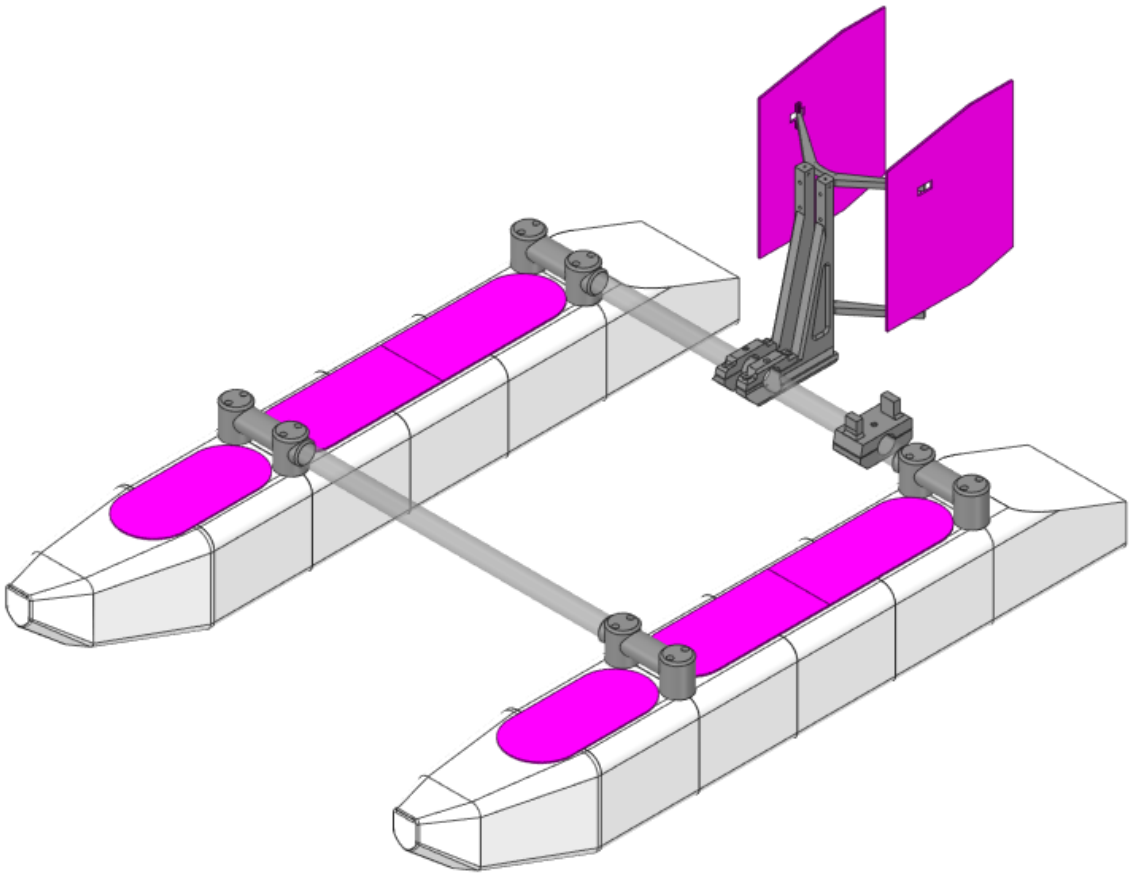
BUILD GUIDE



3D Printed RC Utility Boat

Part 1: Hull and Drive System

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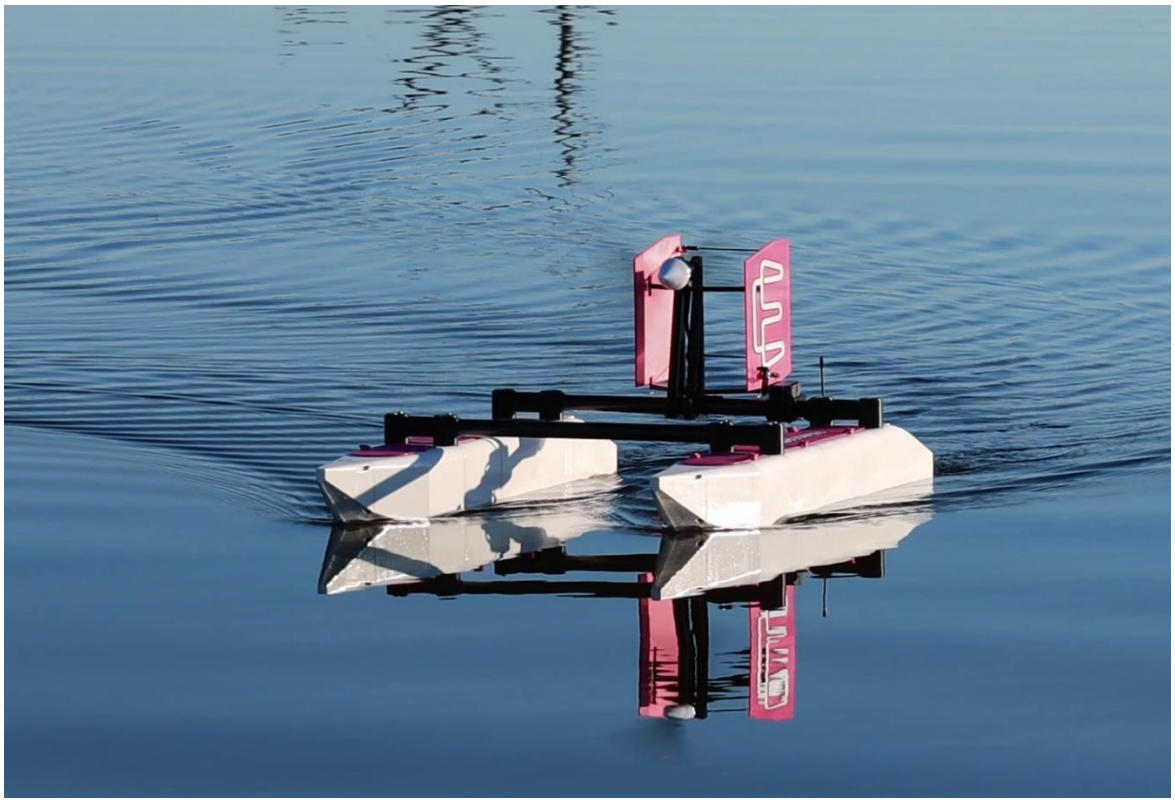
Version 1 – June 2021



About the Design

Electrosync's 3D Printed RC Utility Boat is a large catamaran air boat powered by a brushless motor. The boat is designed to carry environmental and water quality monitoring equipment. It is capable of carrying a large payload inside the hull as well as on the optional modular deck system.

Specification

Overall length:	1,000 mm
Dry weight:	6 kg
Running weight:	7 kg
Payload capacity:	5 kg+
Maximum speed:	~20 km/h

Important Notes

There are 22 STL files that accompany this build guide. It takes approximately 200 hours to print the 81 parts listed in this guide with the recommended print settings (Table 1). It will take much longer to print with a standard 0.4 mm nozzle – this is not recommended as the part tolerance will be incorrect.

This is a prototype design – some parts may require finishing or modification to ensure a perfect fit. If you do find any issues, let me know via email or the Electrosync socials and I'll update and reissue the guide and/or the STL files.

You may see some differences in the parts and images in this guide when compared with the STL files.

The parts are designed to work with specific hardware – details are provided in the guide.

This design is not waterproof. Parts must be prepared to prevent water entering. I recommend two coats of polyester resin on the hull.

I share all of my designs for free. If you have paid for this guide or the STLs or see them for sale, please contact me.

