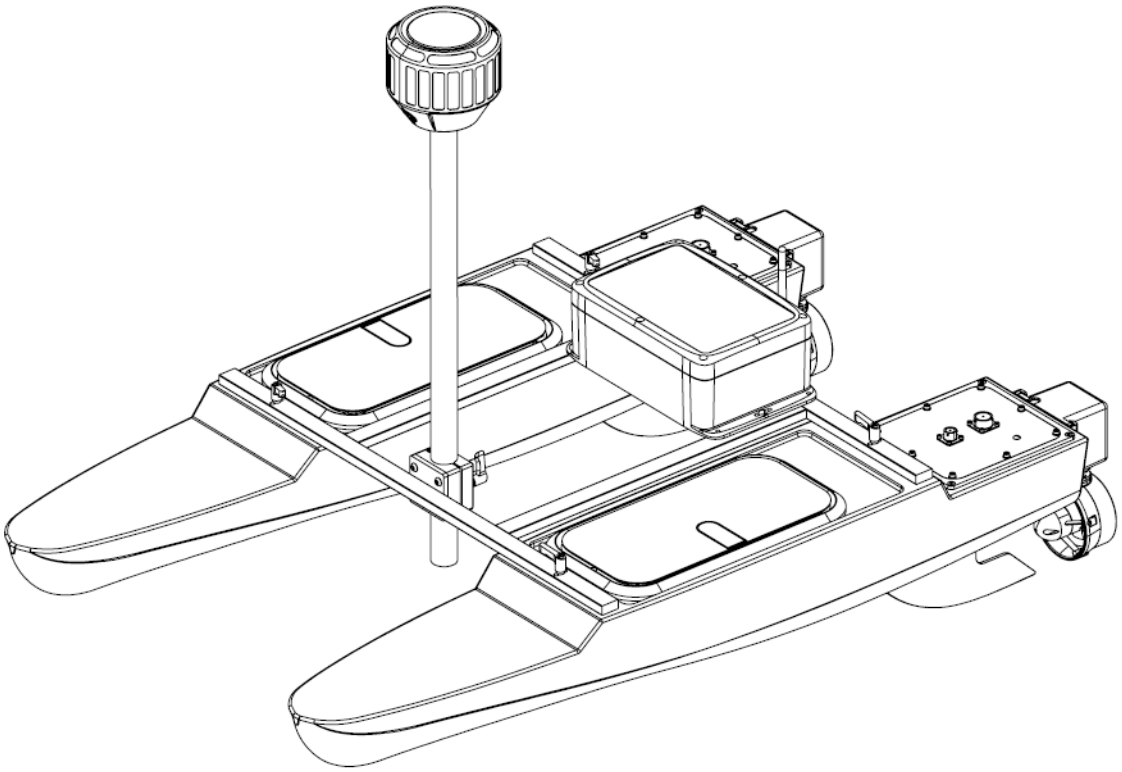
HyDrone™ ASV Servo

Generation 4.5

User and Technical Manual

Seafloor Systems, Inc



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1 Introduction

1.1 System Overview

Welcome to the Seafloor Systems HyDrone™ ASV Servo 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 HyDrone™ ASV Servo offers advanced hydrographic surveying capabilities, flexible payload options, and real-time data viewing. The HyDrone™ ASV Servo features a robust hull and propulsion system, and reliable communication system. This manual is for hydrographic surveyors, marine scientists, and technical personnel involved in underwater mapping and surveying tasks using the HyDrone™ ASV Servo.

1.2 Terms And Acronyms

ANP	AutoNav Plus
ASV	Autonomous Survey Vessel
Bow	Front or forward part of the vessel
BHSC	Button Head Socket Cap Screw
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
UI	User Interface
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 knots (1m/s)
Max Speed	4 knots (2m/s)*
Length	45.6in (1.2m)
Pontoon Width	8.37in (0.21m)
Overall Width	29.25in (0.74m)
Hull Material	High-Density Polyethylene (HDPE)
Hardware	316 Stainless Steel
Weight	33lbs (14.9kg)
Payload	32lbs (14.51kg)
Power	14.8 - 22.2VDC Nominal
Battery Endurance	8.7 Hours At Survey Speed With 6S 22Ah Batteries
Thruster	2x Electric Thrusters
Steering	Directed Thrust
Communication Range	Line of Sight, Up to 0.18mi (300m) (Conditions Dependent)
Remote Control Range	Up To 0.6mi (1km) (Conditions Dependent)
Remote Control Voltage Range	6-8.5VDC
Sea State	Beaufort Sea State 2 and Below (Figure 83)
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 Duration Chart. 3.4

1.4 System Limitations

To limit potential damage to the HyDrone™ ASV Servo, 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 3.4)
- Range outside of 0.6mi (1km) line of sight.
- 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 wind, heavy rain, etc.

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 HyDrone™ ASV Servo will be free from defects in materials or workmanship for a duration of one year from the date of shipment.

Battery Warranty Limitation:

Batteries are excluded from the standard one-year warranty and are instead covered under a limited warranty of ninety (90) days from the date of shipment. This limitation applies to all battery types provided by or included with Seafloor Systems products.

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 HyDrone™ ASV Servo for purposes other than water measurements, or pairing it with instruments exceeding a weight of 25lbs (11.3kg).

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 an online support system during regular business hours. For assistance outside of standard business hours, support is available by appointment.

If your HyDrone™ ASV Servo 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.seafloorsystems.com via the big green button. 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, 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.

- Website: www.seafloorsystems.com
- Phone (PST/PDT): +1 530-677-1019 (Business Hours: Monday - Thursday, 0700-1730)

2 Safety

2.1 Battery Safety

Please read through these instructions carefully before you operate the HyDrone™ ASV Servo.

Important Alert

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

- Before and after every use of a LiPo battery, carefully inspect the pack to ensure no physical damage, swelling or "ballooning" is visible.
- If at any time you have an accident with your HyDrone™ ASV Servo, or if the battery swells, "balloons", or feels too hot to the touch, immediately stop use and carefully follow these safety steps:
  - Using electrical protective gloves, remove the battery pack from your HyDrone™ ASV Servo or charger.
  - Place the battery in a LiPo safety sack or other fireproof container, away from flammable materials and in a well-ventilated area.
  - Observe the battery from a safe distance for at least 30 minutes.
  - If after 30 minutes the pack appears stable, follow the battery disposal instructions below.
  - Under no circumstances should you return a battery to operation that has "ballooned" or been damaged in any way.
- Always handle LiPo batteries with extreme care and take all necessary precautions to avoid battery packs and cells being dinged, dented, punctured, or otherwise damaged.
- Keep battery packs out of the reach of children and pets.
- Do not disassemble, modify, or attempt any form of repair of a LiPo battery.
- Do not allow exposed battery wires to touch each other.
- Always disconnect your battery from any device when not in use. All devices continue to draw power even when turned off.
- Store your batteries in a cool, dry place between 40°F - 80°F (4°C - 26°C). All battery packs should be stored away from any flammable materials in a LiPo safety sack or other fireproof container (not included) with the plugs/connectors covered.
- Batteries should be stored at 3.75-3.85V per cell. Failure to maintain these levels could result in a loss of battery capacity. Do not store batteries with voltage above or below this range for longer than one week. Check cell voltage with a voltage tester, following the included instructions. (Refer to 3.6)
- LiPo batteries must be fully charged and returned to the recommended storage voltage range (3.75-3.85V per cell) at least once a month. Max voltage of a 4S battery is 16.8VDC. Max voltage of a 6S battery is 25.2VDC. (4.2VDC/Cell)
- Always take precautions to cover the battery plugs/connectors while not in use.
- Always transport LiPo batteries in LiPo safety sack or other fireproof container with the battery plugs/connectors covered.
- Never leave LiPo battery packs in an automobile. Temperatures within a vehicle can quickly reach unsafe levels.
- Always keep a class D chemical fire extinguisher nearby, in case of fire when storing, handling, charging, or using LiPo battery packs.

- Make sure the battery connections are connected in the proper polarity. Battery packs should be properly secured within the vehicle to prevent movement and damage to the battery while in use.
- If the battery exceeds temperatures of 140°F (60°C) immediately discontinue charging and isolate the battery pack. Refer to point number two above from the Safety Warnings for further instruction.
- Do not, under any circumstances, heat up a battery pack to increase pack performance. Doing so greatly increases the risk of fire.
- Never allow your HyDrone™ ASV Servo to discharge a LiPo battery pack at more than the recommended continuous discharge rate. Refer to the label of your specific battery to determine the proper continuous discharge rate. You must also refer to your specific vehicle user manual to ensure your batteries' continuous discharge rate is not exceeded.
- Damaged or ruptured battery packs or cells may leak electrolytes which can cause moderate to severe irritation including burning and dryness of the skin and eyes. For contact with the skin, thoroughly wash the affected area with soap and warm water. For contact with the eyes, rinse thoroughly with cool water. Seek immediate medical attention for any burns.

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.

Lithium Polymer Battery (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.
- 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.
- Always use a charger specifically designed for LiPo batteries. Never use NiCD or NiMH chargers to charge LiPo batteries.
- Do not charge LiPo batteries to more than 4.2V per cell.
- Never leave batteries unattended while charging, even when using a LiPo safety sack or another fireproof container. Batteries on charge MUST remain under constant observation so that you may react quickly should any problems arise.

2.3 Vessel Safety

Important Alert

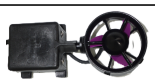
Working with electricity in water environments requires utmost caution and adherence to safety protocols. Here are some important safety guidelines when using the HyDrone™ ASV Servo:

- 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 running 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 HyDrone™ ASV Servo is unattended. Always disconnect all batteries immediately after use.

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

3 System Operation

3.1 What's Included

Item	Quantity	Description	Image*
Pontoons	2	HyDrone™ ASV Servo USV	
Servo Thruster	2	Servo Thruster for Pontoons	
Frame	1	Frame with Pole Mount	
Fins	2	Seafloor Fins	

Frame Bolts	4	M5x25mm BHSC, Washer, and Lock Washer	
Remote Control Unit (RCU)	1	Remote Control Unit for HyDrone™ ASV Servo	
USB Charging Cable	1	Charging Cable for RCU. USB A to USB C Cable.	
LiPo Charger with Power Cable	2	Charger for LiPo Batteries	
AutoNav™	1	AutoNav™ Module	
Shoreside Telemetry Module	1	Paired to AutoNav™	
Serial Cable	1	For GPS input communication	
Pontoon Power Data Cable	2	Keyed for each pontoon	

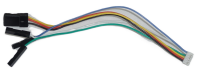
USB Cable	1	USB A to USB A Cable for hardwire connection to AutoNav™	
AutoNav™ hardware	2	To attach AutoNav™ to Frame	
Voltage Tester	1	To measure the LiPo voltage	
USB Drive	1	Loaded with software, drivers, and manuals	
Receiver Programming Cable	1	For Firmware Flashing	
DB9 Null Modem	1	Swaps TX and 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.

