open the Seafloor App, located on the desktop.
4. Connect to the Seafloor App.
5. Using the S2 knob (Refer to 3.6), drop the sensor to the desired depth.
6. The current depth can be viewed on the Seafloor SmartCast App.
7. Use the S2 knob to retrieve the sensor back up.
8. Once home, center the S2 knob.

### Automated SVP Cast Operation:

1. Open App.
2. Connect to the Seafloor SmartCast App.
3. Select Feet or Meter.
4. Enter Desired Depth.
5. Select Set Depth to confirm.
6. Select Disarmed to change state to ARMED. The SmartCast will calibrate zero position of sensor by retracting the SVP into the home position.
7. Select Cast to cast the sensor.
  - Once the cast has begun the system will reset the 'Current Depth' to zero. It will then descend to the 'Desired Depth', pause for two seconds, and then come back up and reset 'Current Depth' a third time. After completion it will disarm itself.

### Caution

**Important** There is a 5 second safety cutoff when the sensor hits the home position. You will not have manual or auto control until the 5 second timer runs out. If you continue to pull the sensor home, the safety cutoff will continue to reset. Constant cycle of the safety cutoff *CAN* damage the SmartCast motor. Always move the S2 knob to center when done.

### Caution

#### Important Tips:

1. RCU control is only possible with PC powered on, otherwise you must use manual rocker switch in gimbal.
2. Do not run the SmartCast while the boat is moving quickly, in heavy current or large waves.
3. Do not get line wrapped in propellers.
4. If the same depth is desired for multiple casts, it is not required to click 'set depth' each time. The previous depth will be used.
5. It is recommended to unspool and respool the line before every mission to ensure the line does not become tangled. Tangled lines can result in the direction of motion to be reversed or large amounts of line being released at once. Both of which can stop the SmartCast from functioning properly.

#### 3.15 HydroCat™ 180 Power Off Procedure

1. Raise sonar pole prior to retrieval. (Refer to 3.6) (Verify sonar output power is off via sonar GUI)
2. Upon retrieval of the HydroCat™ 180, disarm using the RCU SA and SH switch. (Refer to page 3.6)
3. Switch off both pontoon switches. (Refer to 6)

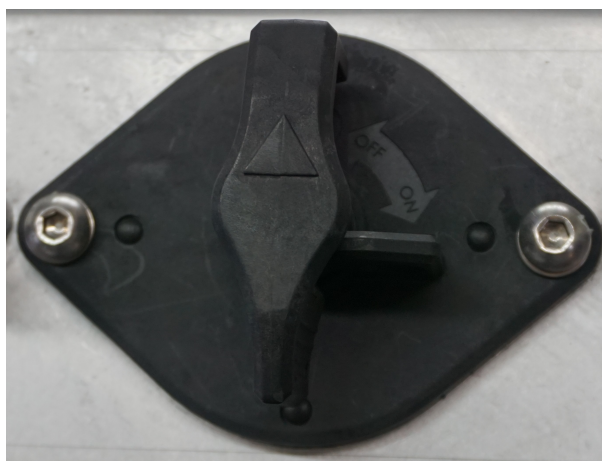


Figure 51: Pontoon Switch - Off

4. Power off both pontoon buttons.
5. Shut down the onboard computer.
6. Power off the inverter.
7. Power off payload switch.
8. Power off RCU by holding Power button until the 4 dots count down. Release at one dot. (Refer to 3.6)

### Caution

If you have powered off the HydroCat™ 180 before raising the Sonar Pole back to its travel position, use the Sonar Pole Manual Override Switch to raise the Sonar Pole.

### Caution

If the inverter remains powered on, it will drain the gimbal batteries completely.

### 3.16 Fail-Safe

#### Important Alert

In case of failure, the HydroCat™ 180 has built in fail-safes if needed for emergency situations.

- Within RCU range you can disarm the USV to stop or prevent throttle commands to the thrusters.
- Outside of RCU range:
  - Manual mode: The vessel will drift with no input. Move shore side position or using RDP connection, set RTL.
  - Autonomous mode: The vessel will continue on it's mission. It is best practice to always survey within the RCU range. Keep RDP connection to stop mission in case of an emergency.
- There are two red emergency kill switch on either side on the gimbaled frame. Pressing either of those will shut down the drivetrain system. (refer to 6)
- It is possible to program other fail safe parameters. By default these are all disabled as there is a potential to interrupt the survey plan. Please contact Seafloor Systems to enable.

### 3.17 Collision Avoidance Assist (CAA) Operation

CAA operation instructions for HydroCat™ 180. **Optional Add On**

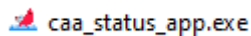
#### Information

CAA requires active LiDAR and GPS to operate.

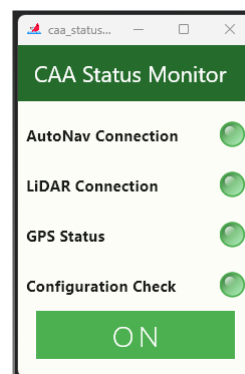
#### Important Alert

CAA is not operational while the HydroCat™ 180 is in manual operation mode.

1. CAA is activated when the CAA power switch is enabled on the HydroCat™ 180.
2. **Monitoring Status:** A CAA status monitor application can be found in EchoBoat/Documents/CAA/Status.



(a) CAA Status Monitor App



(b) CAA Status All Good

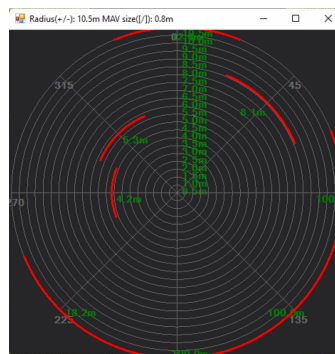
Figure 52: Monitoring CAA Status

- (a) Launch `caa_status_app.exe` to view current status of CAA.
  - (b) If CAA is active all status lights will be green.
3. **Real-time View:** Once active, CAA obstacles can be viewed within Mission Planner.

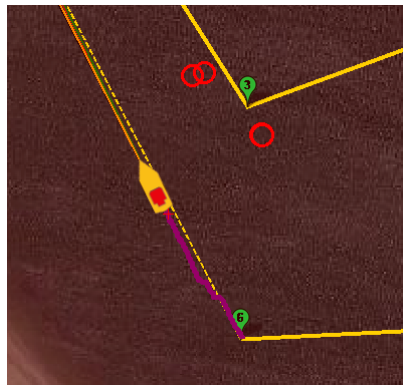




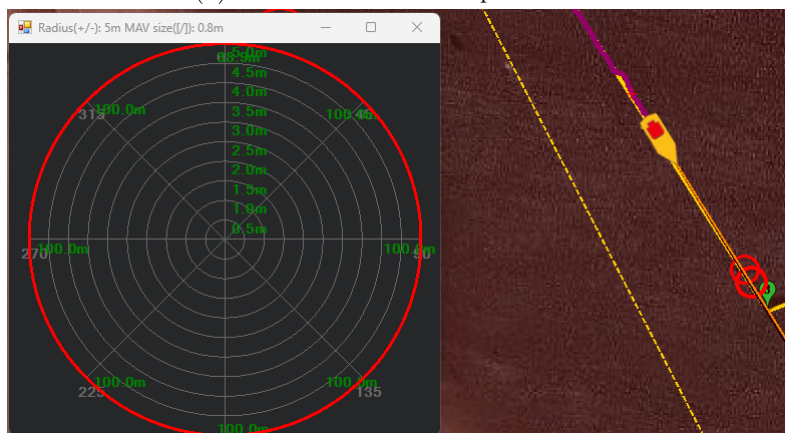
4. **Interpreting Data:** The proximity data is divided into 8 sectors around the HydroCat™ 180.



(a) CAA Obstacles As Proximity Zones



(b) CAA Obstacles As Map Indicators



(c) CAA Obstacles With Proximity

Figure 54: Different Options To Monitoring Obstacles In Mission Planner

5. **Operation:** Once the HydroCat™ 180 is placed in autonomous mode (Refer to 1.4). CAA will use the obstacles detected to navigate around them.

### 3.18 Trailing Checklist

#### Caution

When transporting the HydroCat™ 180 to or from a body of water, adhere to this checklist to prevent any potential damage.

- Sonar Pole is in the home position (Up).
- Sonar pole is secured by 1x ratchet strap.

- Gimbal is secured by 4x ratchet straps in each corner.
- HydroCat™ 180 is secured to the trailer with a minimum of 4x ratchet straps. Use the docking cleats as tie down points.
- SVP is removed from the SmartCast.
- Remove the Onboard Antenna. Disconnect the Ethernet cable and unscrew the pole mount.
- Trim the thrusters for trailering.
  1. Remove the trim rod.
  2. Trim up the thruster to it's max position.
  3. Install trim rod to the highest slot.
  4. Trim down the thruster to rest on the trim rod.
- Entire HydroCat™ 180 system is powered off.

## 4 Frequently Asked Questions (FAQ)

- Water is leaking from the hatch.
  - Verify the condition of the hatch seal and seam. Lubricate or replace as necessary.
- The prop is spinning without engaging the Throttle.
  - Verify that the Throttle Trim is centered. Calibrate if necessary, refer to 6.2.
- HydroCat™ 180 is still powered when the main switch is in the off position.
  - Contact Seafloor Systems.
- HydroCat™ 180 has a limited turning radius or only turns in one direction.
  - Verify that the props are clean of debris. Calibrate, refer to 6.2.
- HydroCat™ 180 is not going into Auto mode.
  - No GPS or Compass Variance. Verify your GPS is outputting GGA, RMC, HDT at 5Hz with a talker ID(Prefix) of GP at a 57600 Baud rate. Use the supplied Null Modem if you are confident your GPS is outputting correctly.
- Thruster no longer has power after getting debris caught in it.
  - Clean caught debris and inspect the 500A and 3x 250A fuses. Refer to 5.2.

## 5 Troubleshooting

### 5.1 AutoNav™ Errors

#### Common Errors:

If the Autonomous Operation is not behaving as expected, open and connect to Mission Planner. The HUD will show errors.

- **EKF3 waiting for GPS config data**
  - No GPS input. Check GNSS output. Use a Null Modem if needed.
- **Bad Gyro Health**
  - Can be ignored. The USV was powered on and moving while initializing.
- **Unhealthy AHRS**
  - Incorrect NMEA GPS strings or an accelerometer calibration is needed. (Refer to 6.4)
- **RC Failsafe**
  - RCU powered off or out of RCU range.
- **EKF Failsafe**
  - GPS position issue. Check GNSS system and NMEA outputs.
- **Internal Error**
  - Powered on incorrectly, reboot.
- **'EKF' will be red**
  - Normally red upon power up or Compass issue. Let stabilize or see above for Compass Variance.
- **Compass Variance with dual antenna GNSS/INS system**
  - Incorrect NMEA GPS strings or primary antenna location is incorrect.

## 5.2 Fuses

### 5.2.1 Gimbal Fuses

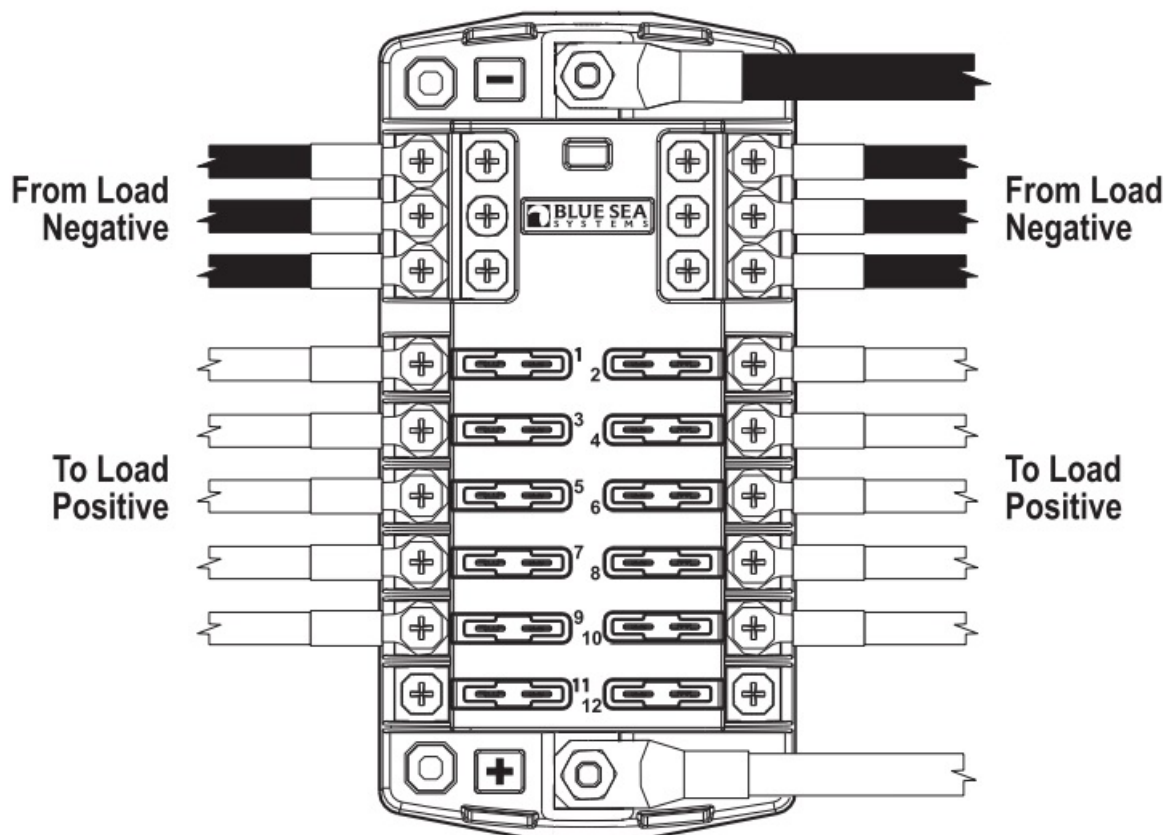


Figure 55: Distribution Fuse Panel

All fuses in Figure 55 are ATC/ATO blade fuse.

1. 5A - Cooling Fans
2. 5A - Onboard PC
3. 25A - SmartCast
4. 3A - Hazard Light
5. 1A - SmartCast Manual Override Switch
6. 1A - AutoNav
7. 5A - CAA
8. 1A - Thruster Controller
9. Unused
10. Unused
11. Unused
12. Unused

Inline Fuses: Mini ATO/ATC

- 25A - Sonar Pole Actuator Control Box

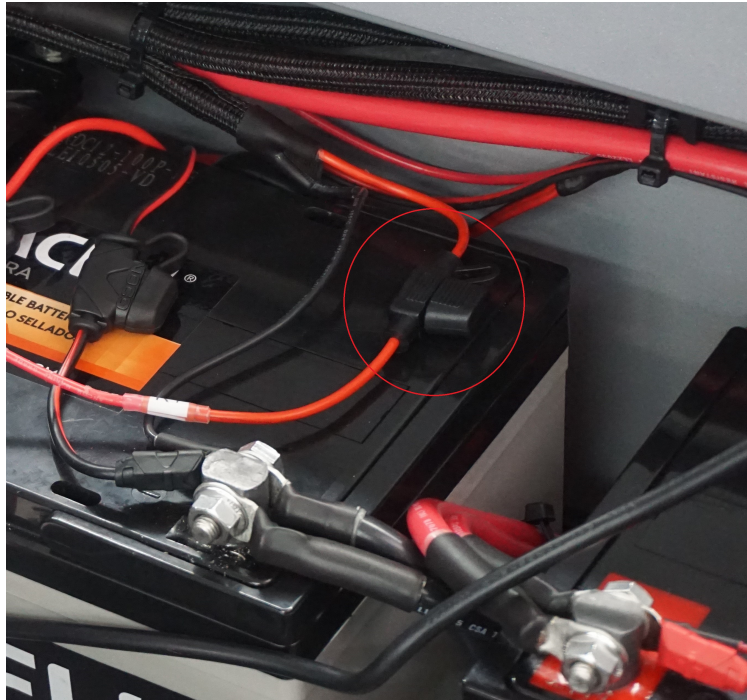


Figure 56: Inline Fuse Location

- 15A - NOCO Charger (Figure 23)

### 5.2.2 Pontoon Fuses

Distribution Fuse Box(Per Pontoon): Figure 8

- 3x 250A MEGA fuse(One per battery)



Figure 57: Pontoon Fuse Panel Cover

Thruster Fuse(Per Pontoon)

- 500A MEGA fuse

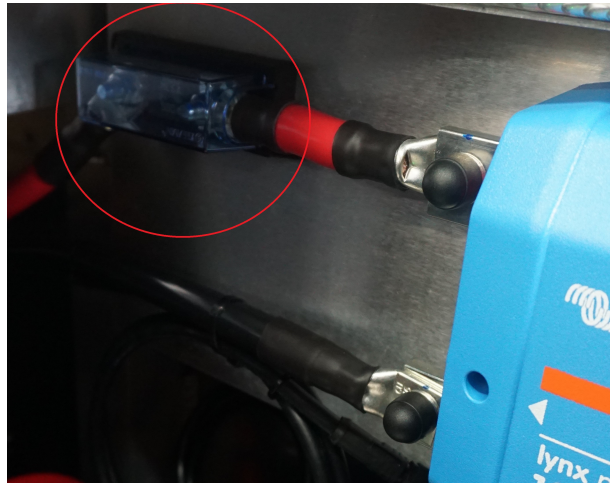


Figure 58: Thruster Fuse Location

Navigation Lights Inline Fuse(Per Pontoon)

- 5A Mini fuse.



Figure 59: Navigation Fuse Location

### 5.3 Pontoon Batteries

#### Important Information

**Before proceeding verify the resettable 80A fuse is 'On'. The yellow RESET trigger will not be visible. Located in each pontoon distribution power panel.**

#### Protection Mode

Reversible protection: Protects the Power 48-5000 by switching off the voltage outputs. After resolving the cause of the error, the Power 48-5000 can be switched on again.

Irreversible protection: The irreversible protection is a second safety measure. If this protection is triggered, the Power 48-5000 is no longer usable and Seafloor Systems must be contacted.

## LED Indications

Slow flashing	2 seconds on, 2 seconds off
Normal flashing	1 second on, 1 second off
Quick flashing	0.5 seconds on, 0.5 seconds off

LED Status	Battery Status	Explanation
Continuously green	Dumb mode: Control on, power on	Battery electronics and battery terminals are switched on.
Slowly flashing green	Standby mode: Control on, power off	Battery electronics are switched on and battery terminals are switched off.
Flashing slowly, white/green alternately	Smart Mode: Control on, power on	Battery electronics are switched on, communication with gateway has been established, and battery terminals are switched on.
Normal flashing green	Charging	Charge.
Solid yellow	20% SOC	Charging status below 20%.
Slowly flashing yellow	10% SOC	Charging status below 10%.
Normal flashing yellow	0% SOC	Charging status 0%.
Quickly flashing yellow	High temperature	High temperature. Battery must cool down.
Solid red	Defect	Battery is defective. Contact Seafloor Systems.
Normal flashing red	Error	See list of errors below.

Table 12: Pontoon Error Status

### Errors (Normal flashing red)

Possible cause of error	Troubleshooting
Temperature too high.	Let battery cool down.
Temperature too low.	Operate USV within specified temperatures.
Short circuit or overcurrent detected.	Check wiring for corrosion or damage.

Table 13: Pontoon Errors (Normal Flashing Red)

## 5.4 Pole Actuators

To access the Sonar Pole Control Actuator Box (Figure 10), remove the 4x M5 bolts holding the top plate on. Remove the 6 screws holding the lid on.

**Problem: Gimbal loss of power with Sonar Actuator Pole down.**

1. Verify gimbal power is greater than 6V.
2. Press ACTUATOR SET Button on the screen.
3. Press HOME on the screen.

**Problem: One actuator does not move.**

1. Follow calibration instructions 5.4.
  - (a) If the calibration does not work, verify all the wires are connected into the green connectors.

**Problem: Actuators do not move.**

1. Check all connector and bulkhead connections. Verify contacts are clean.
2. Check gimbal voltage is greater than 6V.

## 5.5 Thruster Errors

Display	Cause	Troubleshooting
E02	Stator Excess temperature (Motor overheated)	After waiting for a short period (approx. 10 minutes), motor can be operated slowly again. Contact Seafloor Systems.
E05	Motor/propeller blocked	Switch the main switch to the "OFF" position and disconnect the batteries. Release the blockage, and turn the propeller one further turn by hand. Reconnect the batteries to the system.
E06	Voltage to motor is too low	Low state of charge of battery. It may be possible to restart the motor slowly from the stop position.
E07	Overcurrent to motor	Continue at reduced power. Contact Seafloor Systems.
E08	Circuit board access temperature	After waiting for a short period (approx. 10 minutes), motor can be operated slowly again. Contact Seafloor Systems.
E09	Water ingress to pylon	Contact Seafloor Systems.
E21	Incorrect calibration of accelerator lever	Contact Seafloor Systems and provide error code.
E22	Magnetic sensor defective	Contact Seafloor Systems and provide error code.
E23	Value range incorrect	Contact Seafloor Systems and provide error code.
E30	Communication error with motor Error in motor power supply	Check the plug connection of the data cables. Check the cables. If necessary, contact Seafloor Systems and inform them of the error code. Check that the main switch is in the 'ON' position.
E32	Communication error for accelerator	Check plug connections of the data cables. Check the cables.
E33	General communication error	Check the plug connections of the cables. Check the cables. Switch the motor off and on again.
E34	Emergency Stop on	Reset the Emergency Stop button.
E43	Battery flat	Charge battery. It may be possible to restart the motor slowly from the stop position.
Other Error codes	Defect	Contact Seafloor Systems and provide the error code. Check power source, main fuse, and main switch. If power supply is working correctly, contact Seafloor Systems.
Nothing is shown on the display	Defective or no voltage	Check power source, main fuse, and main switch. If power supply is working correctly, contact Seafloor Systems.
E70	Over/undertemperature while charging	Correct the cause of deviation from temperature range; if necessary, remove charger unit and allow it to cool down. Switch battery on and off.
E71	Over/undertemperature while discharging	Correct the cause of deviation from temperature range; if necessary, remove charger unit and allow it to cool down. Switch battery on and off.



E72	Excess temperature of battery FET	Allow battery to cool down. Switch battery on and off.
E73	Overcurrent when discharging	Correct the cause of the overcurrent. Switch battery on and off.
E74	Overcurrent when charging	Remove charger unit. (Use only Torqeedo charger unit) Switch battery on and off.
E75	Pyro-fuse trips	Contact Seafloor Systems.
E76	Undervoltage of battery	Charge battery.
E77	Overvoltage while charging	Remove charger unit. (Use only Torqeedo charger unit) Switch battery on and off.
E78	Overcharging of battery	Remove charger unit. (Use only Torqeedo charger unit) Switch battery on and off.
E79	Battery has electronics defect	Contact Seafloor Systems.
E80	Deep discharge	Contact Seafloor Systems.
E81	Water sensor is triggered	Ensure that the battery environment is dry; if necessary, clean the battery and water sensor. Switch battery on and off.
E82	differing state of charge of multiple batteries	Remove the wiring of the battery bank, and fully charge each battery individually.
E83	Software version error battery	Batteries with different software versions have been connected together. Contact Seafloor Systems.
E85	Imbalance of a battery	During the next charging process, do not disconnect the charger unit after the battery is fully charged. After the end of the charging process, leave the charger unit connected for at least 24 hours longer.

Table 14: Thruster Errors

## 5.6 Hydraulic Steering

If properly maintained, the steering system will provide years of safe and reliable performance. The system has been designed with protection against over-pressure situations by a pressure relief valve. Extreme caution must be exercised when diagnosing and correcting a fault. It is highly recommended that a qualified marine mechanic that has working knowledge of marine steering systems complete the diagnoses and fix.

### Caution

**It is NOT recommended to disassemble the hydraulic pump or remove the steering cylinder rod/shaft at any time. Doing so may cause more damage, leading to irreparable damage and costly replacements.**

### Caution

Do not use the hydraulic steering if it leaks. Contact Seafloor Systems to disable.

Fault	Cause	Solution
Hydraulic pump locks up upon filling.	Blockage in the steering lines.	Remove all steering lines. Blow air through the lines. Any line not allowing good air flow should be replaced.
System is very difficult to fill, air keeps burping out of top of help even after system appears full.	Air remaining in system. Bleed fitting leaking. Coiled hose. Lines not purged free of air.	Bleed steering system again utilizing bleeder fittings fitted on the steering cylinder. Tighten bleeder, replace if leak continues. DO NOT cut hoses, lessen coil or replace with shorter lines. Bleed air from reservoir/compensating lines.