Electrosync

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Introduction

This 3D printed utility boat hull is a catamaran design with both sides of the hull connected with carbon tubes. The boat is powered by a brushless motor and air propeller and steering is via above water control surfaces. A video series showing the design and build process can be found on the Electrosync YouTube channel. Note that there are some differences between the boat in the videos and the boat in this build guide.

The boat is designed to be radio controlled. A minimum of two channels radio equipment is required for throttle and steering, more channels are required if reverse is required and for operating any auxiliary systems.

This guide is for the hull and drive systems only and does not include any of the auxiliary systems

Recommended Print Settings

Table 1 lists recommended print settings that apply to all parts in this guide unless otherwise specified. All parts can be printed on an FDM 3D printer.

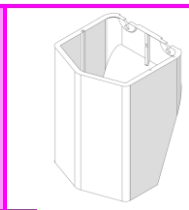
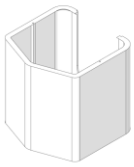
Table 1. Recommended Print Settings

Setting	Value
Minimum build plate size	200 mm x 200 mm
Material	PLA+
Nozzle size	0.6 mm
Print speed	60 mm/s
Layer height	0.36 mm
Initial layer height	0.42 mm
Wall line width	0.6 mm
Initial layer line width	140 %
Wall line count	3
Top layers	3
Bottom layers	3
Infill density	40%

Step One: Printing the Hull Segments

The hull consists of a left and a right pontoon. Each pontoon is made up of 6 main hull segments. 12 hull sections must be printed to make both sides of the hull. Both pontoons are identical.

Table 2. Hull Segments, File Names and Quantity Required

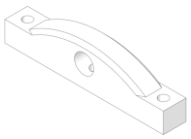
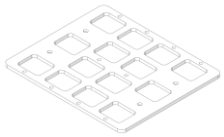
Drawing (print orientation indicated)				
File name	1. Hull – Section Stern.STL	2. Hull – Section 1.STL	3. Hull – Section 2.STL	4. Hull – Section Bow.STL
Quantity required	2	6	2	2
Supports	No	No	No	No
Bed adhesion	No	No	No	No

Recommended print settings are as per Table 1. No supports or bed adhesion are required if parts are printed as per the part orientation shown in Table 2.

Step Two: Printing the Internal Hull Parts

The inside of the hull uses a tray system to mount electronic equipment on. The trays are mounted to support brackets that also serve the purpose of providing lateral strength and ensuring alignment of the hull via carbon fibre tubes that pass through the centre holes of the supports.

Table 3. Internal Hull Parts, File Names and Quantity Required

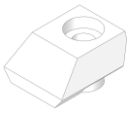
Drawing (print orientation indicated)		
File name	5. Hull – Tray Support.STL	6. Hull – Tray.STL
Quantity required	20 (minimum)	8
Supports	Yes	No
Bed adhesion	No	No

Recommended print settings are as per Table 1. Supports are required for the centre hole in *Hull – Tray Support.STL*. No other supports or bed adhesion are required if parts are printed as per the part orientation shown in Table 3.

Step Three: Printing the External Hull Parts

Each side of the uses two hatches to cover the access ports. The rear hatch is split into two pieces to allow fitting to the hull between the tube mounts. The rails provide a better seal once fitted. The hatches are held in place with friction fit clips. The tube mounts attach to the hull and connect the two pontoons with carbon fibre tube.

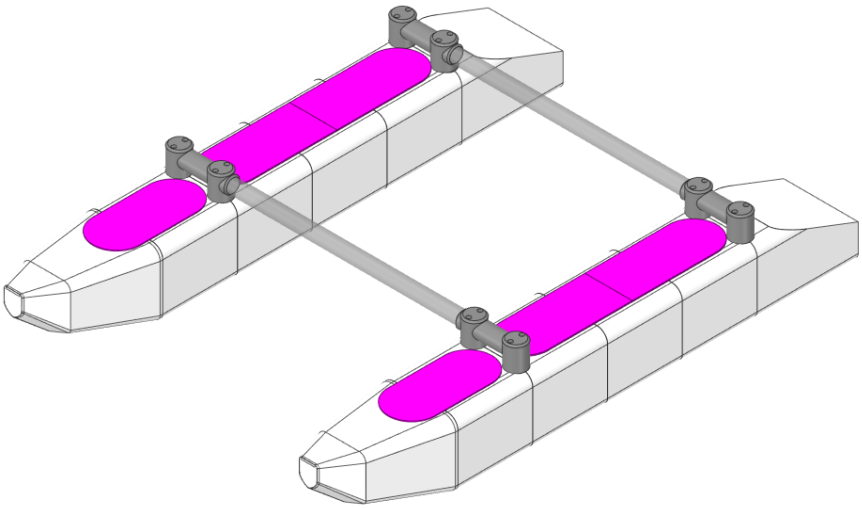
Table 4. External Hull Parts, File Names and Quantity Required

Drawing (print orientation indicated)					
File name	7. Hull – Tube Mount.STL	8. Hull –Hatch Rear.STL	9. Hull –Hatch Rear Rail.STL	10. Hull –Hatch Front.STL	11. Hull – Hatch Clip.STL
Quantity required	4	4	4	2	12
Supports	Yes	No	No	No	Yes
Bed adhesion	No	No	No	No	No

Recommended print settings are as per Table 1. Supports are required for the *Hull – Tube Mount.STL and Hull – Hatch Clip.STL*. No other supports or bed adhesion are required if parts are printed as per the part orientation shown in Table 3. Optionally, *Hull – Hatch Clip.STL* (being a small part) would be appropriate to print on an SLA printer if available.

Step Four: Assembling the Hull Parts

The completed hull looks like the drawing below. Assembly for both sides of the hull is the same aside from the orientation of the tube mounts to accept the carbon fibre tube cross braces.



The bill of materials is listed in Table 5 for hull assembly only.

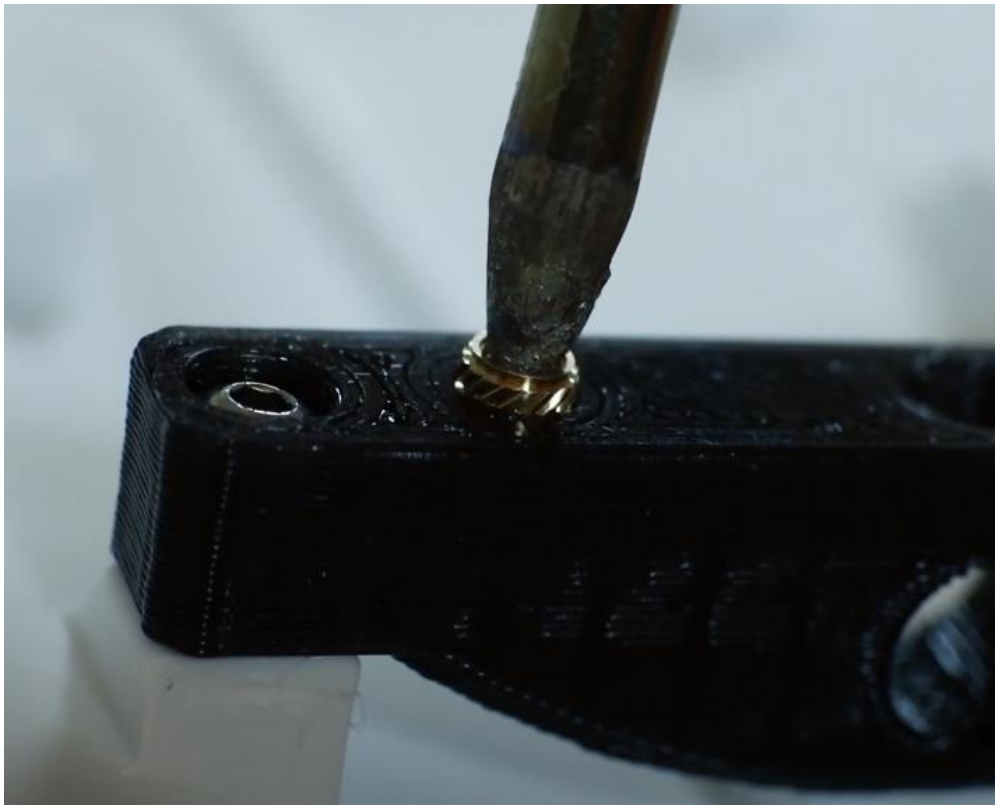
Table 5. Bill of Materials for Assembling the Hull Parts