3.2 System Overview Diagram

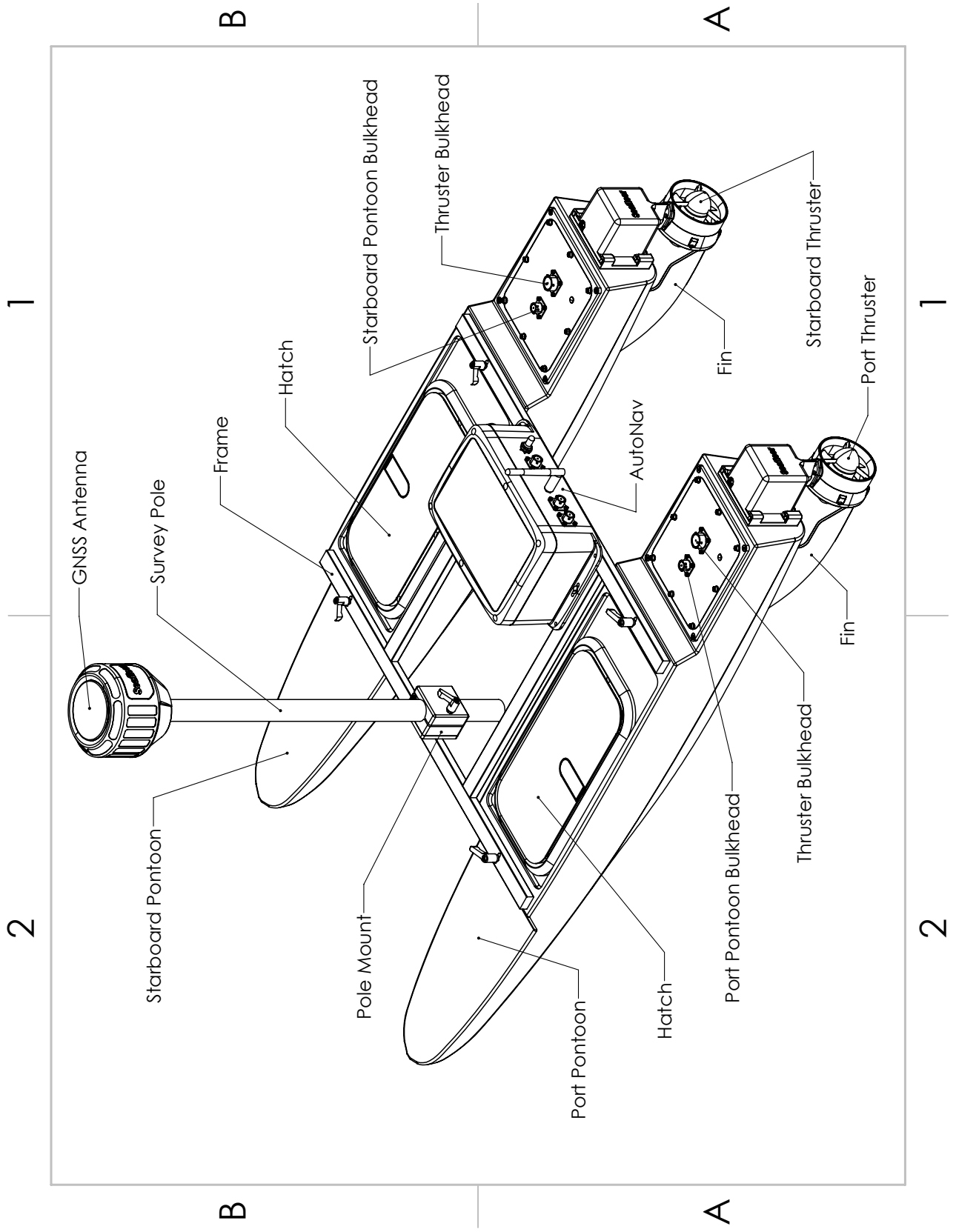


Figure 1: HyDrone™ ASV Servo System Overview

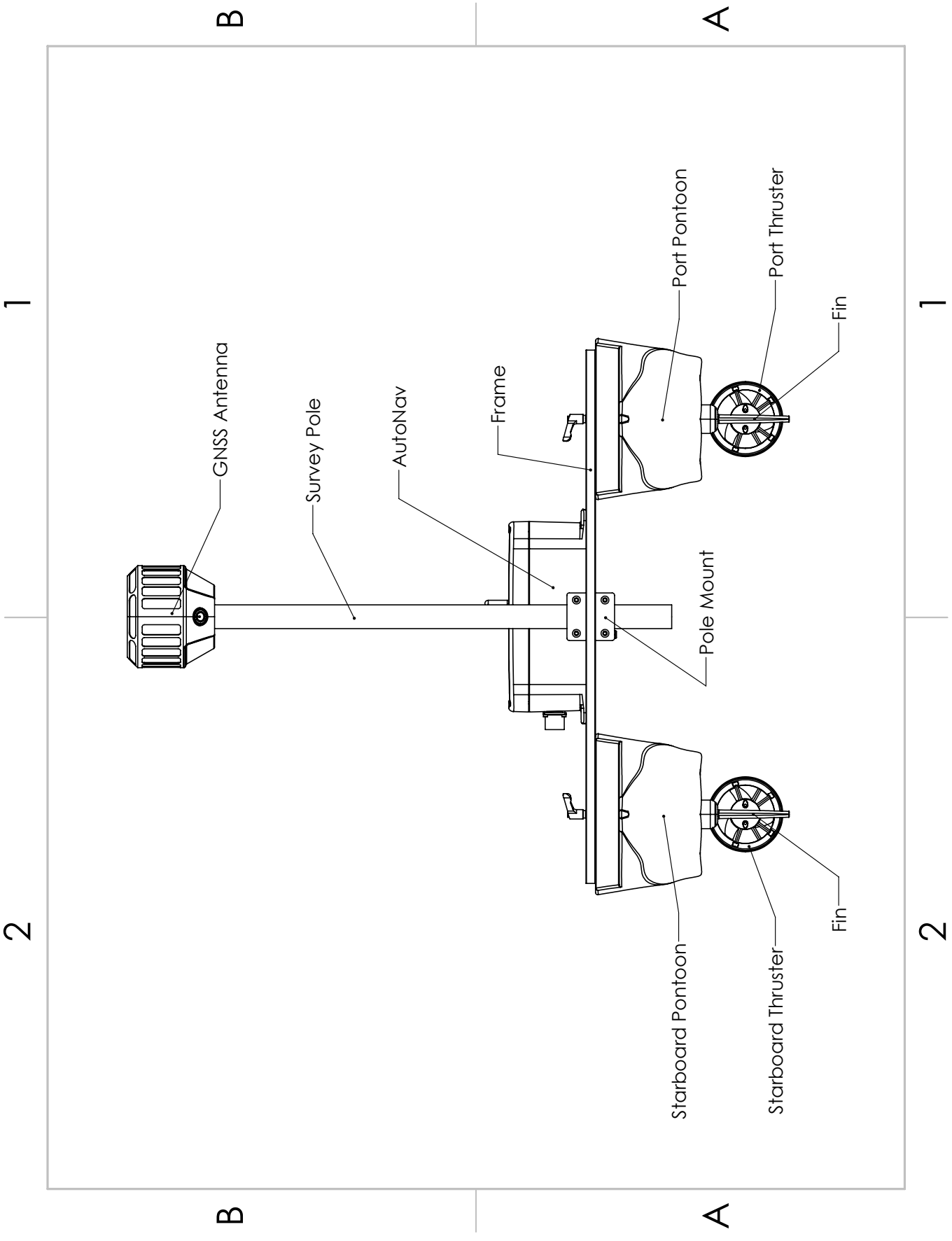


Figure 2: HyDrone™ ASV Servo Front View

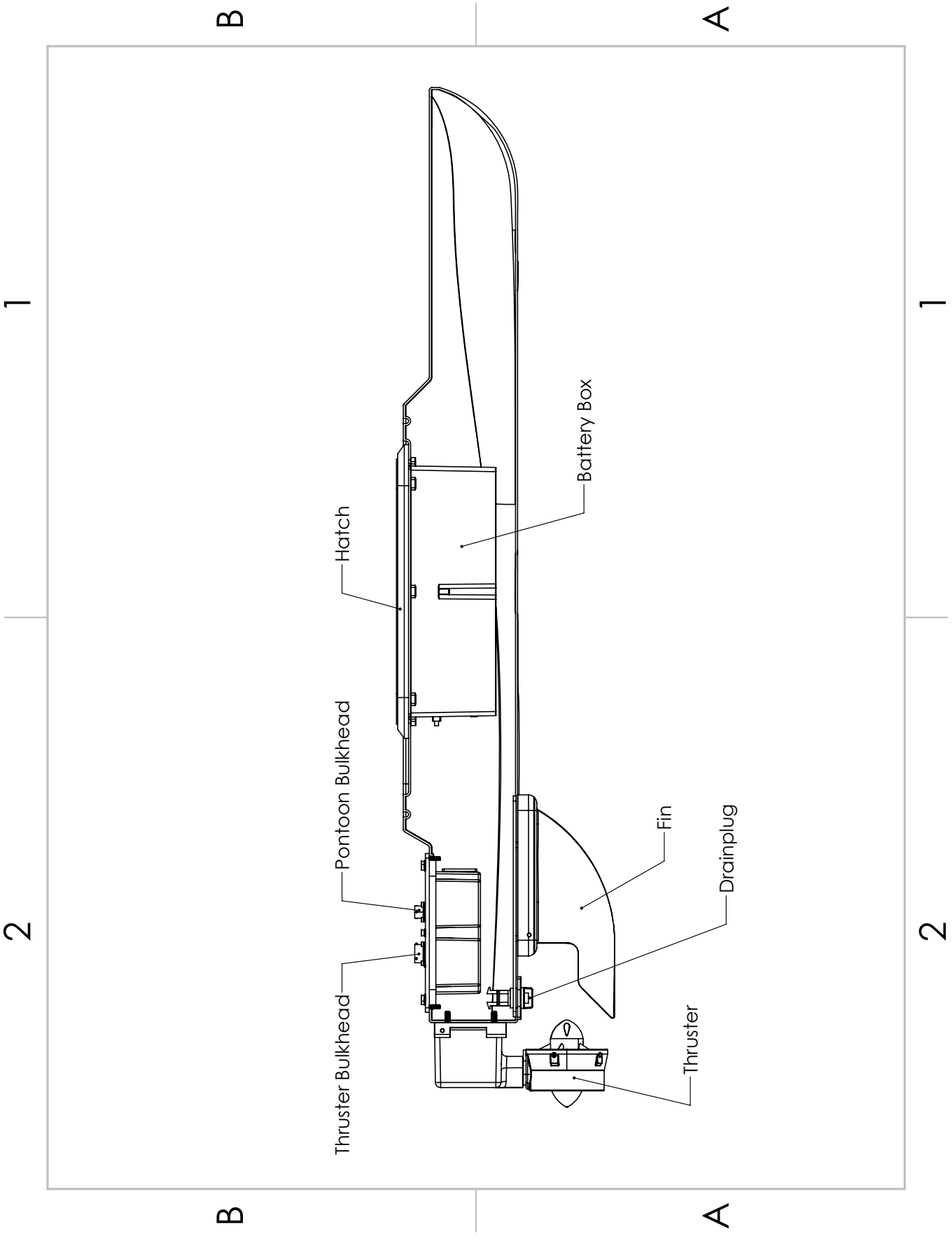


Figure 3: HyDrone™ ASV Servo Side View

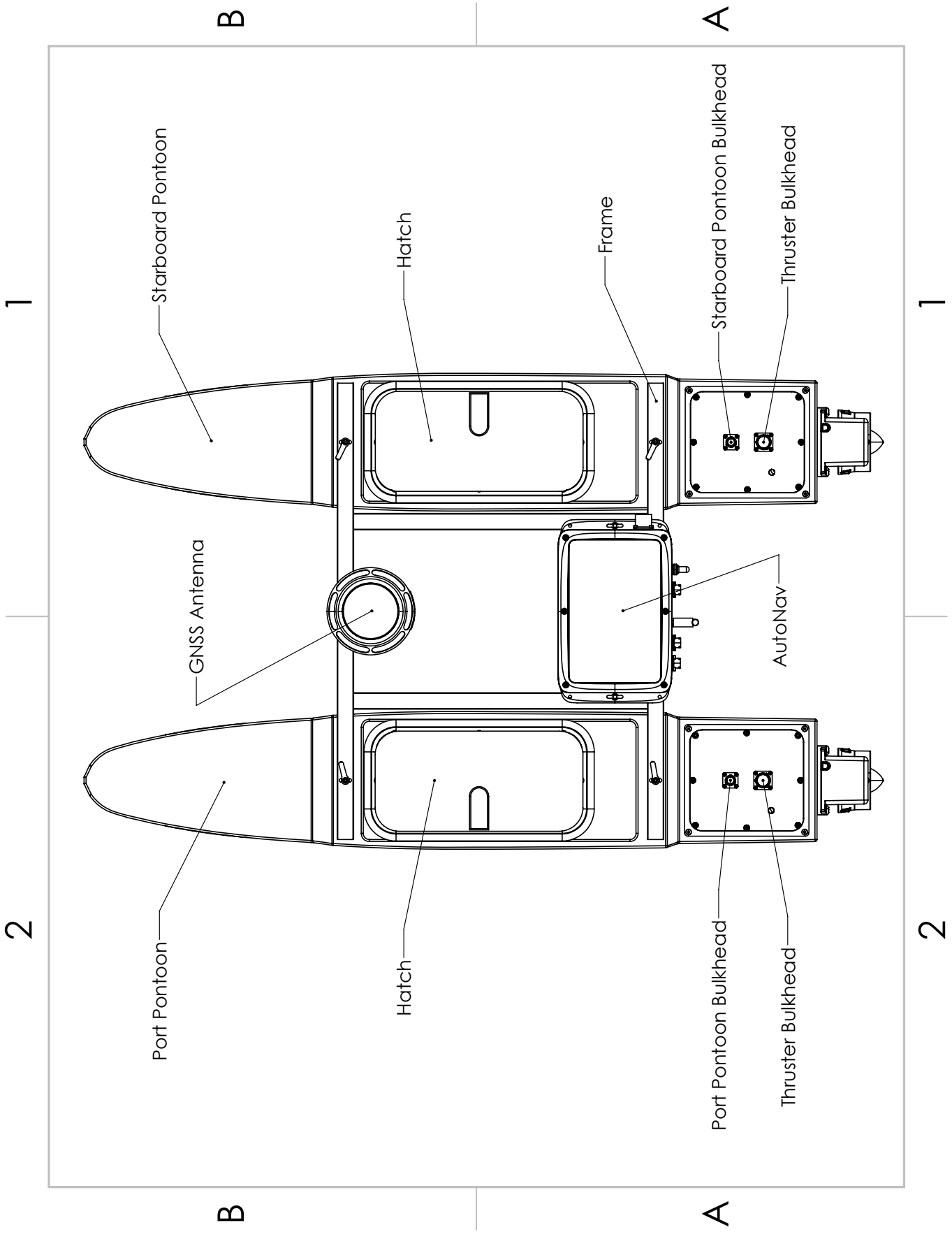


Figure 4: HyDrone™ ASV Servo Top View

1. Port: To Hydrone Port Pontoon Bulkhead (Amphenol Male 6pin)
2. Starboard: To Hydrone Starboard Pontoon Bulkhead (Amphenol Female 6pin)
3. SMA Antenna: Communication to Shoreside Telemetry Module.
4. GPS: GPS input to AutoNav™ (Amphenol Female 6pin)
5. Power: Up - AutoNav™ on. Down - AutoNav™ off.
6. USB: For hardwire connection to AutoNav™.

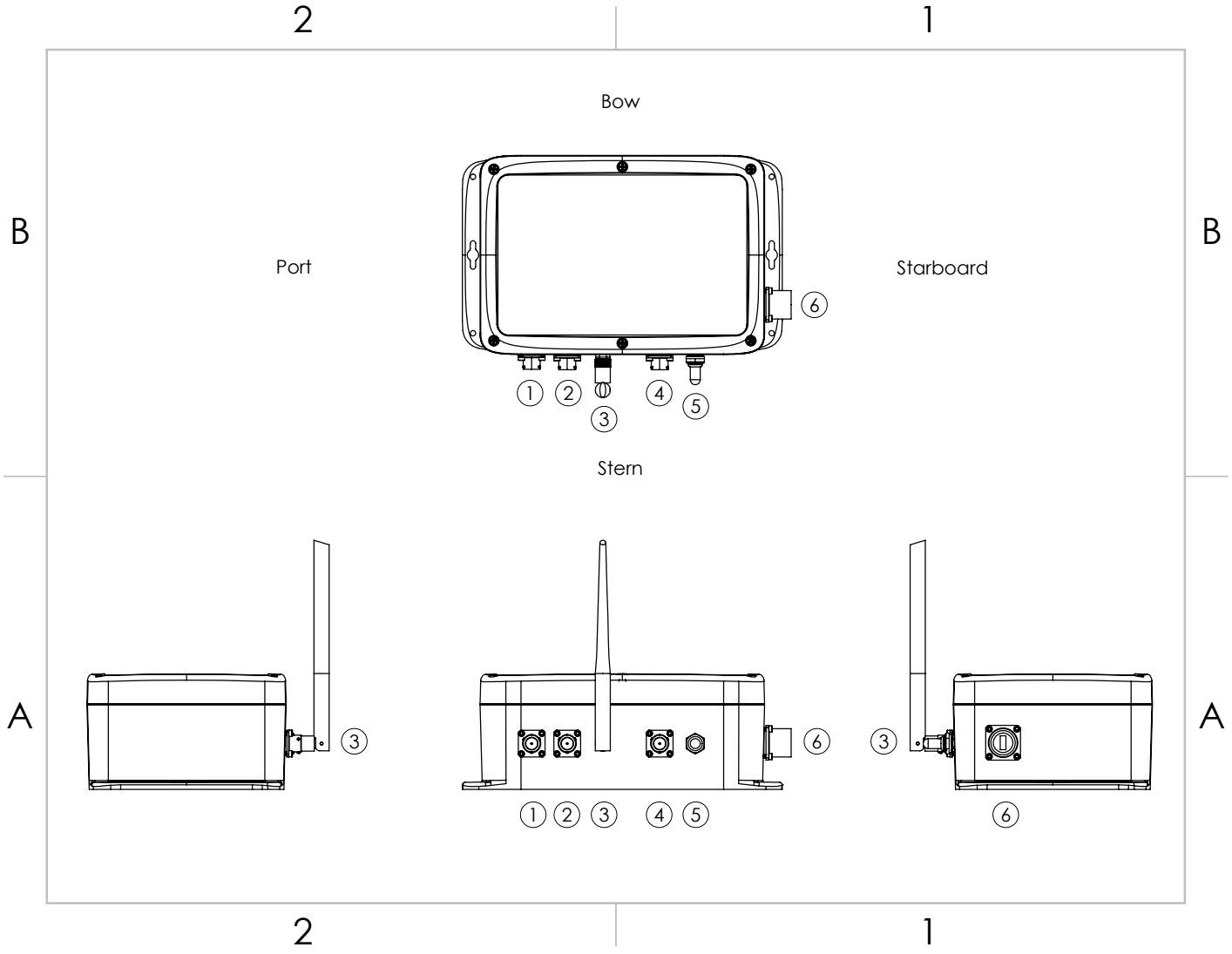


Figure 5: AutoNav™ Layout

3.3 Assembling Your HyDrone™ ASV Servo

Hydrone Pontoons:

1. Open the HyDrone™ ASV Servo case.
2. Arrange an elevated platform for positioning the HyDrone™ ASV Servo pontoons, ensuring sufficient clearance for fins and thrusters.

Figure 6: Pontoons

3. Space the pontoons roughly 1' (30.4cm) apart.
4. Verify the port pontoon and starboard pontoon are on their correct sides.
   - Using the stickers at the stern. Port is left. Starboard is right.
5. Remove the frame from the case and lay it across the two pontoons. The pole mount should be on the front of the vessel.
6. Apply a thin coat of anti-seize to the end of the frame bolts. Loosely install all the supplied stainless steel frame hardware.

Figure 7: Frame Hardware

7. Tighten the hardware.

Figure 8: Frame Attached

8. Flip the HyDrone™ ASV Servo upside down to gain access to the fin mount channel.

9. Slide the fin with the notch facing the bow into the fin mount channel.
10. Tighten the thumbscrew to hold the fin in place.

Figure 9: Fin Installation

11. Flip the Hydrone™ fin side down.
12. At the stern, install the servo thruster and slide it into it's mount.
13. Tighten the thumbscrew to lock the thruster in place.
14. Connect cable into pontoon bulkhead.

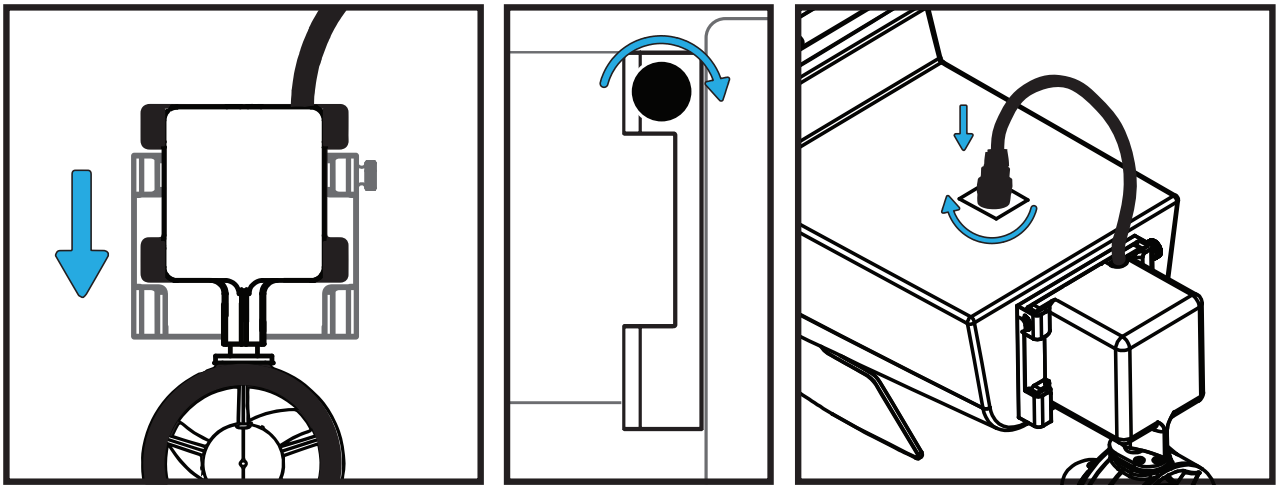


Figure 10: Thruster Installation

15. Place the AutoNav™ on the Hydrone™ frame. Power switch facing the stern. (Figure 5)

16. Install the 2x M5x30 bolts and washers through the AutoNav™ box and frame.
17. Install and tighten the M5 wingnuts.

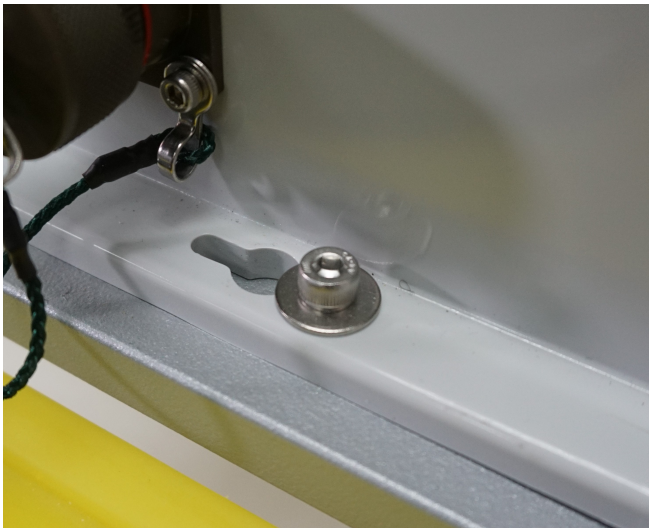


Figure 11: AutoNav™ Mounted

18. Screw in the 1x Telemetry Module Antenna into the SMA bulkhead on the AutoNav™. (Figure 5)

Caution

Do not power AutoNav™ without Telemetry Antenna attached. Potential damage to Telemetry Module if not followed.

19. Unscrew the pontoon and AutoNav™ bulkhead caps.

Information

Verify the Pontoon Power Data Cables have same gender cable ends. Port cable is female cable ends. Starboard cable is male cable ends.

20. Connect the Pontoon Power Data Cable between the pontoon and AutoNav™. **They are gender keyed**. Female cable for port, male cable for starboard.
21. Connect the serial cable into the GPS bulkhead.

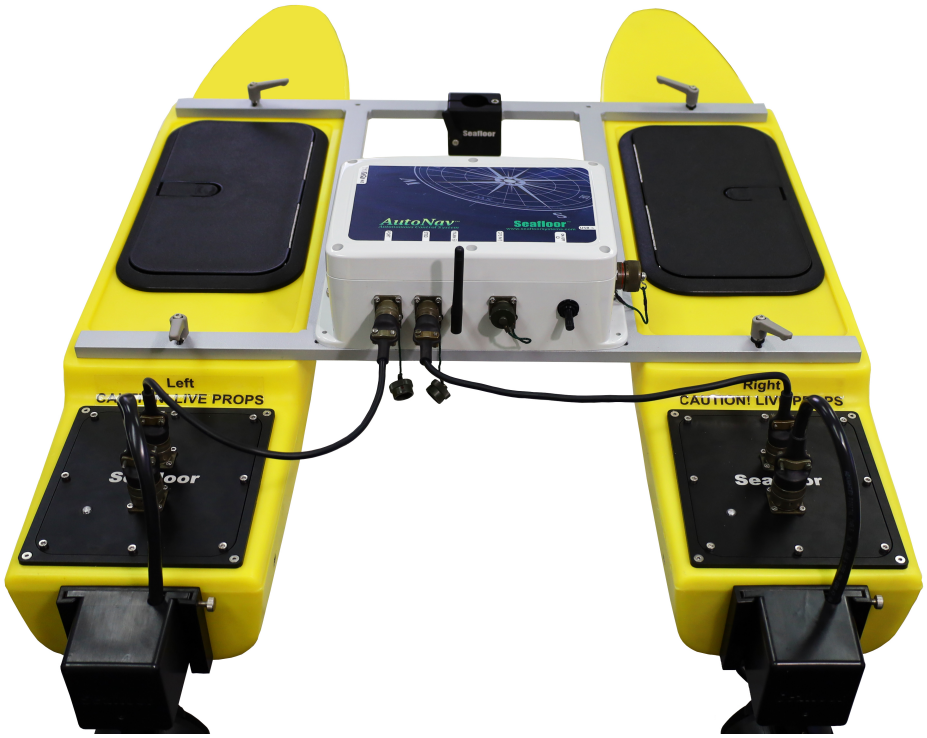


Figure 12: HyDrone™ ASV Servo Assembled

3.4 HyDrone™ ASV Servo Endurance Chart

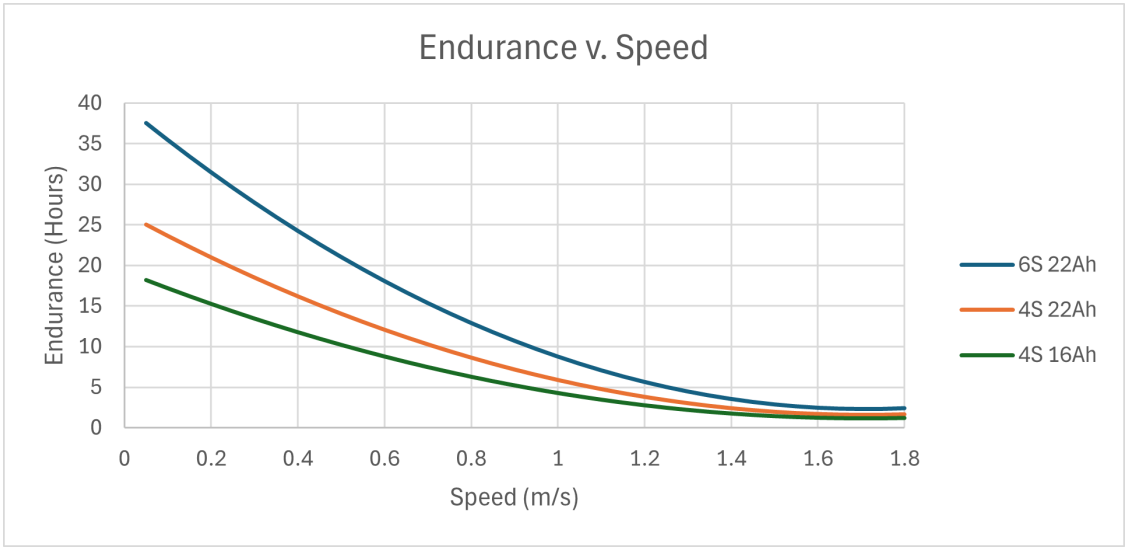


Figure 13: HyDrone™ ASV Servo Endurance Chart

3.5 Remote Control Unit (RCU)

The HyDrone™ ASV Servo is controlled by a Tandem X18 Transmitter.

Information

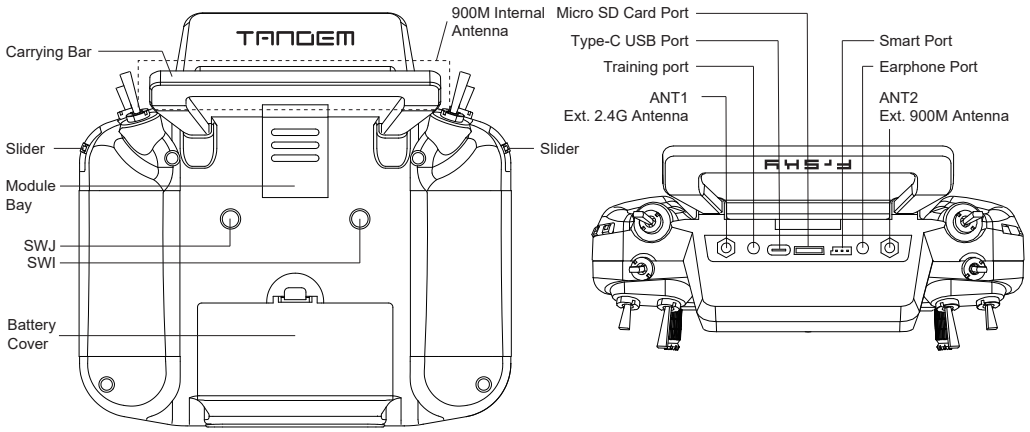
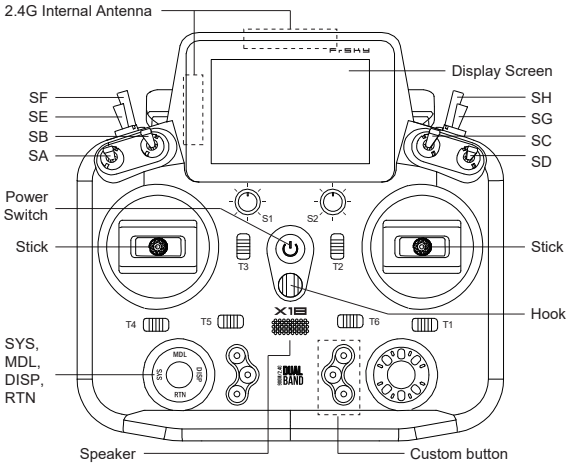


Figure 14: RCU Back and Bottom View

To charge the battery:

- Locate Type-C USB Port
- Connect supplied USB C cable.
- Connect USB A into a suitable charger source. (5VDC at 2amps)

Layout



Switch

- SA: 3 positions; Short Lever
- SB: 3 positions; Long Lever
- SC: 3 positions; Long Lever
- SD: 3 positions; Short Lever
- SE: 3 positions; Short Lever
- SF: 2 positions; Long Lever
- SG: 3 positions; Short Lever
- SH: 2 positions; Momentary, Long lever

You can choose the Switch and define its position in the HARDWARE menu.

1. **USB port is for upgrading, reading/ writing Micro SD cards and internal memory of radio contents and charging. (Micro SD card is not provided with shipment.)**
2. **Smart Port is for firmware upgrade for all FrSky S.Port devices.**

Figure 15: RCU Front View

Remote Control Unit Functions

Power	Press and hold Release when the fourth loading dot appears - to power on Release when the last loading dot shows - to power off
Left Stick	Unused
Right Stick	Throttle (Up/Down Steering (Left/Right)
S1	Volume Clockwise to turn up Counter-Clockwise to turn down
S2	Unused
SA	Arm (Up) (+ SH down/pull) Unused (Center)**(Default Position)** Disarm (Down) (+ SH down/pull)
SB	Loiter (Up) Unused (Center)**(Default Position)** Unused (Down)
SC	Unused
SD	Unused
SE	Unused
SF	Manual (Up/Push)**(Default Position)** Auto (Down/Pull)
SG	Unused
SH	Unused (Up)**(Default Position)** Send Command (Down/Pull) Hold for 5 seconds. To **Arm** SA up + SH down To **Disarm** SA + plus SH down
Digit Trims (T1-6)	Unused
Earphone Port	Unused
Trainer Port	Unused
Module Bay	Unused
Battery Cover	RCU Internal Battery Location

Table 4: RCU Functions

Information

To arm HyDrone™ ASV Servo:

Move SA switch up and hold SH down for 5 seconds. A long alert tone (Beep——) will emit from the AutoNav™, indicating system is armed. See Figure 15

To disarm HyDrone™ ASV Servo:

Move SA switch down and hold SH down for 5 seconds. A short alert tone (Beep-) will emit from the AutoNav™, indicating system is disarmed. See Figure 15

3.6 Voltage Tester

Information

Max voltage of a 4S battery is 16.8VDC. Max voltage of a 6S battery is 25.2VDC. (4.2VDC/Cell)

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.