Steering feels like it's binding up and has friction.	Adjusting nut on support rod is over tightened. Restrictions on hoses. Mechanical interference with other components. Incorrect fluid has been used to fill system. Damaged steering body. Cylinder mounting plate is too tight.	Nut should be hand-tight. Drain and flush, fill and bleed with SeaStar fluid. Replace steering cylinder completely. With Cylinder not connected, the plate must move up/down freely. Replace if hard to move.
System is very bumpy and requires to hold turning too long.	Air, dirt, or debris in system.	Bleed system. Replace hydraulic pump, flush system. (DO NOT attempt to repair hydraulic pump)

Table 15: Hydraulic Steering Faults

## 5.7 SmartCast

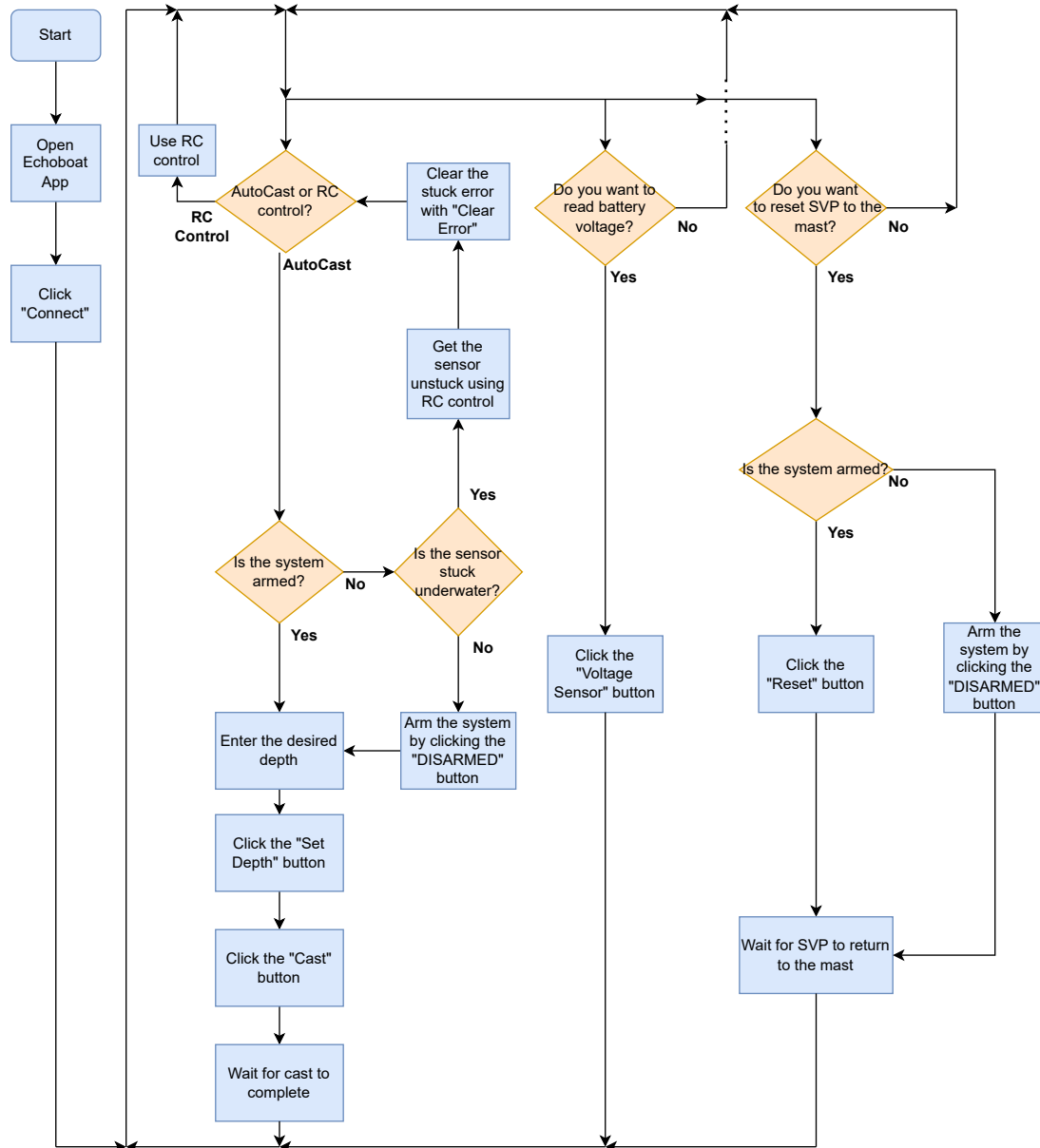


Figure 60: SmartCast Flow Diagram

## 5.8 Collision Avoidance Assist (CAA)

To verify the CAA is scanning objects correctly:

1. **Launching Foxglove Studio:** This can be done by searching for it in your Windows Taskbar application launcher.

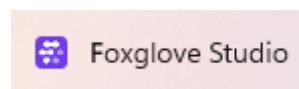


Figure 61: FoxGlove Studio

2. In Foxglove Studio, in the **Open data source** section, select **Open connection** Connect to a live robot or server.

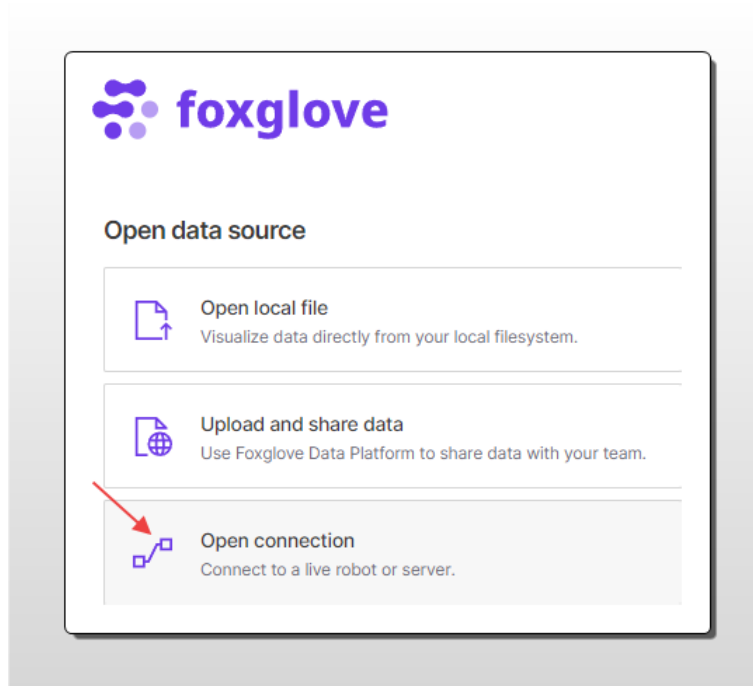


Figure 62: FoxGlove Open Connection

3. Select **Rosbridge**
4. Enter the **WebSocket URL** for the HydroCat™ 180, which is `ws://192.168.1.200:9090`.
5. Click **Open** to establish your connection to CAA

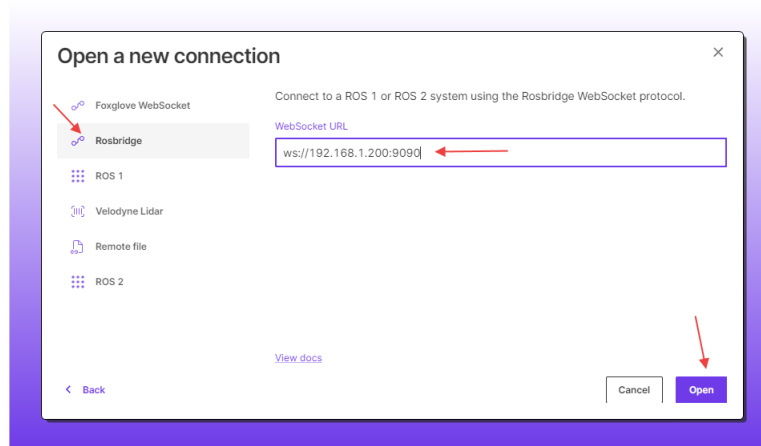


Figure 63: Connecting To CAA

6. The default panel configuration or the last used panel configuration will be shown with active LiDAR data.
7. **Resetting FoxGlove Studio Panel Configuration:** To set standard panel configuration or if panel settings were changed please import the configuration file to fix:
  - (a) Click the selection menu at the top left of the Foxglove Studio Application.
  - (b) Select **View**.
  - (c) Select **Import layout from file...**
  - (d) The standard panel configuration template will be stored in EchoBoat/Documents/CAA.

- i. LidarOnlyCAAv5-Foxglove-Studio-Panels.json for LiDAR only CAA.
- ii. FullCAAv5-Foxglove-Studio-Panels.json for Full CAA with LiDAR and Computer Vision.

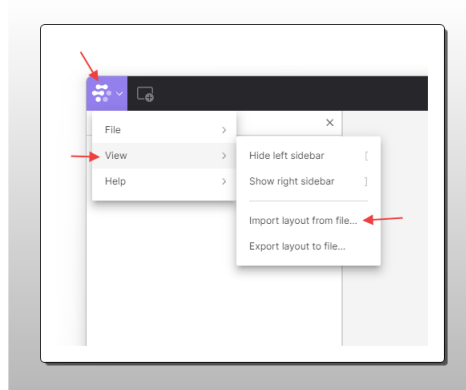


Figure 64: Importing A Default Panel Layout For Foxglove Studio

8. **Interpreting Foxglove Studio:** Once the HydroCat™ 180 receives data from the CAA, the live data can be seen in five main panels; NearIR LiDAR, LiDAR Signal Image, 3D View, lidar\_obstacles, and Map.

**Information**

Full CAA with Computer Vision has an additional four panels; Left Camera, Right Camera, camera\_obstacles, and detected object types.

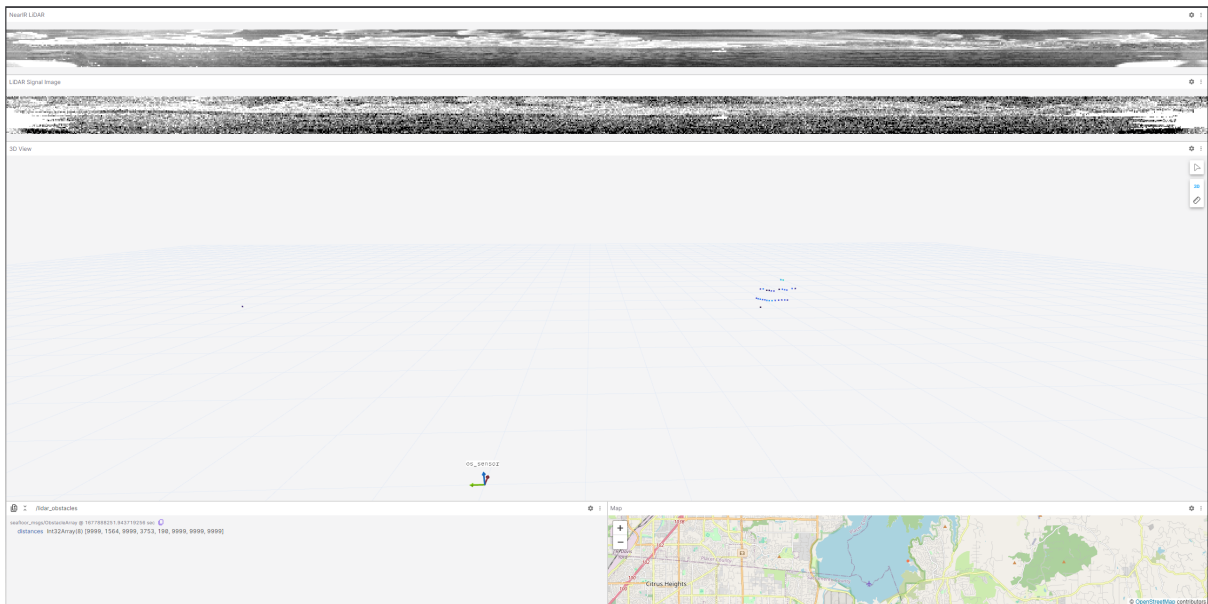


Figure 65: LiDAR Only FoxGlove Panels

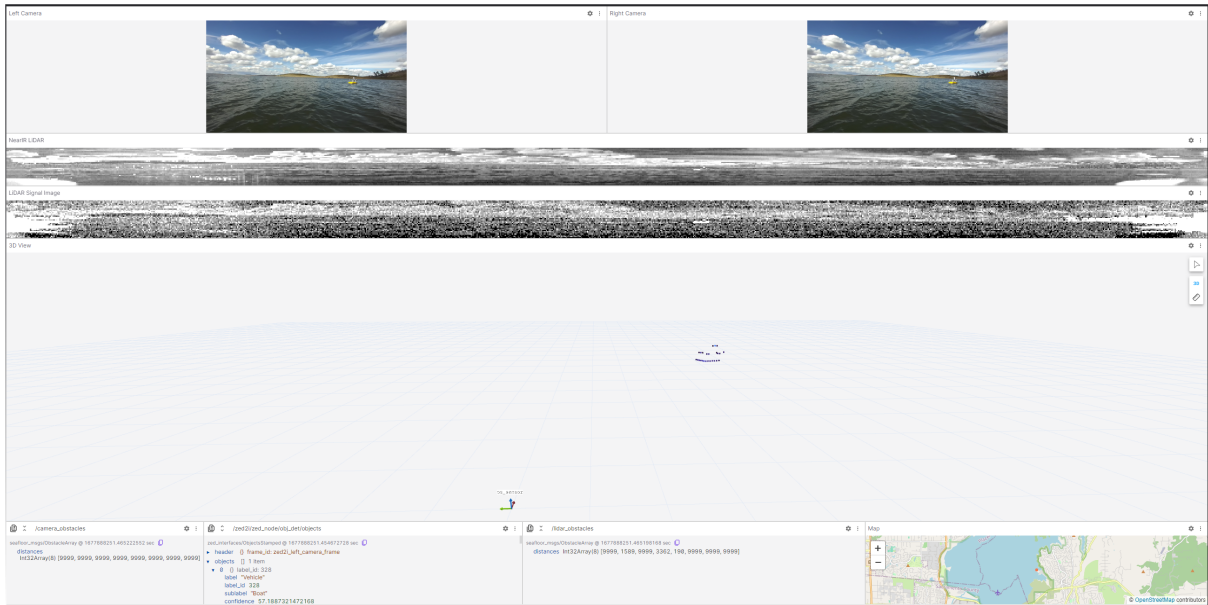


Figure 66: Full CAA FoxGlove Panels

- (a) **3D View Panel:** The red arrows show the forward direction that CAA is viewing. This panel can be used to view the 3D environment in different ways.
- i. **Change Perspective:** Click and drag the mouse within the 3D panel to alter the view-point or angle from which the 3D scene is observed.
  - ii. **Pan:** Hold down the right mouse button and drag the mouse to move the view horizontally or vertically across the scene.
  - iii. **Zoom:** Scroll the mouse wheel to change the distance between the viewer and the 3D scene, making objects appear larger or smaller.
  - iv. **Rotate:** Hold down the left mouse button and drag the mouse to change the orientation of the 3D scene.
- (a) **Obstacles Detected:** Once CAA detects an obstacle with the LiDAR.
- i. **Distance, Angle, Degree:** The obstacles distance, angle off the LiDAR, and degree off the HydroCat™ 180 are calculated and displayed in the 3D View.
  - ii. **Proximity Zones:** The proximity zones are populated with the nearest obstacles from around the HydroCat™ 180.
  - iii. **Interpreting lidar\_obstacles:**
    - A. The values in lidar\_obstacles are in centimeter distances.
    - B. A value of 9999 indicates that there is no obstacle seen by CAA for that zone.
    - C. The lidar\_obstacles array is from the first value which is the 45 degree angle directly in front of the HydroCat™ 180 rotating every 45 degrees clockwise.

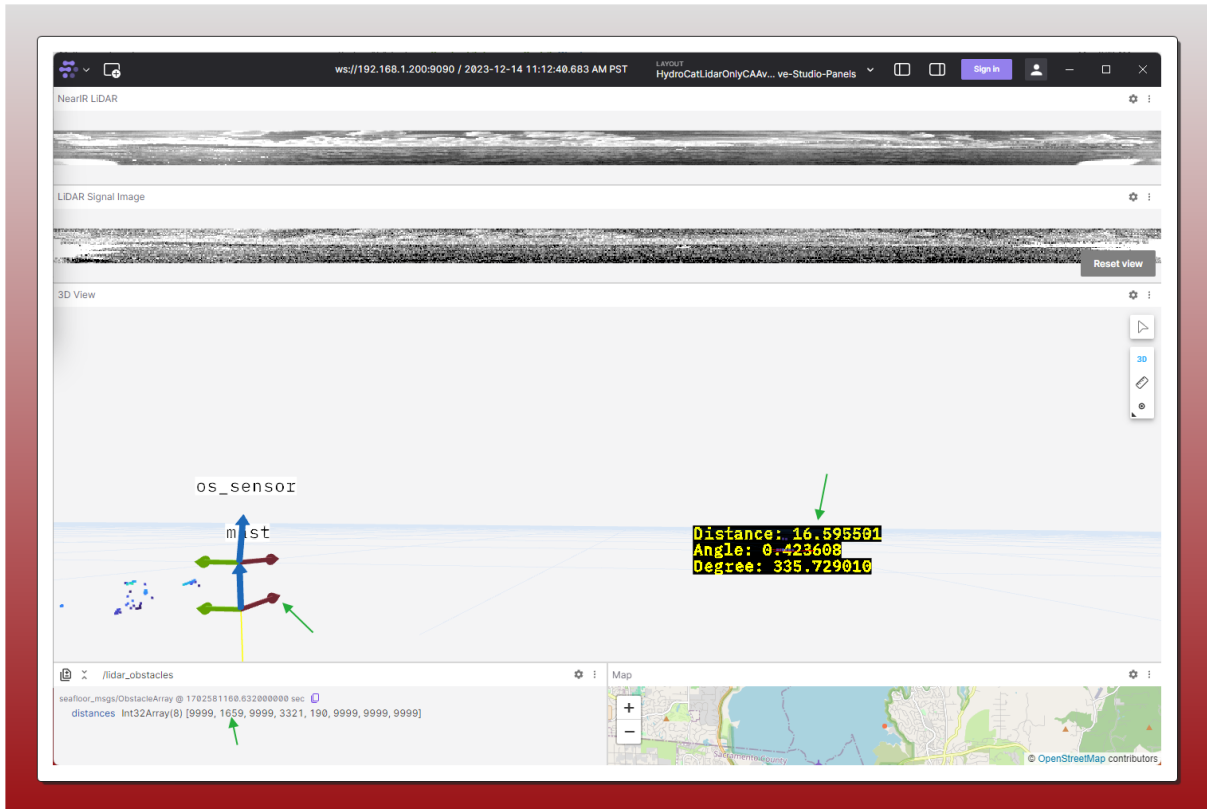


Figure 67: Obstacle Detected

- (b) **Disabling Distance View:** To disable viewing the distance calculations from CAA detected obstacles.
- i. Click the gear icon in the top right side of the 3D View Panel.
  - ii. Click **Toggle visibility** next to `/lidar_clustering/distances`
  - iii. An icon for a closed eye will appear and the selection will be greyed out.
  - iv. Click the **X** at the top right of the Panel selection menu to close the 3D panel menu.

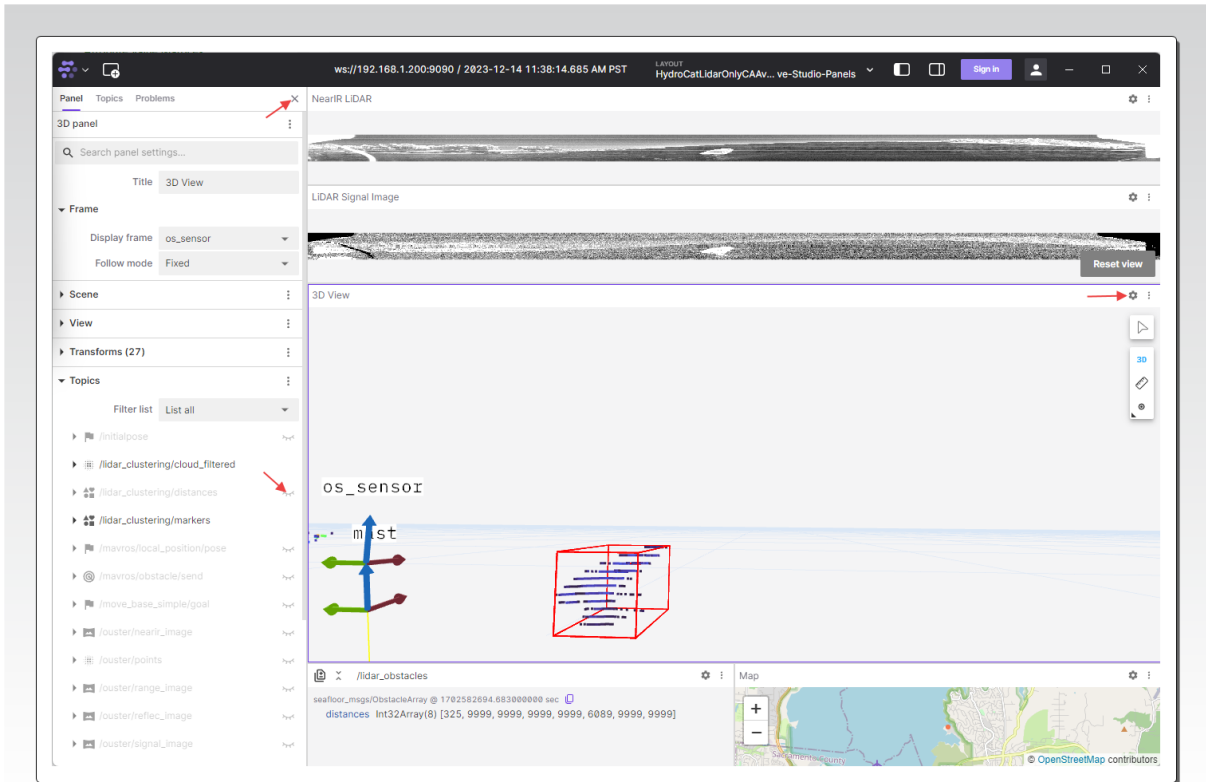


Figure 68: Disabling Distance Viewing

- v. Obstacles will now only be seen with their bounding boxes and not display distances.

### Important Alert

CAA is not operational if the HydroCat™ 180 is not receiving correct LiDAR data.

If LiDAR data is not showing up or the viewing angle is incorrect. Check the cabling and mounting of the LiDAR. Please contact Seafloor Systems to remote assist if a cabling or mounting issue was not found.

## 6 Configuring Procedures

### 6.1 RCU Receiver Binding Procedure

#### Archer R8 Pro Binding:

Registration is only required if the RCU or Receiver (RCVR) was replaced. Skip to step 7 to bind for either receivers.

If you are changing RCU and know the REG ID, you can skip the registration process by changing the new RCU REG ID.

1. Refer to 3.6 for button or switch locations on RCU.
2. Power on the RCU, power off the Archer R8 Pro.
3. Quick press 'Menu' on the RCU.



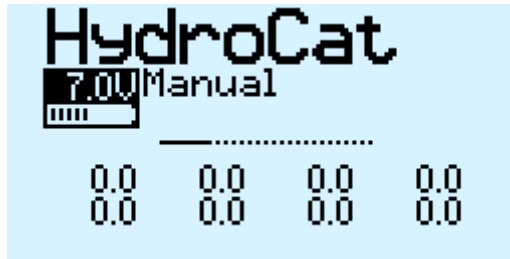


Figure 69: RCU Model Select Screen

4. Quick press 'Page' to switch to SETUP Page 2/13.

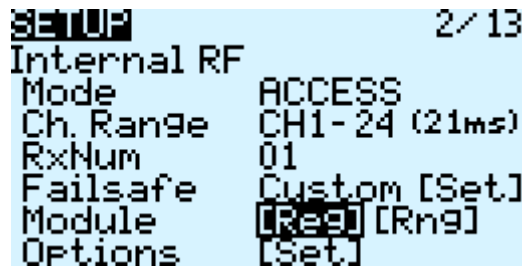


Figure 70: RCU Internal RF

5. Using the ENT knob, scroll down to INTERNAL RF. See figure 70.
  - (a) Archer R8 Pro Registration: (Registration ID is the vessel serial number)
    - i. Under Internal RF, Click Reg. A menu will pop up with 'Waiting...'.
      - If you are changing to a new RCU and know the REG ID, you can scroll up and change ID. Once changed, skip to Step 7 below.

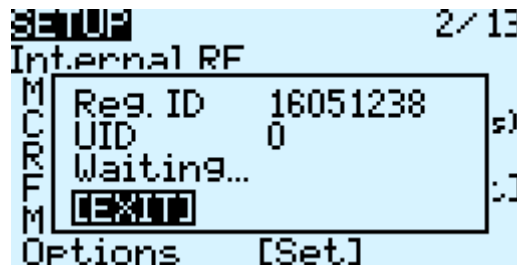


Figure 71: RCU - Waiting To Register

- ii. On the Archer R8 Pro, hold down the receiver button while powering up the Archer R8 Pro. See figure 72.



Figure 72: Archer R8 Pro

- It is suggested to disconnect the main cable to remove power and reconnect when power is needed.
- iii. On the RCU, 'Waiting...' will be replaced with the model name.
  - iv. Press Enter to confirm, registration complete.
  - v. Power off the receiver.
6. Scroll to Receiver 1 and select Bnd.
  7. Power on the Archer R8 Pro.



Figure 73: RCU Binding Screen - SimuRX1/2 Is Only Used For Simulation

8. Press OK once bind is successful.

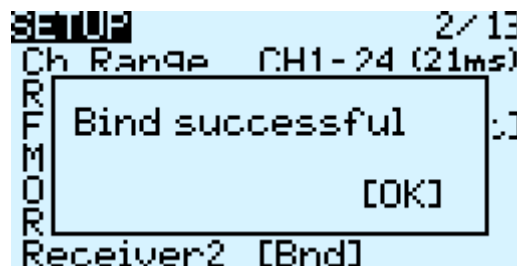


Figure 74: RCU Bind Successful

### R9 Stab OTA Binding:

1. Refer to 3.6 for button or switch location on RCU.
2. Long Range Module must be installed for this section.
3. Power on the RCU, power off the R9 Stab OTA.
4. Quick press 'Menu' on the RCU.

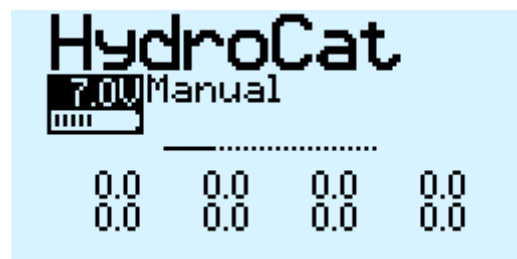


Figure 75: RCU Model Select Screen

5. Quick press 'Page' to switch to SETUP Page 2/12.

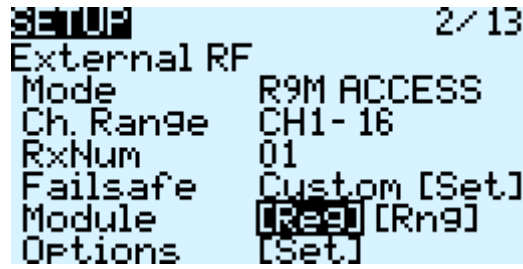


Figure 76: RCU External RF

6. Using the ENT knob, scroll down to EXTERNAL RF. See figure 76.

7. Registration is only required if a RCU or Rx was replaced.

(a) R9 Stab OTA Registration:

i. Under External RF, Click Reg. A menu will pop up with 'Waiting...'

- If you are changing to a new RCU and know the REG ID, you can scroll up and change ID. Once changed, skip to Step 7 below.