Item	Quantity
M3 x 4 mm heat-set inserts	80
M3 x 12 mm machine head screws	40
M3 x 6 mm machine head screws	32
8 mm x 600 mm carbon fibre tube	2
M3 x 10 mm self-tapping screw	4
25 mm x 575 mm carbon fibre tube	2
M5 x 60 mm socket head bolts	16
M5 nylon lock nuts	16
M3 x 15 mm machine head screws	12
M3 nylon lock nuts	12
2-part epoxy glue	50 ml

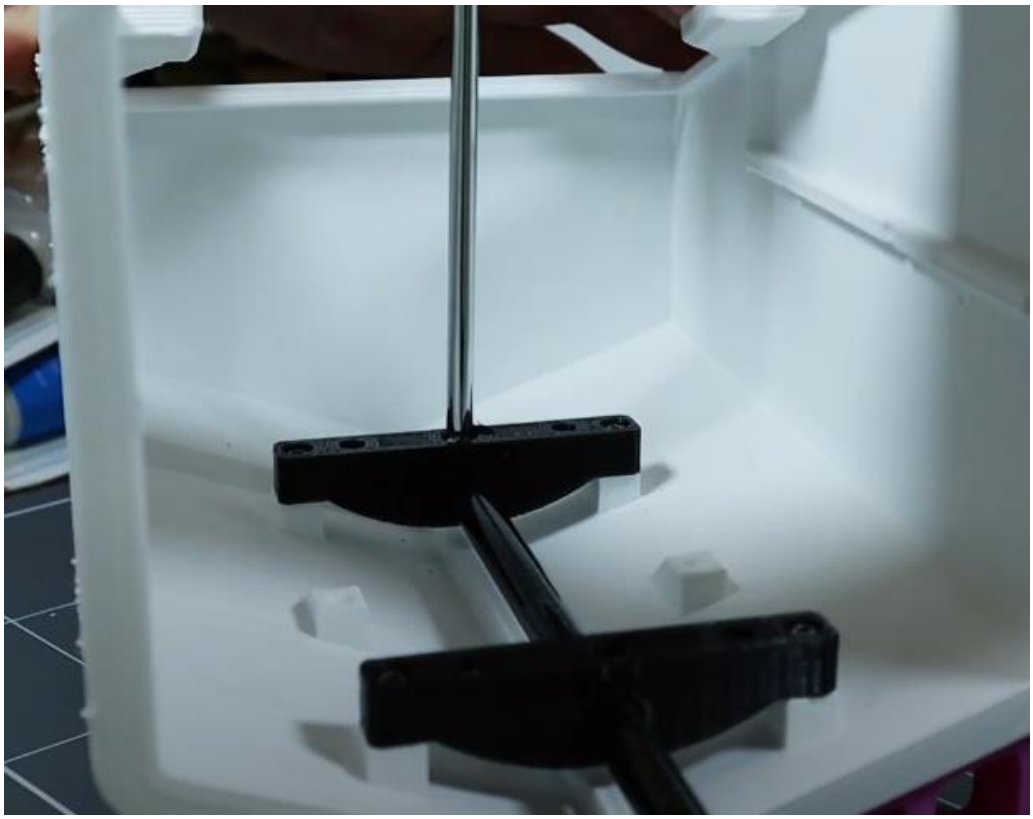
1. Before the tray supports can be installed in the hull section, **M3 x 4 mm heat-set inserts** must be fitted to the hull sections. These are fitted using a soldering iron. The image below shows a typical install (ignoring the middle mounts).

2. Install the tray supports into the hull with **M3 x 12 mm machine head screws**.

3. Install **M3 x 4 mm heat-set inserts** into the tray mounts.



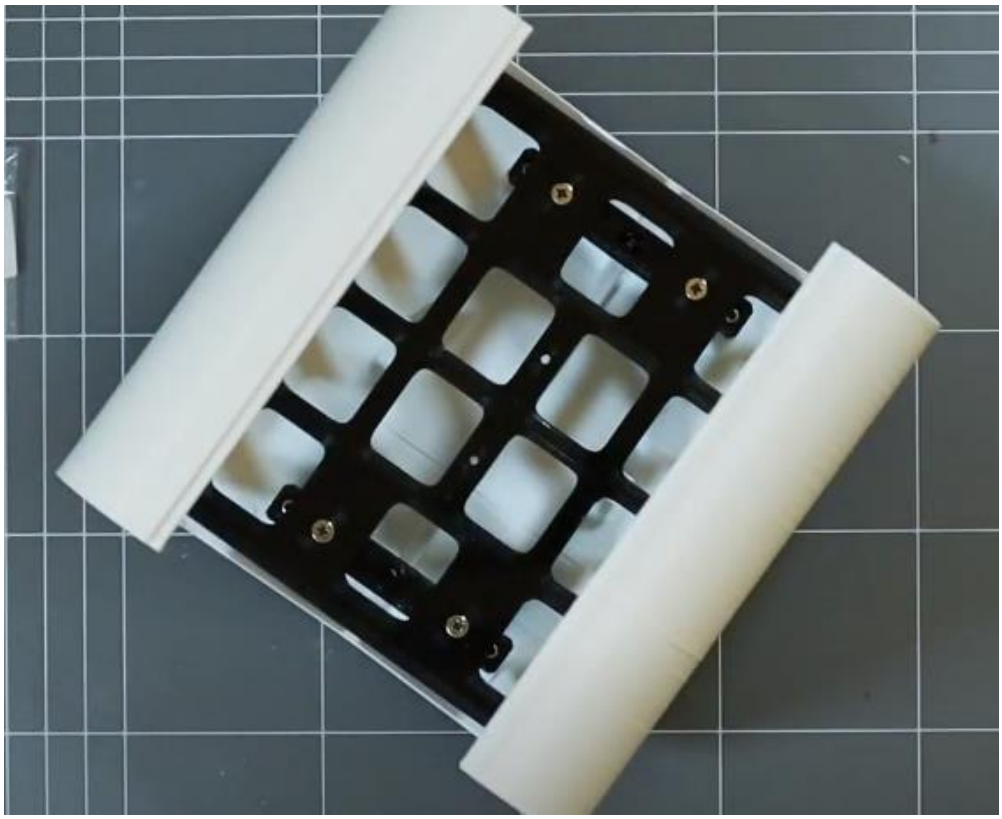
4. Before installing the trays onto the tray mounts, the hull must be assembled first. Start with the stern and fasten the **8 mm x 600 mm carbon fibre tube** in the rearward most tray mount by drilling through the hole in the top of the tray mount and using a **M3 x 10 mm self-tapping screw**.



5. Using **2-part epoxy glue** (JB Marine Weld is recommended), join each of the sections together by passing them onto **8 mm x 600 mm carbon fibre tube** one by one. You will need to work quickly before the epoxy goes off.