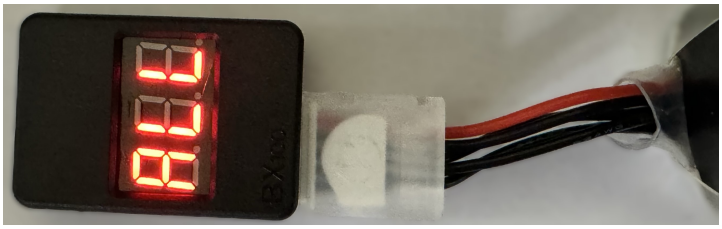


Figure 16: LiPo Voltage Tester

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

3.7 Battery Charging

3.7.1 Tattu Charger

Important Alert

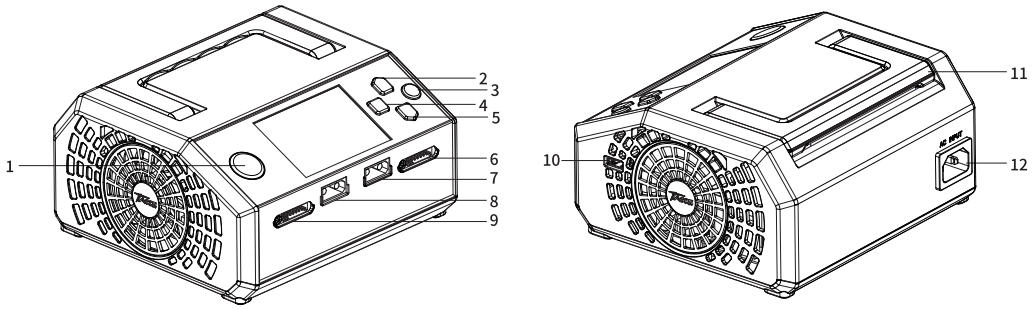
Never leave batteries unattended while charging. Batteries on charge MUST remain under constant observation so that you may react quickly should any problems arise.

Caution

Max voltage of a 4S battery is 16.8VDC. Max voltage of a 6S battery is 25.2VDC. (4.2VDC/Cell)

Caution

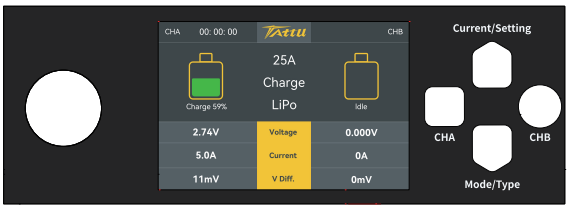
Charging LiPo Battery: with Tattu Charger



NO.	Description	NO.	Description
1	Power Switch	2	Current/Settings
3	CHB	4	CHA
5	Mode/Type	6	Balance Port B
7	Channel B	8	Channel A
9	Balance Port A	10	USB Upgrade Port
11	Handle	12	AC Input Port

Figure 17: Tattu Charger Layout

1. Using the supplied voltage tester, verify each cell is above 3.2V, below 4.2V, and within 10% of each other. Please refer to 2.1.
2. Plug the Tattu TA1000 Charger into an AC 100-240VAC outlet. Note that the battery is not connected to the charger currently.
3. Short press the Power Switch to power on the charger. The screen will display the start-up interface.
4. After powering on, the internal self-test interface displays for 5 seconds. After a successful self-test it will automatically switch to the main interface.
5. Connect the female XT90 from the LiPo battery into the male XT90 connector on the charger. Then, connect the balance lead into the charger.
   (a) Charging G-Tech Smart Batteries:
      i. If communication between the battery and charger is successful, the charger will automatically set charge settings and start after 6 seconds.
   (a) Charging Non G-Tech Smart Batteries:
      i. Using the up and down button, select the appropriate current, operation mode, and battery type.
      ii. Press and hold the CH A or CH B button to start charge operation.



Button	Mode	Function
Power Switch	Short Press/Long Press	Short press to turn on/Long press to turn off
Current/Settings	Short Press/Long Press	Short press to select current/ Long press to enter the setting interface
Mode/Chemistry	Short Press/Long Press	Short press to select Charge/storage mode/ Long press to select battery chemistry Lipo/LiHV
CHA	Short Press/Long Press	Short press to return or view the interface of a single cell/Long press to start or pause the process of CHA
CHB	Short Press/Long Press	Short press to confirm or view the interface of a single cell/Long press to start or pause the process of CHB

Figure 18: Tattu Charger Operation

6. Press and hold the corresponding channel button to pause the charging operation.
7. During the charging process the main screen will provide the following information:
   (a) Charge time
   (b) Charge percentage
   (c) Status
   (d) Voltage
   (e) Current
   (f) Real-time voltage difference

Important Alert

WARNING: Always check charging parameters before initiating the charge process. Charging any battery with improper settings, including charging a battery in the wrong mode, can result in property damage and fire.

8. When charging is complete, two beeps will be heard and the display will read "Done 100%" with a full green battery indicator.
9. Disconnect the battery from the charger.
10. Long press the Power Switch for 3 seconds to power off the charger.

Important Alert

WARNING: For safety, please do not disconnect the battery while charging. If you need to remove, please pause or cancel charging first.

Technical Data

Input Voltage	100-240 VAC
Max Charge Current	25.0A
Discharge Current	6.0A
Max Charge Power	2x500W
Max Discharge Power	2x70W
Balance Cells	1-7s
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C

Table 6: Tattu Charger Technical Data

3.8 Pre-Launch Check List

- Check all RCU switches and knobs are in correct positions for power on. **Ensure volume knob is fully clockwise**. (Refer to 3.9)
- Check that no warnings are displayed when RCU is powered on. Determine cause of any warning and correct.
- Check that no alarms are heard (**See volume knob note above**) or felt (Haptic Vibration Feedback System).
- Check model displayed on main screen is correct. (Figure 27)
- Check RCU battery voltage is sufficient to perform lake test. 6-8.5VDC
- Check pontoon battery voltage level is fully charged. 16.8VDC (4.2VDC/Cell)
- Check propulsion system functions properly with manual control.
- Check the GPS system is fully charged.
- Check the AutoNav™ is receiving accurate GPS position in Mission Planner.
- Check the AutoNav™ has the correct heading in Mission Planner.
- Check the AutoNav™ does not show any errors in Mission Planner.

3.9 HyDrone™ ASV Servo Power On Procedure

Caution

- Disconnect the batteries of the HyDrone™ ASV Servo at 12.8VDC (3.2VDC/Cell) to avoid irreversible damage. (Refer to 1.4)
- To extend the battery life of the HyDrone™ ASV Servo, it is advisable to power it off prior to when the voltage discharges to 13.6VDC (3.4VDC/Cell). (Refer to 1.4)

Information

1. Power on the RCU. (Refer to 3.5)
2. Verify the right joystick is centered.
3. Install fully charged 4S 16.8VDC (4.2VDC/Cell) batteries into each pontoon. Connect the female XT90 connector of the battery to the male XT90 connector of the power switch.
4. Power on the AutoNav™. Three step up tones can be heard roughly 10 seconds after powering on, indicating that the AutoNav™ is initialized.
5. Power on both pontoon switches (Figure 1), wait 15 seconds for the ESCs to initialize with a series of beeps.
6. Arm the HyDrone™ ASV Servo with the RCU. (Refer to 3.5)
7. Verify controls function correctly. (Refer to 5.1)
8. Secure all hatches with the hatch wrench before launching vessel.

Caution

Do not run thrusters for more than a few seconds out of the water.

3.10 Manual Operation

HyDrone™ ASV Servo is a directed steered vessel. The right joystick controls both throttle and steering. Must have forward or reverse thrust for 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. For a right turn, move the right joystick to the right.
- 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 HyDrone™ ASV Servo is headed toward you.

3.11 Autonomous Operation - Mission Planner

Information

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

- GGA and RMC at 5Hz with a GP Talker ID(Prefix) at 38400 baud rate. RS232 Protocol with DB9 connector. USB to DB9 adapter does 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

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 3.5)
- 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

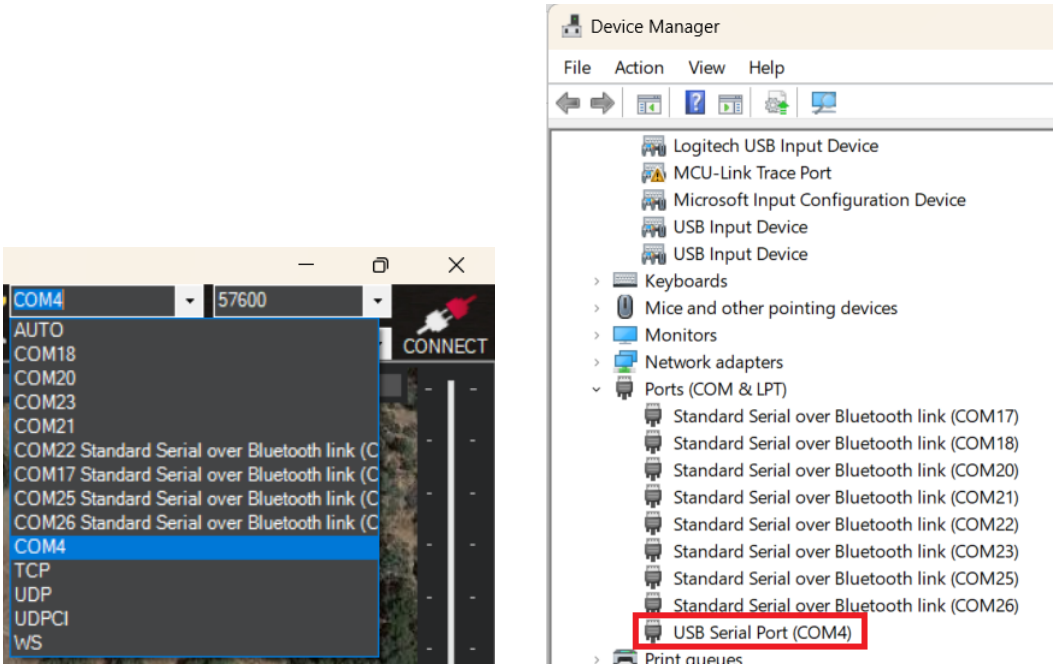
Internet connection on the field laptop is required to view satellite background images.

Caution

Do not assume satellite images of water level are correct. Always drive the perimeter with the HyDrone™ ASV Servo.

Mission Planner:

1. Open Mission Planner on a field laptop.
2. Connect the USB from the Telemetry Module into the field laptop.
3. Connect to the AutoNav™. (Your Windows may assign a different COM port number.)



(a) Mission Planner COM Port (b) Device Manager COM Port

Figure 19: USB Telemetry Module COM Port

- Choose the Telemetry Module COM port
- 57600 baud rate

4. Click PLAN.
5. Find your survey area.
6. Click the circled polygon in the top left and select 'Draw a Polygon'.

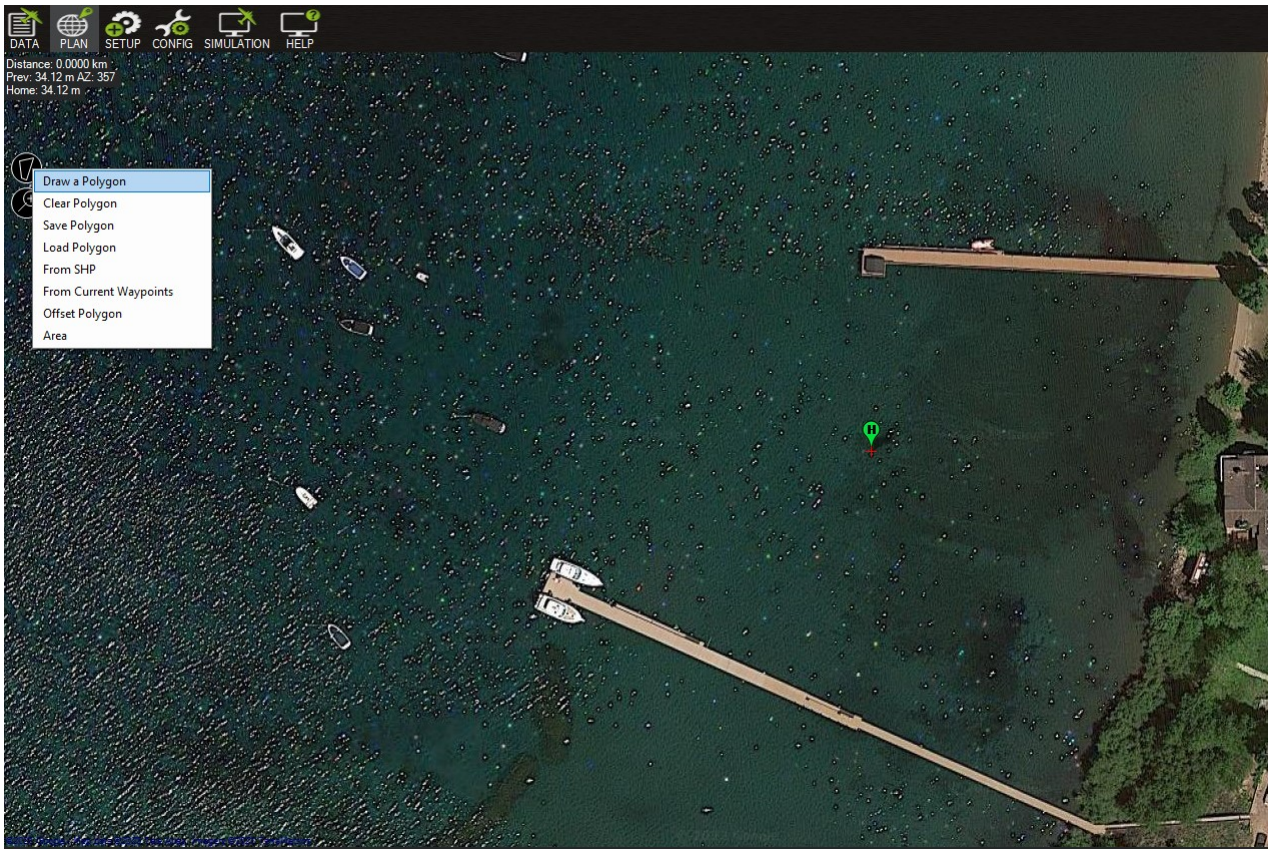


Figure 20: Polygon Select

7. 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 HyDrone™ ASV Servo to desired location and drop polygon points at each extent.
8. Right click survey area. Highlight 'Auto WP' and select 'SimpleGrid'.

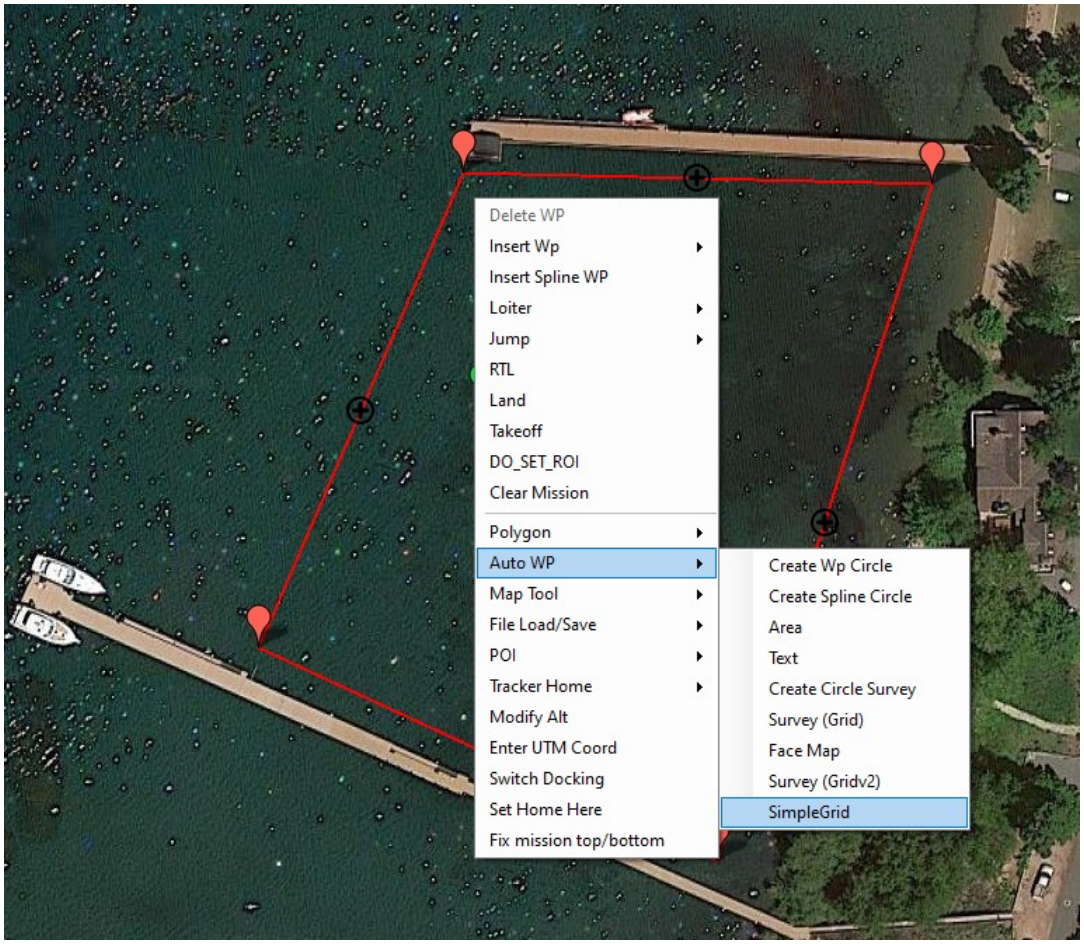


Figure 21: SimpleGrid Select

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 7: SimpleGrid Settings

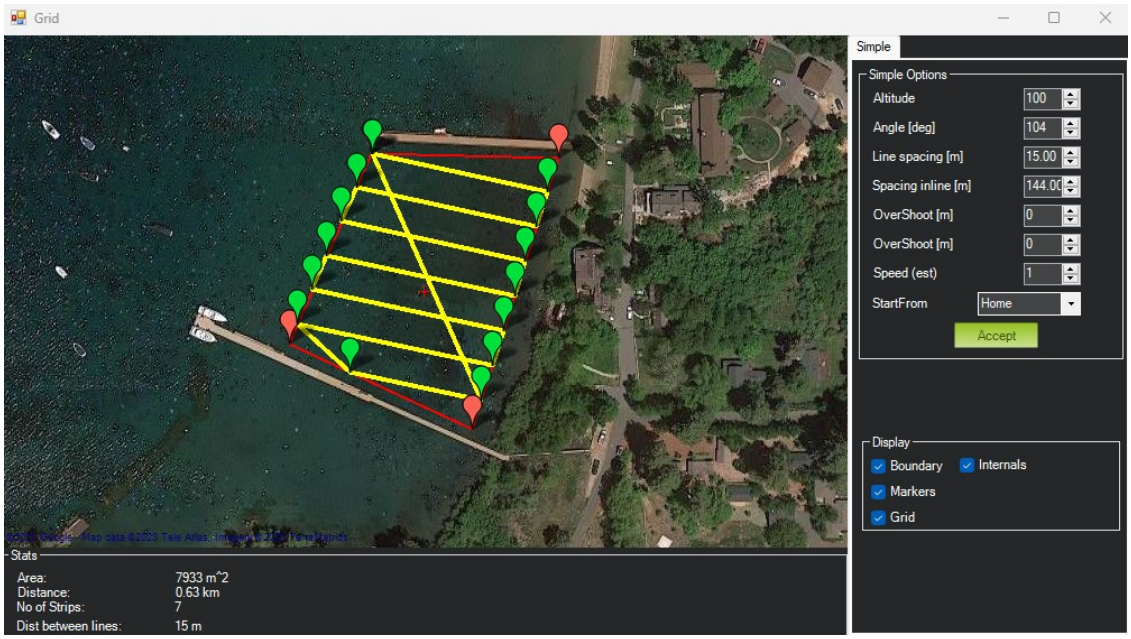


Figure 22: SimpleGrid Settings

9. Delete the first command, speed change.

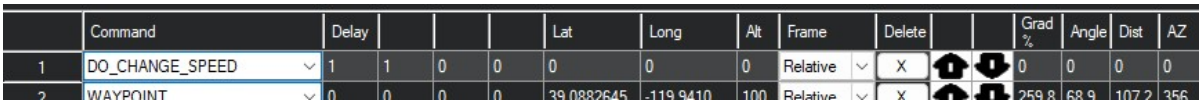


Figure 23: Delete DO_CHANGE_SPEED

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

10. Click 'Write' on the right panel.

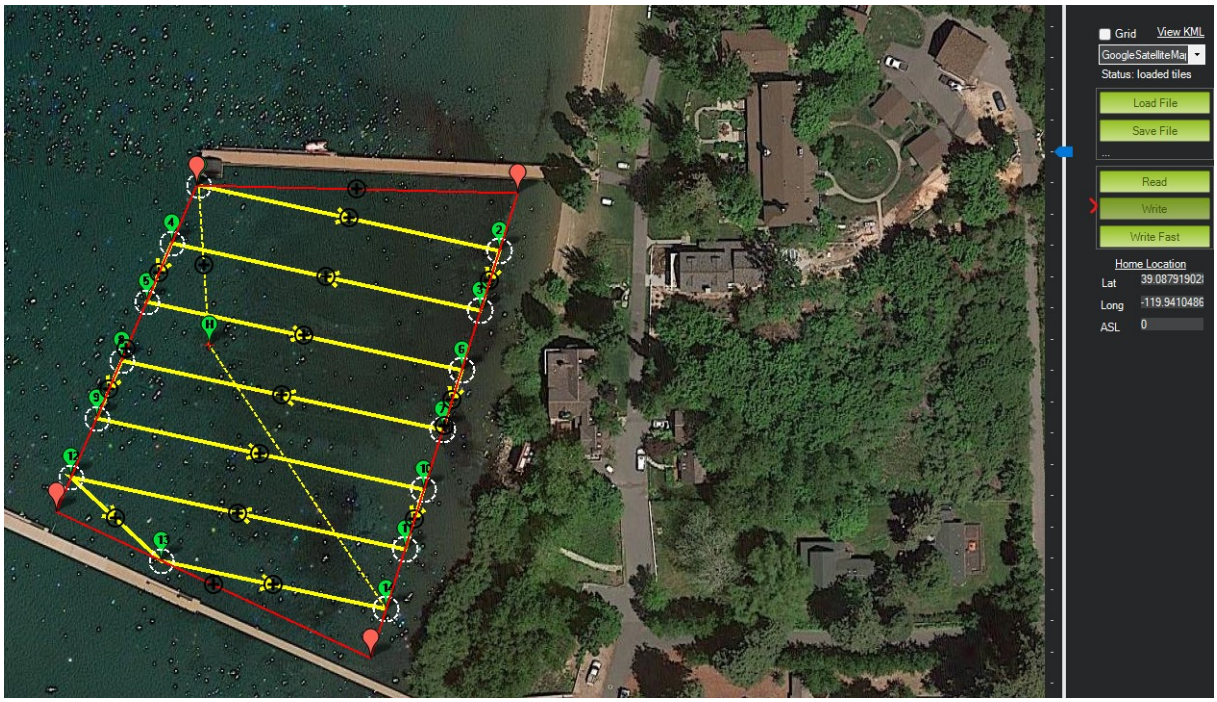


Figure 24: Write Mission

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

11. 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.