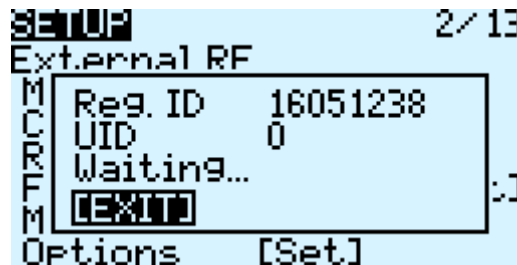


Figure 77: RCU - Waiting To Register

ii. On the R9 Stab OTA, hold down the receiver button while powering up the R9 Stab OTA. See figure 78.

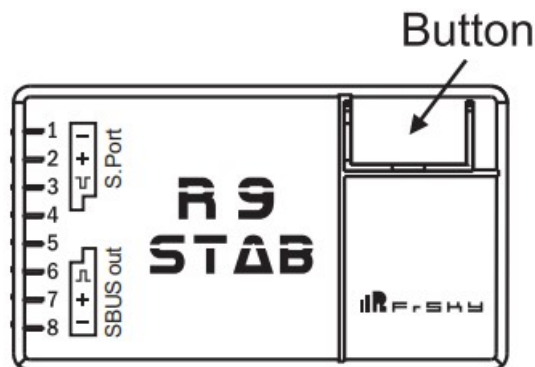


Figure 78: R9 Stab OTA

- It is suggested to disconnect the main cable to remove power and reconnect when power is needed.

iii. On the RCU, 'Waiting...' will be replaced with the model name.

iv. Press Enter to confirm, registration complete.

v. Power off the receiver.

8. Scroll to Receiver 1 and select Bnd.

9. Power on the R9 Stab OTA.



Figure 79: RCU Binding Screen - SimuRX1/2 Is Only Used For Simulation

10. Press OK once bind is successful.

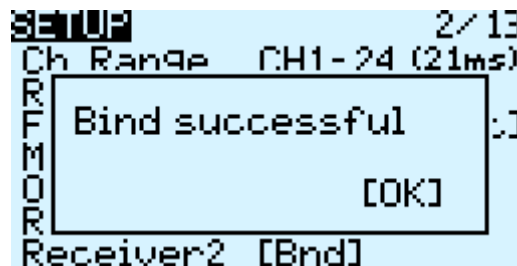


Figure 80: RCU Bind Successful

## 6.2 RCU Calibration Procedure

Calibrations should only be initiated if the HydroCat™ 180 demonstrates a delayed response or excessively quick response, while the remainder of the joystick throw remains unchanged.

### Information

All calibrations must be done in the correct order. Please refer to 3.6 to familiarize yourself with the RCU controls.

1. HydroCat™ 180 must be powered off.
2. Power on the RCU. (Refer to 3.6)

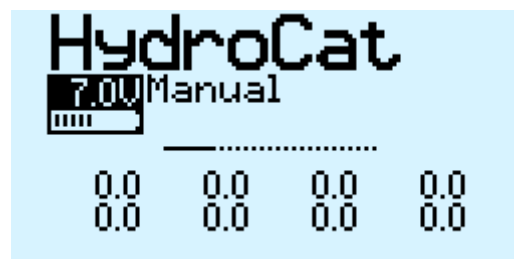


Figure 81: Main Screen

3. Hold down 'Menu' button.

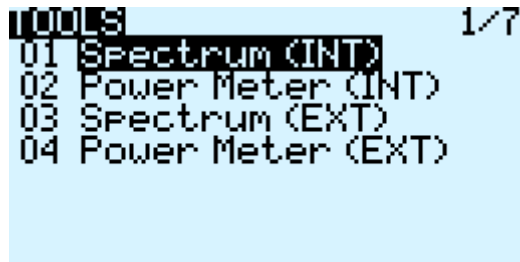


Figure 82: RCU Settings

4. Quick press 'Page' to switch to HARDWARE to Page 6/7.

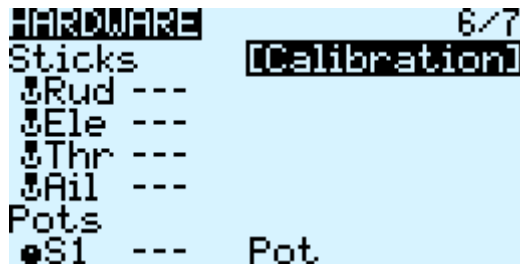


Figure 83: Hardware Page

5. Highlight 'Calibration' and select.
6. Follow the onscreen instructions.



Figure 84: Start Of Calibration

7. Once calibration is complete, screen will cycle back to start of calibration page.
8. Press Exit twice to exit back to main screen.

### 6.3 RCU AutoNav™ Calibration

1. Power on the RCU.
2. Power on the AutoNav™. (AutoNav™ can be powered via vessel or USB port.)
3. Connect to the AutoNav™. (USB Telemetry Module is 57600 baud rate. USB Cable is 115200 baud rate.)
4. Vessel MUST be disarmed.
5. Select Setup tab.

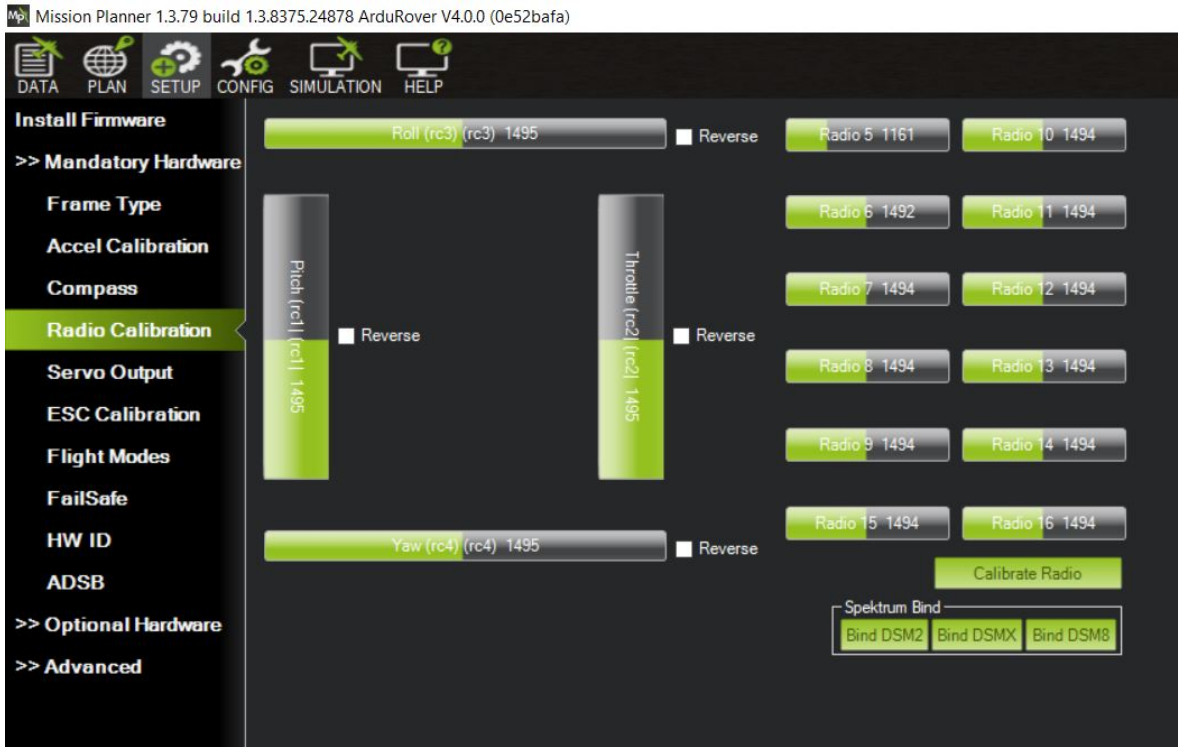


Figure 85: Setup Tab

6. Select Mandatory Hardware.
7. Select Radio Calibration.

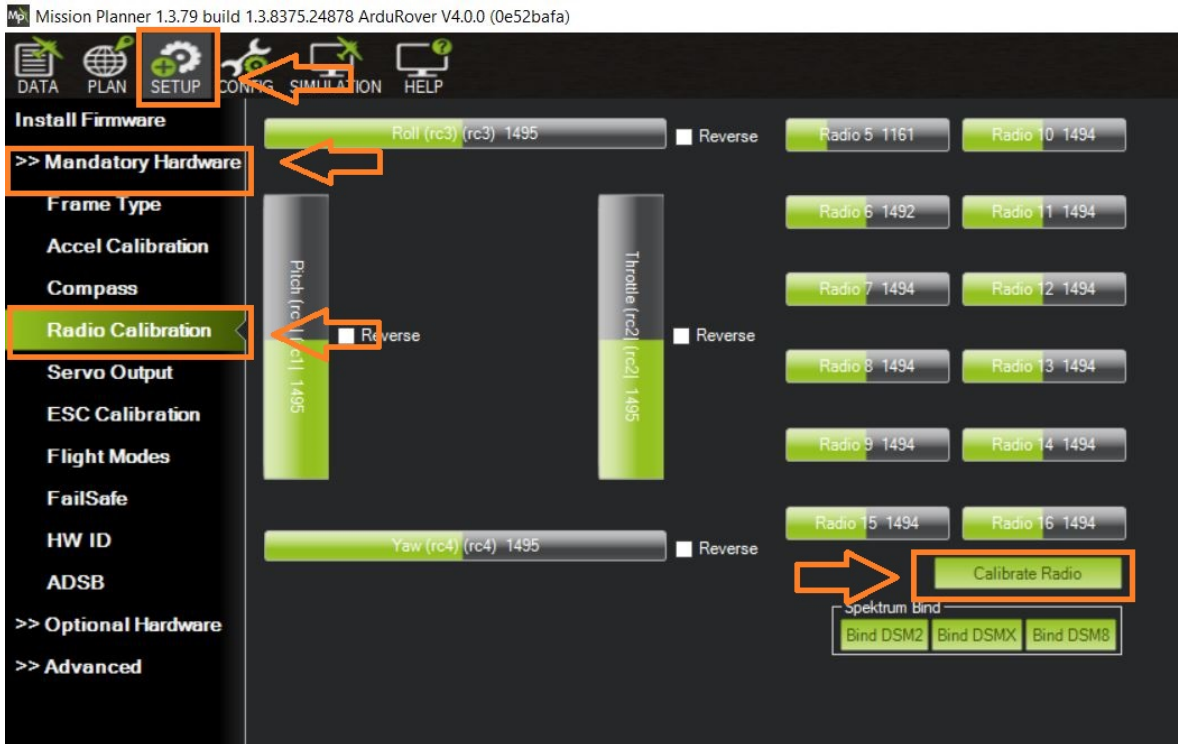
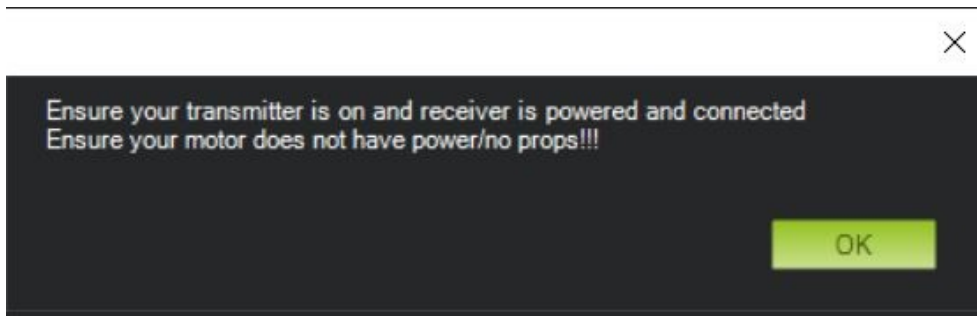
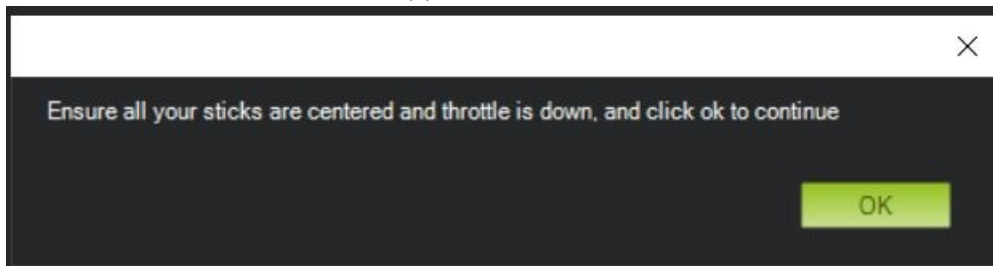


Figure 86: Radio Calibration Steps

8. Select Calibrate Radio.



(a) Power Warning



(b) Radio Cal Instructions

Figure 87: Pop Ups

9. Move all joystick to their min and max positions.
10. Move all switches to each position. Be sure to arm and disarm.
11. You will notice each active channel will have a red line indicating the received min and max signal.

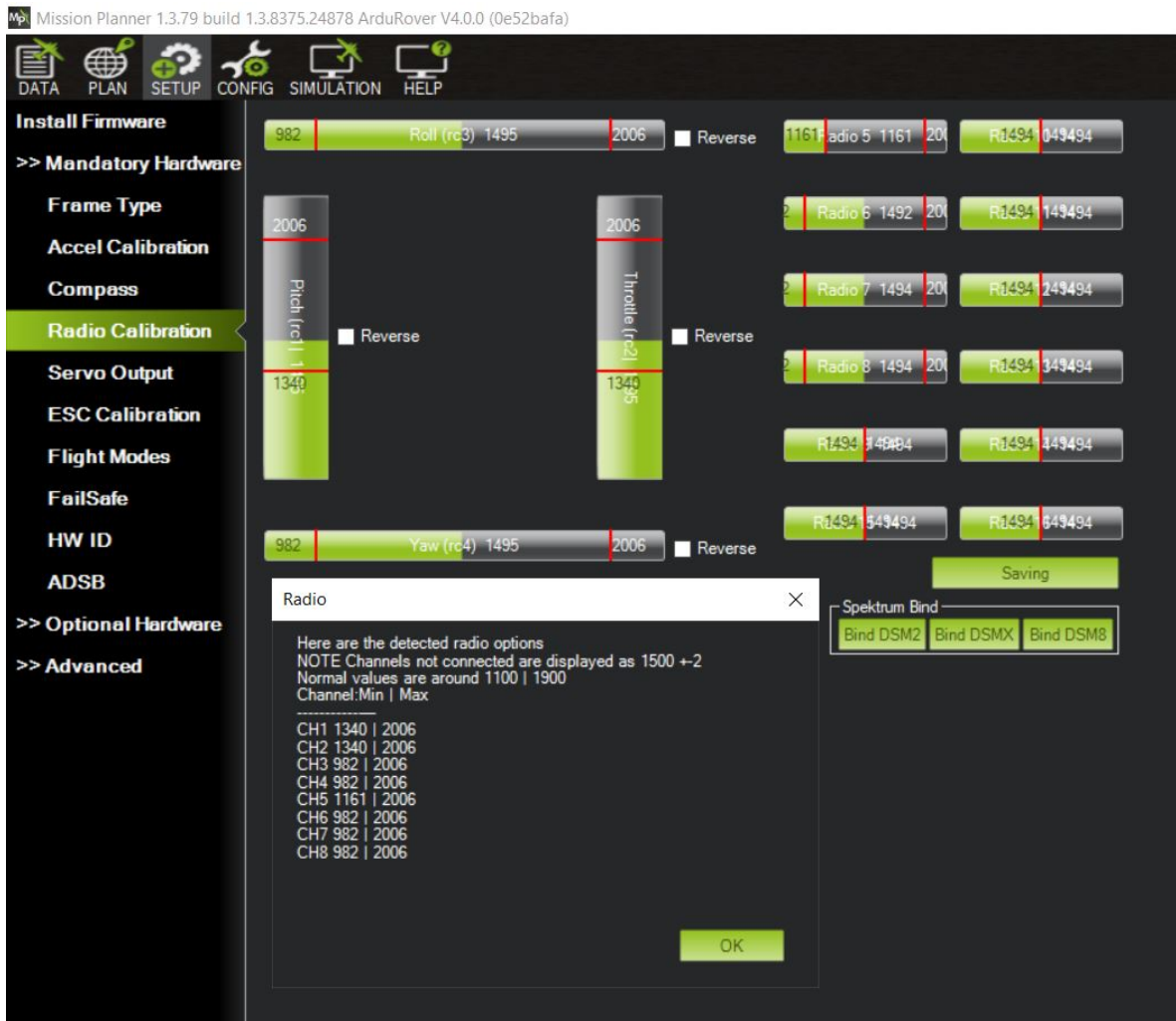


Figure 88: Radio Calibration Verification

12. Select Click when Done.

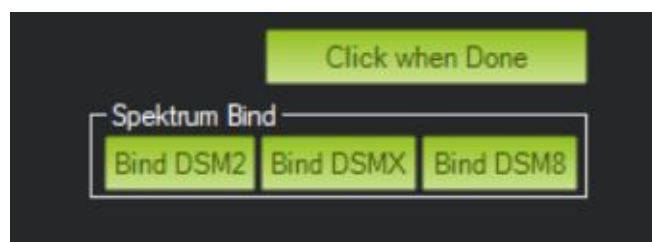


Figure 89: Click When Done

13. A page will popup indicating the new min and max values. Press OK. (Refer to Figure 88)



## 6.4 AutoNav™ Accel Calibration

1. Remove AutoNav™ from HydroCat™ 180. Disconnect all cables.
2. Connect the 3ft (1M) USB A to A cable into communication port of the AutoNav™.
3. Connect the opposite end into the onboard PC.
4. Open Mission Planner.
5. Connect to the AutoNav™ with 115200 baud rate.
6. Select Setup tab.

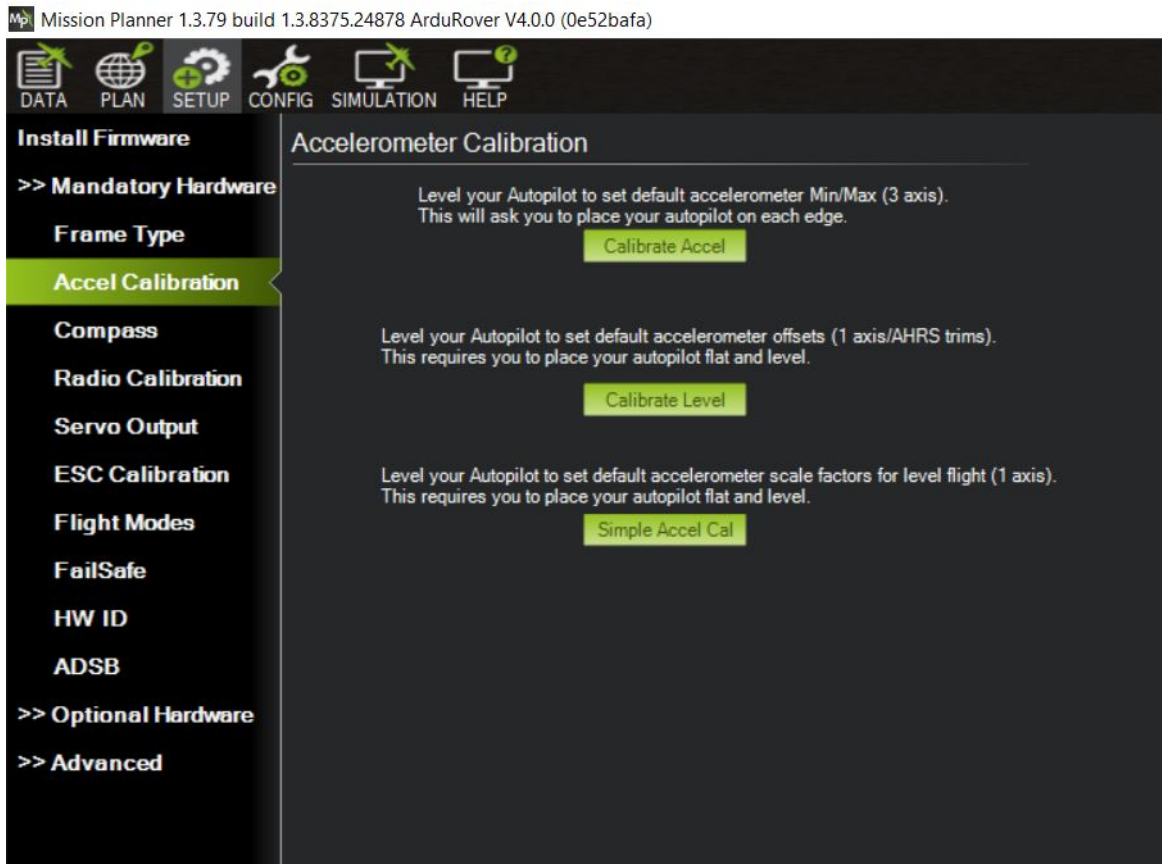


Figure 90: Accel Calibration

7. Select Mandatory Hardware.
8. Select Accel Calibration.

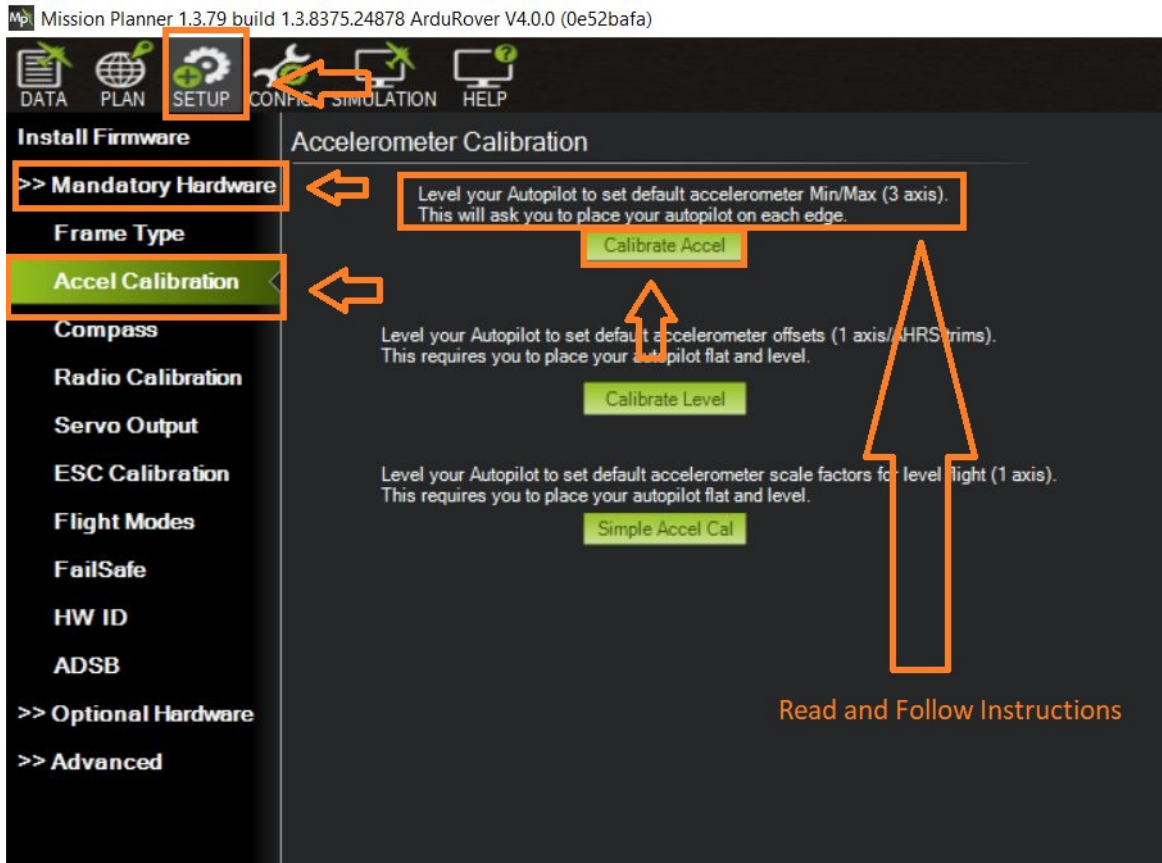


Figure 91: Accel Calibration Steps

9. Set the AutoNav™ on a level surface.
10. Select Calibrate Accel(3 axis). You will rotate and hold the AutoNav™ on each axis. Instructions will be present during the process. **Bulkheads are always facing backwards(stern).**

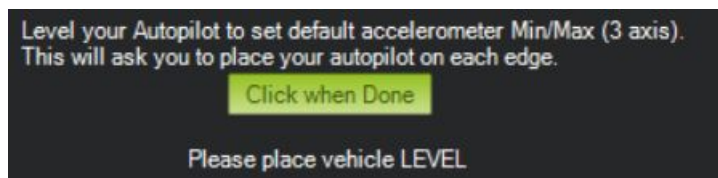


Figure 92: Accel Calibration In Process

- (a) First is a level surface. Click button when done.
  - (b) Rotate on it's left side. Click button when done.
  - (c) Rotate on it's right side. Click button when done.
  - (d) Rotate nose down. (Bulkheads facing the sky) Click button when done.
  - (e) Rotate nose up. (Bulkheads facing the ground) Click button when done.
  - (f) Rotate it upside down. Click button when done.
11. 3 axis calibration is complete.

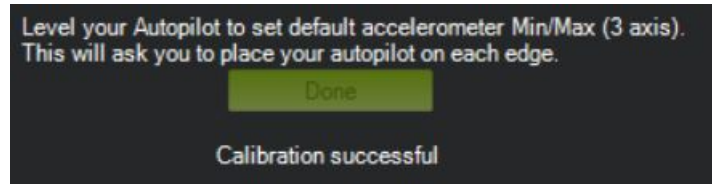


Figure 93: Accel Calibration Complete

12. Set the AutoNav™ on a level surface again.
13. Select Calibration Level. (See Figure 90)

## 6.5 Sonar Pole Actuators Calibration Procedure

To access the Sonar Pole Control Actuator Box(Figure 10, remove the 4x M5 bolts holding the top plate on. Remove the 6 screws holding the lid on.

### Calibration:

1. Remove the sonar system from the Sonar Actuator Pole.
2. Press ACTUATOR SET button on the screen.
3. Press CAL button on the screen.
4. The actuators will extend and retract a total of three times.
5. Calibration complete.

## 7 Service and Maintenance

### 7.1 Maintaining Your Investment

Maintaining your HydroCat™ 180 asset is essential for its reliable performance. Regular maintenance includes routine checks of propulsion system, sensor, and electronics to ensure they are in optimal working condition. Keeping the hull clean as well as verifying the integrity of communication links and power sources, is crucial. By adhering to a proactive maintenance regimen, the USV remains mission-ready, maximizing its effectiveness and longevity.