Optional: Each section of the hull has two small indents on the mating aces that can be drilled with a 1.75 mm drill bit to add 20 mm lengths of filament to assist with hull section alignment.

6. Once all hull sections are assembled, weight can be used on the bow to apply downward pressure while the epoxy dries. Once the epoxy has dried, another **M3 x 10 mm self-tapping screw** can be fitted to the bow end of the **8 mm x 600 mm carbon fibre tube** to secure it. The trays can now be fitted using **M3 x 6 mm machine head screws** as per the example below.



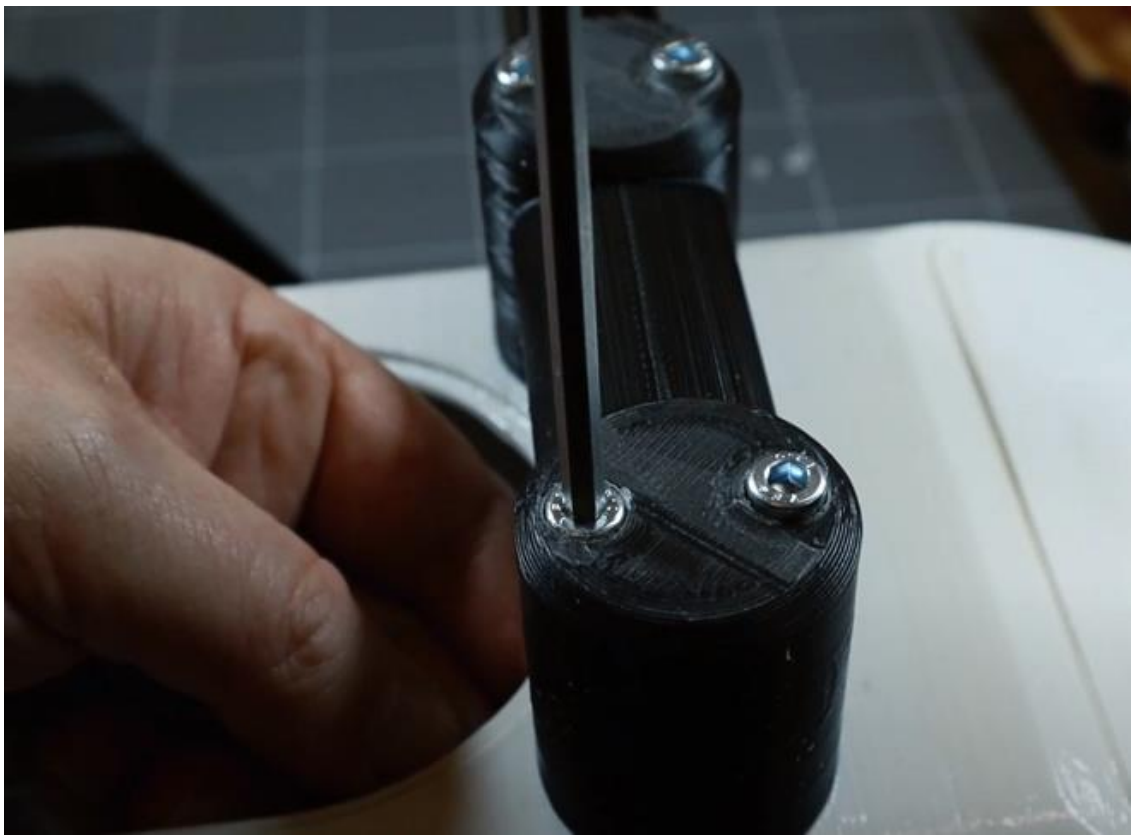
7. It’s now time to look at the external hull fittings. We will start by preparing the **25 mm x 575 mm carbon fibre tube**. The tube must be drilled (or milled) to accept the **M5 x 60 mm socket head bolts** through the tube mounts. The image below shows the carbon fibre tube fitted inside the tube mount while being milled.

8. When milling, pass **M5 x 60 mm socket head bolts** through the holes (1) to act as an end stop for the carbon fibre tube. Only mill the carbon fibre tube through the holes (2).

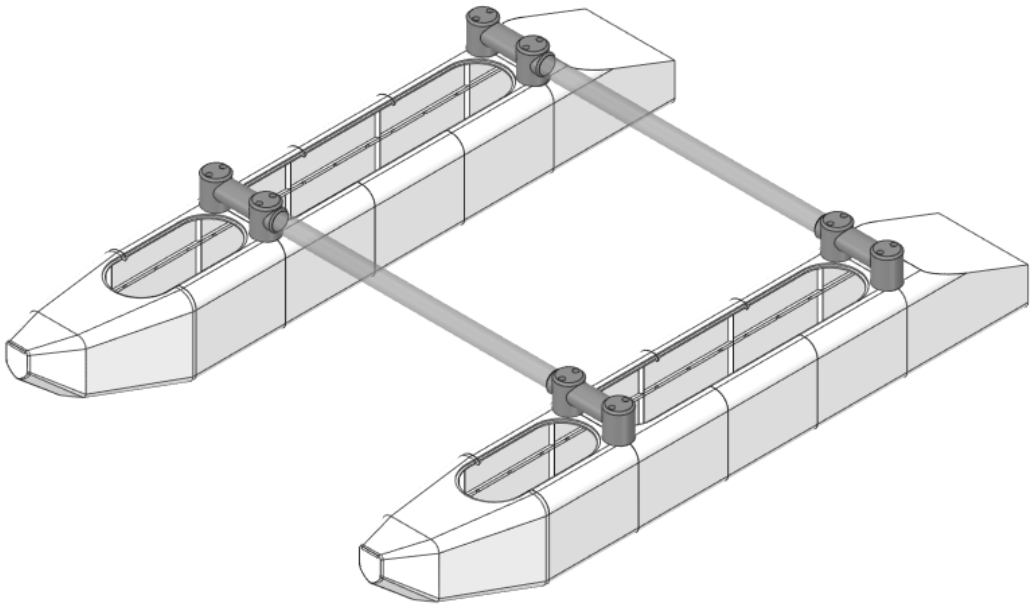
9. Using **2-part epoxy glue**, add a thin coating to the end of the **25 mm x 575 mm carbon fibre tube**.

10. Then slide the tube mount on to the **25 mm x 575 mm carbon fibre tube** and use **M5 x 60 mm socket head bolts** to position it correctly. Repeat the process for the other end of the **25 mm x 575 mm carbon fibre tube** and tube mount. Pay particular attention to ensure that both tube mounts are orientated correctly.