3.12 HyDrone™ ASV Servo Power Off Procedure

1. Upon retrieval of the HyDrone™ ASV Servo, disarm using the RCU SA and SH switch. (Refer to 3.5)
2. Power off the AutoNav™.
3. Power off both pontoon switches. (Figure 1)
4. Disconnect each 4S battery. Disconnect the female XT90 connector of the battery from the male XT90 connector of the power switch.
5. Power off RCU by holding Power button until the 4 dots count down. Release at one dot. (Refer to 3.5)

3.13 Fail-Safe

Important Alert

If there's a failure, the HyDrone™ ASV Servo is equipped with integrated fail-safes to address emergency situations if necessary.

- Within RCU range you can disarm the USV to stop or prevent throttle commands to the thrusters.
- Outside of RCU range if loss of comms:
  - Manual mode: The vessel will drift with no input. Attempt to reconnect by moving shoreside position and set RTL.
  - Autonomous mode: The vessel will continue on it's mission. It is best practice to always survey within the RCU range.
- 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 if you wish to enable.

4 Frequently Asked Questions (FAQ)

- Why does the thruster motor not respond while the HyDrone™ ASV Servo is powered? Alert tone of beep-, beep- (1 second interval) is heard.
  - There is no signal from the receiver. Verify that the RCU is powered and that the RCU and receiver are bound. Verify all connections are clean and fully seated.
- Why is the hatch leaking?
  - Verify the condition of the hatch seal. Lubricate or replace as necessary.
- Why is the prop spinning without engaging the throttle?
  - Verify that the throttle trim is centered. Calibrate if necessary.
- Why does the HyDrone™ ASV Servo have a limited turning radius or only turns in one direction?

  - Verify that the props are clean of debris. If issue still persists, calibrate ESC. (Refer to 6.3)

- Why is the receiver not powered?
  - Connector is not fully seated or inadvertently disconnected.

- Why isn't the thruster functioning while the servo can still rotate? An alert tone of beep-, beep- (1 second interval) can be heard.
  - No signal from receiver. Verify RCU is powered. Verify RCU and receiver are paired. Calibrate ESC. (Refer to 6.3)

- HyDrone™ ASV Servo is not going into Auto mode.
  - No GPS or Compass Variance. Verify your GPS is outputting GGA and RMC at 5Hz with a talker ID(Prefix) of GP at a 38400 Baud rate. Use the supplied Null Modem if you are confident your GPS is outputting correctly. Calibrate the compass.

- AutoNav™ disconnects from Mission Planner if driven too far away.
  - The supplied USB Telemetry Module is good up to 300m range. (Conditions dependent) To increase the range you must increase the height of the US Telemetry Module antenna.

- USB telemetry module is not being found in Device Manager.
  - Download and install the USB telemetry module driver from the supplied USB Drive.

5 Troubleshooting

5.1 Current Propeller Orientation and Rotation

Information

USVs and spare parts manufactured after September 9, 2024, have standardized to one prop rotation and orientation.

If the propellers on a HyDrone™ ASV Servo are rotating in the wrong direction, it will cause the boat to move in circles when attempting to go forward. Similarly, installing the wrong propeller will also lead to same issue. If you recently installed a new thruster or propeller, please use the below information to check proper orientation and rotation.

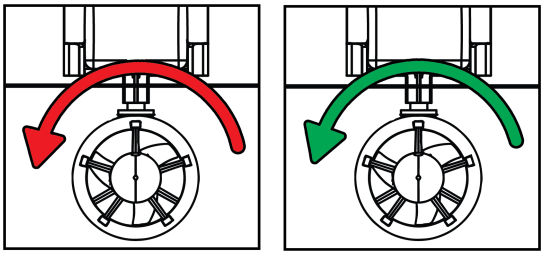


Figure 25: HyDrone™ ASV Servo Prop Rotation
(Colors Illustrate Maritime Navigation Lights)

- Both Thrusters:
  - Motor must rotate counterclockwise(CCW) (Figure 25)
  - Prop is CW

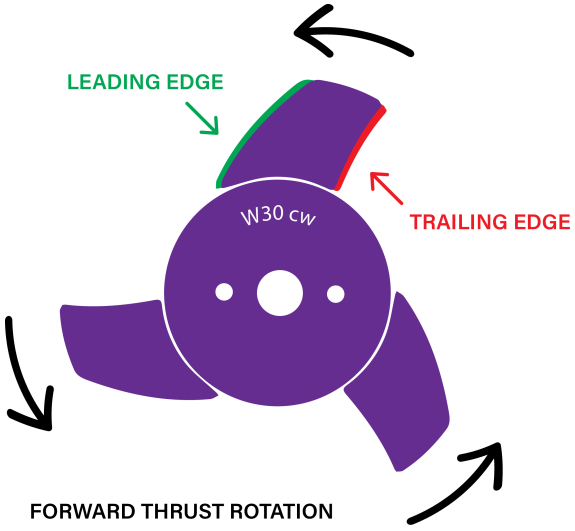


Figure 26: W30 CW Prop

5.2 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 6.5)
- 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 single antenna GPS system
  - Incorrect NMEA GPS strings or compass calibration required.

5.3 RCU Fault

Flashing Green Power Button

- Indicates the device is attempting to charge while the battery is removed or there is a fault with the battery.

6 Configure Procedure

6.1 RCU Receiver Binding Procedure

Archer Plus R6 Binding:

Registration is only required if the RCU or Receiver (RCVR) was replaced. Skip to step 9 to bind for either receivers.

1. Refer to 3.5 for button or switch location on RCU.
2. Power on the RCU, power off the Archer Plus R6.
3. Press the MDL button.

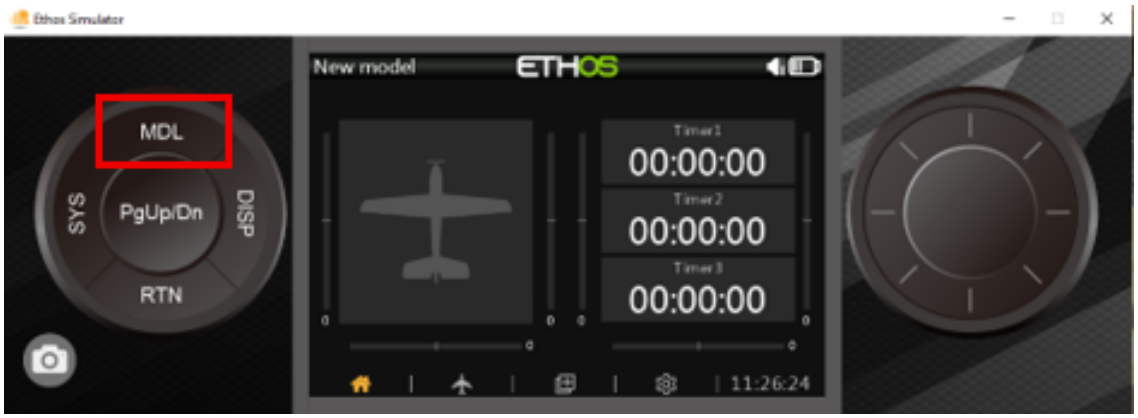


Figure 27: Main Screen

4. Select RF System.

Figure 28: Model Screen

5. Archer Plus R6 Owner Registration ID: (Registration ID is the vessel serial number)

Figure 29: RF System

6. Select Internal Module

7. 2.4G set on.

Figure 30: 2.4G Set

8. Antenna set to internal.

Figure 31: Antenna Set

(a) Select Register.

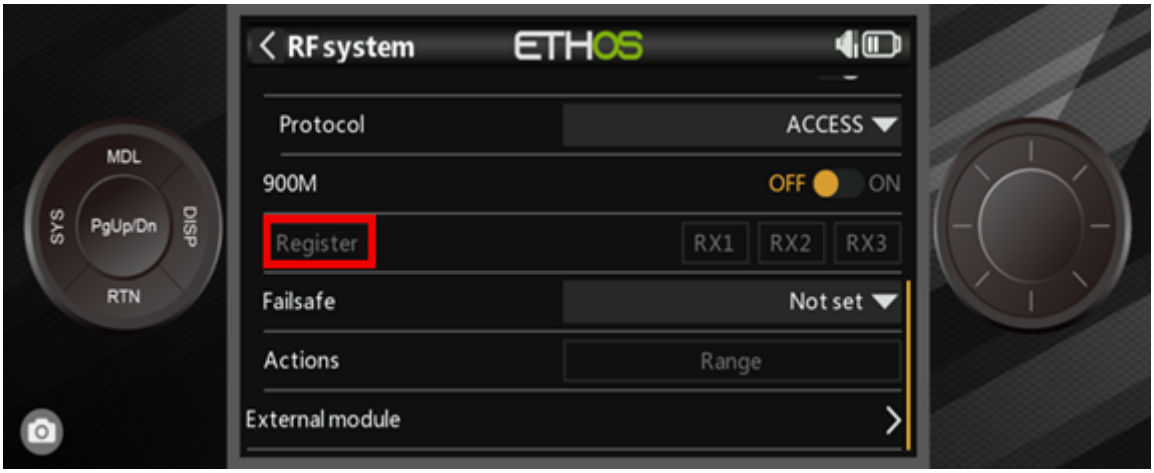


Figure 32: Registration

(b) On the Archer Plus R6, press and hold the bind button as you power on.

(c) If registration was successful the LED will be green and red.

(d) On the RCU, select ok to confirm registration.

(e) power off the Archer Plus R6.

9. Select RX1 on the RCU.

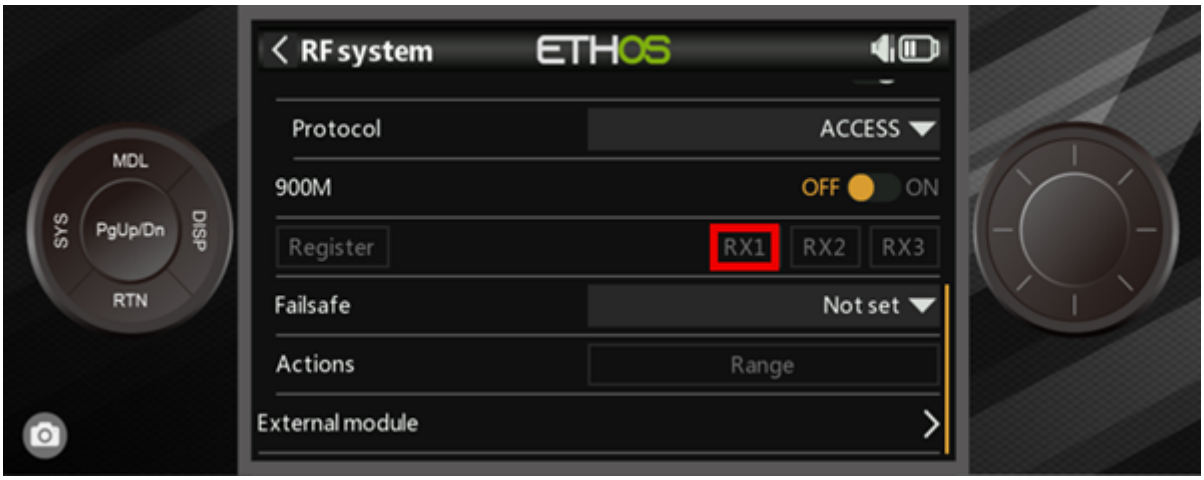


Figure 33: Receiver Binding

10. Power on the Archer Plus R6.
11. Press RTN to confirm the Archer Plus R6 was bound.

6.2 RCU Telemetry Configuration Procedure

Information

Telemetry configuration is only required if the RCU or Receiver (RCVR) was replaced. RCU and Receiver must be bound.

1. Refer to 3.5 for button or switch location on RCU.
2. Power on the RCU, power on the HyDrone™ ASV Servo.

3. Press the MDL button.

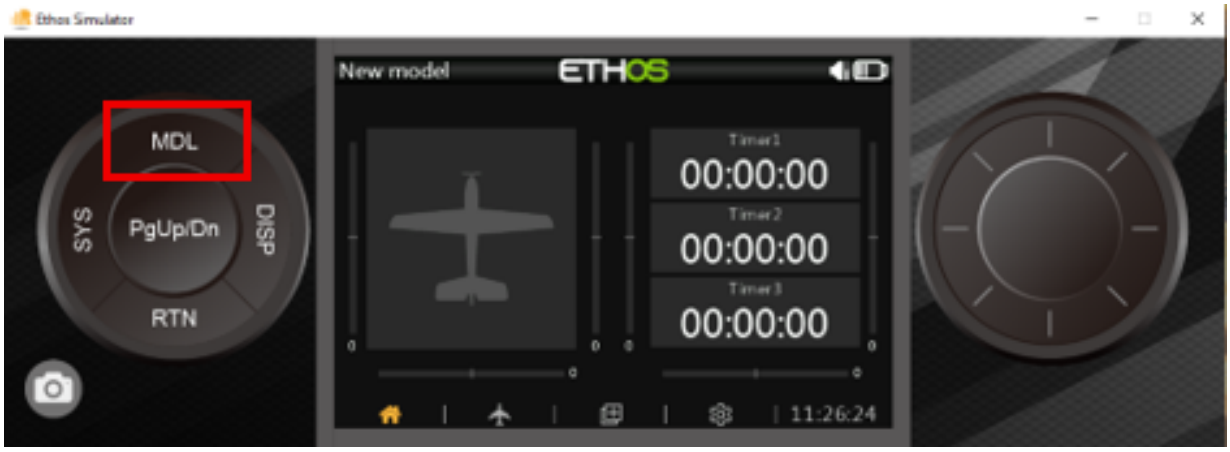


Figure 34: Model Select Screen

4. Scroll and select 'Telemetery'.

Figure 35: Telemetry Page

5. Select 'Delete all'.
6. Select 'Yes'.
7. Set 'Discover new sensors' to ON.

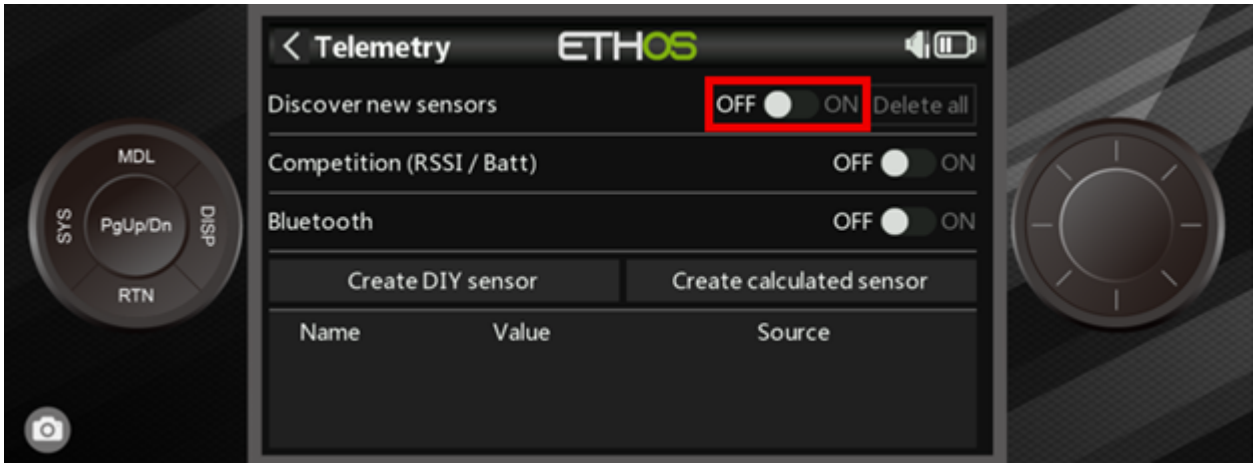


Figure 36: Discover New Sensors

8. ADC2 sensor will be active.
9. Select the ADC2 sensor.
10. Select 'edit'.

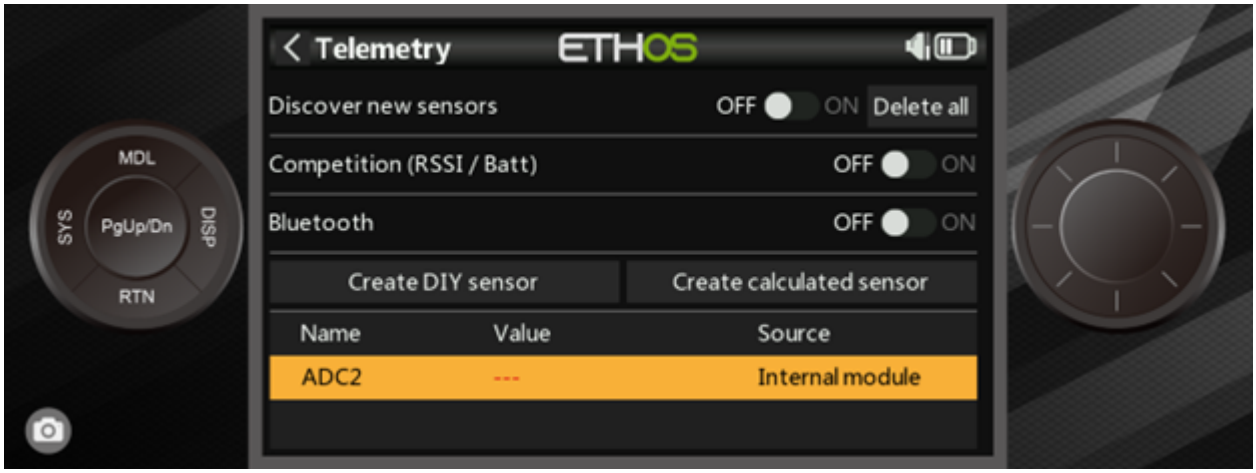


Figure 37: ADC2 Sensor Page

11. At the top of the screen is the pontoon voltage.
12. Scroll down to the Ratio. Modify the value to set the pontoon voltage. Use the supplied Voltage Checker to check the pontoon voltage.