### 7.2 Storage

- Store indoors with all hatches open for air circulation.
- Pontoon batteries charged above 43VDC - check every month.
- Gimbal batteries fully charged - check every month.
  - If planning on storing the HydroCat™ 180 for an extended period. Disconnect the power into the Sonar Pole Control Box.
- pontoons and gimbal are dry.

### Caution

The Sonar Pole Control Box, depicted in Figure 10, is equipped with a persistent memory. It remains powered continuously through the gimbal batteries, even when the Gimbal Power Switch is turned off. Keeping the gimbal batteries fully charged each month is crucial. If stored for an extended period confirm the Sonar Pole is in the travel position before disconnecting power.

## 7.3 Service

### 7.3.1 Anode Replacement

There are five (5) galvanic anodes per thruster.

Shaft Anode:

1. Using a M32 open end wrench, unscrew the shaft anode.
2. Replace as necessary.

Thruster Anode(in front of prop):

1. Using 6mm Allen driver remove the two bolts holding the two halves together.
2. Replace as necessary.

Transom Anode:

- Using the trim switch (Refer to 3.4), tilt the thruster upwards as far as it will go.
- Loosen the two hex bolts on both sides of the inner part of the transom.
- Replace as necessary.

There is one (1) galvanic anode per pontoon

- Using a 4mm Allen driver unscrew the anode from the fin of the pontoon. (Figure 8)
- Replace as necessary.

### 7.3.2 Propeller Replacement

1. USV must be powered off.
2. Unscrew the shaft anode with a M32 socket.
3. Remove cotter pin.
4. Remove the crown nut with a M24 socket.
5. Remove washer and pull off propeller.

### 7.3.3 Hydraulic Steering

#### Caution

It is highly recommended that a qualified marine mechanic that has working knowledge of marine steering systems complete the work. **After first 20 hours, then every 100 hours or 6 months thereafter (which ever comes first).**

1. All points noted above.
2. Check tightness of ALL fasteners/fittings throughout the steering system. Tighten to correct torque specifications as required.
3. Check for mechanical play or slop throughout steering system, correct as required.
4. Check for signs of corrosion. If corrosion is present contact Seafloor Systems.

**After every 200 hours or 12 months (which ever comes first).**

1. All points above noted.
2. Remove support rod from engine steering/tilt tube. Clean engine steering/tilt tube and re-grease using a good quality marine grease.
3. Grease support rod liberally.

4. Grease all contact points show in Figure 94. DO NOT remove tiller bolt and re-grease.
5. Inspect hydraulic oil for cleanliness, flush if required.

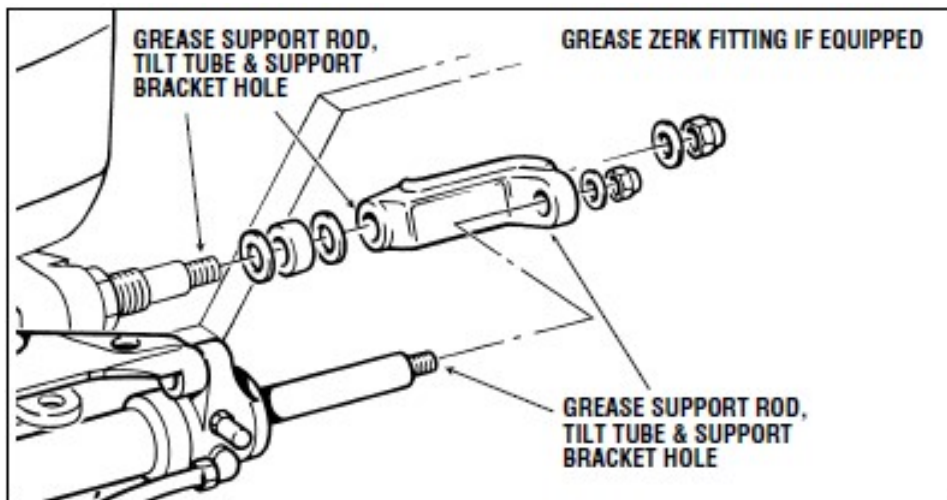


Figure 94: Grease locations

#### 7.3.4 Purging Hydraulic Steering

##### Caution

It is highly recommended that a qualified marine mechanic that has working knowledge of marine steering systems complete the work.

These instructions show how to fill and purge a SeaStar steering system with the SeaStar Autopilot pump installed. The same steps apply to all cylinders with the exception of which bleed fitting to open and close and the direction the cylinder rod moves.

The use of a Power Purge kit (HA5445 or equivalent) is highly recommended and will improve the speed and quality of the purge procedure.

##### Information

This procedure requires three people. One person may not be able to remove all the air from the system, which will result in spongy, unresponsive steering. During the entire filling procedure, oil **MUST** be visible in the filler tube. **DO NOT** allow oil level to disappear into the helm pump, as this may introduce air into the system and increase your filling time.

**Hydraulic Fluid:** SeaStar recommends use of SeaStar Steering Fluid **ONLY** in the hydraulic steering systems. SeaStar Steering Systems have been engineered and validated using their proprietary SeaStar Hydraulic Steering Fluid. SeaStar Steering fluid is engineered with a special additive package that contains anti-foaming and anti-rusting agents, anti-oxidants, viscosity stabilizers, corrosion inhibitors, wear additives as well as water emulsification additives. It is highly recommended that SeaStar Steering Fluid be used to ensure optimum system performance and safety.

##### Caution

Any non-approved fluid may cause serious damage to the steering system resulting in possible loss of steering, causing property damage, personal injury and/or death. Use of any non-approved fluid may result in the following:

- Higher steering effort, particularly at ambient or lower temperatures and/or over time due to oil degradation and breakdown.
- Increased steering slip and/or drift resulting in lost motion.

- Foaming or air entrapment causing a bumpy feel during steering.
- High rates of moisture absorption causing internal component corrosion.
- Scratched steering cylinder bores and shafts due to contamination or elevated wear rates.
- Seal degradation – incompatibility with various proprietary seal compounds used in our products.

### Caution

In an emergency, SeaStar EPS Fluid, any MD-3/4 rated ATF or MILPRF-5606H equivalent fluid that is filtered through a fine mesh screen can be used. The system **MUST** be thoroughly flushed as soon as possible with genuine SeaStar Steering Fluid after using an emergency fluid.

### Caution

Never fill or mix brake fluids, triglycerides or polyalkylene glycols within a hydraulic steering system.

Required Parts for Purging:

- SeaStar Steering Fluid, minimum of 2qts
- Empty container
- Hose A - 1/2" ID, minimum length 3ft (0.9m)
- Hose B - 5/16 ID, minimum length 2ft (0.6m)
- Hose clamp for Hose A
- Adjustable Crescent Wrench

### Important Alert

**Only purge one hydraulic system at a time**

How to purge the hydraulic system:

1. Remove stern hatch to access the hydraulic pump.
2. Remove bolts holding down hydraulic pump mounting plate.
3. Power on the RCU. (Refer to 3.6)
  - (a) DO NOT ARM THE HydroCat™ 180.
4. Power on the gimbal. (Refer to 11)
5. Power on the pontoon you're working on. (Refer to 11)
6. Power on the Pontoon Power Switch. (Refer to 6).
7. Remove brass cap on hydraulic pump.



Figure 95: Brass Cap Covering Inlet Fitting

8. Attach Hose A to the inlet. Use a hose clamp to seal it.
9. Put the other end of Hose A into the SeaStar steering fluid.
10. Remove the caps on the hydraulic steering.



Figure 96: Bleeder Fitting Locations

11. Attach Hose B to the starboard fitting.
12. Attach the other end of Hose B into the empty container.
13. Loosen the starboard bleeder fitting. (Figure 96)
14. Loosen Inlet fitting two full turns. (Figure 95)
15. Hold the Thruster centered during the next step. (Figure 97)



Figure 97: Hold Thruster During Purging Process

16. Using the RCU, turn left with the left joystick.
17. Keeping the left joystick held down to the left, let the hydraulic pump continuously run to drain the air out of the system.
18. Make sure you do not run out of steering fluid during this process.

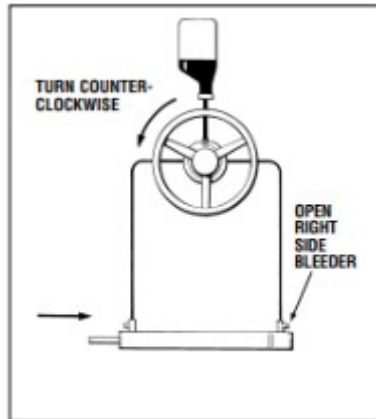


Figure 98: Starboard Bleeder Fitting - Open

19. Once all the air is removed, tighten the starboard bleeder fitting.
20. Transfer Hose B to the port bleeder fitting.
21. Loosen the port bleeder fitting.
22. Hold the Thruster centered during the next step. (Figure 97)
23. Using the RCU, turn right with the left joystick.
24. Keeping the left joystick held down to the right, let the hydraulic pump continuously run to drain the air out of the system.
25. Make sure you do not run out of steering fluid during this process.

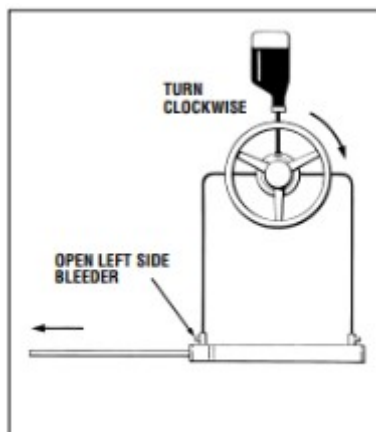


Figure 99: Port Bleeder Fitting - Open

26. Once all the air is removed, tighten the port bleeder fitting.
27. Torque the two bleeder fittings to 180 in-lbs (20.34 Nm). (Figure 96)
28. Remove Hose B from the bleeder fitting and reinstall the rubber covers.
29. Tighten the inlet fitting and remove Hose A.
30. Torque the inlet fitting to 180 in-lbs (20.34 Nm). (Figure 95)
31. Install the brass cap and torque to 180 in-lbs (20.34 Nm). (Figure 95)
32. Using the RCU, steer the thruster left and right while checking for any leaks in the hydraulic system.



33. Install the hydraulic pump back onto the pontoon plate using 222 MS Loctite or equivalent thread locker.

### 7.3.5 RCU RTC Battery Replacement

Replace the RTC battery when you receive "Battery Warning: RTC Battery Low".

Part Required:

- CR21220 Coin Battery

Tool Required:

- Phillips Screwdriver

1. Power off and flip over the RCU.
2. Locate the two visible Phillip screws and unscrew them.



Figure 100: RCU 2x Screw Locations

3. Remove the module bay cover.
4. Remove the battery cover. (Figure 19)
5. Disconnect the battery.



Figure 101: RCU Final Screw Locations

6. Locate the additional two Phillip screws and unscrew them.
7. Carefully split case of the RCU.

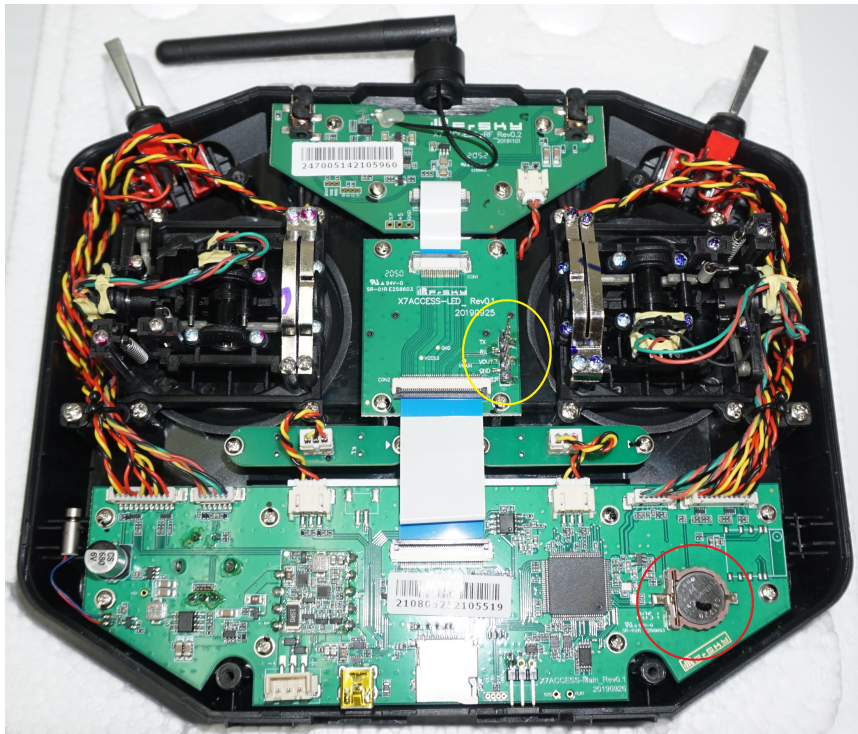


Figure 102: RCU RTC Location

8. Locate the RTC battery(circled red) and remove it.
9. Replace it with a new CR1220 battery.

10. Carefully put the two case halves together. Verify the module bay pins (circled yellow in Figure 102) slide through the slot (Figure 19).
11. Screw in the four Philip screws.
12. Connect the battery.
13. Install battery spacing foam.
14. Install the battery and module bay covers.

## **7.4 Maintenance Schedule**

### **7.4.1 Pre-launch Checklist**

- Hull inspection for damage, cracks, or signs of wear.
- Seals are lubricated with silicone-based lubricants.
- Anti-seize on hardware.
- Electronics are functioning.
- Batteries are fully charged.
- Check all hardware is tight.
- Check all cable connections are screwed tight.
- Confirm full insulation of all cables.
- Check thruster tilting device for leaks and proper functionality.

### **7.4.2 After Recovery Checklist**

- Hull inspection for damage, cracks, or signs of wear.
- Seals are lubricated with silicone-based lubricants.
- Anti-seize on hardware.
- Remove and lube drain plugs with anti-seize.
- Electronics are functioning.
- Batteries are fully charged.
- Check all hardware is tight.
- Cleaned with fresh water and mild soap.
- Dried off.
- Stored with hatches open for circulation.

### **7.4.3 Monthly Checklist**

- Hull inspection for damage, cracks, or signs of wear.
- Check for loose or corroded electrical connections.
- Check bearing bolts are tight(pitch & roll axis)
- Check wear on pivot axles.
- Lubricate seals with silicone-based lubricants.
- Anti-seize on hardware.

- Remove and lube drain plugs with anti-seize.
- Electronics are functioning.
- Inspect Anodes, replace as necessary.
- Battery maintenance.
  - Pontoon batteries should be stored above 43VDC.
  - Gimbal batteries should be fully charged.
  - Long Range Battery should be stored at 7.2VDC.
- Replenish any parts that were pulled from the spares kit.
- Stored with hatches open for circulation.
- Inspect Shark Hide exterior pontoon coverage, reapply if necessary.

Trailer:

- Check tire pressure.
- Check bearing oil/grease level.
- Check bolts are tight.
- Check leaf springs aren't broken.
- Check brake pads.

## 8 Technical Diagrams

### 8.1 Beaufort Sea State Chart

Estimating Wind Speed and Sea State with Visual Clues				
Beaufort number	Wind Description	Wind Speed	Wave Height	Visual Clues
<b>0</b>	Calm	0 knots	0 feet	Sea is like a mirror. Smoke rises vertically.
<b>1</b>	Light Air	1-3 kts	< 1/2	Ripples with the appearance of scales are formed, but without foam crests. Smoke drifts from funnel.
<b>2</b>	Light breeze	4-6 kts	1/2 ft (max 1)	Small wavelets, still short but more pronounced, crests have glassy appearance and do not break. Wind felt on face. Smoke rises at about 80 degrees.
<b>3</b>	Gentle Breeze	7-10 kts	2 ft (max 3)	Large wavelets, crests begin to break. Foam of glassy appearance. Perhaps scattered white horses (white caps). Wind extends light flag and pennants. Smoke rises at about 70 deg.
<b>4</b>	Moderate Breeze	11-16 kts	3 ft (max 5)	Small waves, becoming longer. Fairly frequent white horses (white caps). Wind raises dust and loose paper on deck. Smoke rises at about 50 deg. No noticeable sound in the rigging. Slack halyards curve and sway. Heavy flag flaps limply.
<b>5</b>	Fresh Breeze	17-21 kts	6 ft (max 8)	Moderate waves, taking more pronounced long form. Many white horses (white caps) are formed (chance of some spray). Wind felt strongly on face. Smoke rises at about 30 deg. Slack halyards whip while bending continuously to leeward. Taut halyards maintain slightly bent position. Low whistle in the rigging. Heavy flag doesn't extended but flaps over entire length.
<b>6</b>	Strong Breeze	22-27 kts	9 ft (max 12)	Large waves begin to form. White foam crests are more extensive everywhere (probably some spray). Wind stings face in temperatures below 35 deg F (2C). Slight effort in maintaining balance against wind. Smoke rises at about 15 deg. Both slack and taut halyards whip slightly in bent position. Low moaning, rather than whistle, in the rigging. Heavy flag extends and flaps more vigorous.
<b>7</b>	Near Gale	28-33 kts	13 ft (max 19)	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of wind. Necessary to lean slightly into the wind to maintain balance. Smoke rises at about 5 to 10 deg. Higher pitched moaning and whistling heard from rigging. Halyards still whip slightly. Heavy flag extends fully and flaps only at the end. Oilskins and loose clothing inflate and pull against the body.
<b>8</b>	Gale	34-40 kts	18 ft (max 25)	Moderately high waves of greater length. Edges of crests begin to break into the spindrift. The foam is blown in well-marked streaks along the direction of the wind. Head pushed back by the force of the wind if allowed to relax. Oilskins and loose clothing inflate and pull strongly. Halyards rigidly bent. Loud whistle from rigging. Heavy flag straight out and whipping.
<b>9</b>	Strong Gale	41-47 kts	23 ft (max 32)	High waves. Dense streaks of foam along direction of wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.
<b>10</b>	Storm	48-55 kts	29 ft (max 41)	Very high waves with long overhanging crests. The resulting foam, in great patches is blown in dense streaks along the direction of the wind. On the whole, the sea takes on a whitish appearance. Tumbling of the sea becomes heavy and shock-like. Visibility affected.
<b>11</b>	Violent Storm	56-63 kts	37 ft (max 52)	Exceptionally high waves (small and medium-sized ships might be for time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere, the edges of the wave crests are blown into froth. Visibility greatly affected.
<b>12</b>	Hurricane	64+ kts	45+ ft	The air is filled with foam and spray. The sea is completely white with driving spray. Visibility is seriously affected.

Figure 103: Beaufort Sea State

## 8.2 Offset Drawing

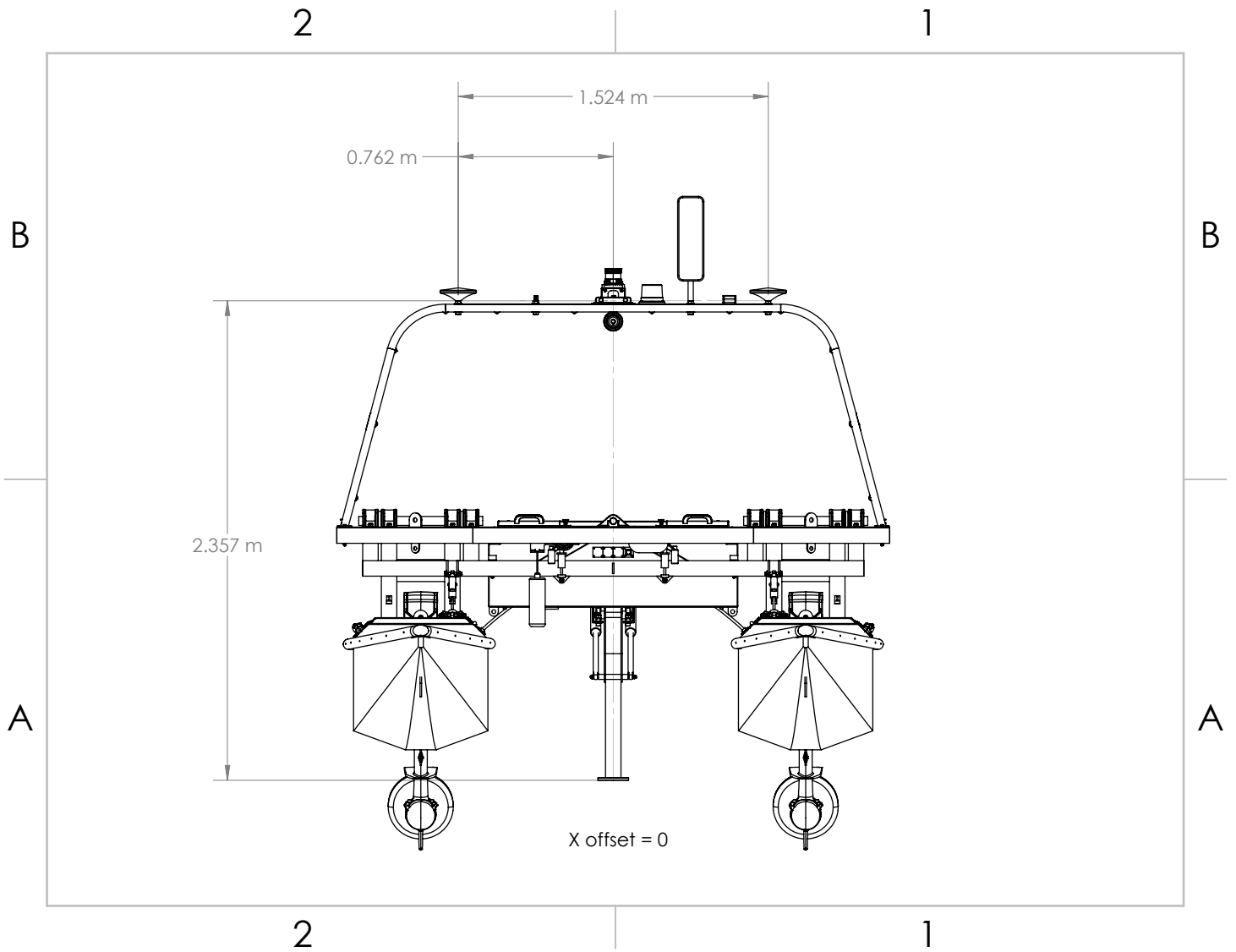


Figure 104: HydroCat™ 180 Offset Diagram

### Information

Reference numbers for Seafloor System vessels only. For optimal accuracy, please measure your own offsets.