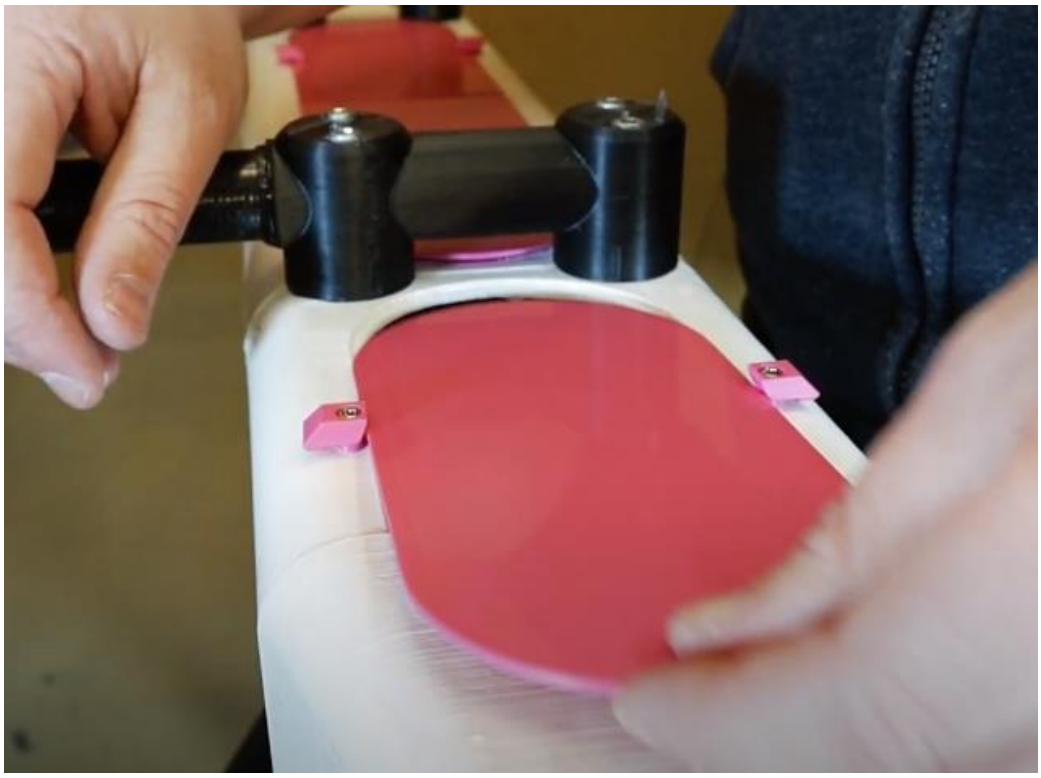
11. Drill the mounting faces on the hull to accept the **M5 x 60 mm socket head bolts** and then fasten using **M5 nylon lock nuts** on the inside of the hull. Tighten just enough to remove any place in the nut and bolt. Do not overtighten.



12. The partially assembled boat should now look like the image below.

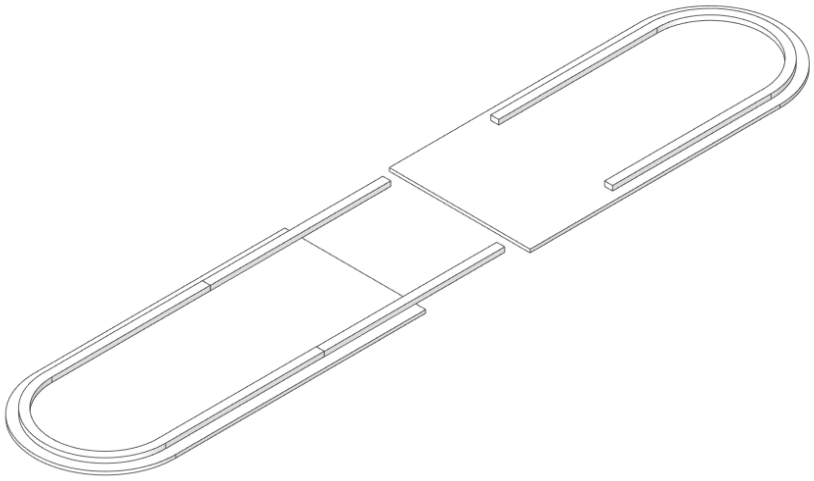


13. There are six dimples marked on the hull sections for drilling with a 3 mm drill bit to allow the hatch clips to be installed. The hatch clips are fitted with **M3 x 15 mm machine head screws** and **M3 nylon lock nuts**. The lock nuts should be tightened enough inside the hull to provide a good friction fit when the hatches are fitted. The front hatch slides into place and then the hatch clips are rotated to hold it firmly in place.

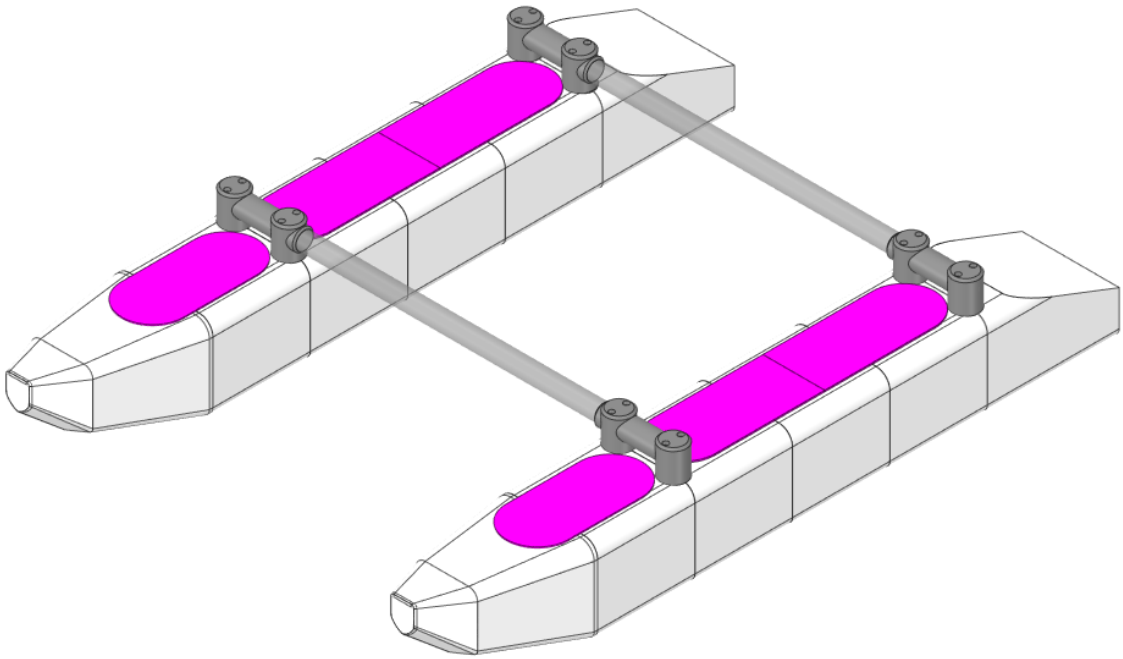


14. The rear hatch must be assembled in two pieces as per the image below so that it can fit between the tube mounts.

Optional: The hatch can be made watertight through the addition of tape or you could try using TPU filament to create a gasket-like seal.



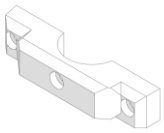
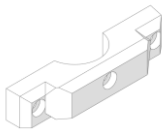
15. The partially assembled boat should now look like the image below.

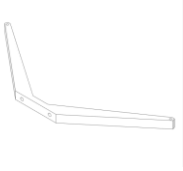
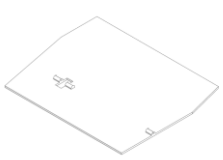


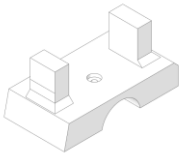
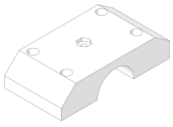
Step Five: Printing the Drive Parts

The drive system consists of a motor mount, rudders and servo mount. The motor and servo mounts fir standard radio controlled parts.