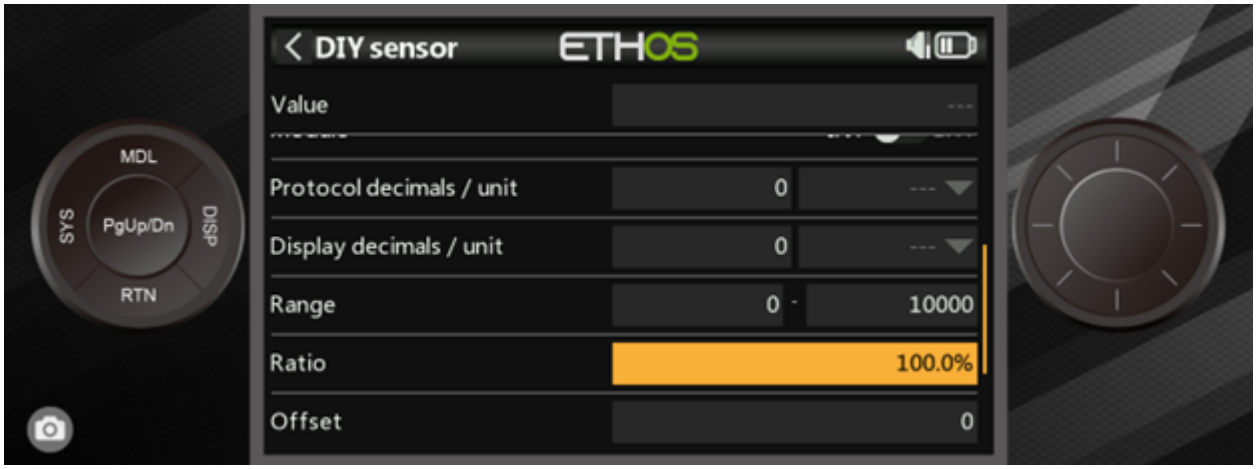


Figure 38: Ratio Setup

13. Press RTN until you are back at the main screen.
14. Select the window icon.

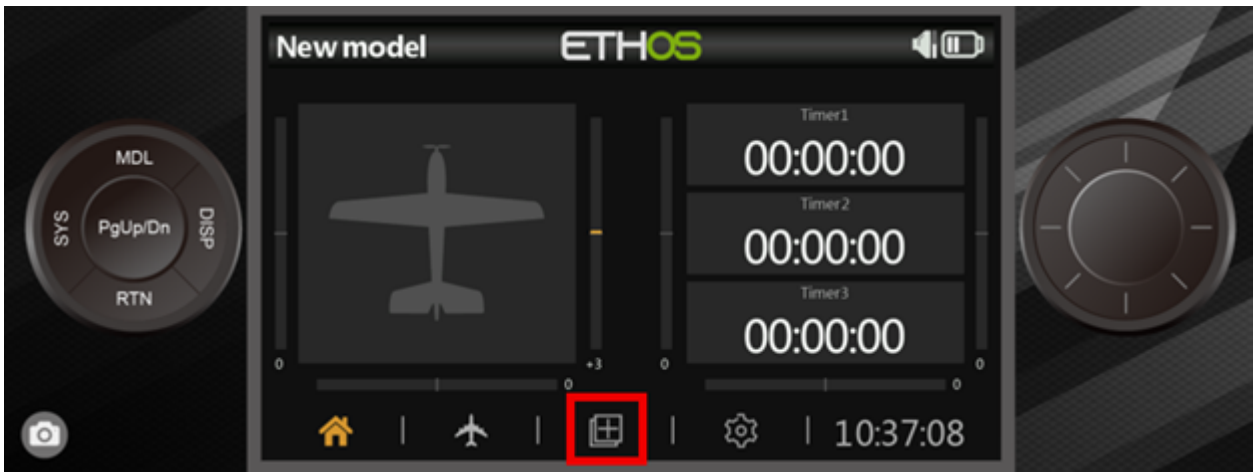


Figure 39: Configuration Icon

15. Select Change

Figure 40: Configuration Page

16. Select '—'
17. Select Value

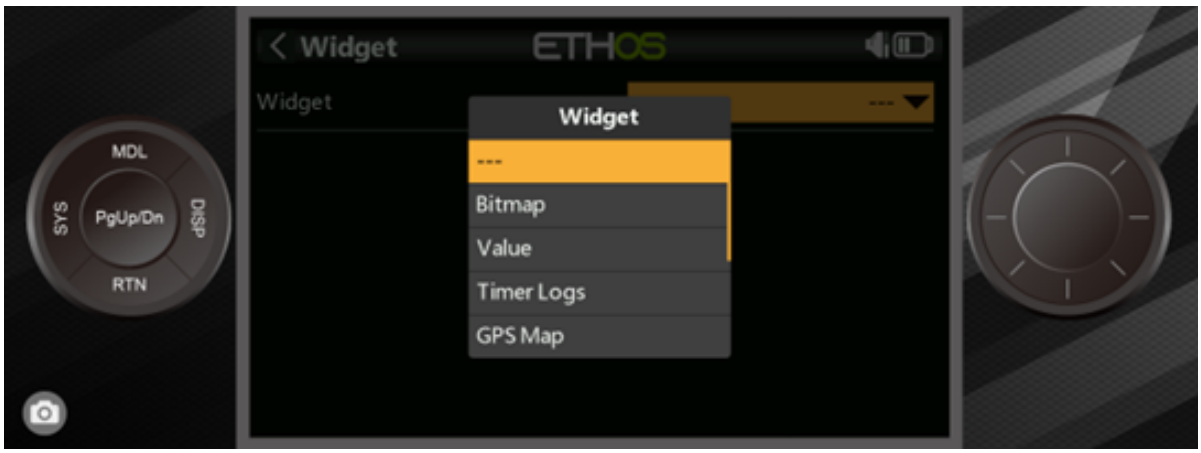


Figure 41: Widget Source

18. Select Source drop down.

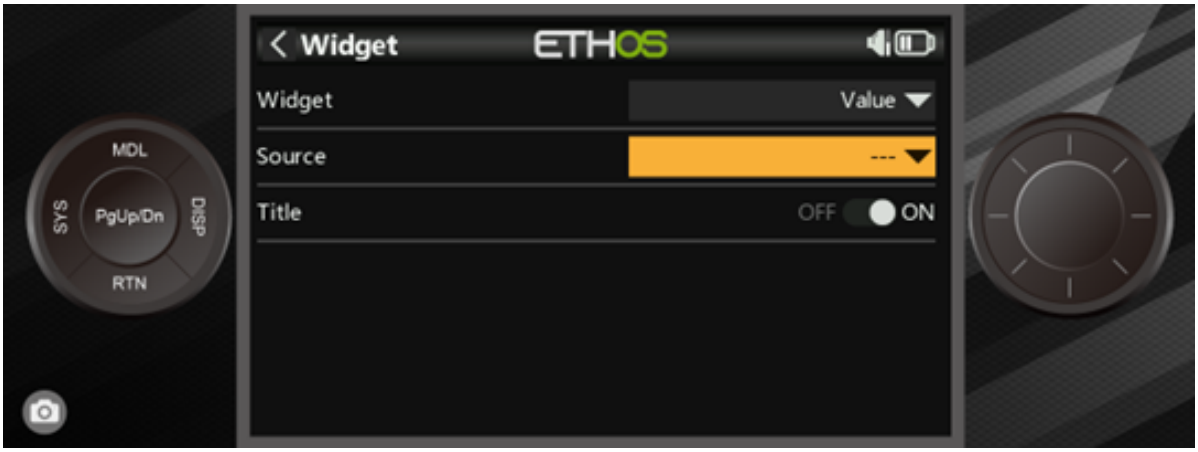


Figure 42: Source Selection

19. Select Telemetry.

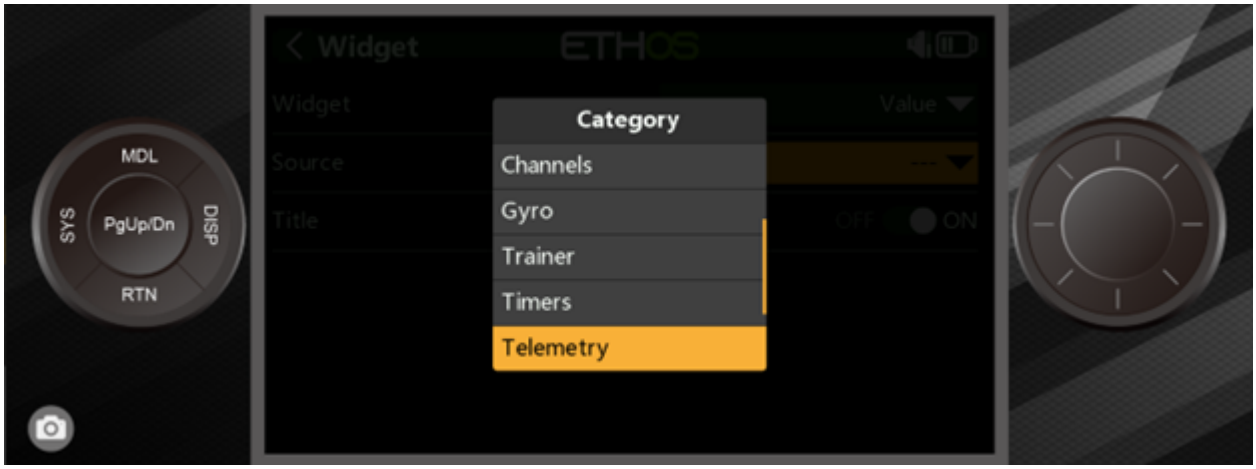


Figure 43: Telemetry Selection

20. Scroll and select 'ADC2'

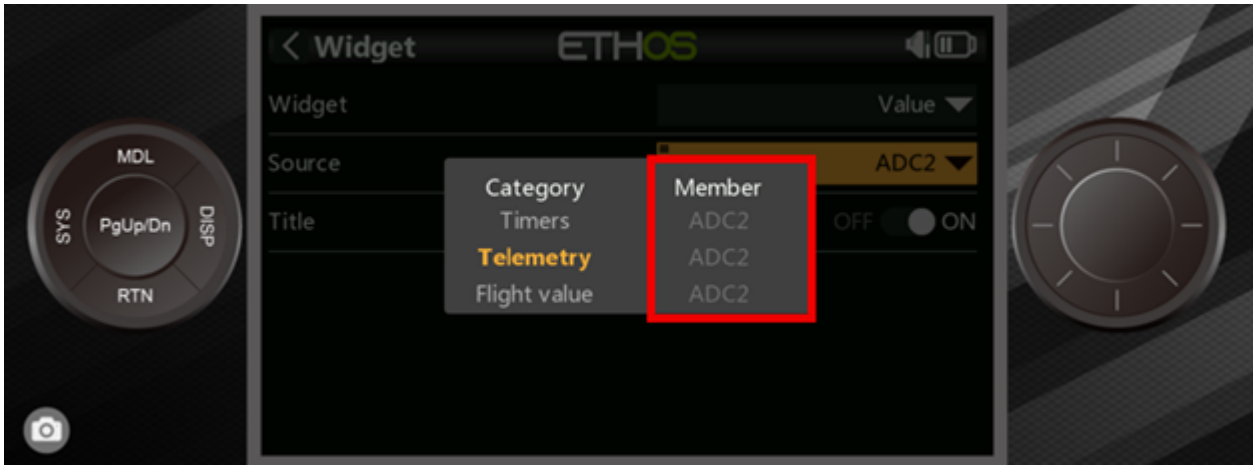


Figure 44: ADC2 Source

21. Press RTN until you're back on the main screen.
22. The voltage of the highest battery will be displayed.

6.3 RCU Calibration Procedure

Calibrations should only be initiated if the HyDrone™ ASV Servo 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 3.5 to familiarize yourself with the RCU controls.

1. **HyDrone™ ASV Servo must be powered off.**
2. Power on the RCU. (Refer to 3.5)
3. Select the settings icon.
4. Select Hardware.

Figure 45: RCU Settings

5. Select 'Analogs Calibration'.

Figure 46: Hardware Page

6. Select calibrate.
7. Follow the onscreen instructions.
8. Once calibration is complete, screen will cycle back to start of calibration page.
9. Press RTN four times to return back to main screen.

6.4 RCU AutoNav Calibration

1. Power on the RCU.
2. Power on the AutoNav™.
3. Connect to the AutoNav™. (USB Cable is 115200 baud rate)
4. Vessel **MUST** be disarmed.
5. Select Setup tab.

Figure 47: Setup Tab

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

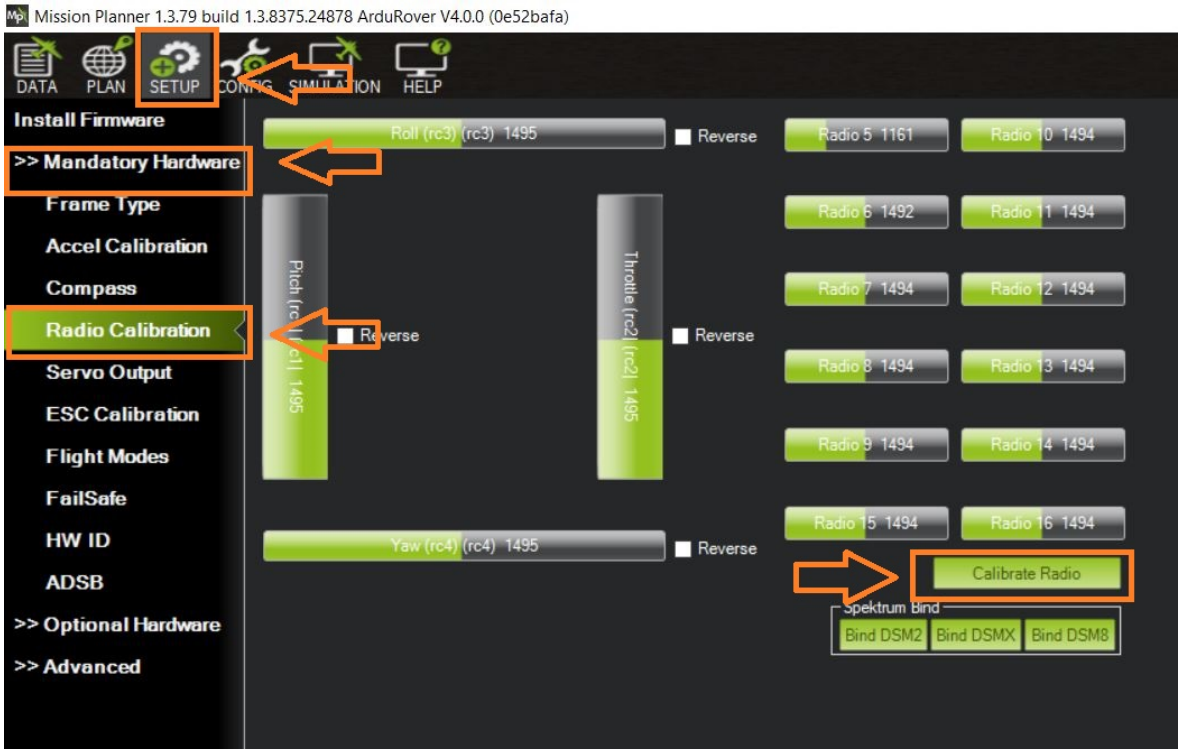
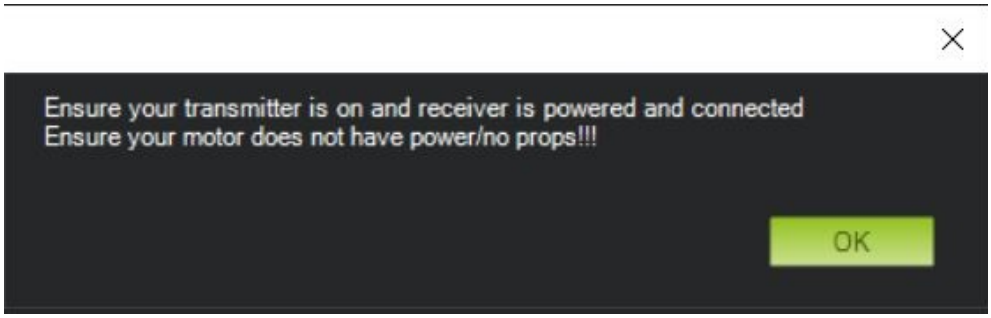
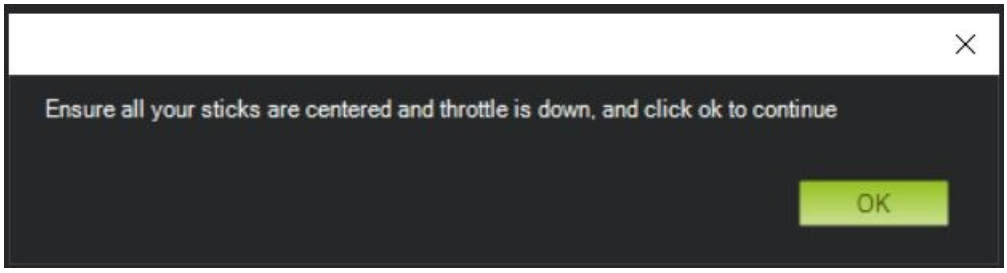


Figure 48: Radio Calibration Steps

8. Select Calibrate Radio.



(a) Power Warning



(b) Radio Cal Instructions

Figure 49: 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.

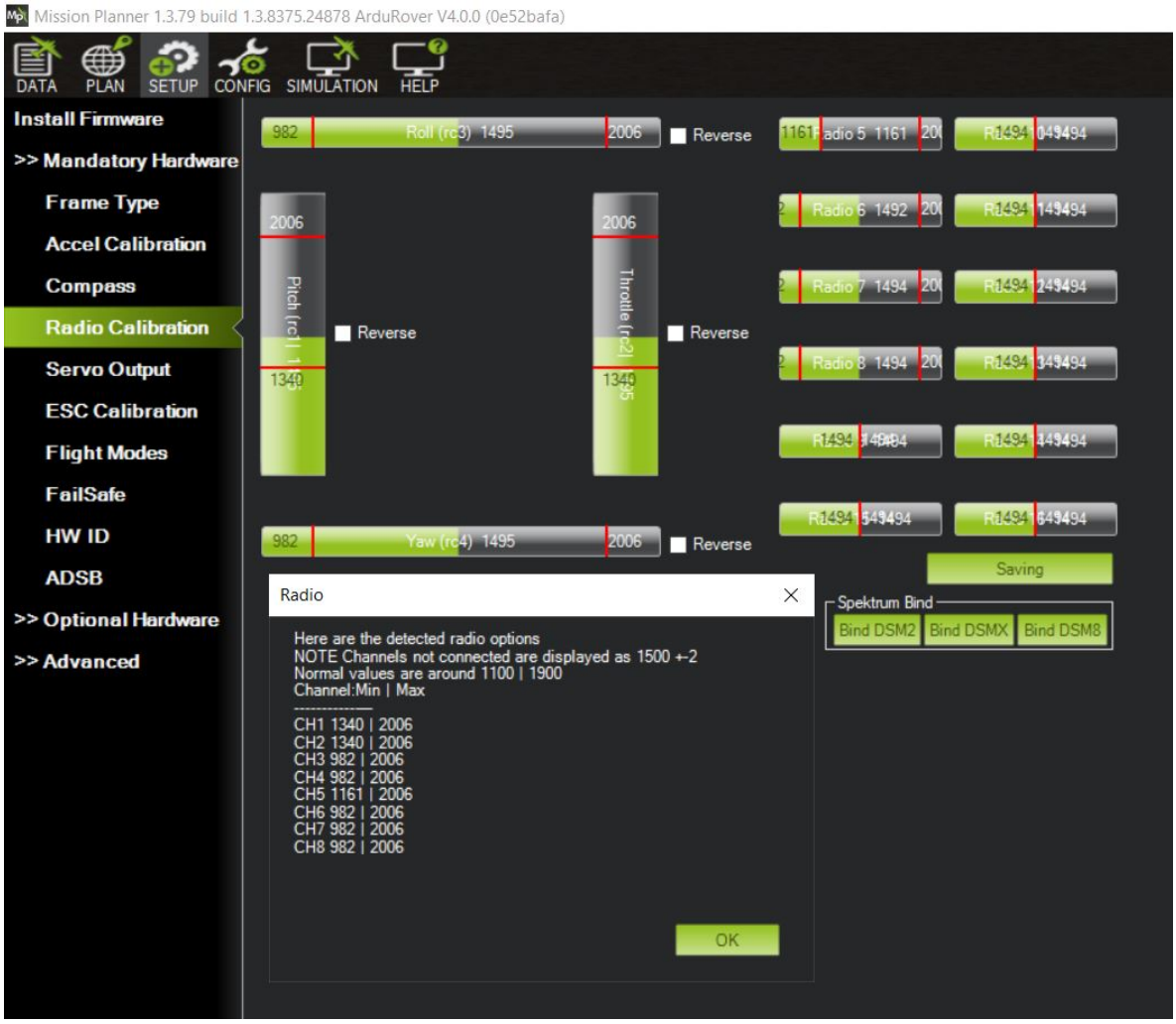


Figure 50: Radio Calibration Verification

12. Select Click when Done.

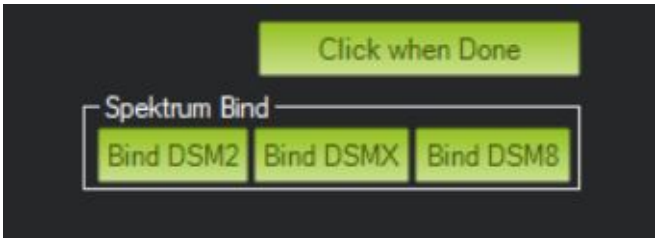


Figure 51: Click When Done

13. A page will popup indicating the new min and max values. Press OK. (Refer to Figure 50)

6.5 AutoNav™ Accel Calibration Procedure

1. Remove AutoNav™ from the HyDrone™. Disconnect all cables.
2. Connect the supplied 3' USB A to USB A into the field laptop and AutoNav™.
3. Open Mission Planner.
4. Connect to the AutoNav™.

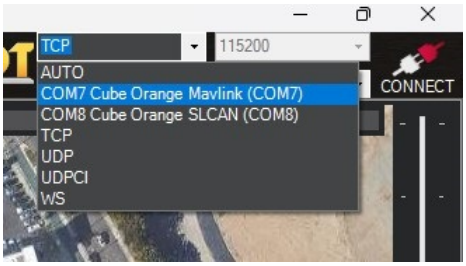


Figure 52: COM Port

- Choose Mavlink COM port
- 115200 baud rate

5. AutoNav™ must be disarmed.
6. Select Setup tab.

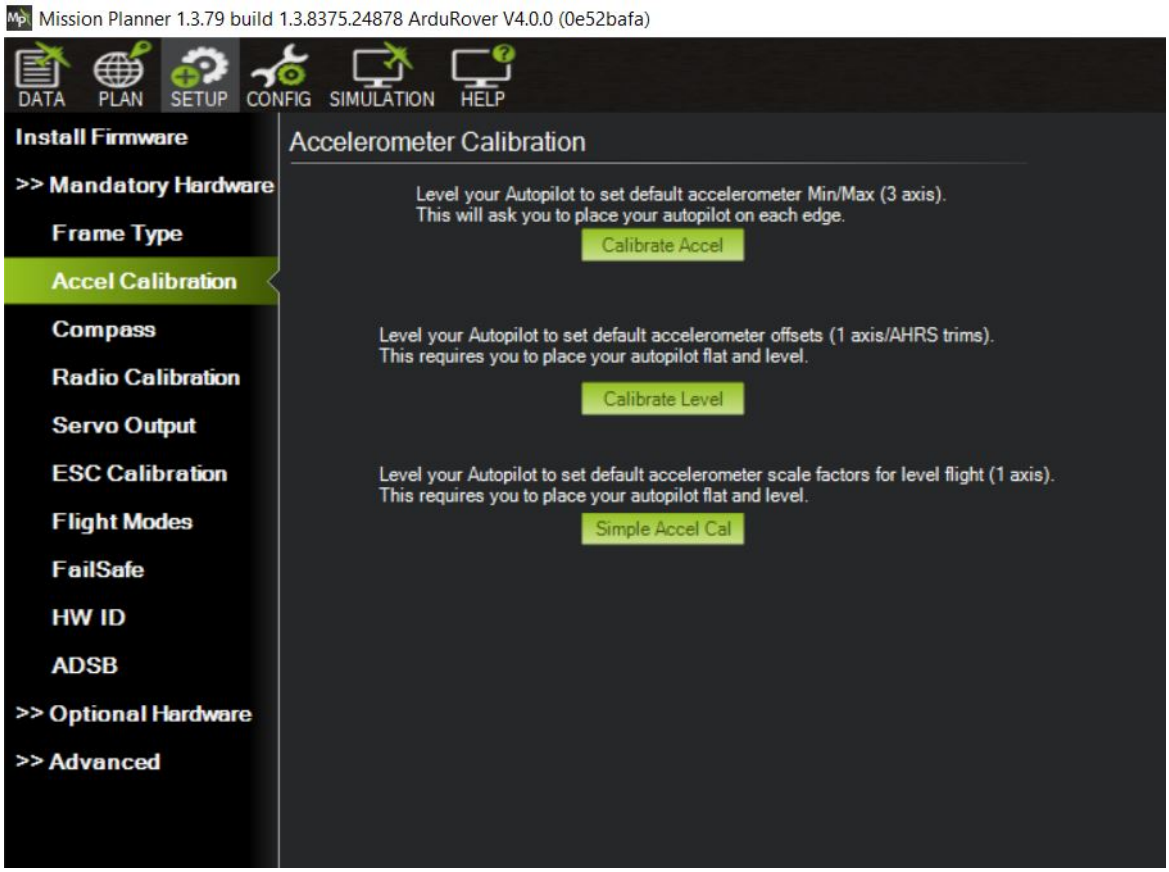


Figure 53: Accel Calibration

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

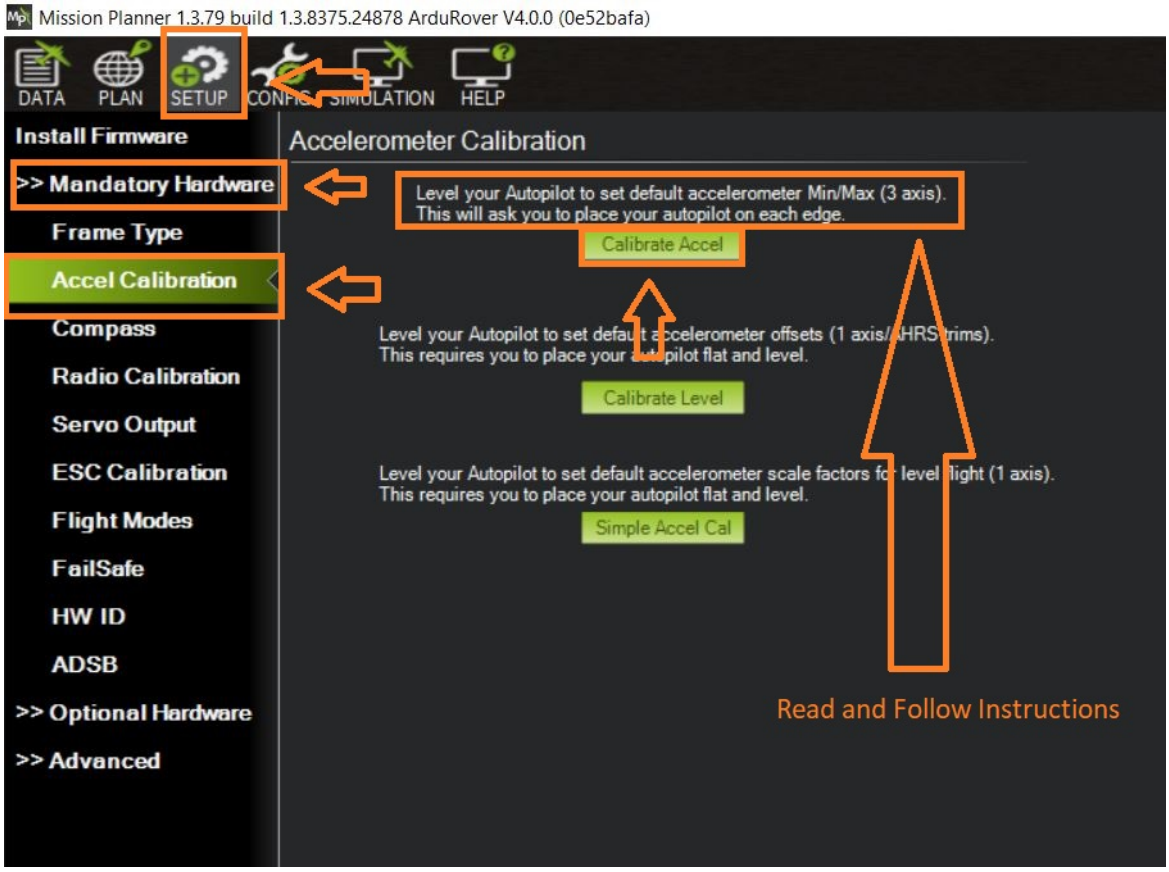


Figure 54: Accel Calibration Steps

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. **Starting with the bulkheads facing backwards(stern).**

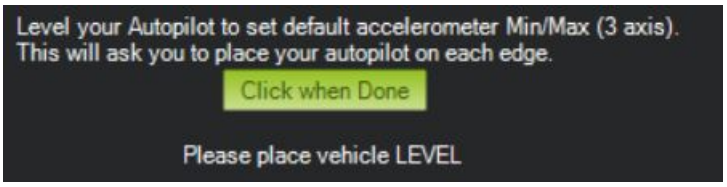


Figure 55: Accel Calibration In Process

(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.