### 8.3 Block Diagrams

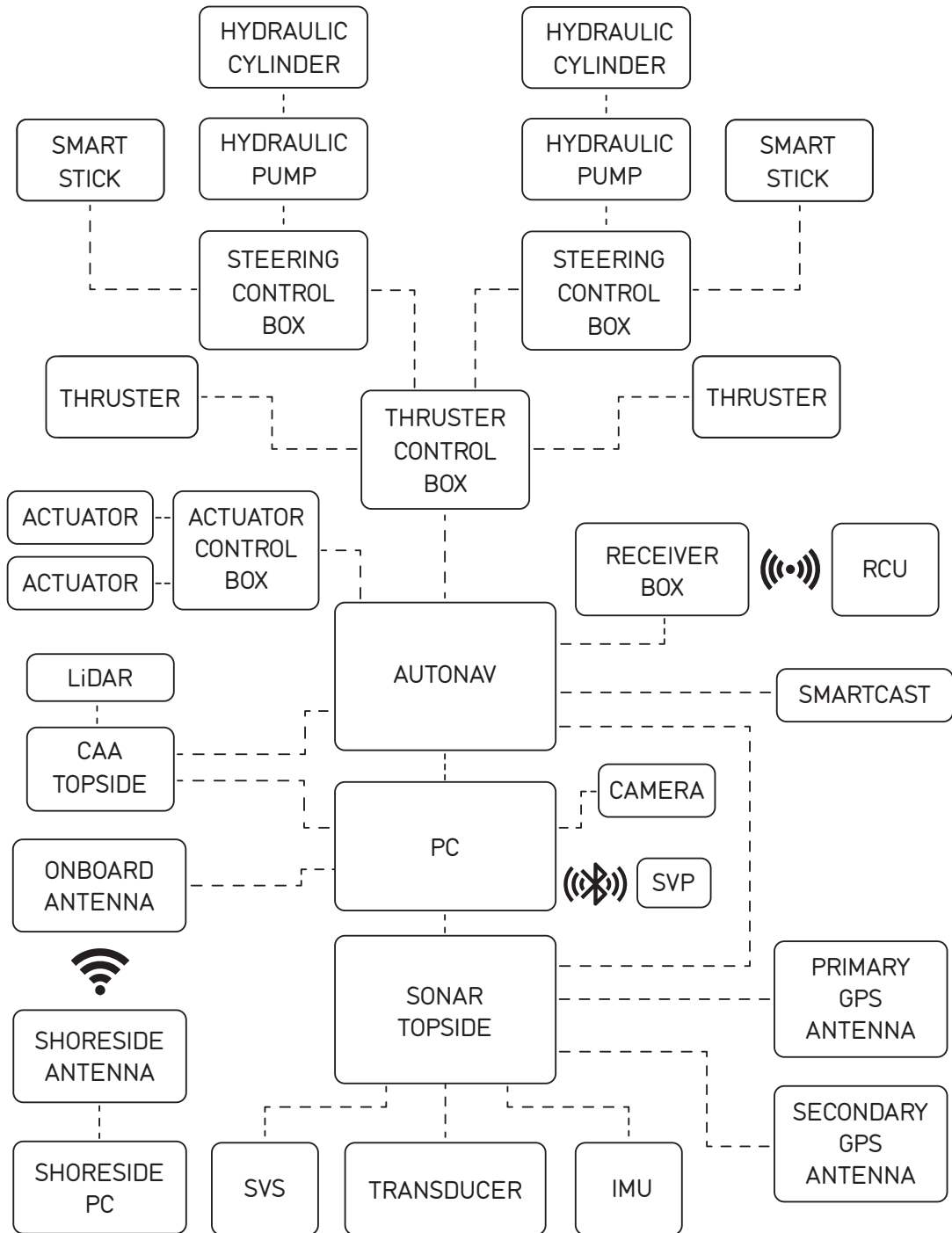


Figure 105: Block Diagram

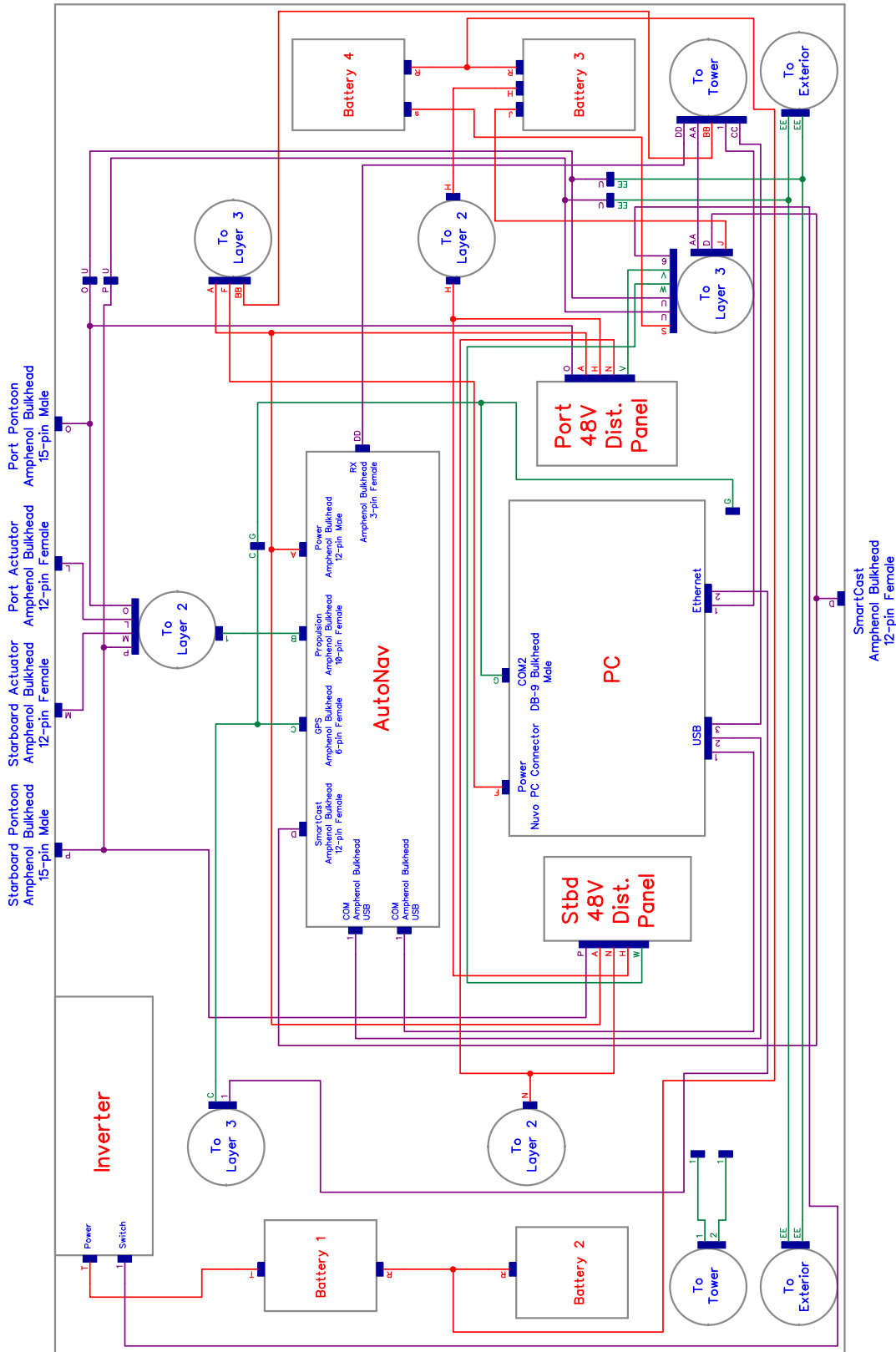


Figure 106: Gimbal Layer 1 Block Electrical Diagram



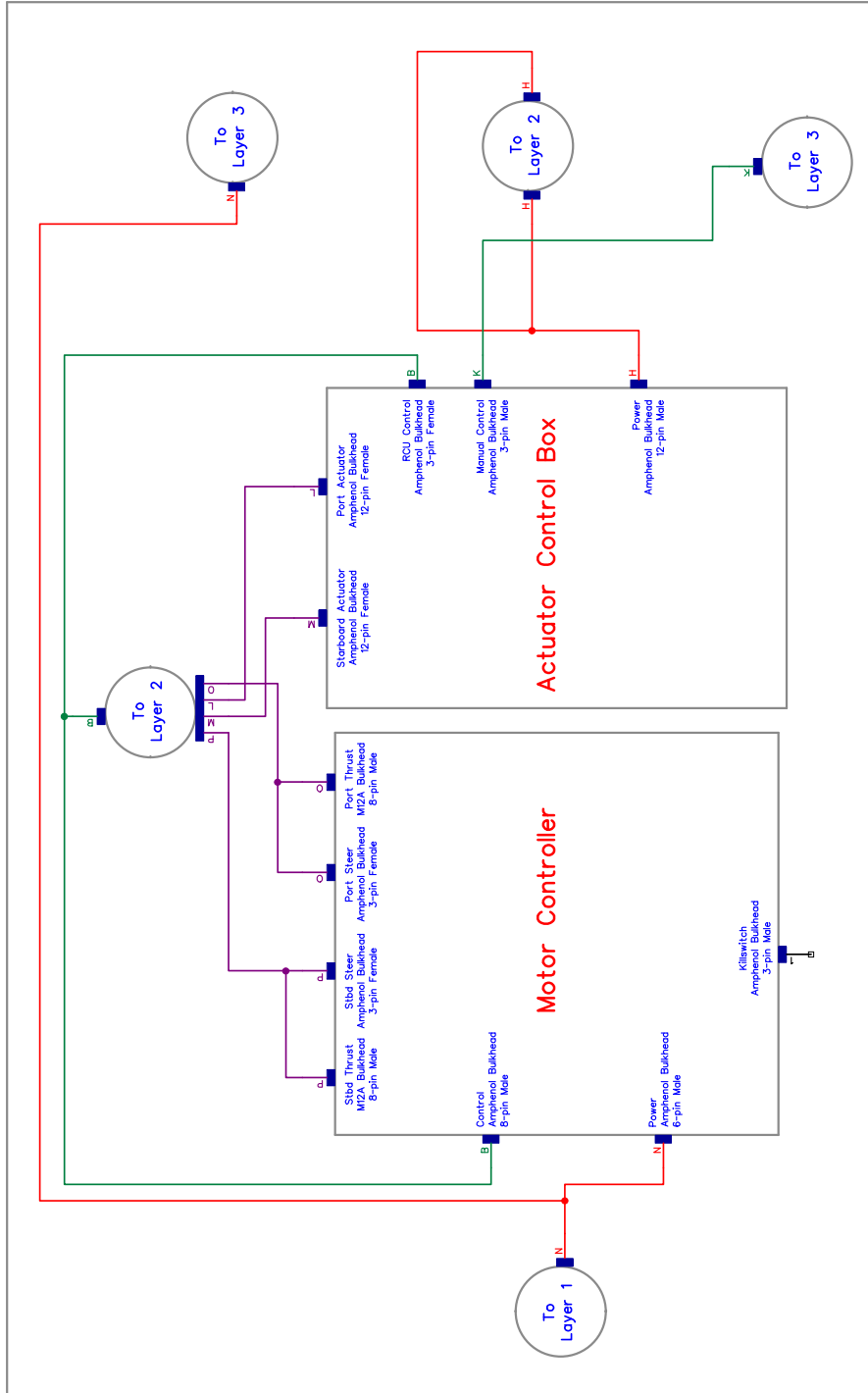


Figure 107: Gimbal Layer 2 Block Electrical Diagram



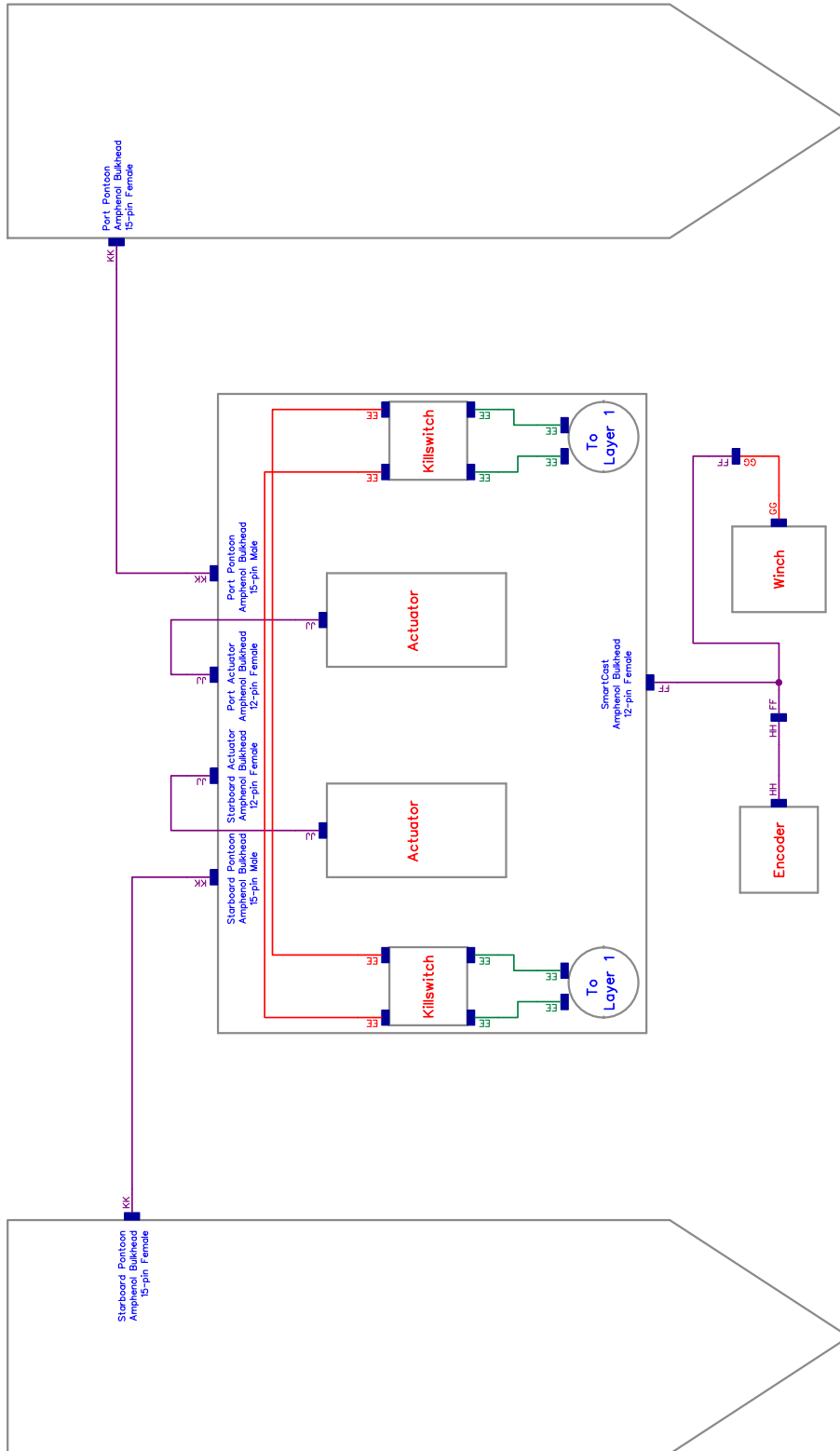


Figure 109: Mast Block Electrical Diagram

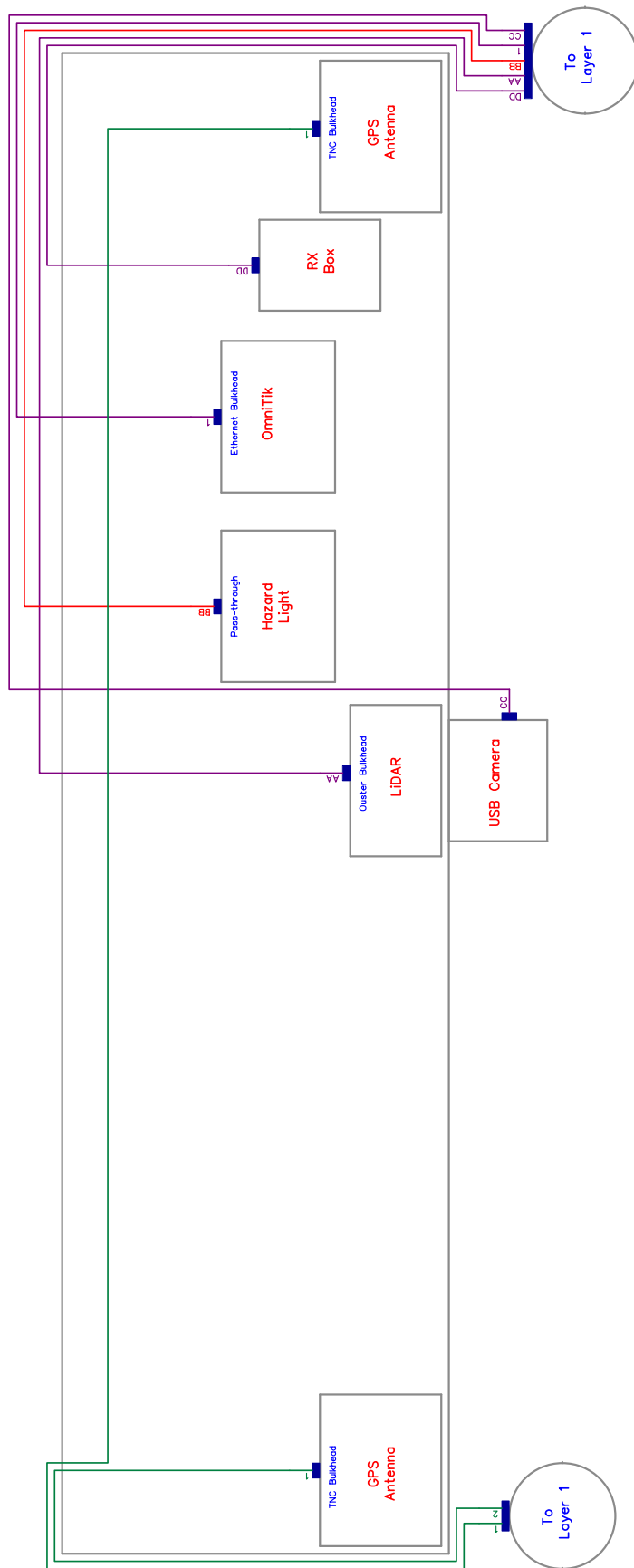


Figure 110: External Connections Block Electrical Diagram

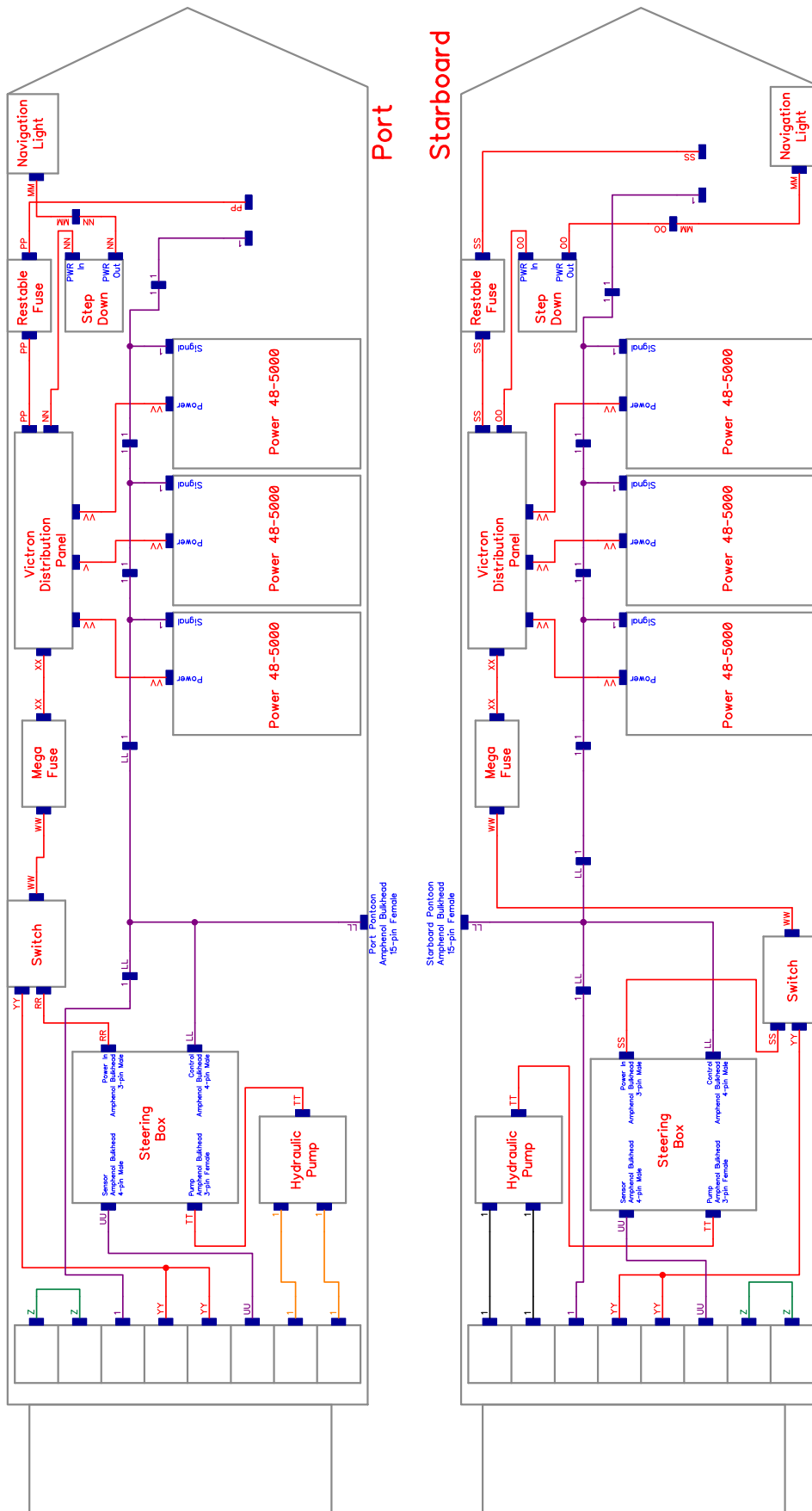


Figure 111: Pontoon Block Electrical Diagram

## 8.4 Electrical Diagrams

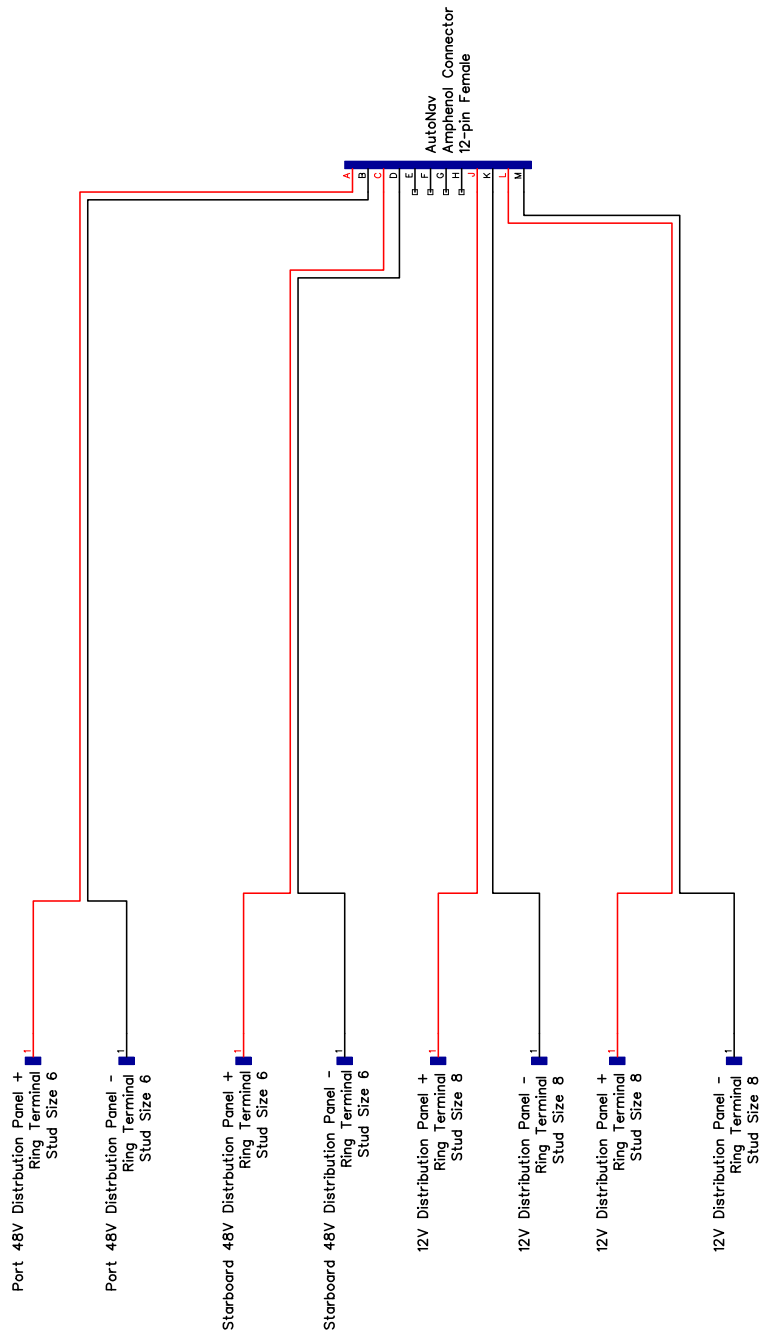


Figure 112: Cable A - AutoNav Power

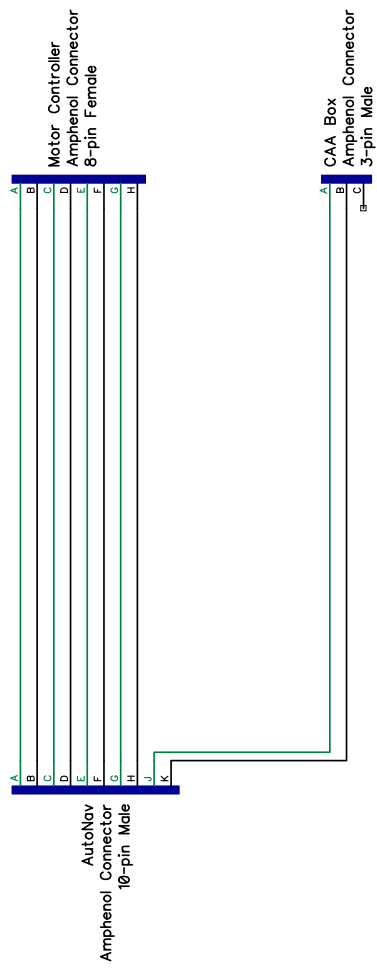


Figure 113: Cable B - AutoNav Propulsion

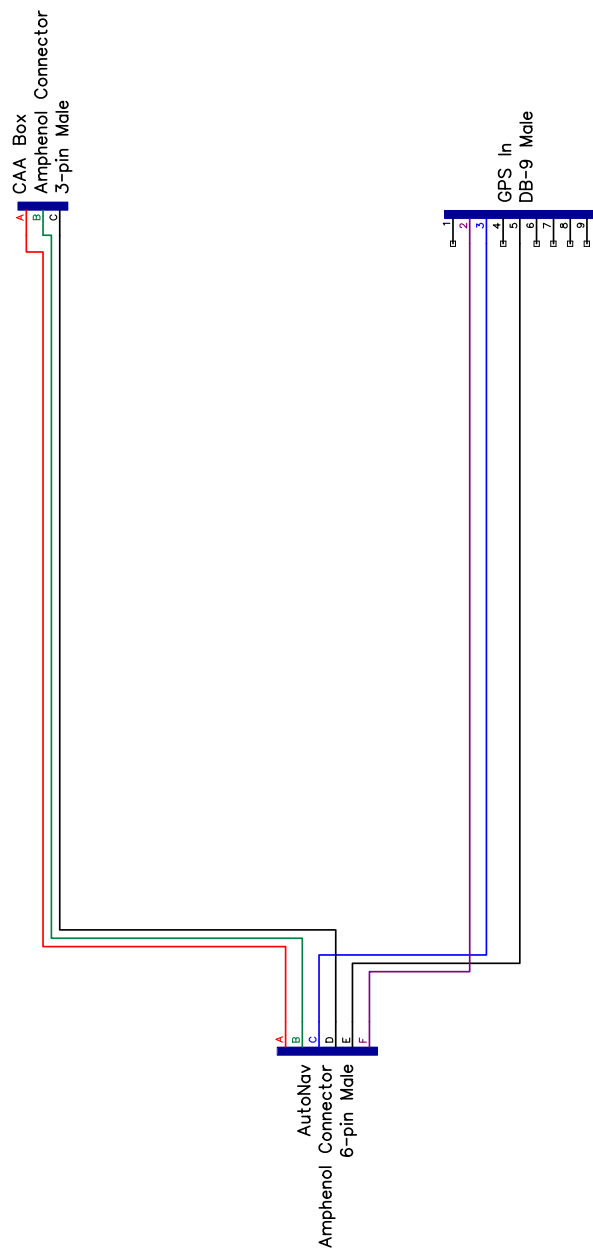


Figure 114: Cable C - CAA/GPS



Bulkhead Letter	Seismic Wire Color
A	Grey
B	Green
D	White
E	Yellow
K	Blue
M	Brown