Table 6. Drive Parts, File Names and Quantity Required

Drawing (print orientation indicated)				
File name	12. Drive – Motor Mount Left.STL	13. Drive – Motor Mount Right.STL	14. Drive – Motor Mount Clamp Left	15. Drive – Motor Mount Clamp Right
Quantity required	1	1	1	1
Supports	No	No	No	No
Bed adhesion	No	No	No	No

Drawing (print orientation indicated)				
File name	16. Drive – Rudder Mount.STL	17. Drive – Rudder Left.STL	18. Drive – Rudder Right.STL	19. Drive – Rudder Linkage Spacer.STL
Quantity required	2	1	1	1
Supports	No	No	No	No
Bed adhesion	No	No	No	No

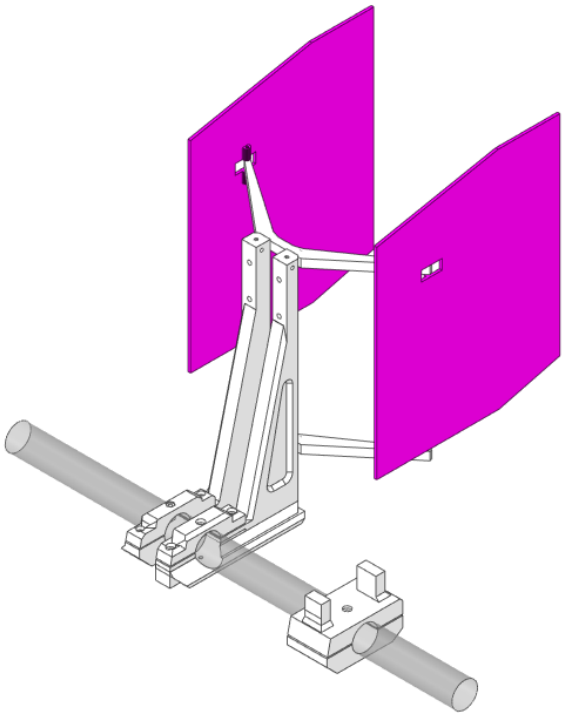
Drawing (print orientation indicated)			
File name	20. Drive – Rudder Linkage Horn	21. Drive – Servo Mount.STL	22. Drive – Servo Mount Clamp.STL
Quantity required	4	1	1
Supports	No	Yes	Yes
Bed adhesion	No	No	No

Recommended print settings are as per Table 1. Supports are required for the two parts that make up the servo mount. No other supports or bed adhesion are required if parts are printed as per the part orientation shown in Table 3.

Step Six: Assembling the Drive Parts

The completed drive parts look like the drawing below.

Optional: There are two cavities inside each of the sides of the motor mount parts. These are for increasing part strength by inserting carbon fibre tubes or rods (8 mm and 6 mm diameter).

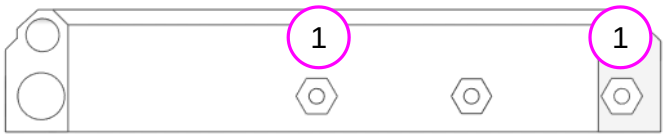


The bill of materials is listed in Table 7 for drive parts assembly only.

Table 7. Bill of Materials for Assembling the Drive Parts

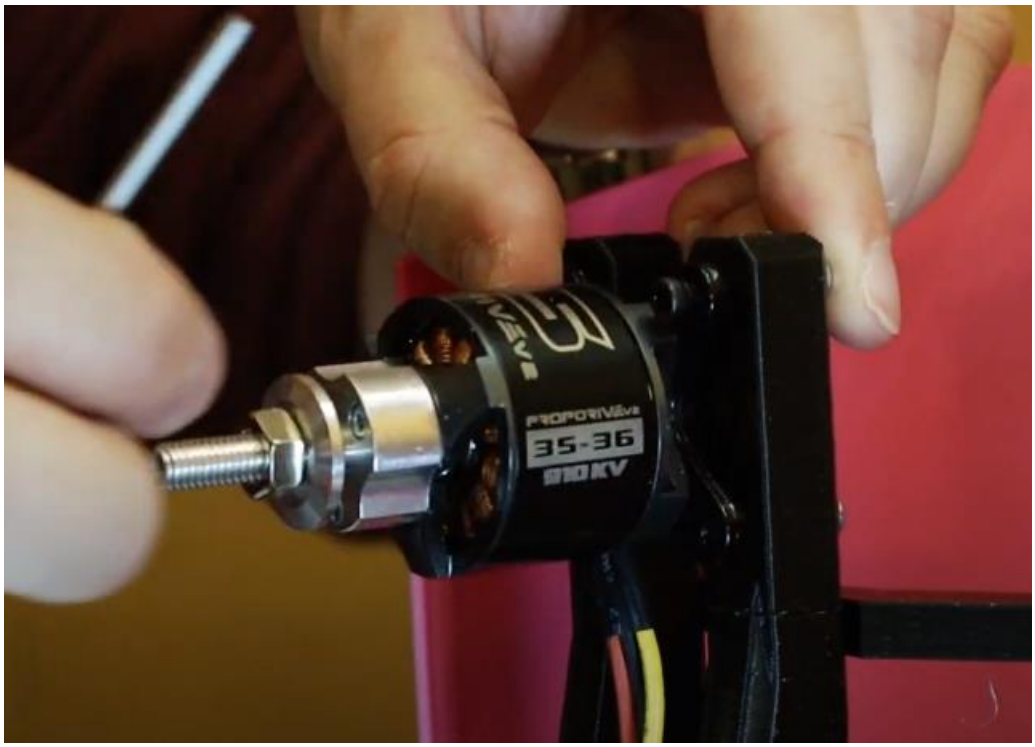
Item	Quantity
M3 nuts	7
M3 x 30 mm machine head screws	4
M3 x 40 mm machine head screws	3
M2 x 10 mm machine head screws	4
M2 nuts	4
M2.5 x 27mm x 3mm Nylon Ball Joint	6
M3 x 10 mm machine head screws	4
M3 nylon lock nuts	4
2.5 mm x 130 mm carbon fibre rod	2
1 mm x 30 mm piano or servo wire	4
M3 x 4 mm heat-set inserts	4
2.5 mm x 100 mm carbon fibre rod	1
2.5 mm clevis	2

1. Fit **M3 nuts** to the bottom of both sides of the motor mounts (1).

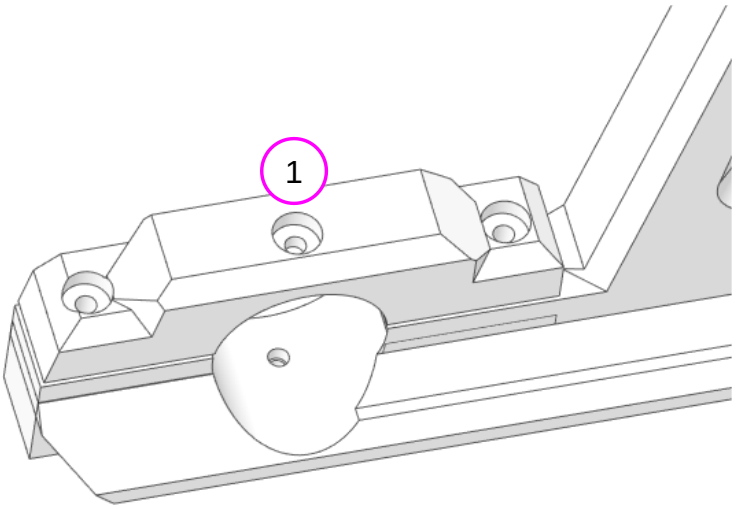


2. Measure the centre of the rear cross brace carbon fibre tube and then position one side of the motor mount in place. Position the motor mount brace on top and use **M3 x 30 mm machine head screws** to loosely fasten in position. Do the same for the other side of the motor mount.