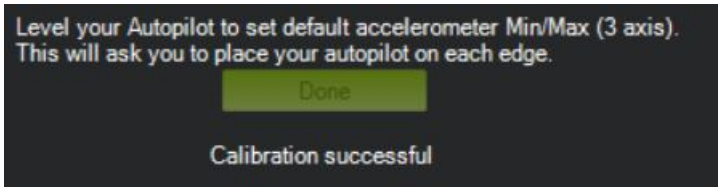


Figure 56: Accel Calibration Complete

12. Set the AutoNav™ on a level surface again.
13. Select Calibration Level. (See Figure 53)

6.6 AutoNav™ Compass Calibration Procedure

Information

Compass calibration should be performed away from metal buildings and any electronic equipment.

1. Remove AutoNav™ from the HyDrone™. Disconnect all cables.
2. Connect the supplied 3' USB A to USB A into the field laptop and AutoNav™.
3. Open Mission Planner.
4. Connect to the AutoNav™

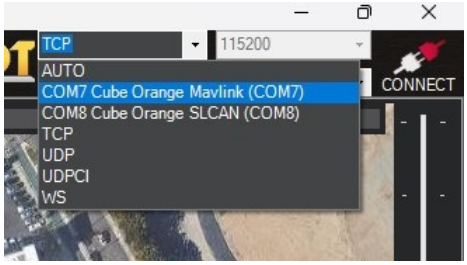


Figure 57: COM Port

- Choose Mavlink COM port
- 115200 baud rate

5. AutoNav™ must be disarmed.
6. Select Setup tab.
7. Select Mandatory Hardware.
8. Select Compass.
9. Select Start.

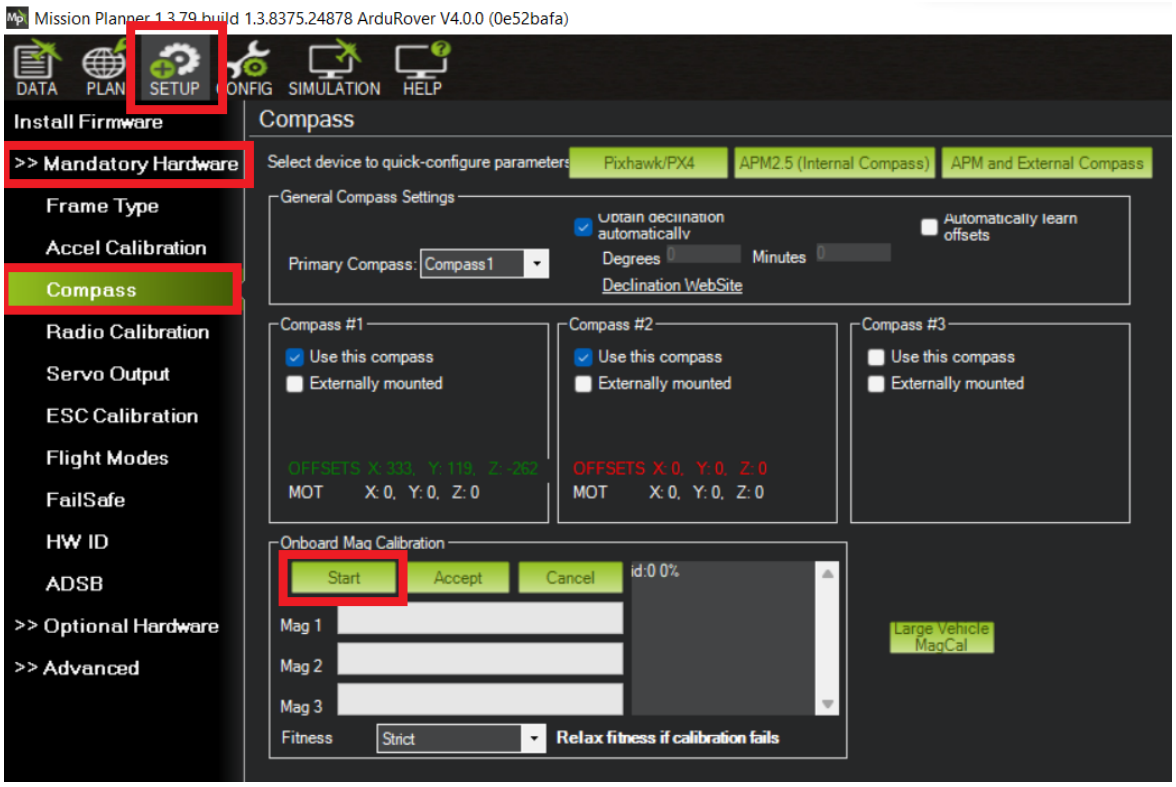


Figure 58: Compass Calibration Steps

10. Rotate the AutoNav™ 360 degrees on the X, Y, and Z axis.

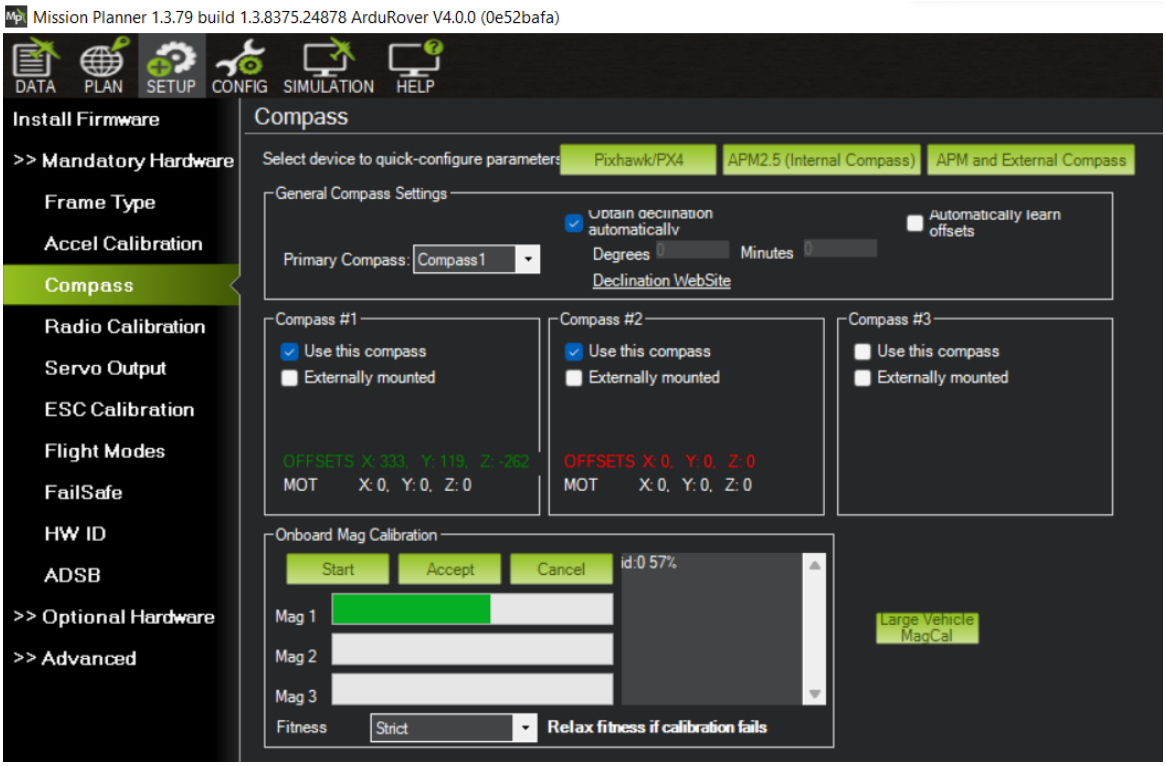


Figure 59: Compass Calibration Progress

11. Mag 1 green progress bar will start increasing.

12. A "Please reboot the autopilot" popup will indicate compass calibration is complete.

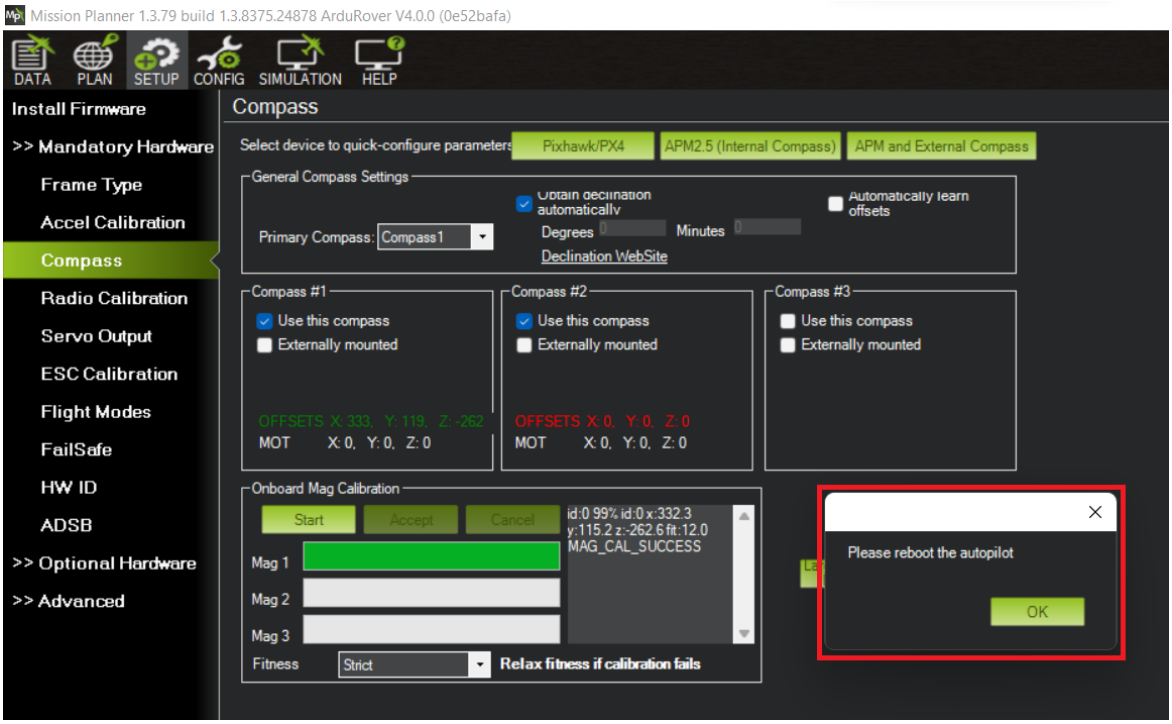


Figure 60: Compass Calibration Complete

13. Select 'OK'.
14. Press CTRL and F keys to open up the advanced tools screen.
15. Select 'reboot pixhawk'.

Figure 61: CTRL-F Screen

16. The autopilot hardware will reboot. Mission Planner will disconnect and automatically reconnect. (If it does not, you can manually connect)

Figure 62: Reboot Complete

17. Calibration complete.

7 Service And Maintenance

7.1 Maintaining Your Investment

Maintaining your HyDrone™ ASV Servo 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.
- LiPo batteries stored at 3.75-3.85V a cell - check every month.
- Pontoon internals are dry

7.3 Service

7.3.1 Thruster Replacement

Thruster Removal:

1. Disconnect the connector from the pontoon bulkhead.
2. Unscrew locking thumbscrew.
3. Slide the housing up to remove from mount.

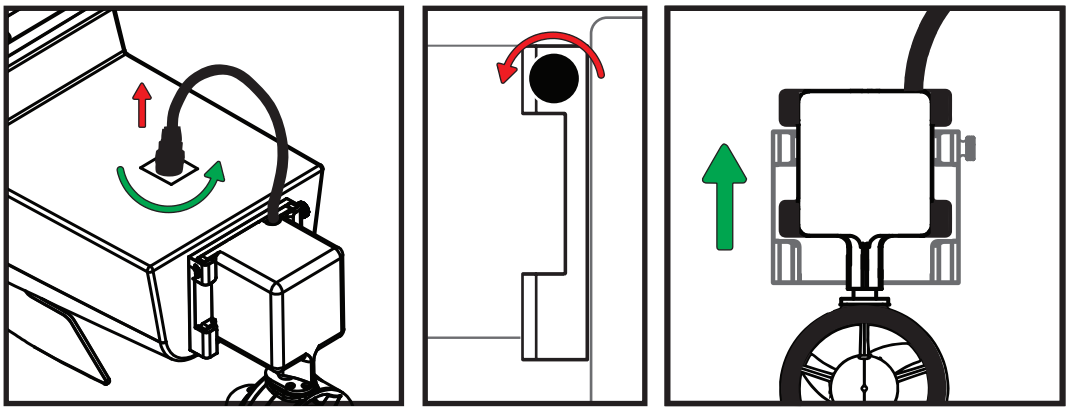


Figure 63: Thruster Removal

Thruster Installation:

1. Slide the housing down into the mount.
2. Tighten locking thumbscrew.
3. Connect the connector into the pontoon bulkhead.

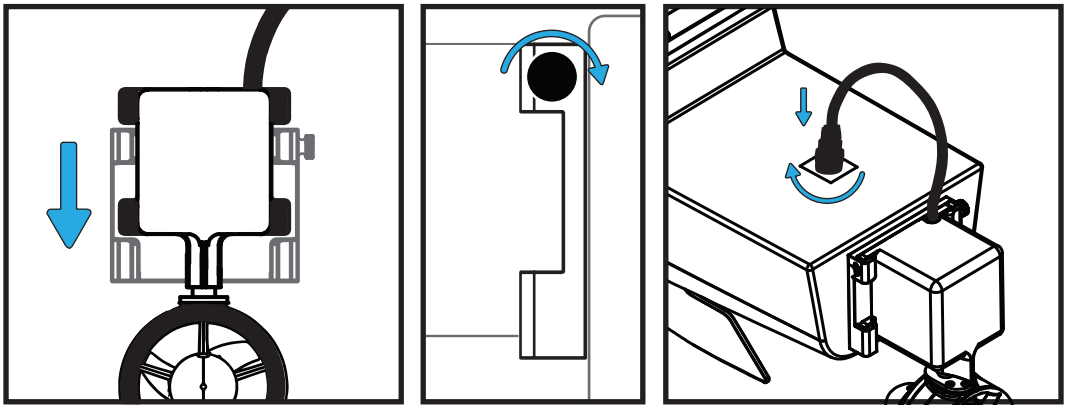


Figure 64: Thruster Installation

7.3.2 Propeller Replacement

Caution

Use Vibra-tite with all hardware. Plastic may become damaged if Vibra-tite instructions are not properly followed.

1. Remove the Thruster from the pontoon. (Figure 63)
2. Flip over the Servo Thruster to access the back panel.

3. Remove the 2x Philip screws with a #3 screwdriver.

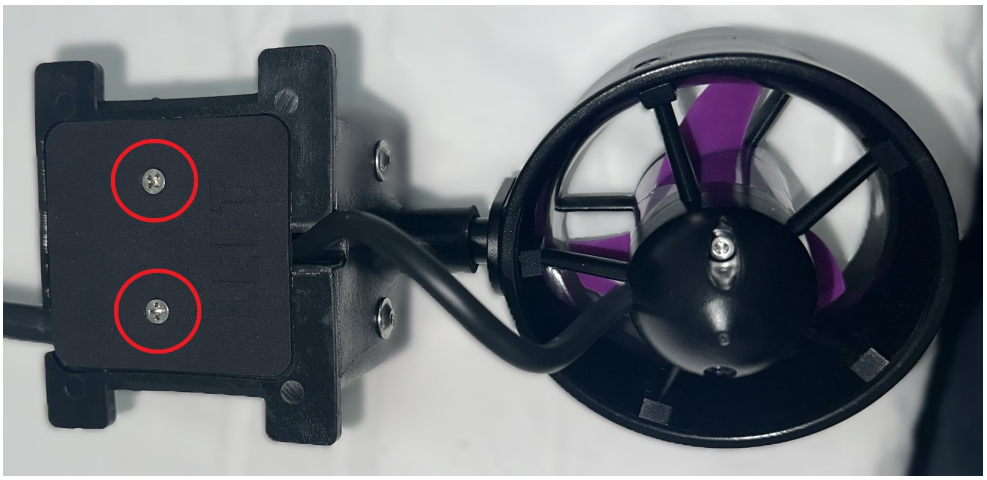


Figure 65: Thruster Access Panel

4. Rotate the thruster to gain access to the thruster shaft bolt.
5. Use a 7m socket to remove the M4 bolt.

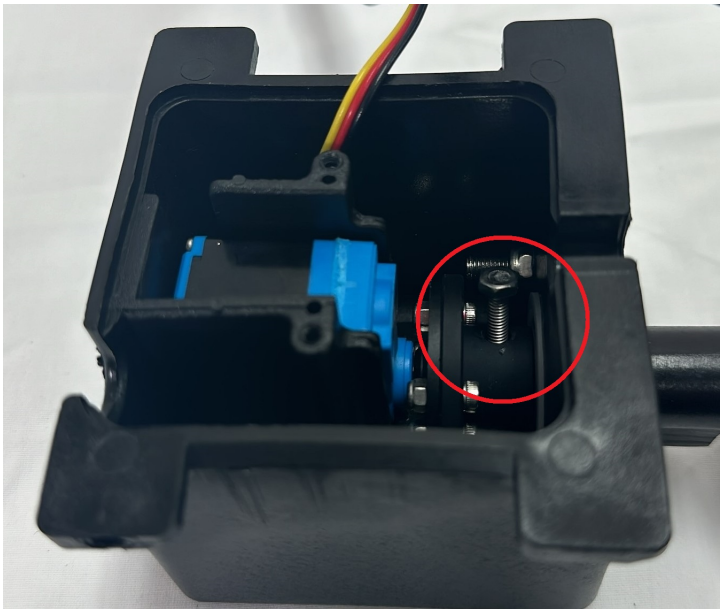


Figure 66: Thruster Shaft (Skid Does Not Have Servo)

6. Slide the thruster shaft out from the housing.
7. Remove the 3x M3x6 bolts with a 2mm Allen driver.
8. Remove the 1x screw with a #3 Philips screwdriver.

Figure 67: Thruster Adapter Shaft Removal

9. Remove the 4x screws with a #3 Philips screwdriver.

Figure 68: Thruster Housing Removal

10. Remove the 2x screws with a #3 Philips screwdriver.

Figure 69: Prop Removal

11. Remove the prop. The prop may be suctioned to the motor housing. Use care when removing.

Figure 70: Prop Removed

12. Install the replacement W30 prop.
13. Follow the instructions in reverse order for reassembly.

Caution

Be careful not to pinch any wires when installing the access panel cover.

7.3.3 Motor Cleaning

Caution

Use Vibra-tite with all hardware. Plastic may become damaged if Vibra-tite instructions are not properly followed.

1. Remove the Thruster from the pontoon. (Figure 63)
2. Flip over the Servo Thruster to access the back panel.
3. Remove the 2x Philip screws with a #3 screwdriver..