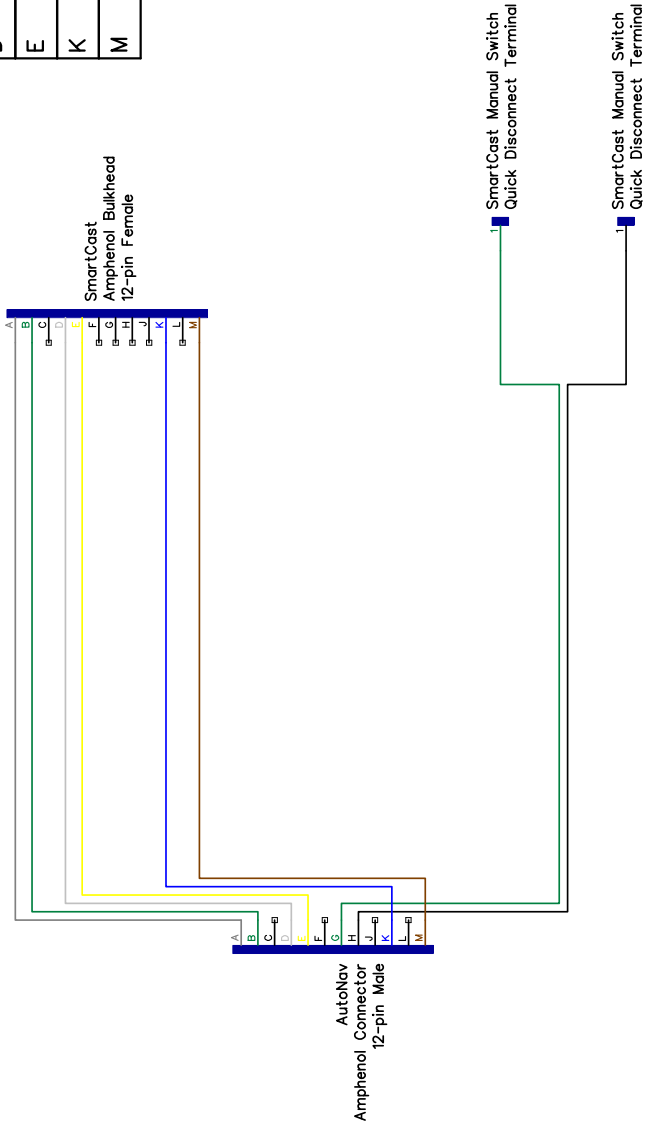


Figure 115: Cable D - Internal SmartCast

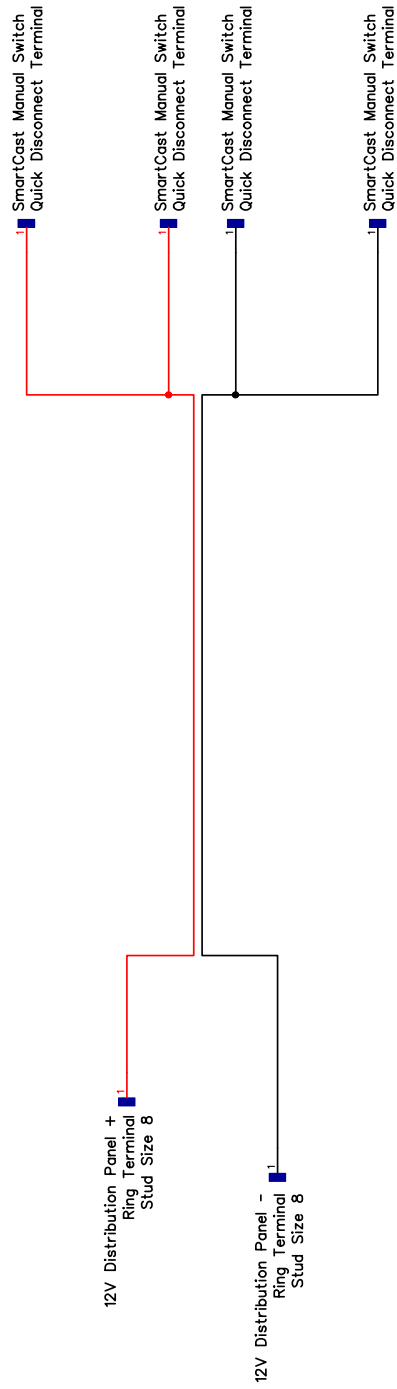


Figure 116: Cable E - SmartCast Manual Power

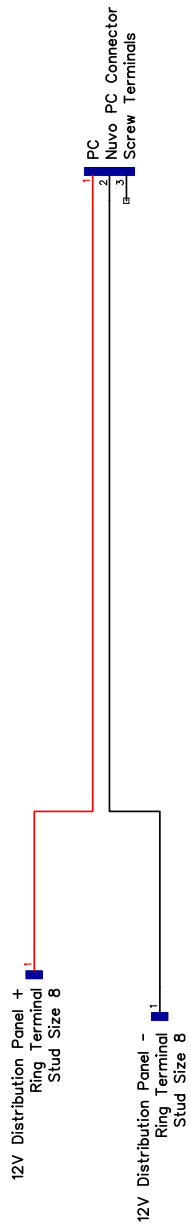
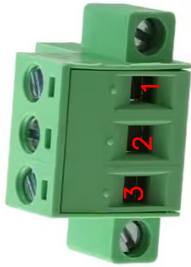


Figure 117: Cable F - PC Power

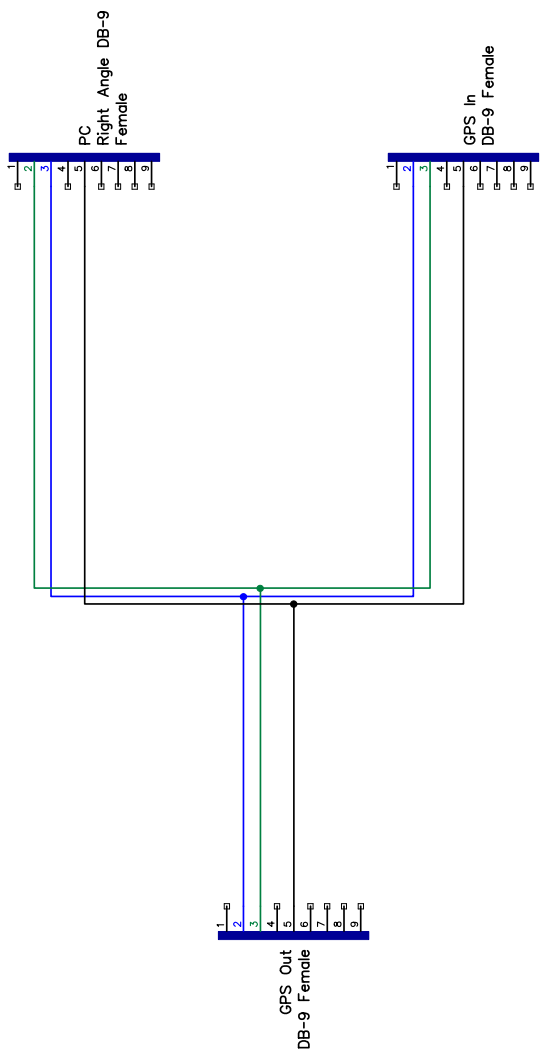


Figure 118: Cable G - GPS Splitter

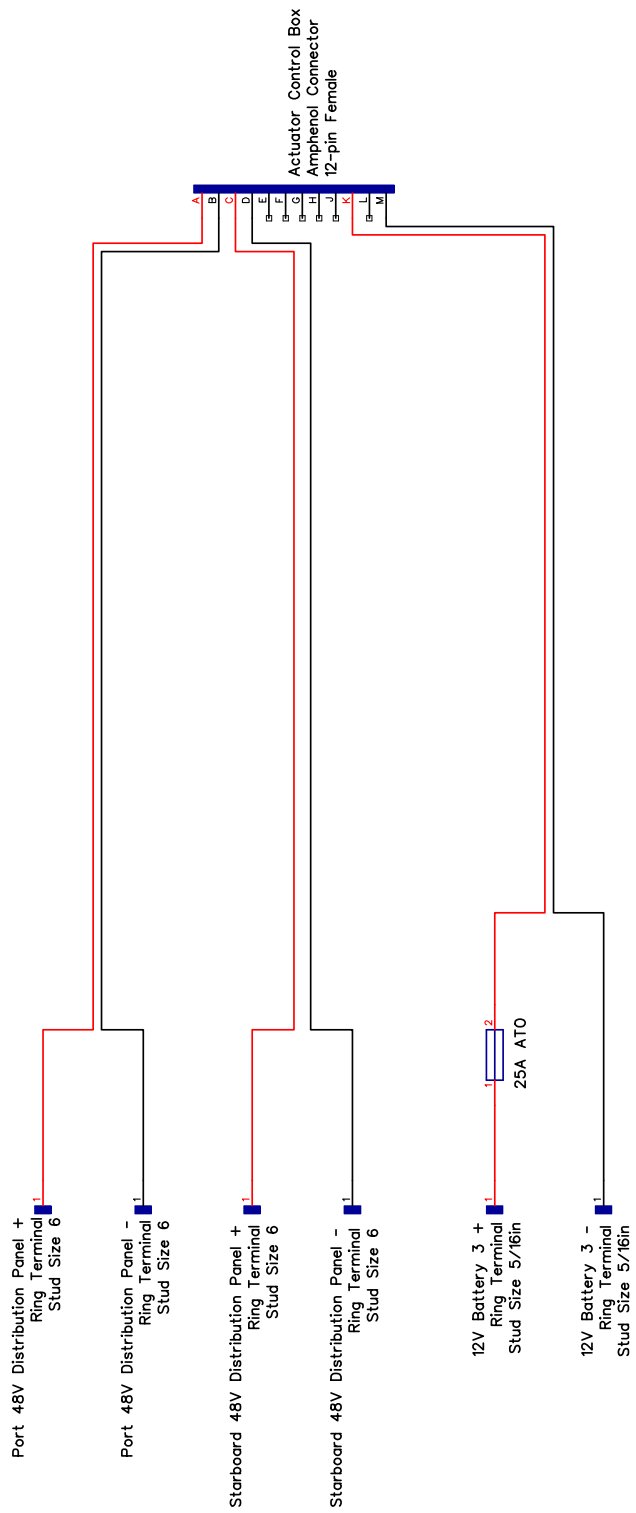


Figure 119: Cable H - Actuator Box Power

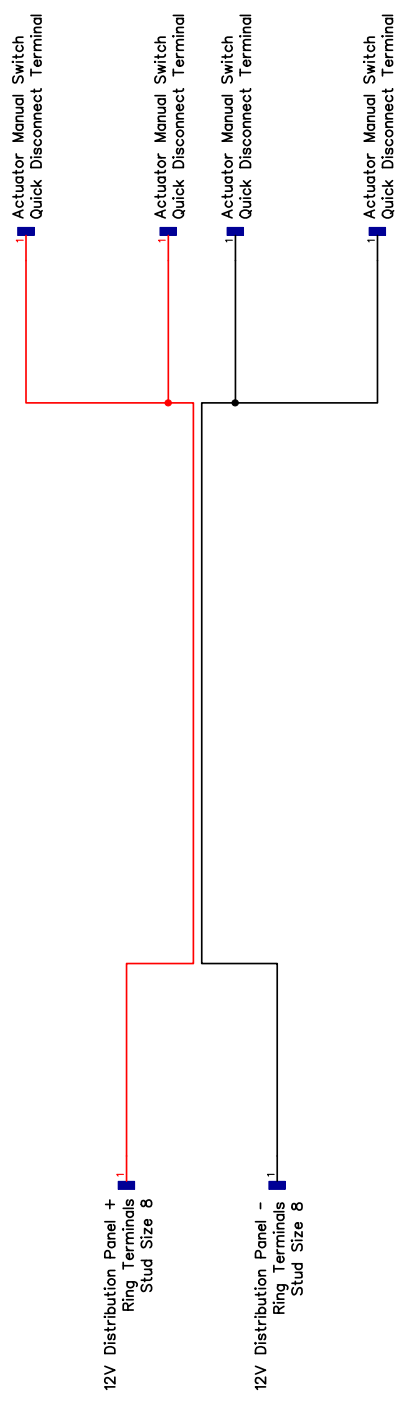


Figure 120: Cable J - Actuator Manual Power

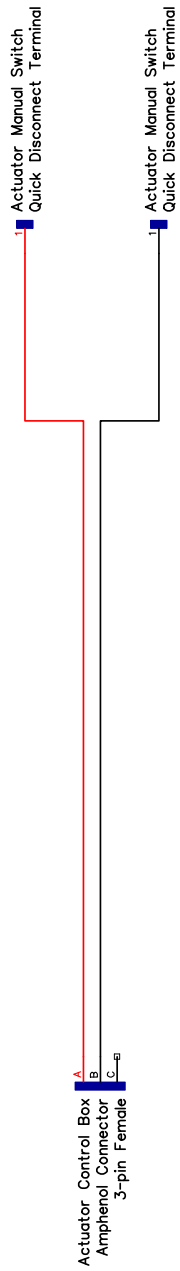


Figure 121: Cable K - Actuator Manual Data

Amphenol Pin	Seismic Color
A	Grey
B	Green
D	White
E	Yellow
J	Blue
L	Brown

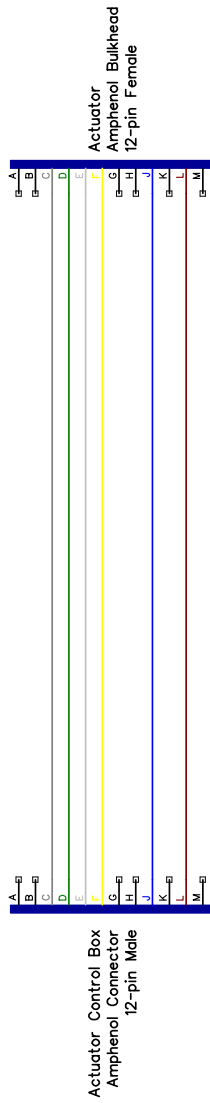


Figure 122: Cable L/M - Actuator



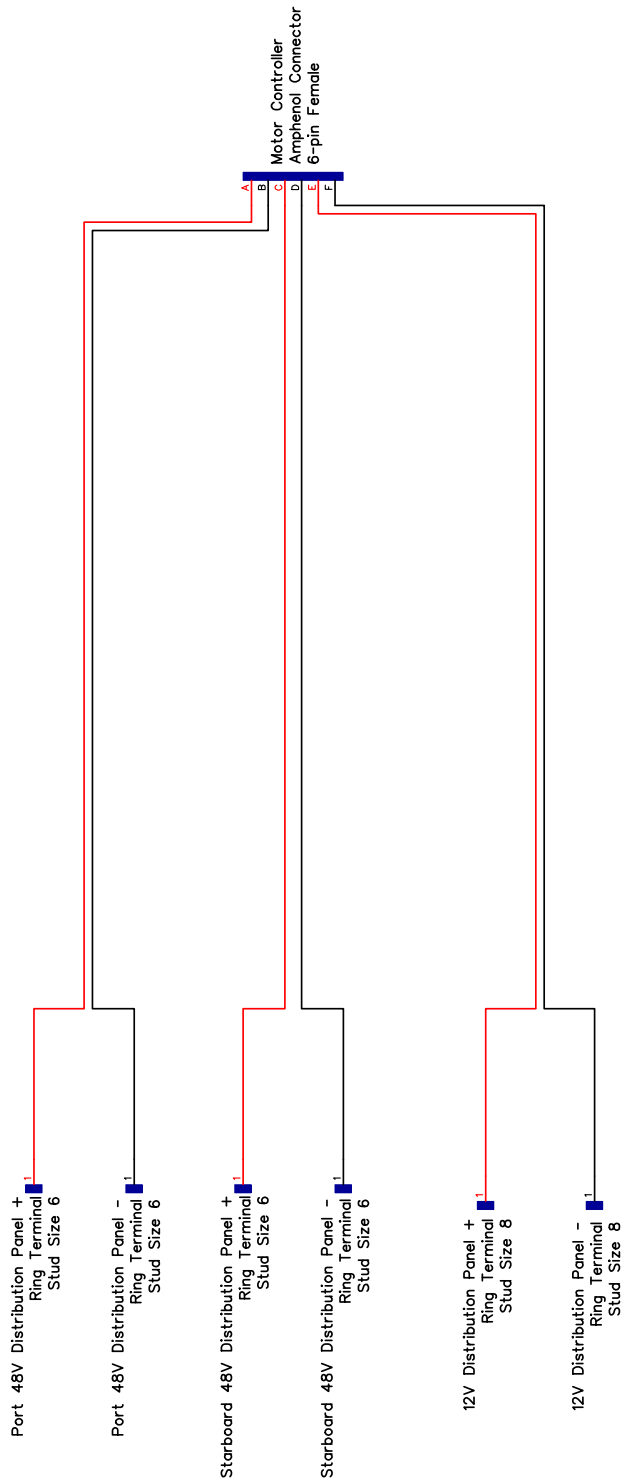


Figure 123: Cable N - Motor Controller Power

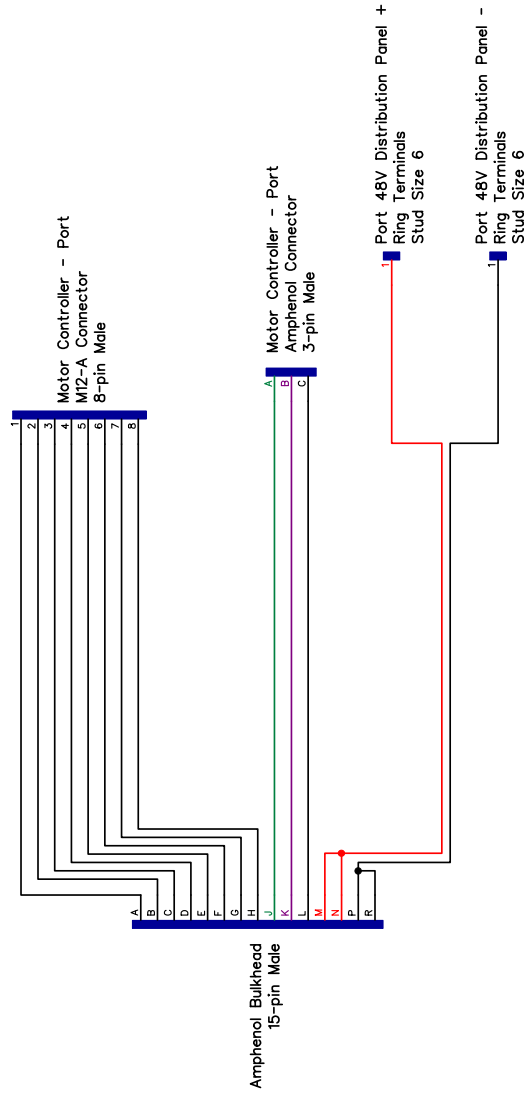
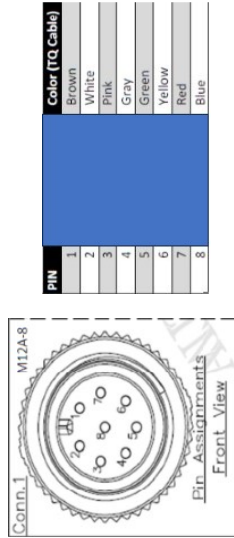