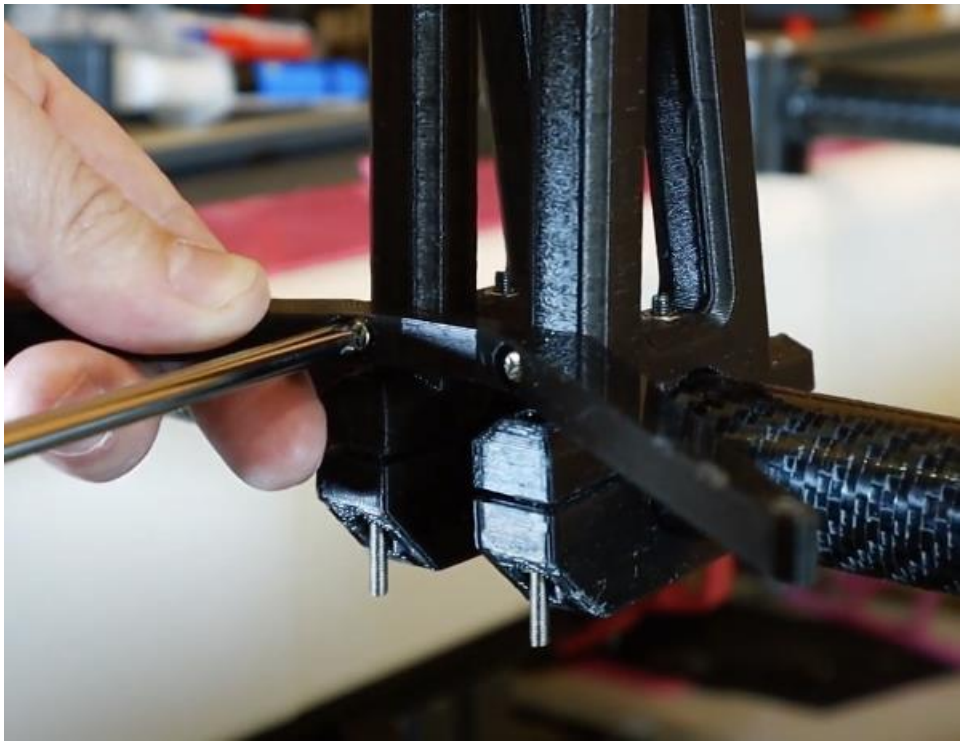
3. If you have your brushless motor handy, now is a good time to fit it up to ensure that the mounts are square before fastening them to the tube tightly. The motor is mounted using standard hardware (check the requirements for your motor – parts not included in bill of materials).



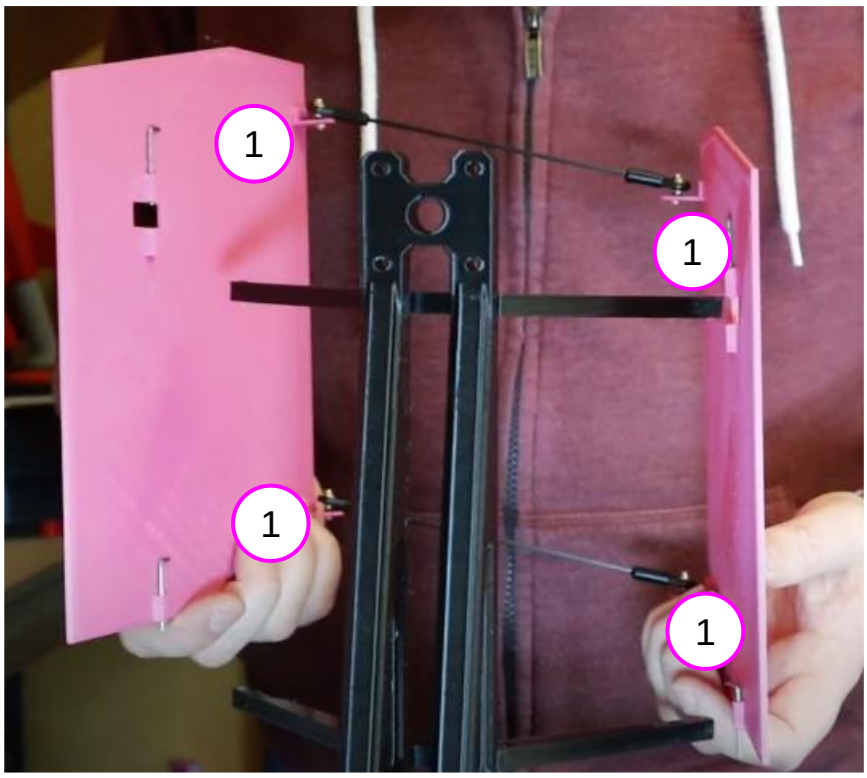
4. The motor mounts and brackets have a hole (1) centred on the carbon fibre tube. Drill these holes at 90° through the carbon fibre tube. There is no need to offset the angle of the motor mount to alter the hull's pitch as this can be done using spacers when mounting the motor if required later on. Fit **M3 nuts** in the bottom of the motor mount braces and then secure the mounts through the tube using **M3 x 40 mm machine head screws**.



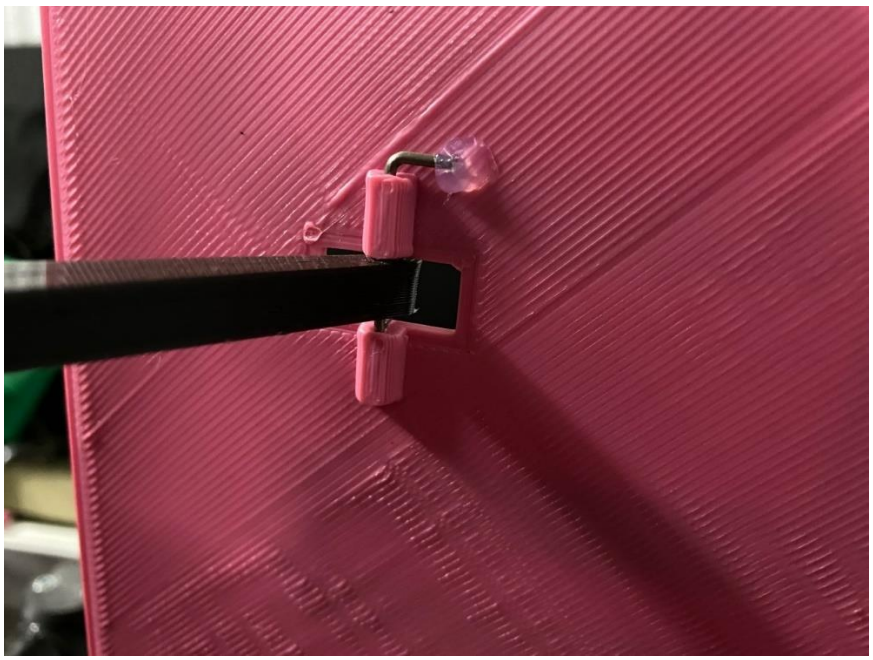
5. Fit both rudder mounts to the motor mount with **M3 x 10 mm self-tapping screws**.



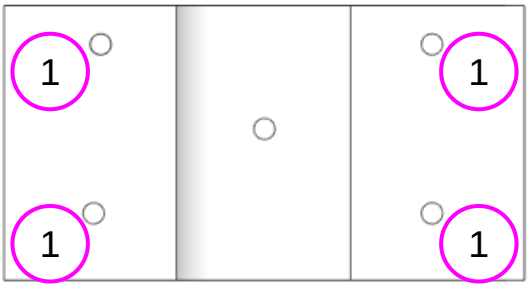
6. The rudder linkage horns are attached to each rudder using 2-part epoxy glue. The position is not important as long as they are symmetrical on both rudders. **M2.5 x 27mm x 3mm Nylon Ball Joints** are fitted using **M2 x 10 mm machine head screws** and **M2 nuts**. Both sides of the rudder are connected using **2.5 mm x 130 mm carbon fibre rod**.