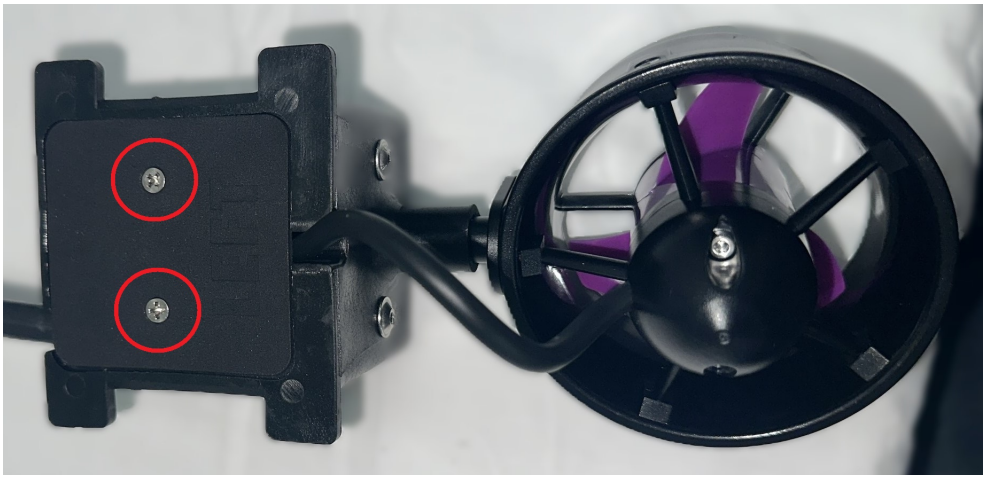


Figure 71: Thruster Access Panel

4. Rotate the thruster to gain access to the thruster shaft bolt.
5. Use a 7m socket to remove the M4 bolt.

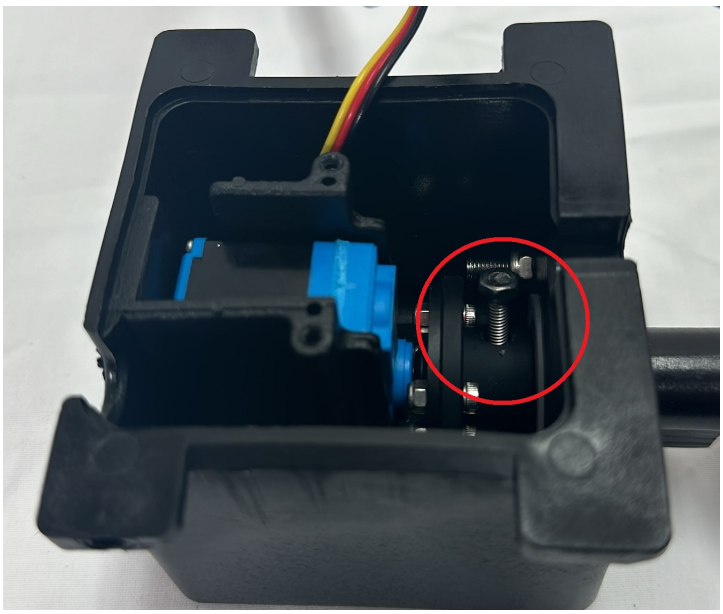


Figure 72: Thruster Shaft (Skid Does Not Have Servo)

6. Slide the thruster shaft out from the housing.
7. Remove the 3x M3x6 bolts with a 2mm Allen driver.
8. Remove the 1x screw with a #3 Philip screwdriver.

Figure 73: Thruster Adapter Shaft Removal

9. Remove the 4x screws with a #3 Philips screwdriver.

Figure 74: Thruster Housing Removal

10. Remove the 2x screws with a #3 Philips screwdriver.

Figure 75: Prop Removal

11. Remove the prop. The prop may be suctioned to the motor housing. Use care when removing.

Figure 76: Prop Removed

12. Remove the 2x M3 bolts with a 2.5mm Allen driver

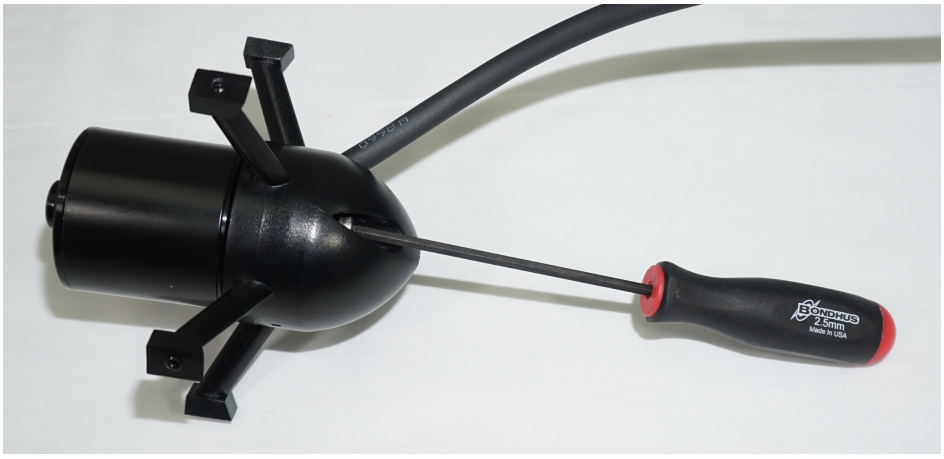


Figure 77: Motor Housing Removal

13. Loosen the 2x set screws on the collar towards the bow using a 1.5mm driver(not supplied).

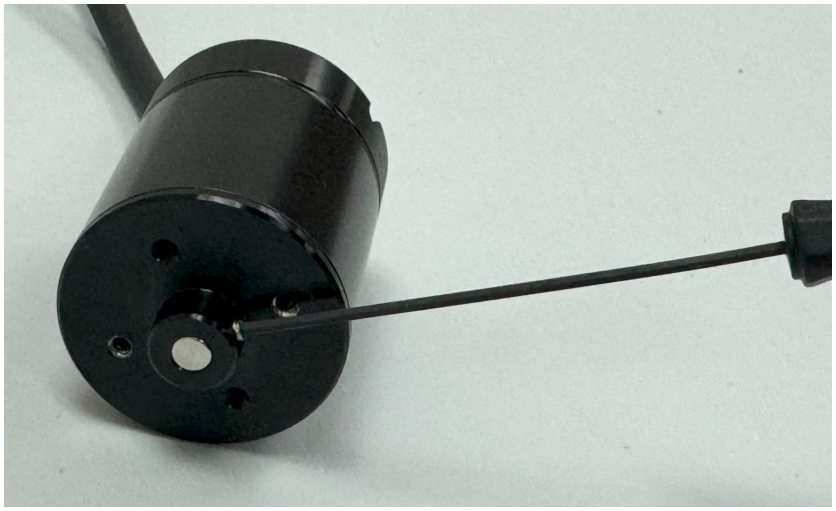


Figure 78: Rotor Removal

14. The motor rotor and stator are magnets. To remove, pull on the motor rotor to slide off.

Figure 79: Stator And Rotor

15. Inspect the magnets and protective coverings. Clean with mild soap and water.
16. Follow the instructions in reverse order for reassembly.

Caution

Be careful not to pinch any wires when installing the access panel cover.

7.3.4 RCU RTC Battery Replacement

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

Part Required:

- CR21220 Coin Battery

Tool Required:

- 2.5mm Allen Driver

1. Power off and flip over the RCU.
2. Remove the four visible socket head screws.

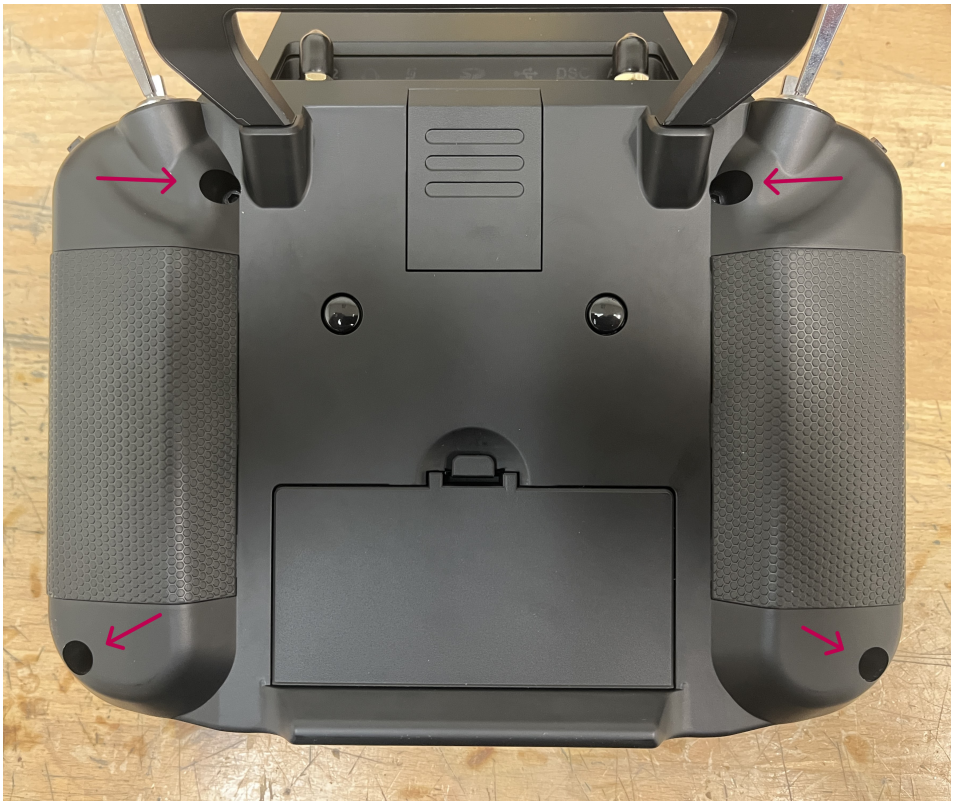


Figure 80: RCU Screw Locations

3. Remove the battery cover. (Figure 14)
4. Disconnect the battery.
5. Carefully split case of the RCU.

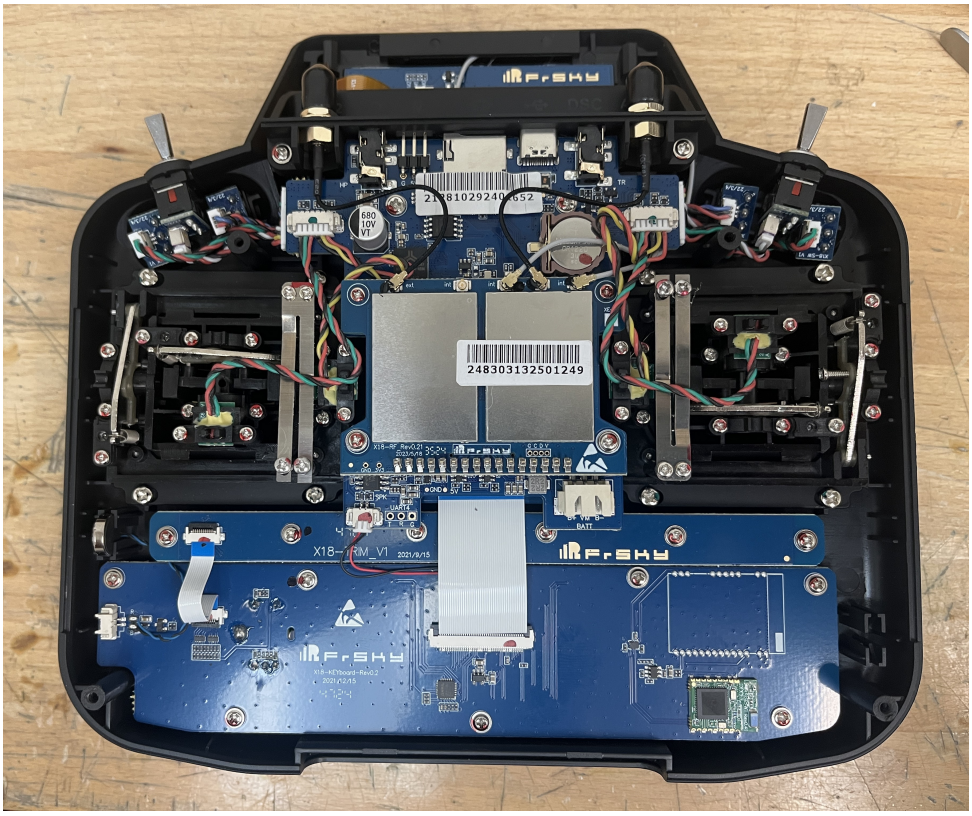


Figure 81: RCU Split

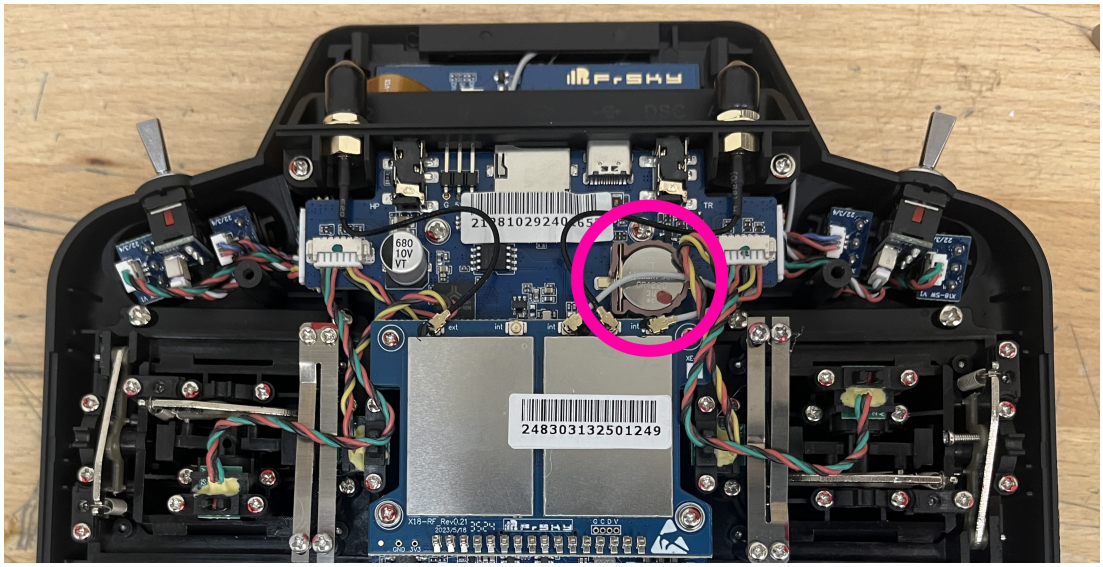


Figure 82: RCU RTC Location

6. Locate the RTC battery(circled in Figure 82) and remove it.
7. Replace it with a new CR1220 battery.
8. Carefully put the two case halves together.
9. Screw in the four socket head screws.
10. Connect the battery.
11. Install the battery cover.

7.4 Maintenance Schedule

7.4.1 Pre-launch

- 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 that cable connections are screwed tight.
- Confirm full insulation of all cables.

7.4.2 After Recovery

- 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.
- Cleaned with fresh water and mild soap.
- Dried off.
- Stored with hatches open for circulation.

7.4.3 Monthly

- Hull inspection for damage, cracks, or signs of wear.
- Check for loose or corroded electrical connections.
- Lubricate seals with silicone-based lubricants.
- Anti-seize on hardware.
- Electronics are functioning.
- Battery maintenance.
  - LiPo batteries should be stored at 3.6V a cell.
- Replenish any parts that were pulled from the spares kit.
- Stored with hatches open for circulation.

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
0	Calm	0 knots	0 feet	Sea is like a mirror. Smoke rises vertically.
1	Light Air	1-3 kts	< 1/2	Ripples with the appearance of scales are formed, but without foam crests. Smoke drifts from funnel.
2	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.
3	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.
4	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.
5	Fresh Breeze	17-21kts	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.
6	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.
7	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.
8	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.
9	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.
10	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.
11	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.
12	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 83: Beaufort Sea State