Figure 124: Cable O/P - Gimbal 15 Pin

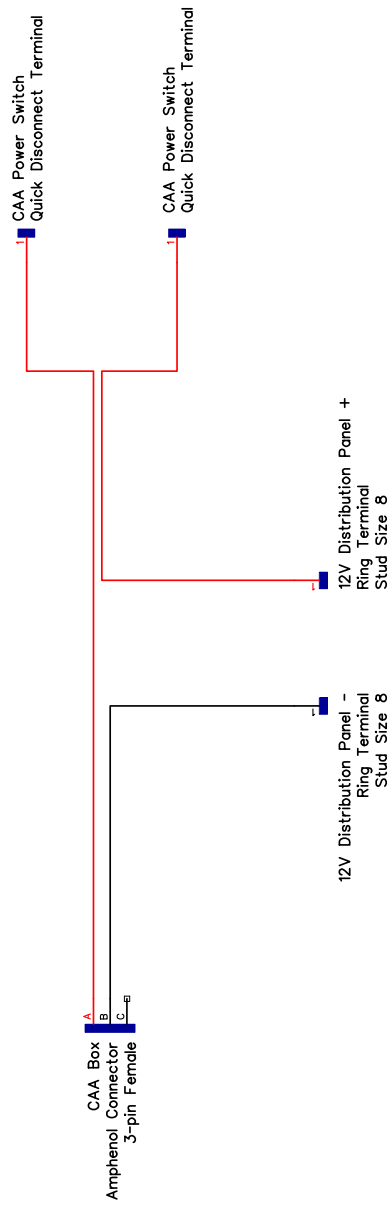


Figure 125: Cable Q - CAA Power

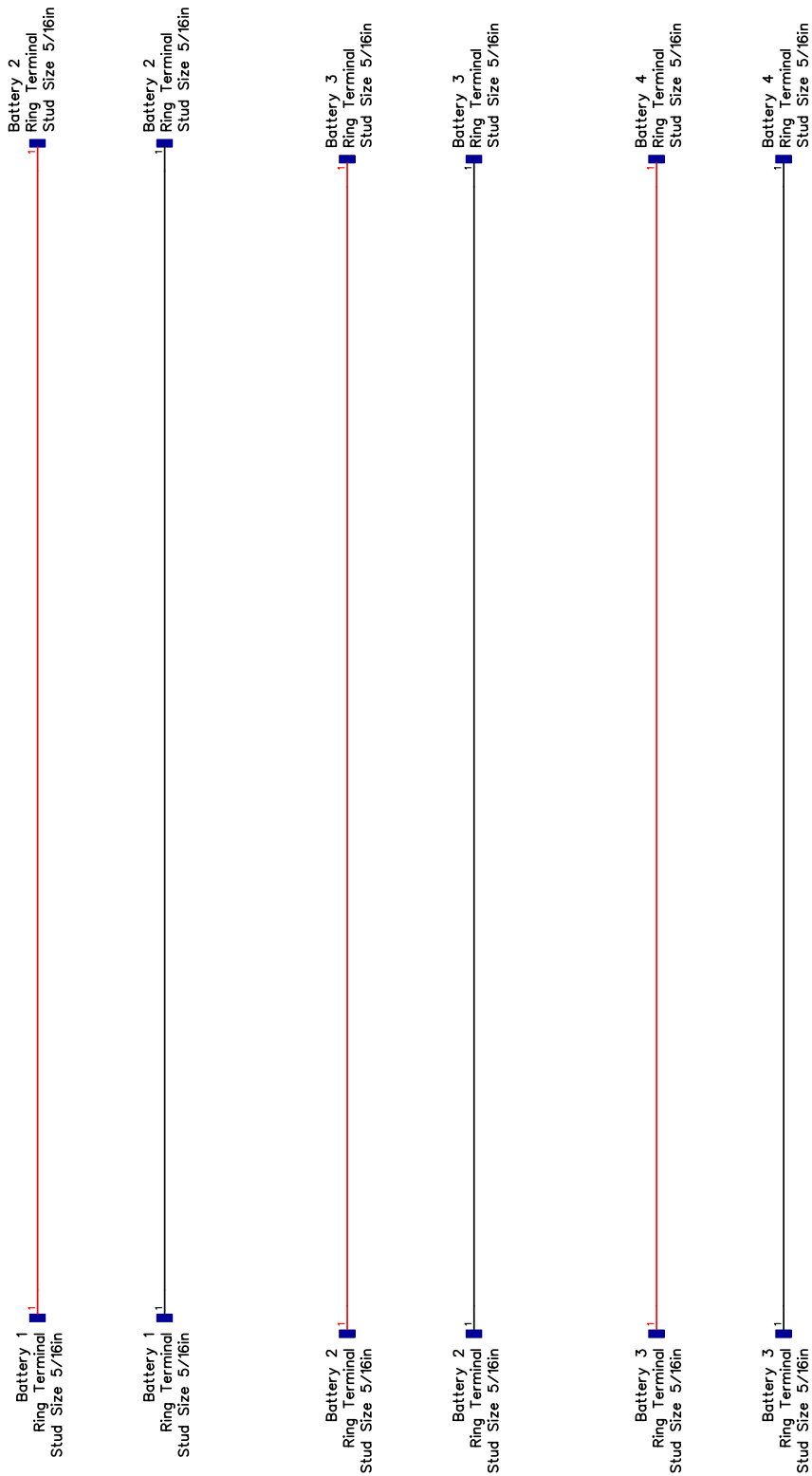


Figure 126: Cable R - Gimbal Battery

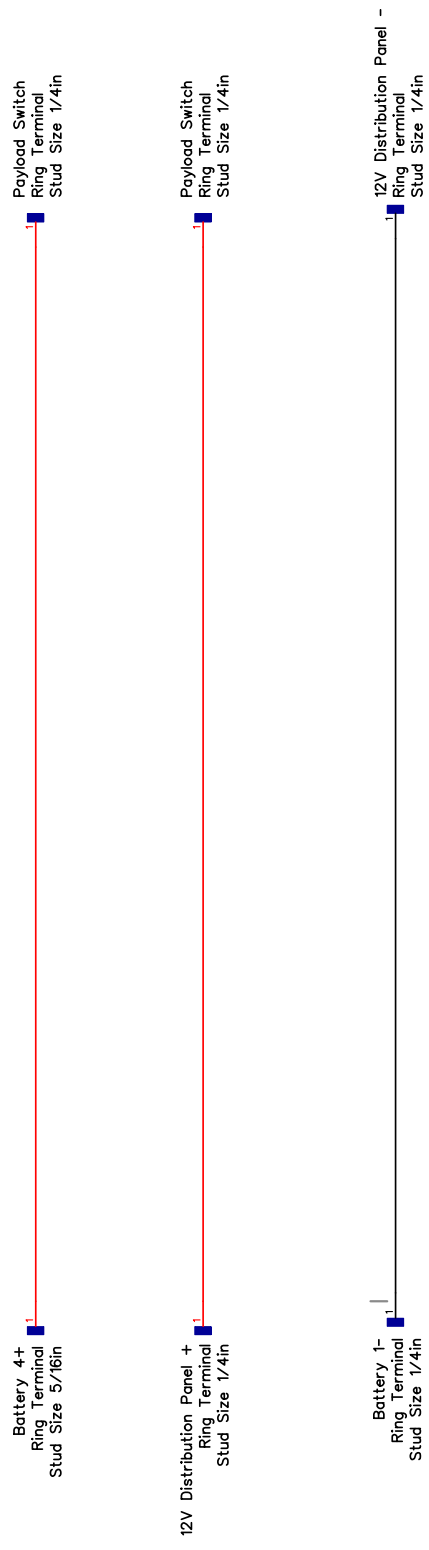


Figure 127: Cable S - Distribution Panel Power

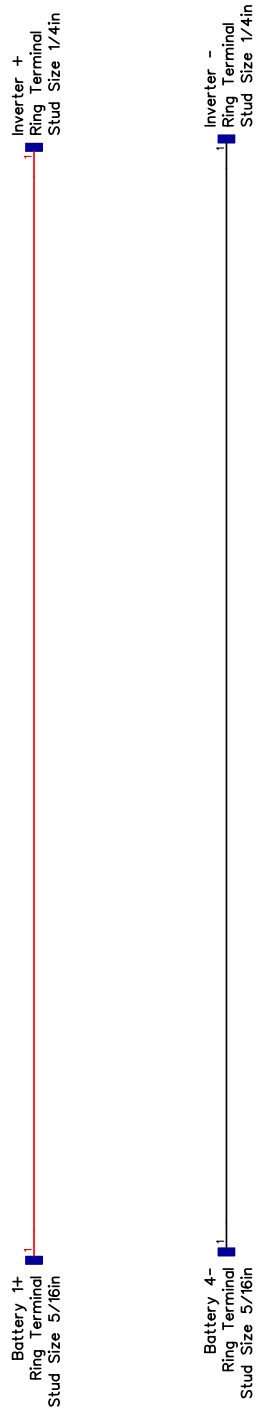


Figure 128: Cable T - Inverter Power

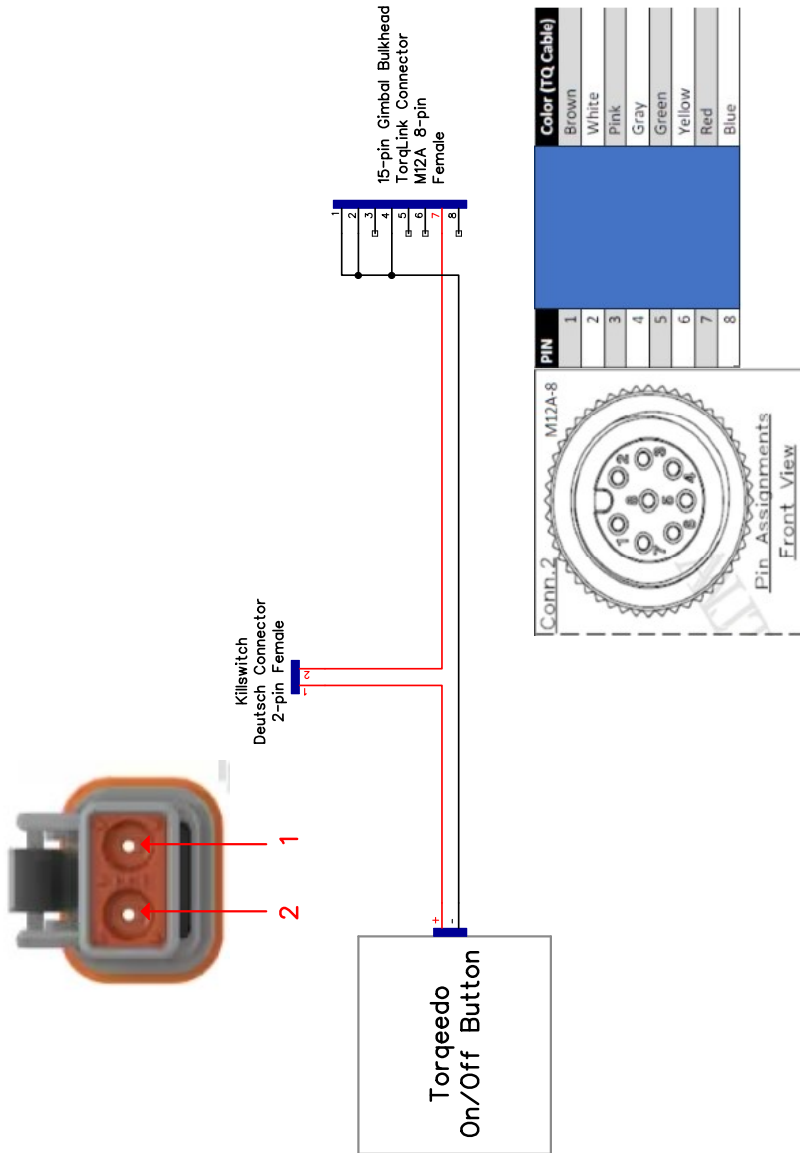


Figure 129: Cable U - Pontoon Power

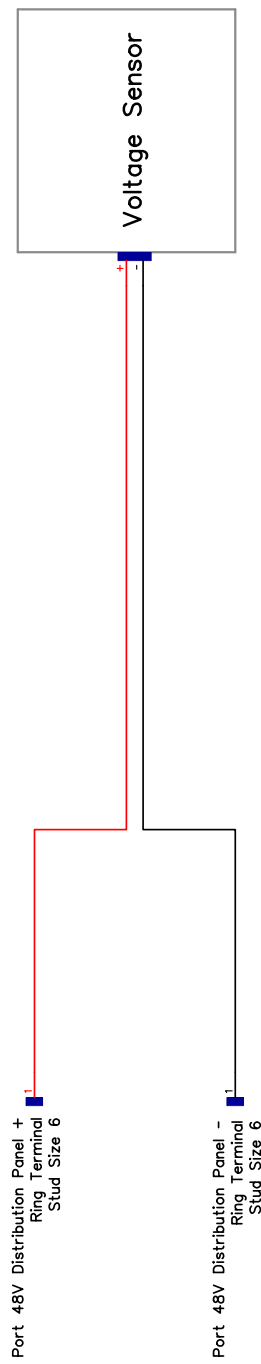


Figure 130: Cable V/W - Pontoon Voltage Monitor



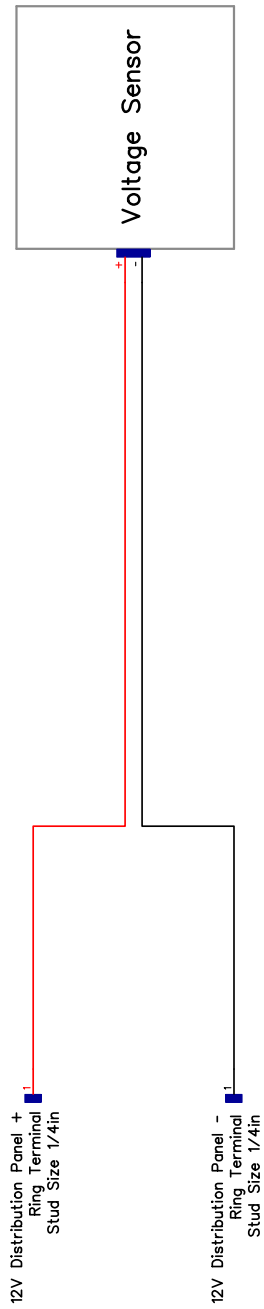


Figure 131: Cable X - Gimbal Voltage Monitor

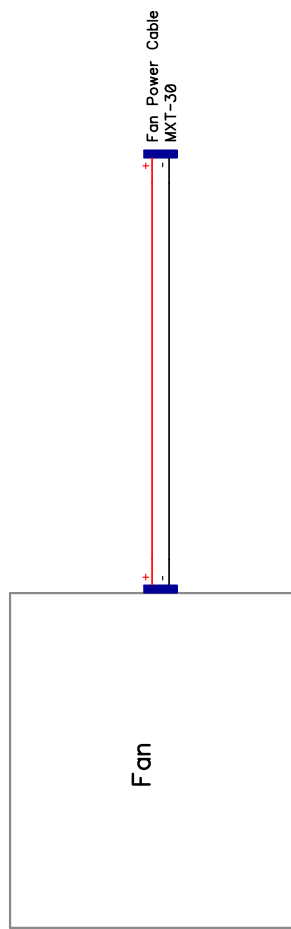


Figure 132: Cable Y - Cooling Fan

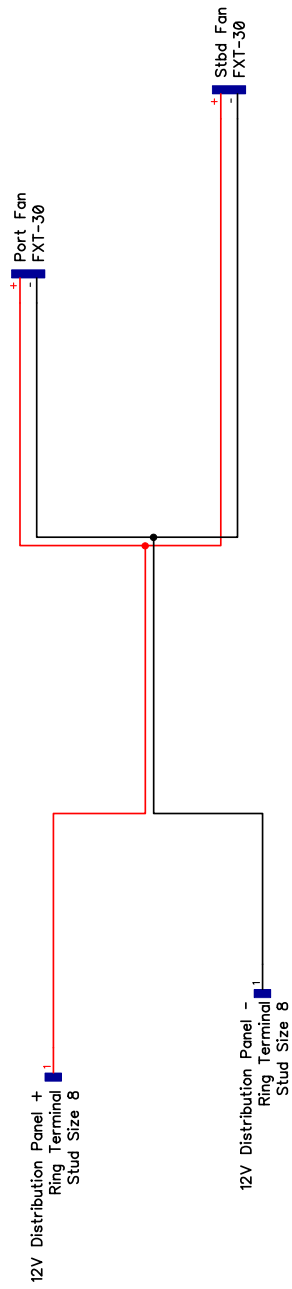


Figure 133: Cable Z - Cooling Fan Power

Amphenol	Wire Color	Ouster Pin
A	Blue/ W	10
B	Blue	9
C	Brown/ W	12
D	Brown	11
E	Green/ W	8
F	Green	6
G	Orange/ W	5
H	Orange	4
J	Black	7
K	Purple	3
L	Red	1
M	Yellow	2

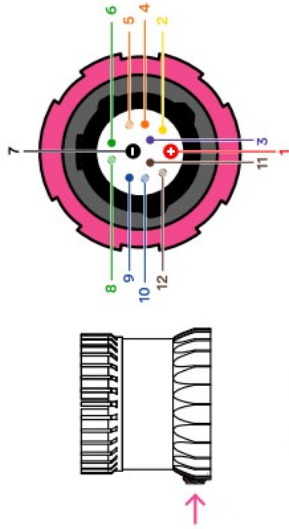
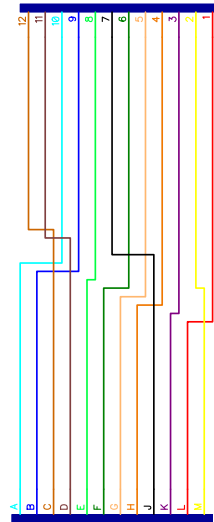


Figure 5.1: cable pinout of on-sensor receptacle

!!!WARNING!!!

This pinout is the for device-side  
The cable pinout will be mirrored



CAA Box  
Amphenol Connector  
12-pin Male

LiDAR  
Ouster Connector  
12-pin Male

Figure 134: Cable AA - LiDAR

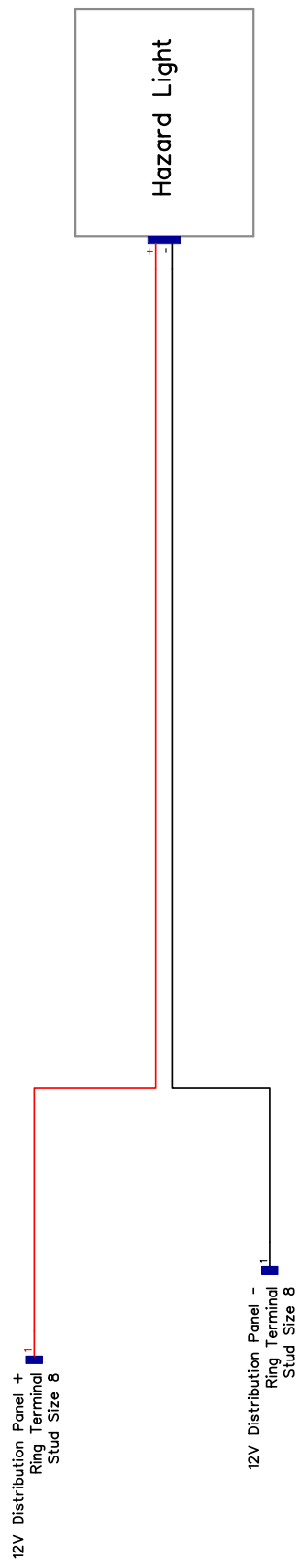


Figure 135: Cable BB - Hazard Light

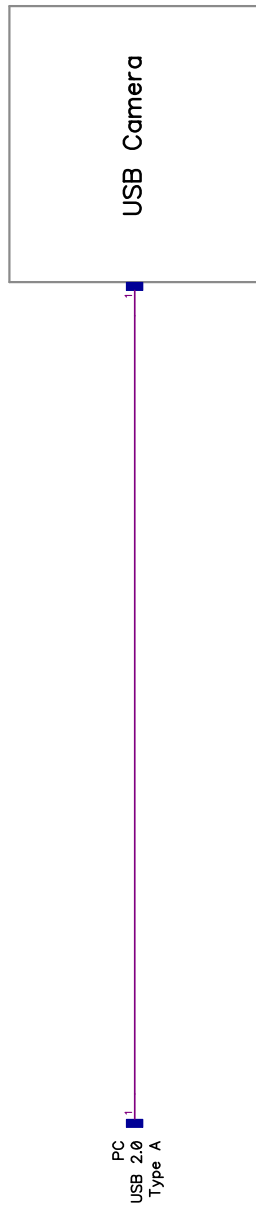


Figure 136: Cable CC - USB Camera

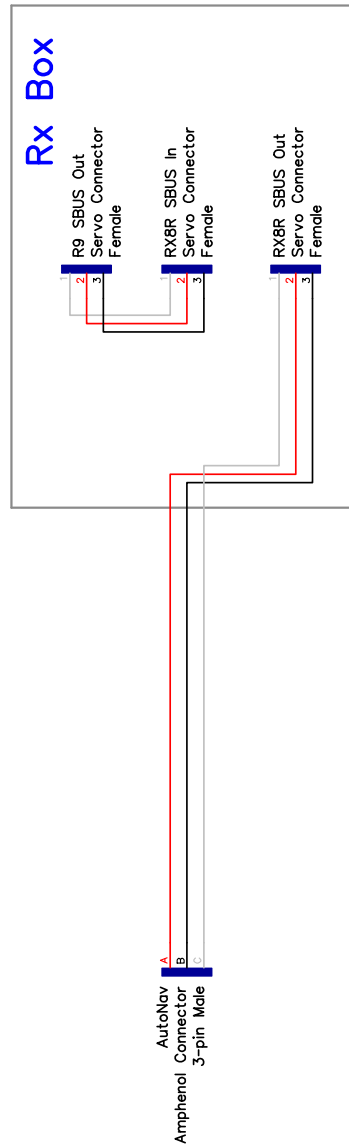


Figure 137: Cable DD - Receiver Box

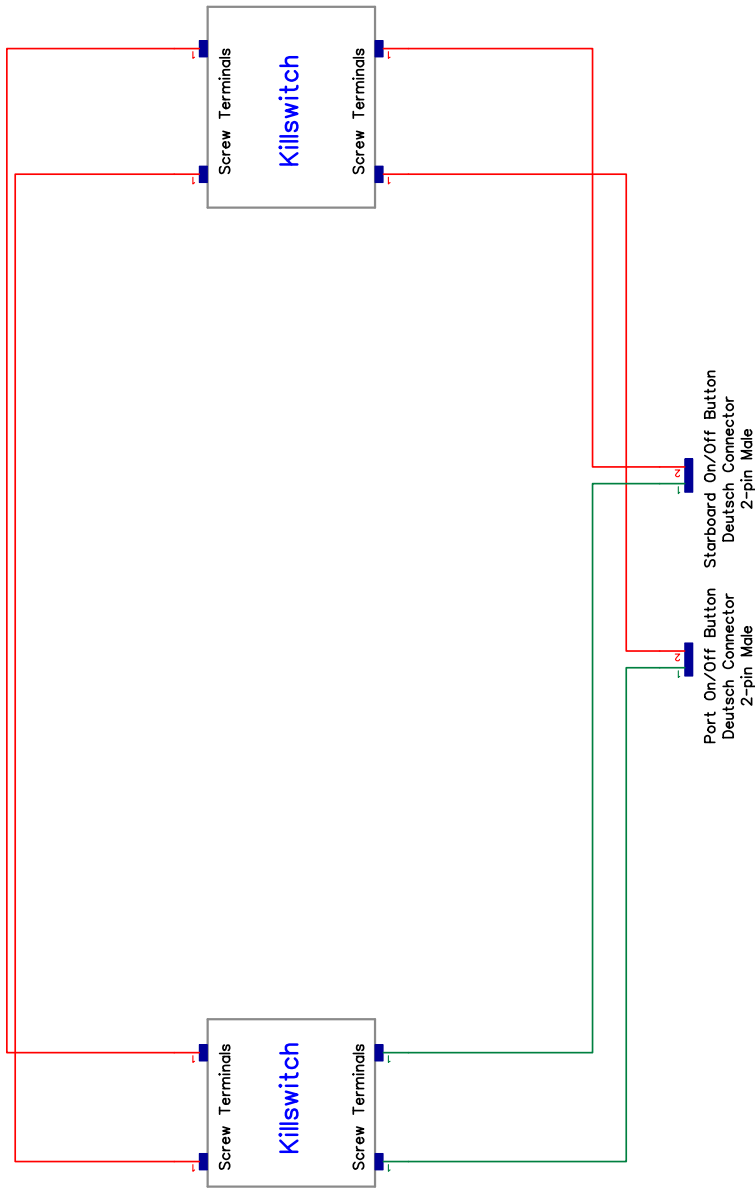


Figure 138: Cable EE - Kill Switch



Bulkhead Letter	Seismic Wire Color
A	Grey
B	Green
D	White
E	Yellow
K	Blue
M	Brown

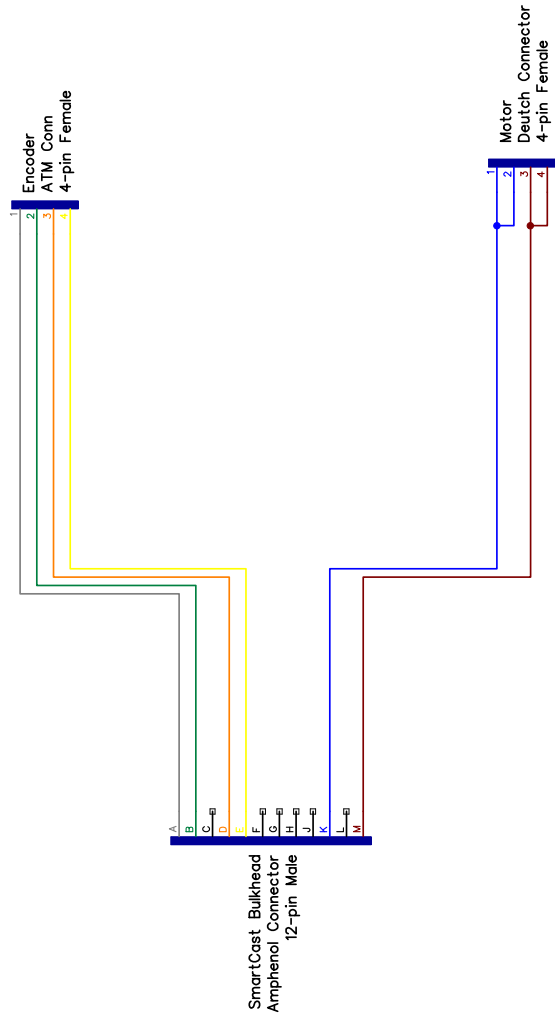


Figure 139: Cable FF - External SmartCast

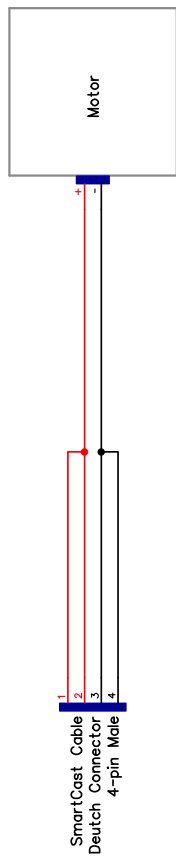


Figure 140: Cable GG - SmartCast

Encoder Wire Color	ATM Connector Pin Number
Grey	1
Green	2
Red	3
Blue	4

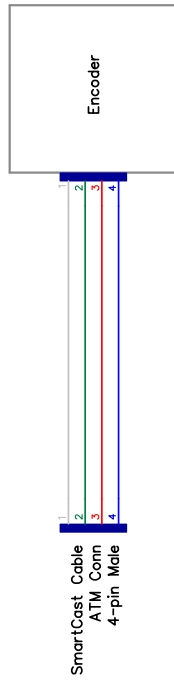


Figure 141: Cable HH - SmartCast Encoder

Act_Color	Amph. Pin	Function
Red	J	Motor +
Black	L	Motor -
Yellow	C	Vcc
White	D	GND
Brown	E	Data 1
Green	F	Data 2