7. To secure the rudders to the rudder mounts, small hinge pins must be made. I used 1 mm servo linkage wire to create a small pin that is held in place with a 90° bend. You can use whatever you have on hand. A small amount of hot glue at the top of the pin prevents them from vibrating out.

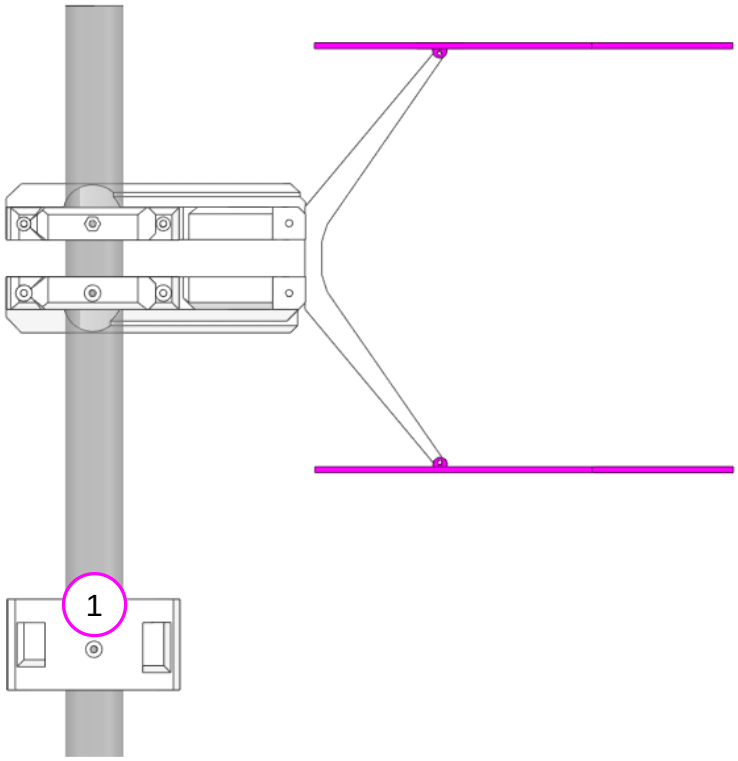


8. Insert **M3 x 4 mm heat-set inserts** using a soldering iron into the holes (1) in the bottom of the servo mount.

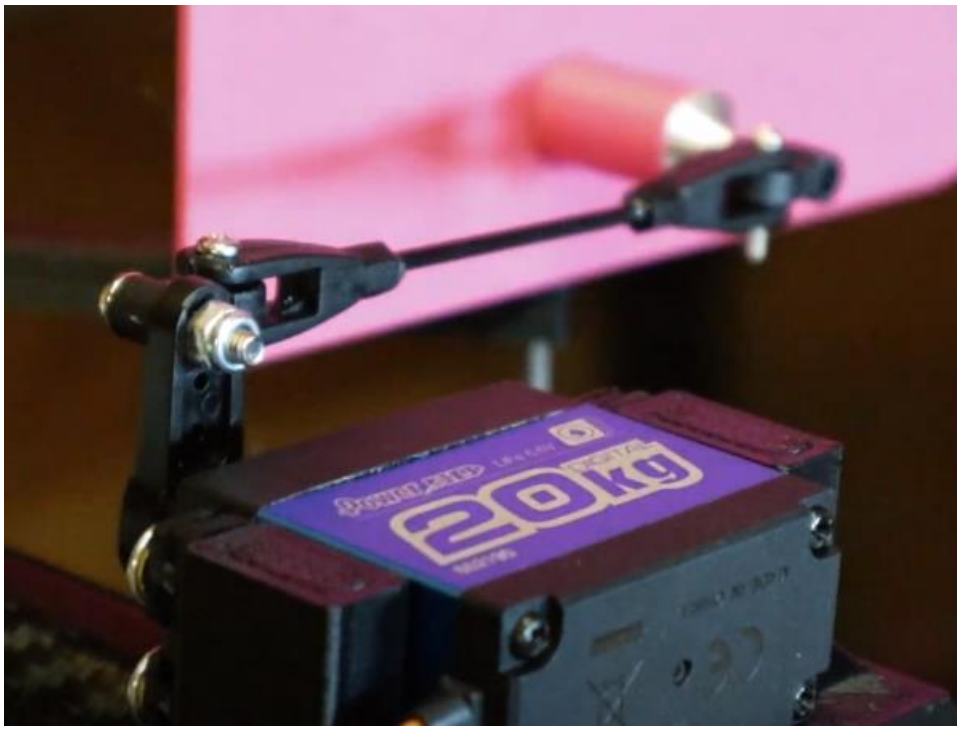


9. Position the servo mount at an appropriate position on the carbon fibre tube to suit your servo and control linkage hardware (not included in bill of materials). A recommended position is shown below.

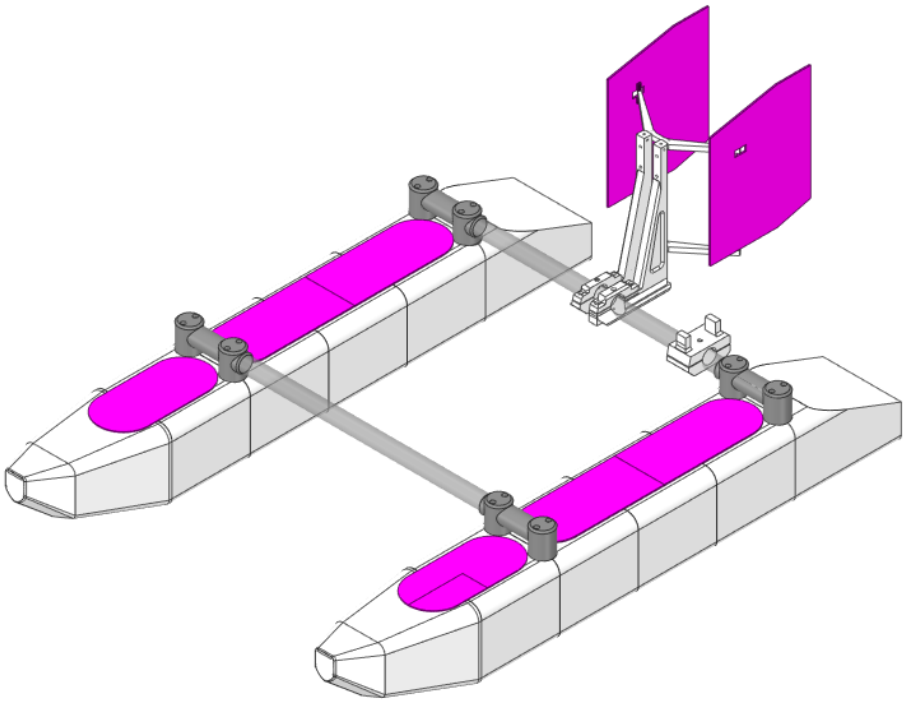
*Optional: If required, a hole can be drilled through the servo mount hole (1) and carbon fibre tube to provide increased mounting strength using **M3 x 40 mm machine head screw** and an **M3 nut**.*



10. The servo mount suits a standard sized servo. A waterproof servo is recommended. Fit your servo using the included mounting hardware (not included in bill of materials). The image below shows the rudder linkage in place. The rudder spacer is fitted by drilling a 3 mm hole in the rudder and using control horn hardware to secure it. The control horns from servo to rudder are connected by a **2.5 mm x 100 mm carbon fibre rod** secured with two-part epoxy glue to the **2.5 mm clevises**.



This is the end of this build guide and your boat should like the image below.



Thanks for building and if you share your build online please tag @electrosync or get in touch directly.

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