8.2 Block Diagrams

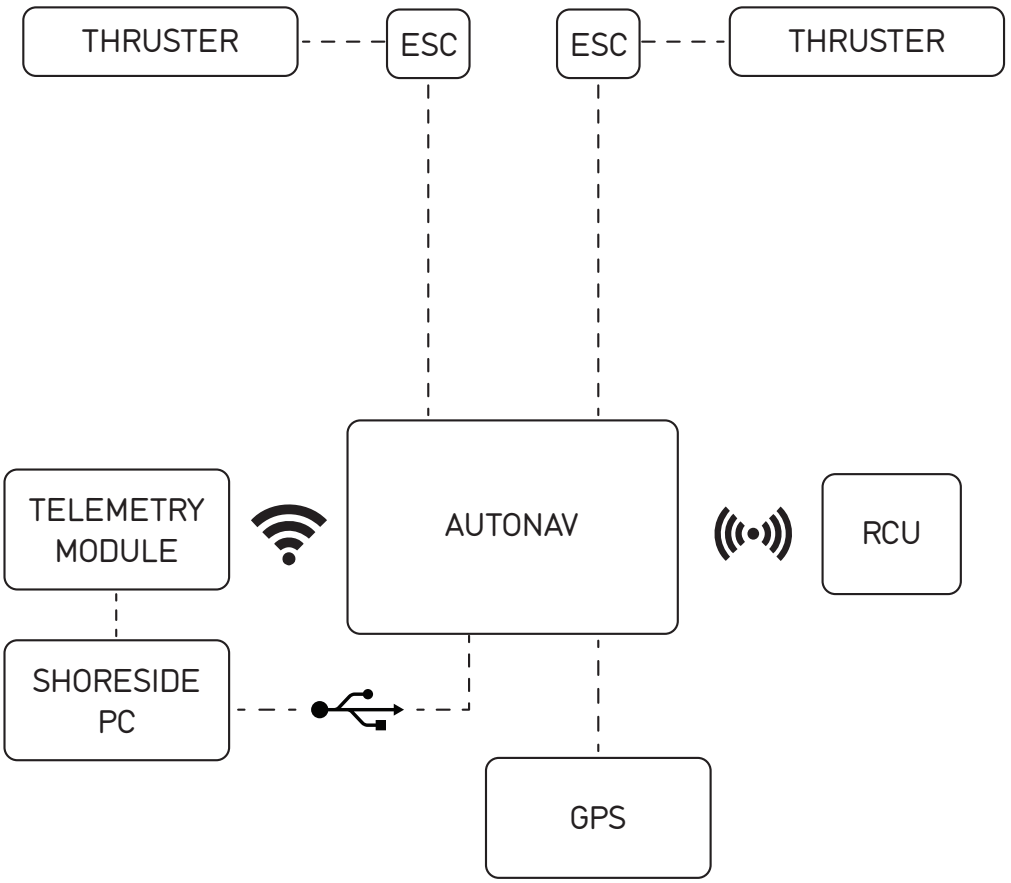


Figure 84: Block Diagram

8.3 Electrical Diagrams

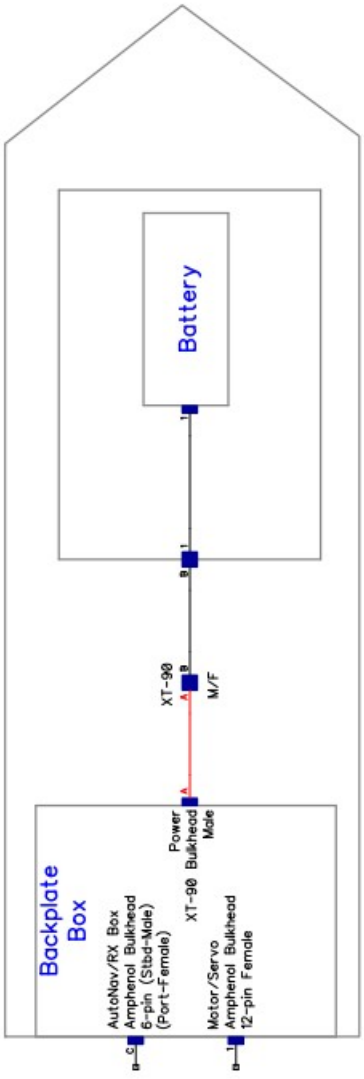


Figure 85: HyDrone™ ASV Servo Electrical Diagram

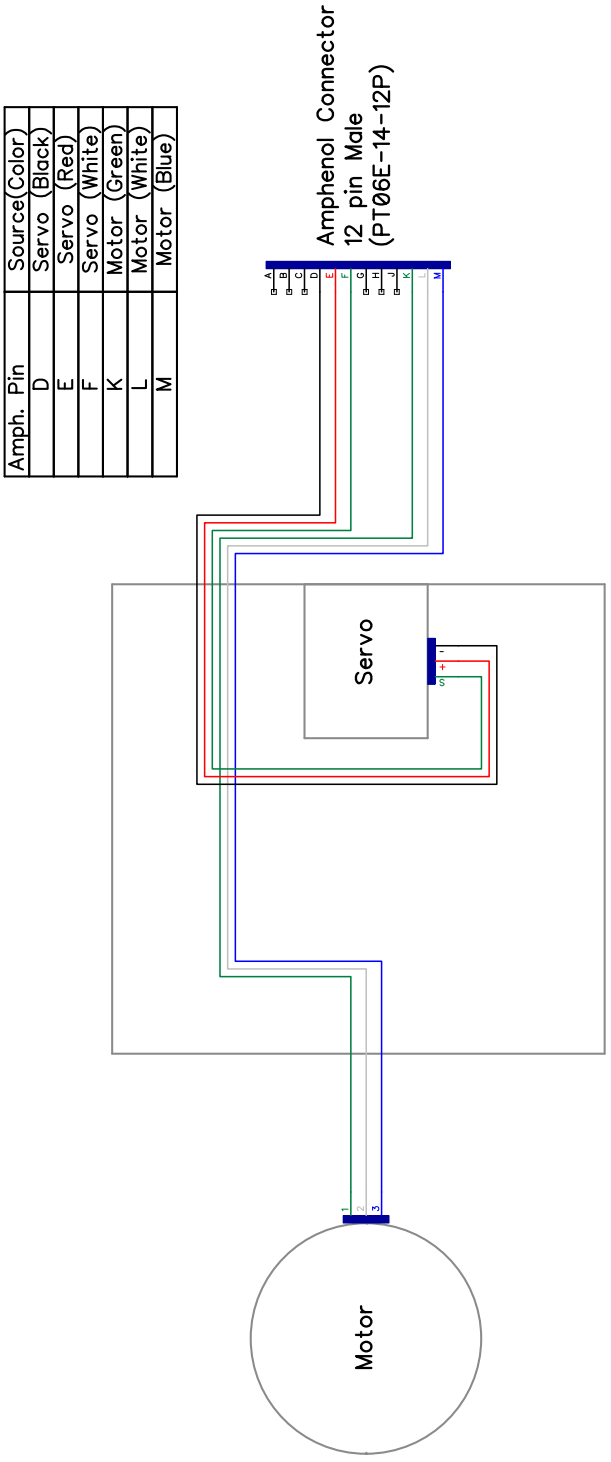


Figure 86: Thruster Electrical Diagram

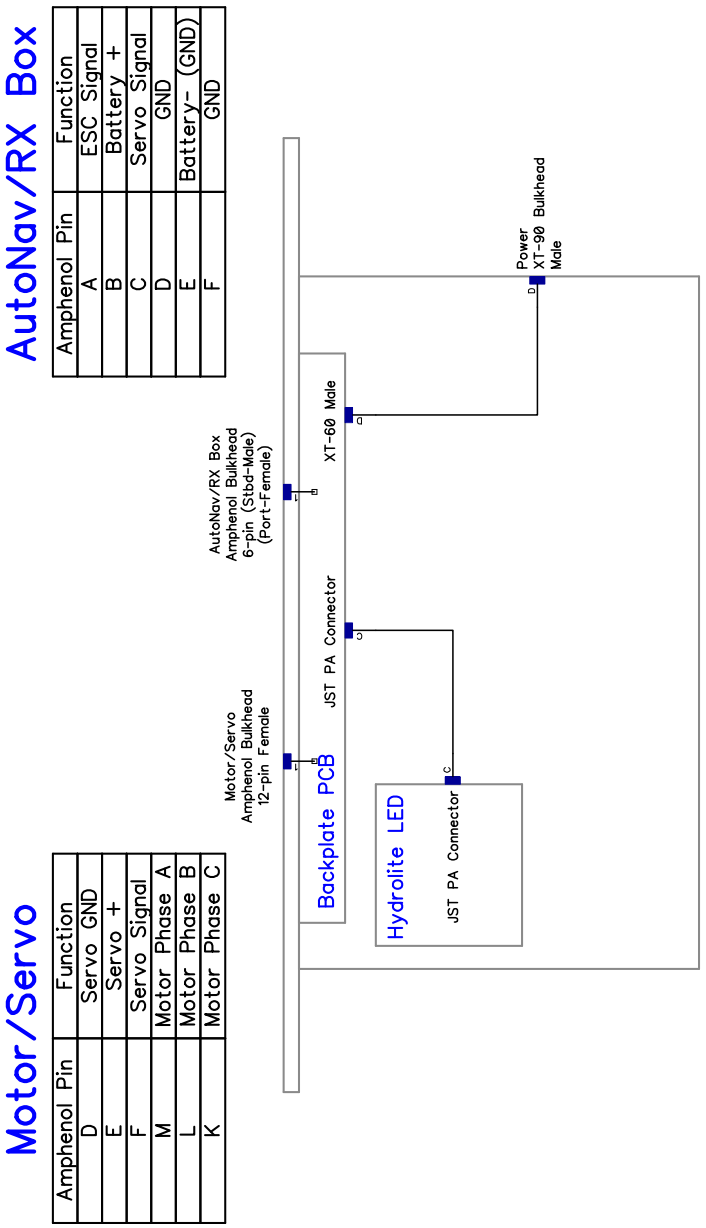


Figure 87: Stern Assembly Diagram

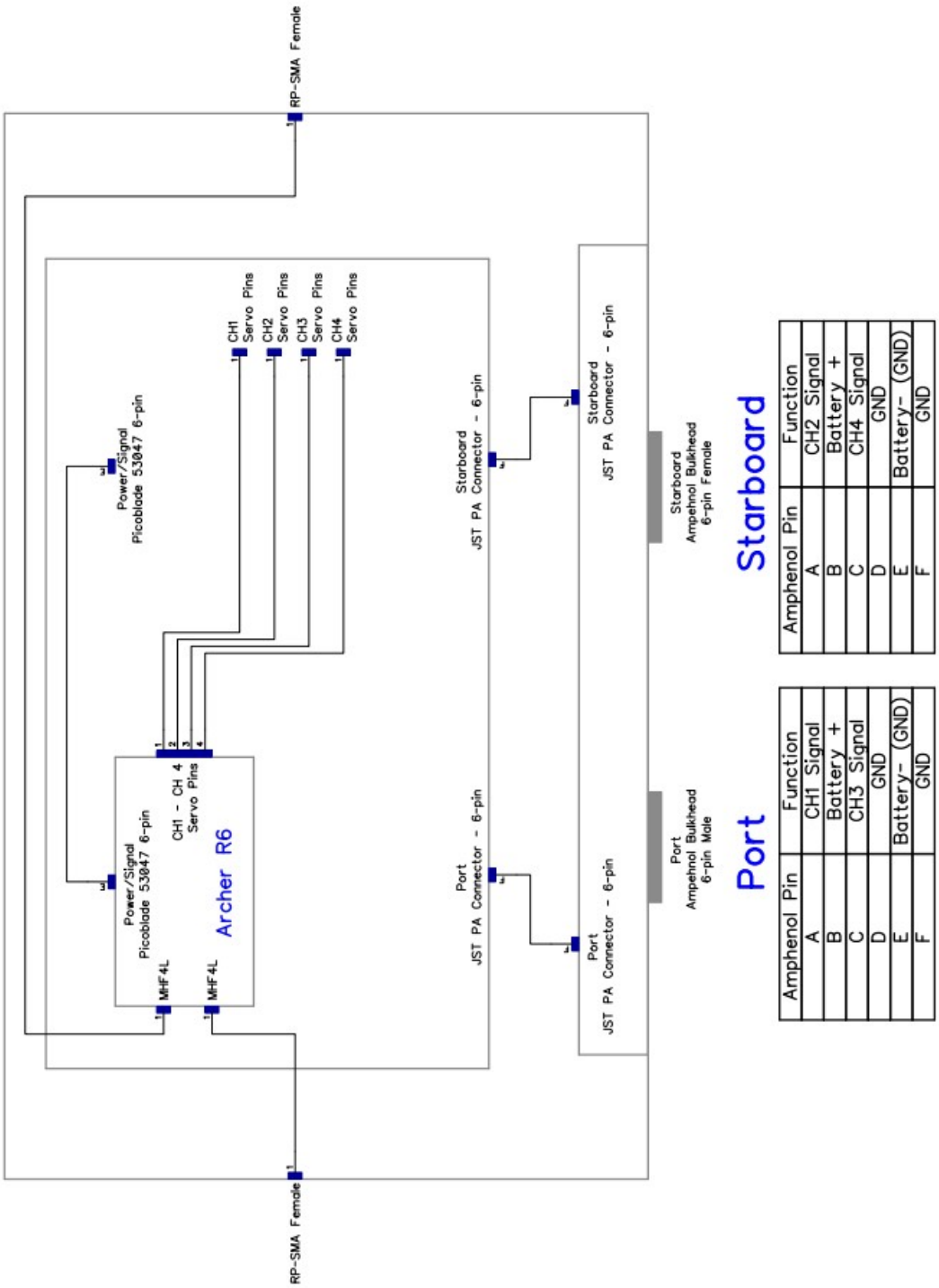


Figure 88: RCVNav Diagram

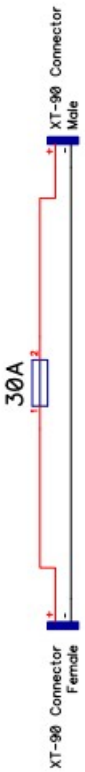


Figure 89: Cable A Diagram

Figure 90: Cable B Diagram

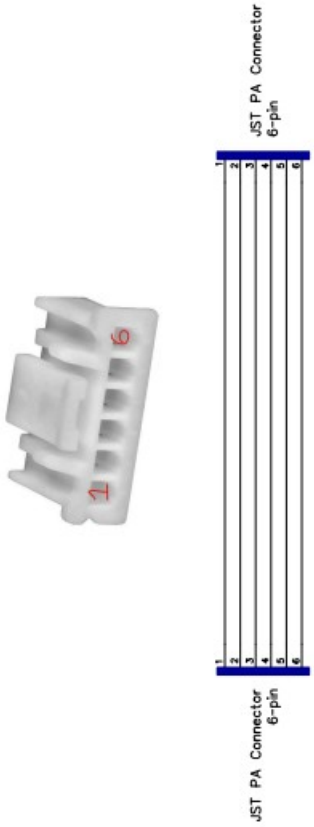


Figure 91: Cable C Diagram

Figure 92: Cable D Diagram

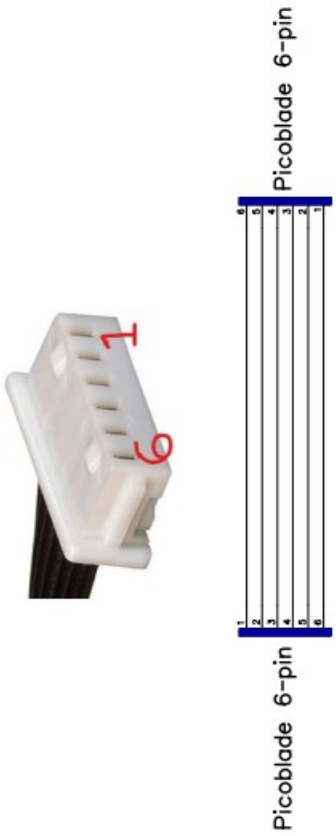


Figure 93: Cable E Diagram

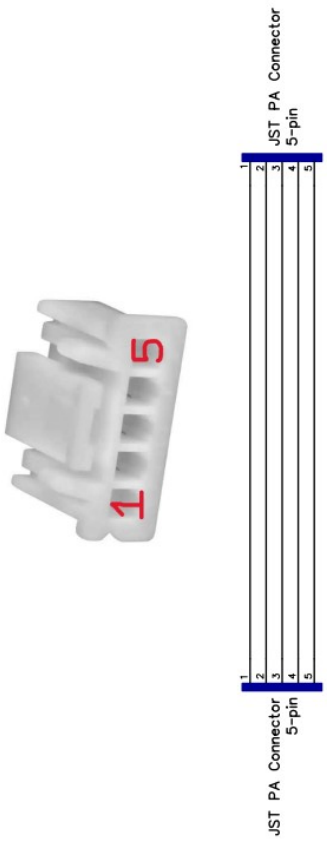


Figure 94: Cable F Diagram

Port

Amphenol Bulkhead
6-pin Male

Pin	Function
A	ESC Signal
B	N/C
C	Servo Signal
D	ESC Ground
E	N/C
F	Servo Ground

Starboard

Amphenol Bulkhead
6-pin Female

Pin	Function
A	ESC Signal
B	Battery +
C	Servo Signal
D	ESC Ground
E	Battery -
F	Servo Ground

GPS

Amphenol Bulkhead
6-pin Female

Pin	Function
A	N/C
B	N/C
C	GPS RX
D	N/C
E	GPS GND
F	GPS TX

Figure 95: AutoNav™ Bulkhead Pinout

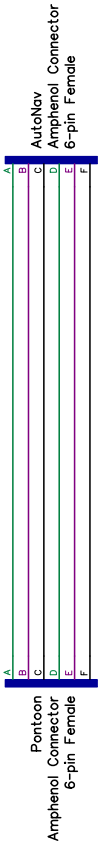


Figure 96: Port Pontoon Power Data Cable

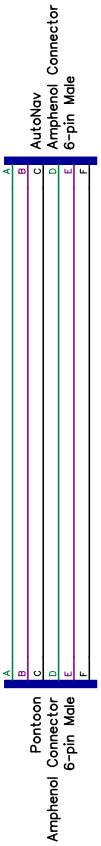


Figure 97: Starboard Pontoon Power Data Cable

Amphenol Pin	Serial Cable Color	Serial Pin	Function
C	Red	3	AutoNav RX (In)
E	Brown	5	Ground
F	Gray	2	AutoNav TX (Out)

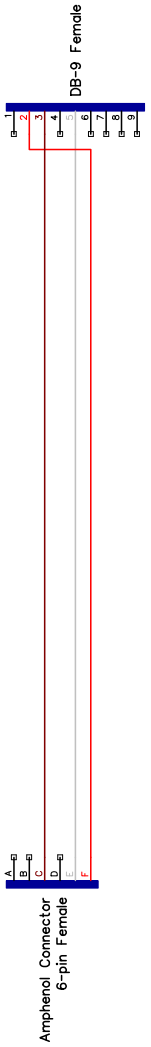


Figure 98: Serial Cable

8.4 Mechanical Diagrams

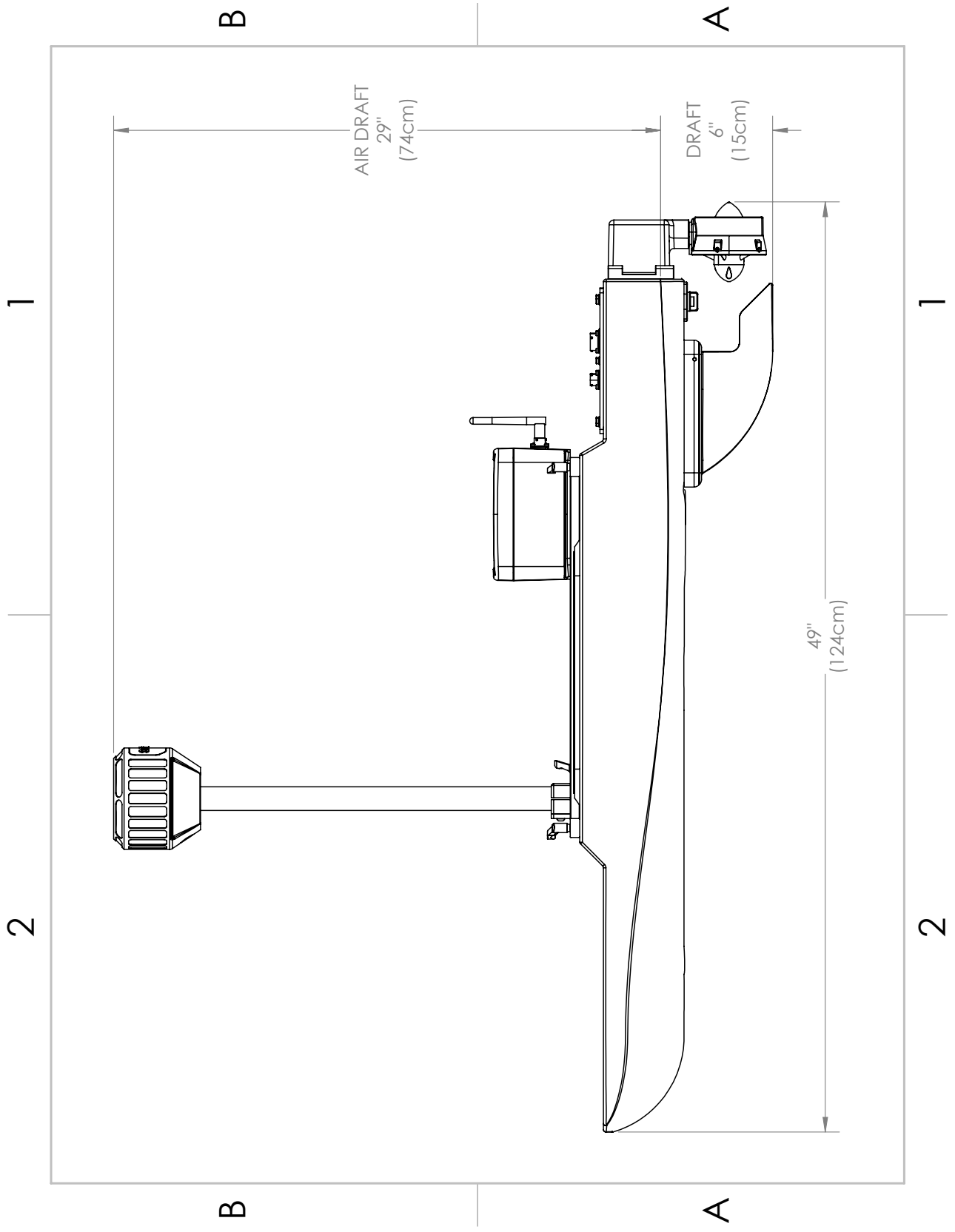


Figure 99: Side View Diagram

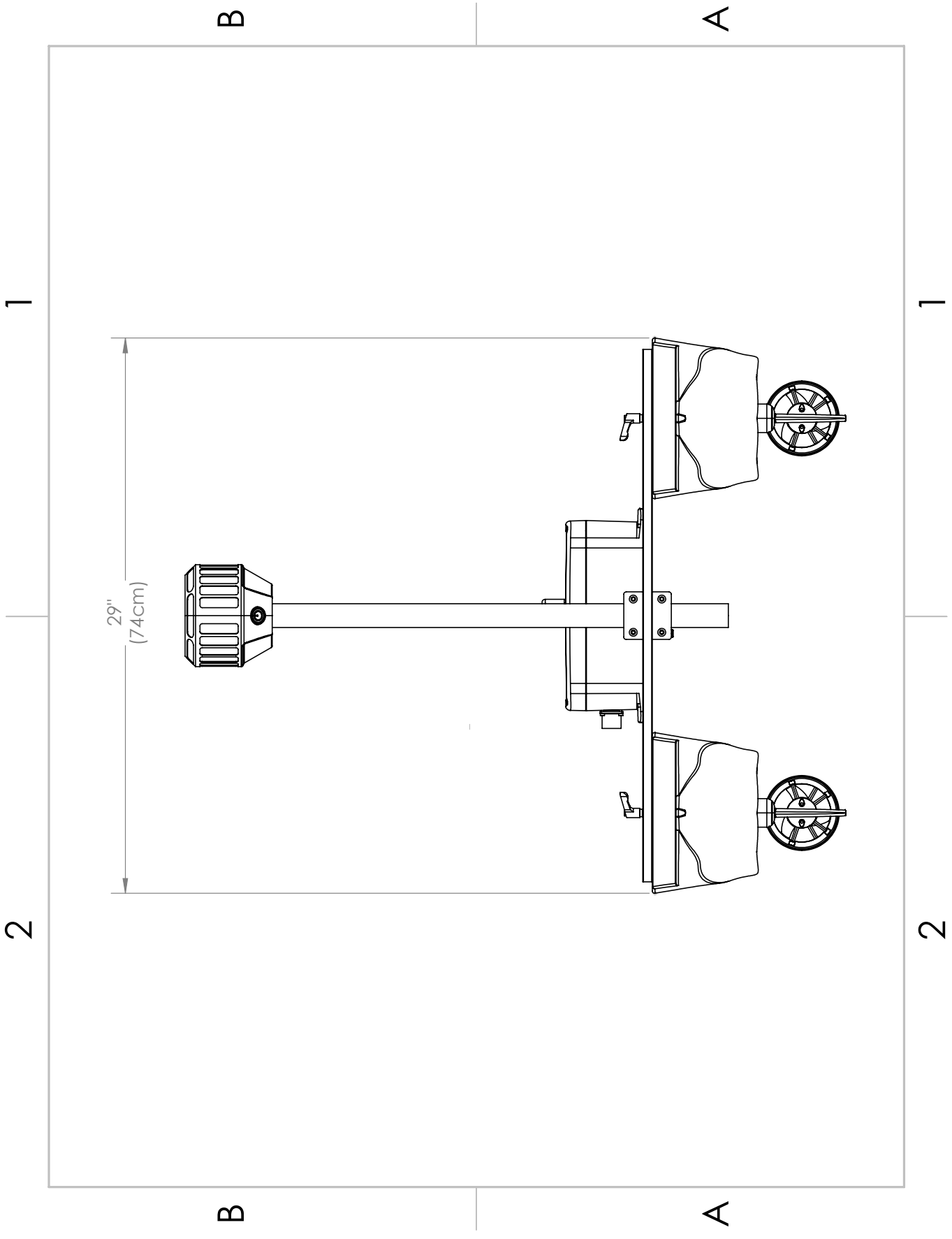


Figure 100: Front View Diagram

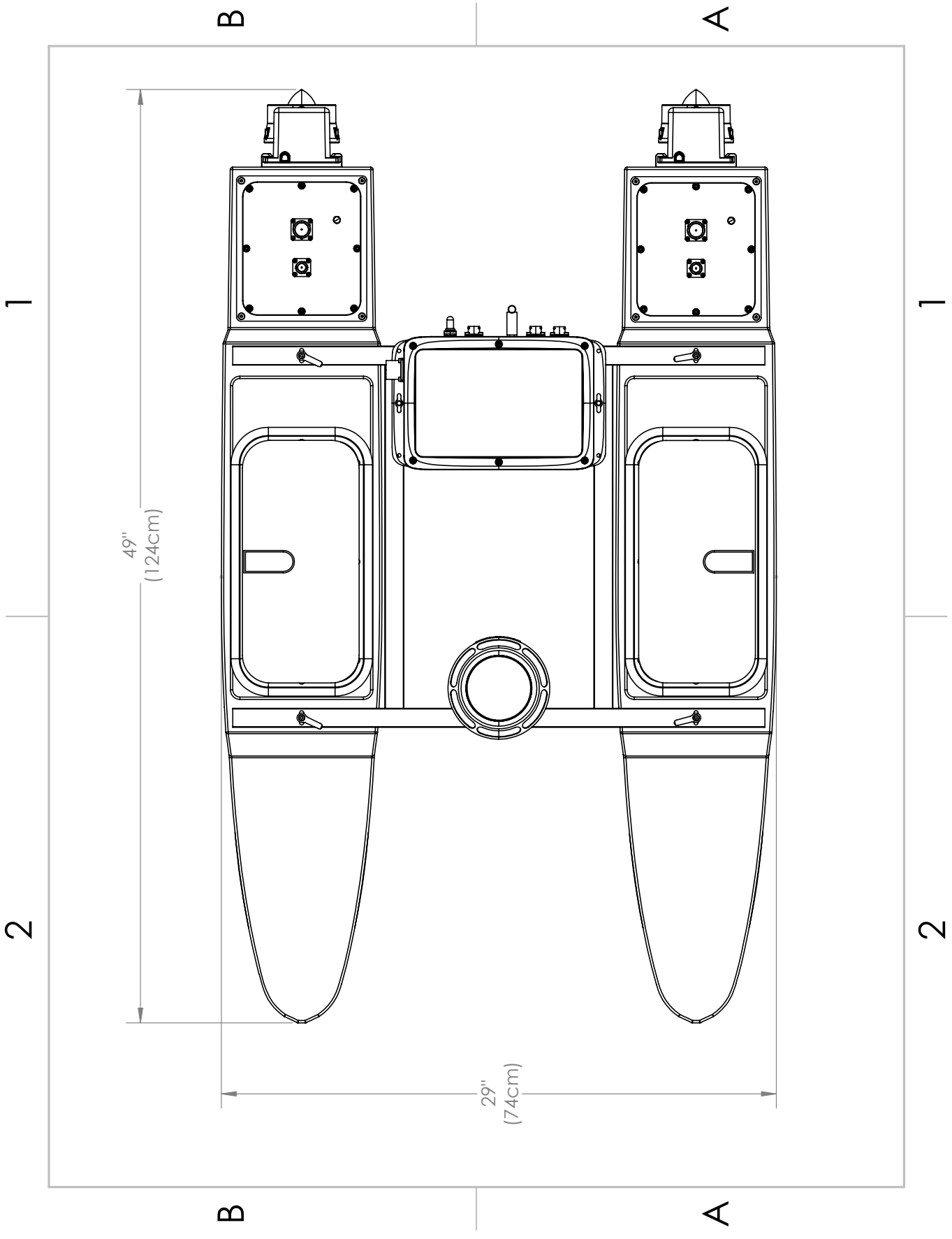


Figure 101: Top View Diagram

Revision History

Revision	Date	Author(s)	Description
1.0	7.30.2025	BA	Created