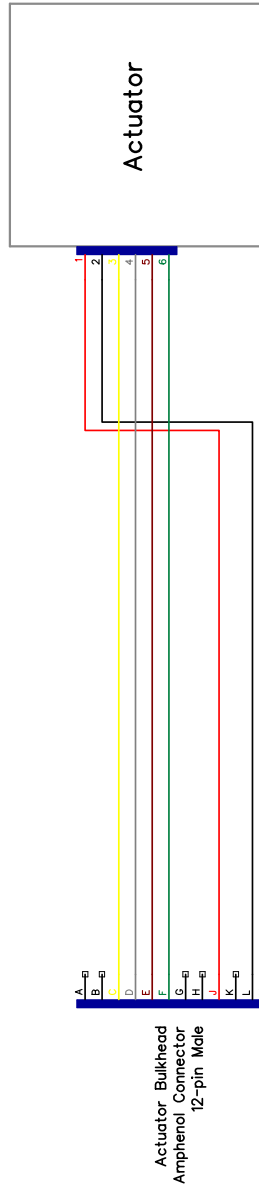


Figure 142: Cable JJ - Actuator

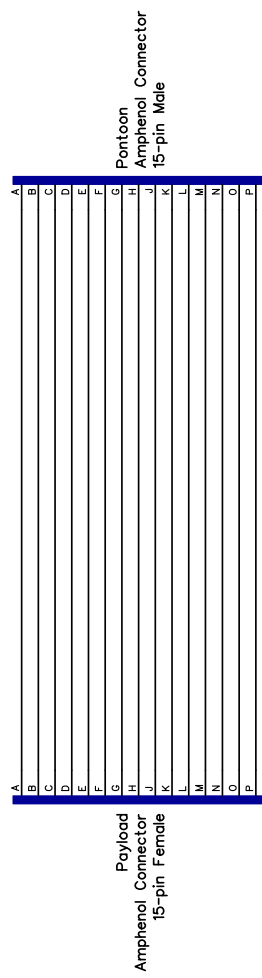


Figure 143: Cable KK - Pontoon

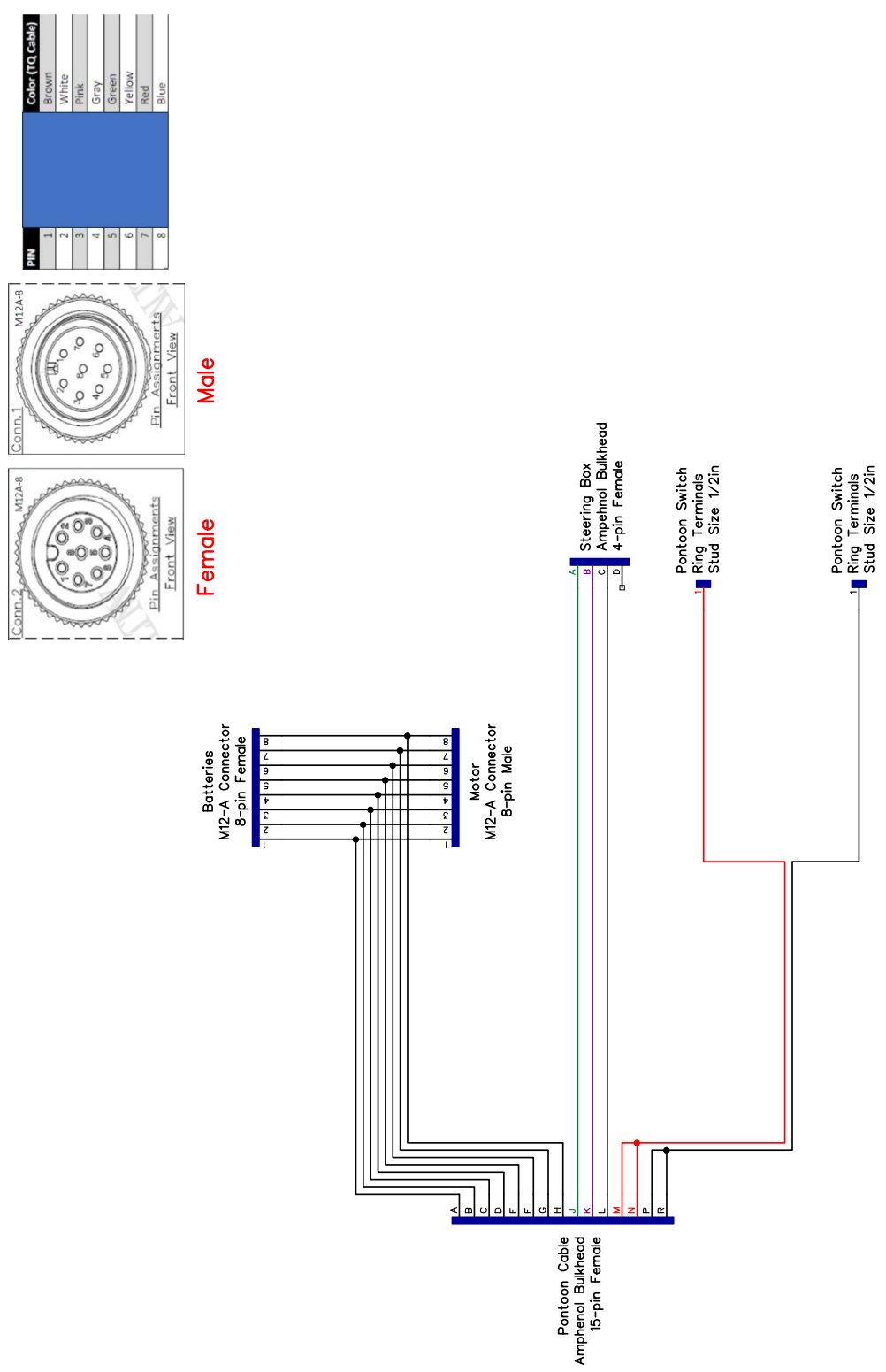


Figure 144: Cable LL - Pontoon 15 Pin

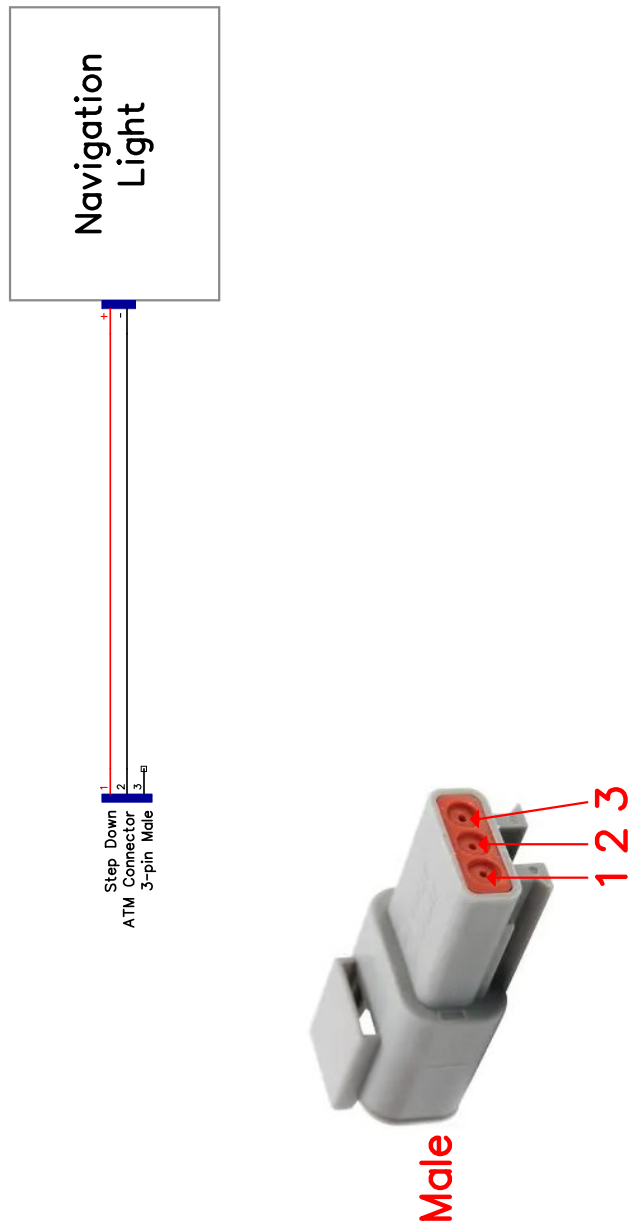


Figure 145: Cable MM - Navigation Light

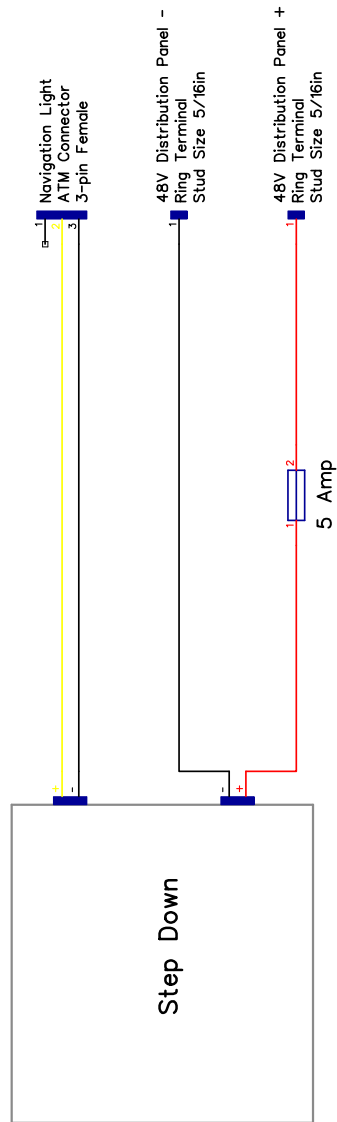
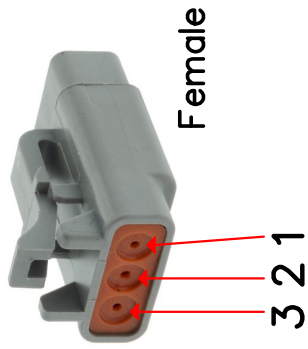


Figure 146: Cable NN/OO - Navigation Light Power



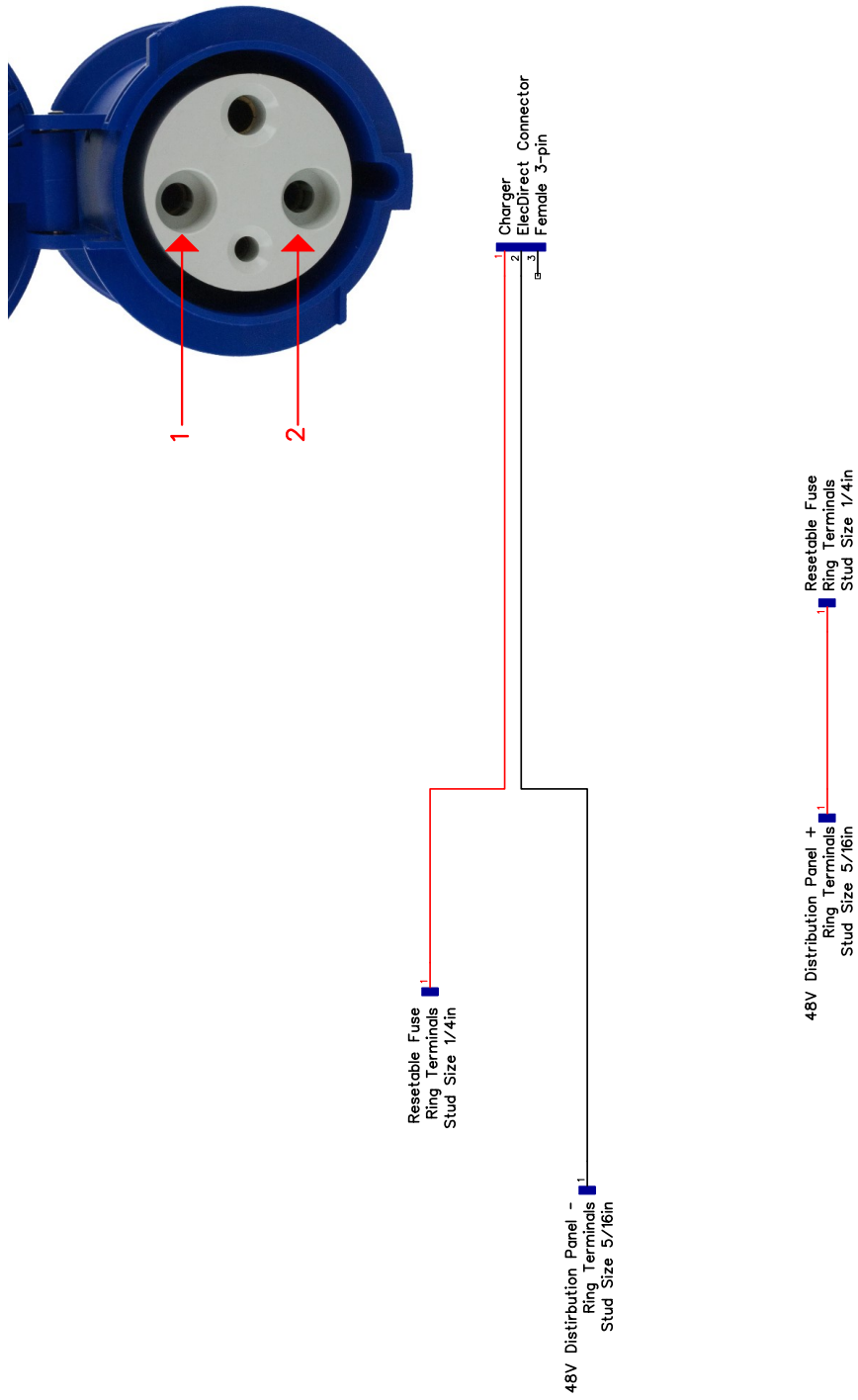


Figure 147: Cable PP/QQ - Pontoon Charging

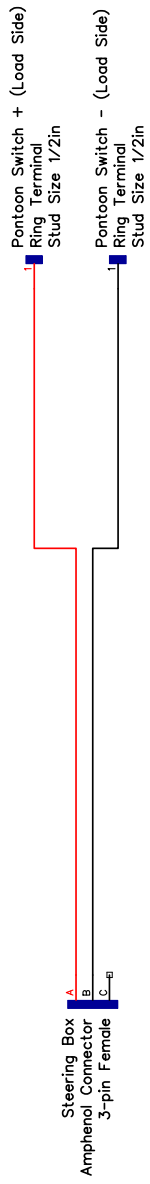


Figure 148: Cable RR/SS - Steering Box Power

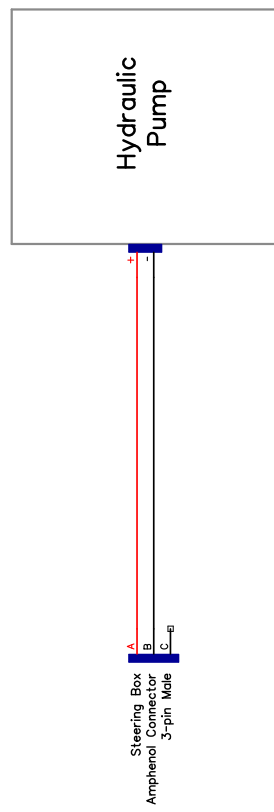


Figure 149: Cable TT - Hydraulic Pump

Wire Color	Pin Num
White	A
Red	B
Black	C

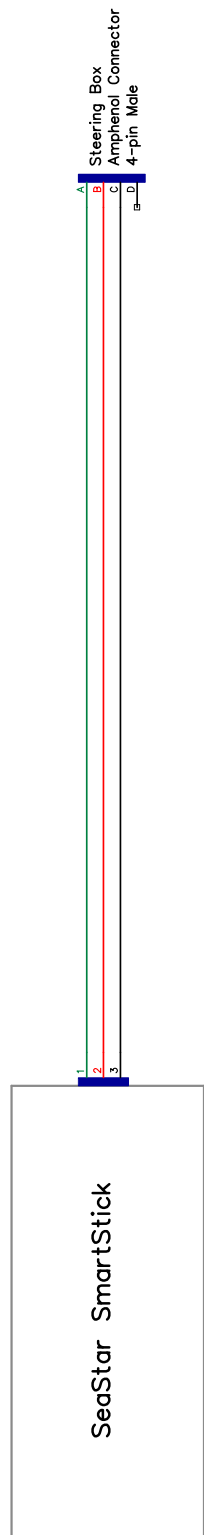


Figure 150: Cable UU - Steering Feedback

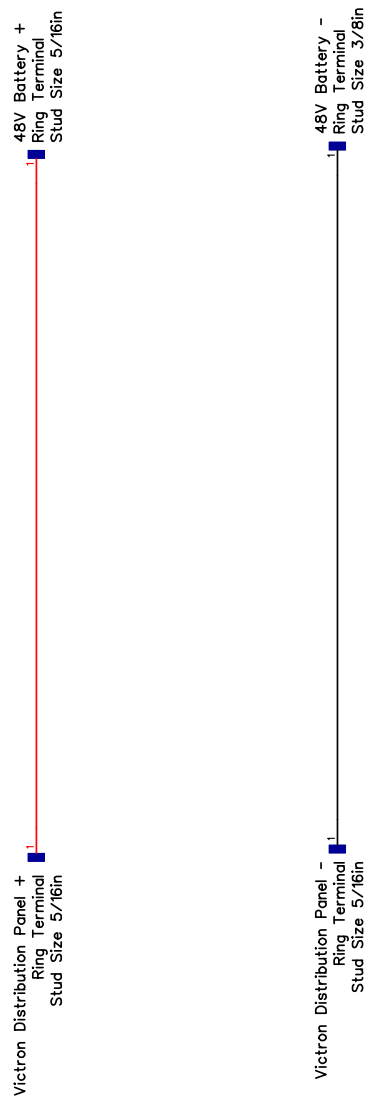


Figure 151: Cable VV - Pontoon Parallel

## Port



## Starboard



Figure 152: Cable WW - Pontoon Main Power



Figure 153: Cable XX - Pontoon Distribution

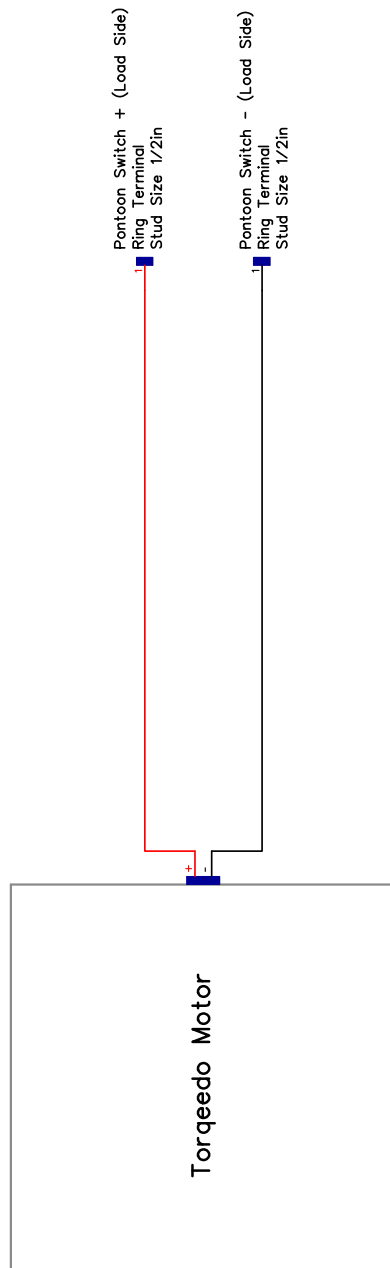


Figure 154: Cable YY - Thruster



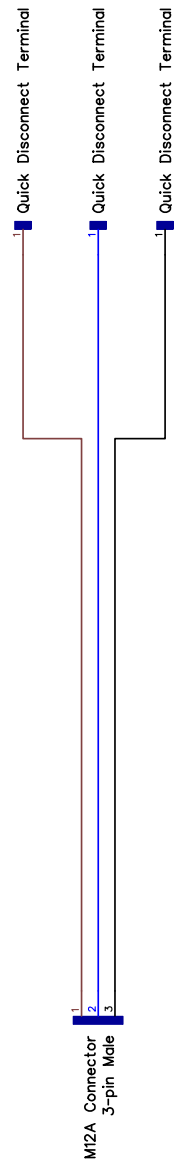


Figure 155: Cable ZZ - Pontoon Charger

## 8.5 Mechanical Diagrams

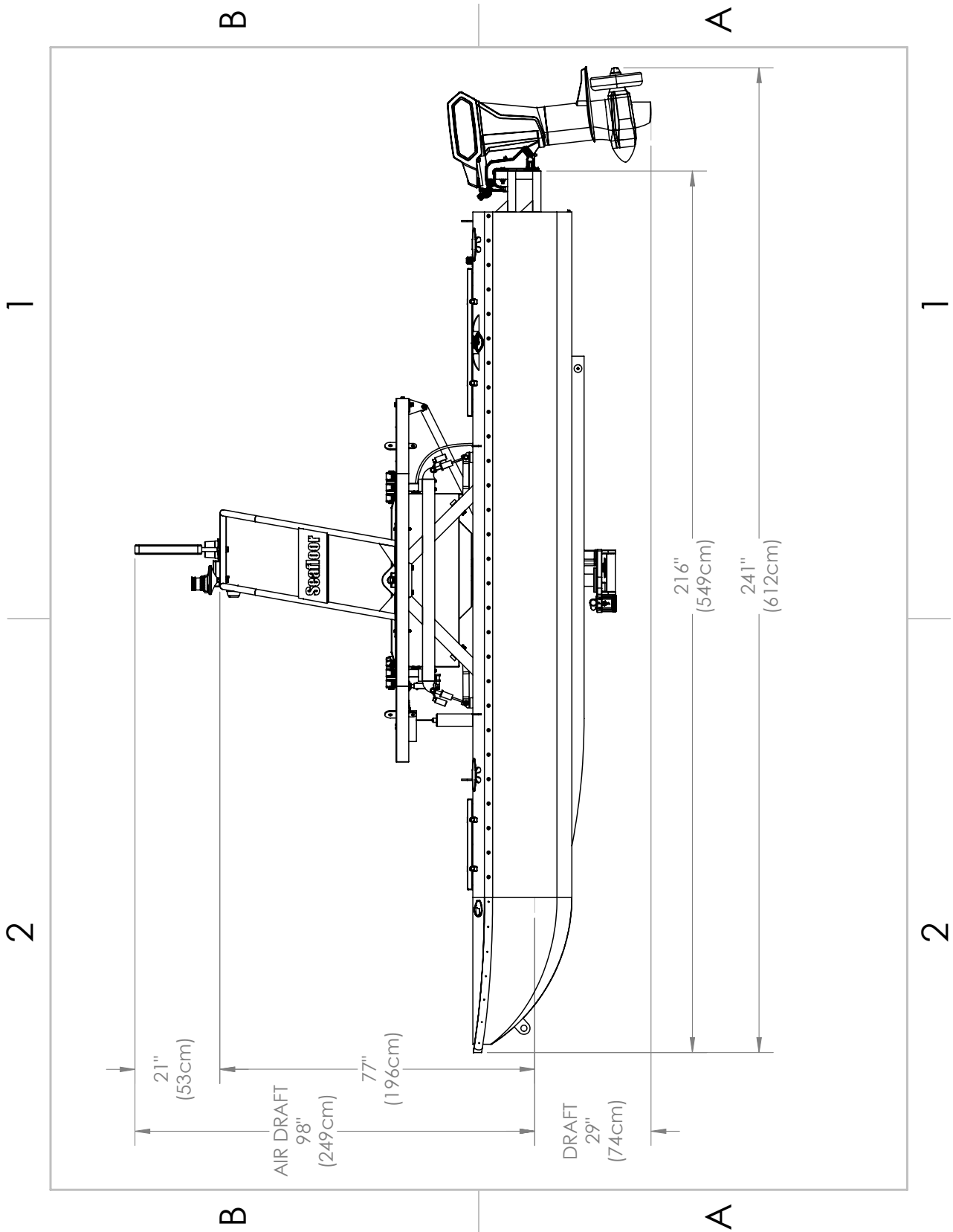


Figure 156: Side View Diagram

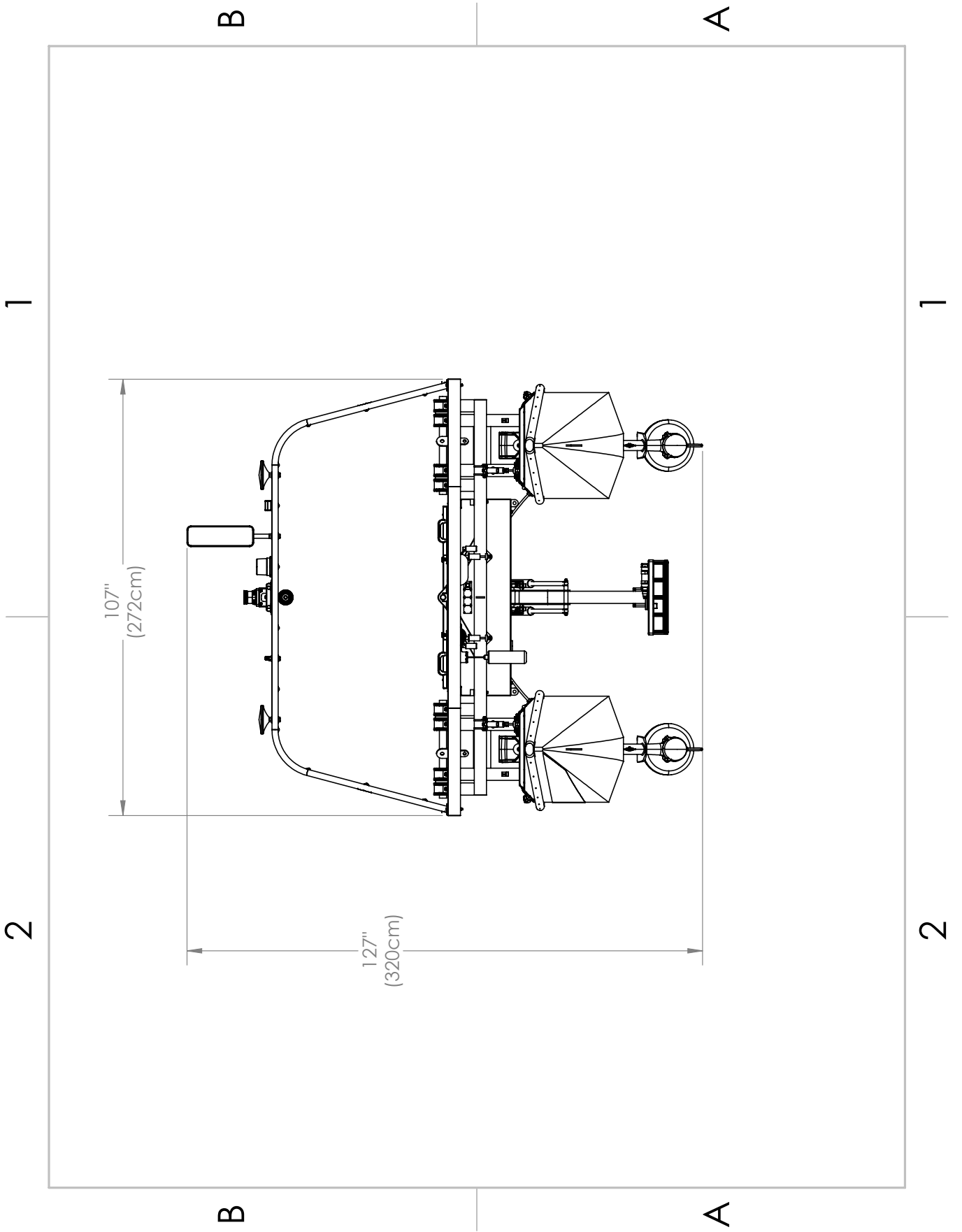


Figure 157: Front View Diagram

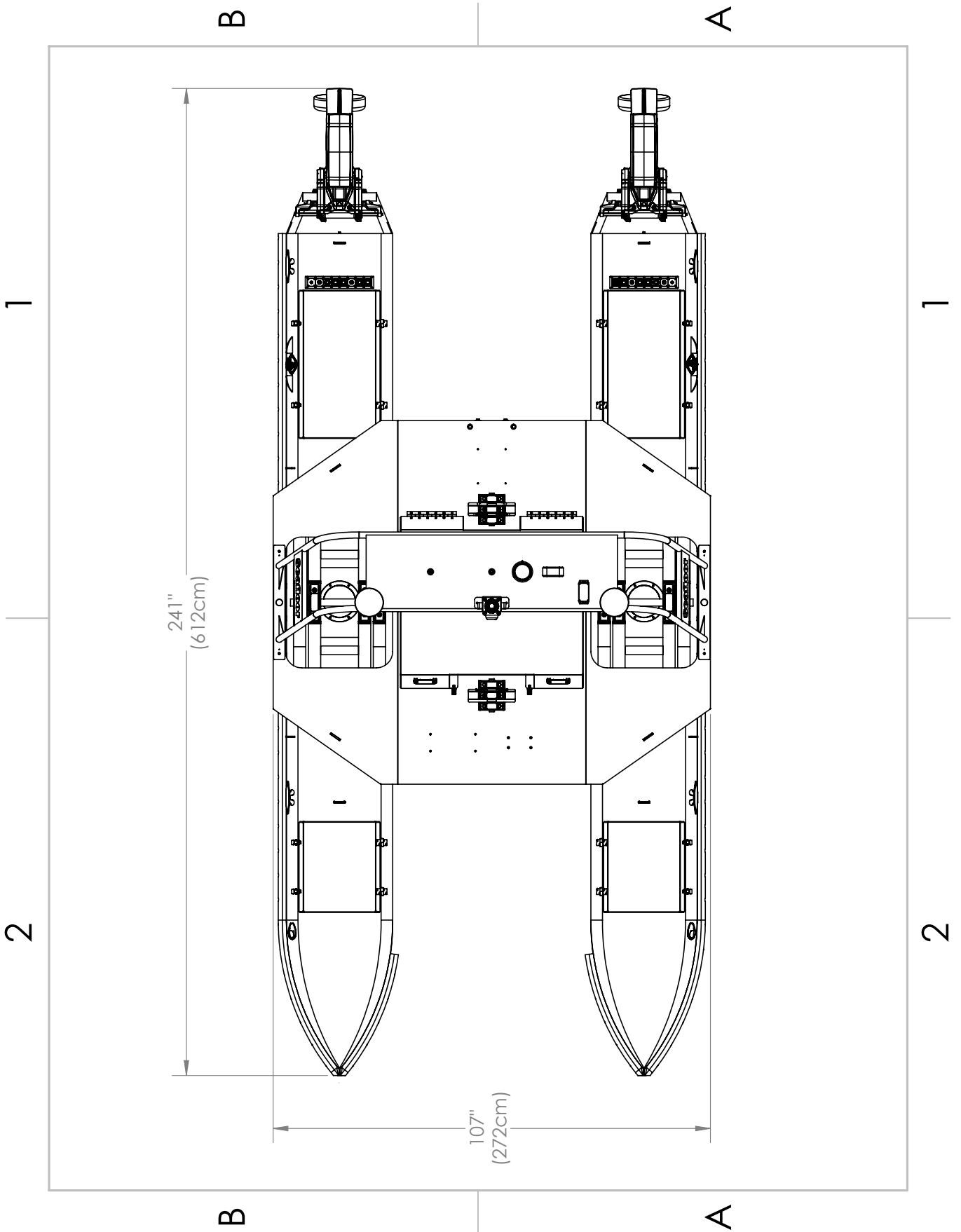


Figure 158: Top View Diagram

## Revision History

Revision	Date	Author(s)	Description
1.0	2.29.2024	BA	Created
1.1	2.29.2024	BA	Added Beaufort Sea State Chart
1.2	3.7.2024	BA	Added Voltage Tester and RCU RTC Battery Replacement