

FireFlighters Drone Build Book



Tools/Equipment

- Needle nose pliers
- Wire cutters
- Soldering iron
- Allen keys
- M3 nuts/bolts
- M2 nuts/bolts

Print Parts

- A Prusa XL was used to 3D print parts
- PLA Carbon Fiber filament
- 30% infill with zigzag pattern
- Organic support touching baseplate only
- Prusa slicer file and STL files can be found on the GitHub
 - <https://github.com/Mark-Yazemboski/Autonomy-Capstone-FireFighters>

Remove Supports

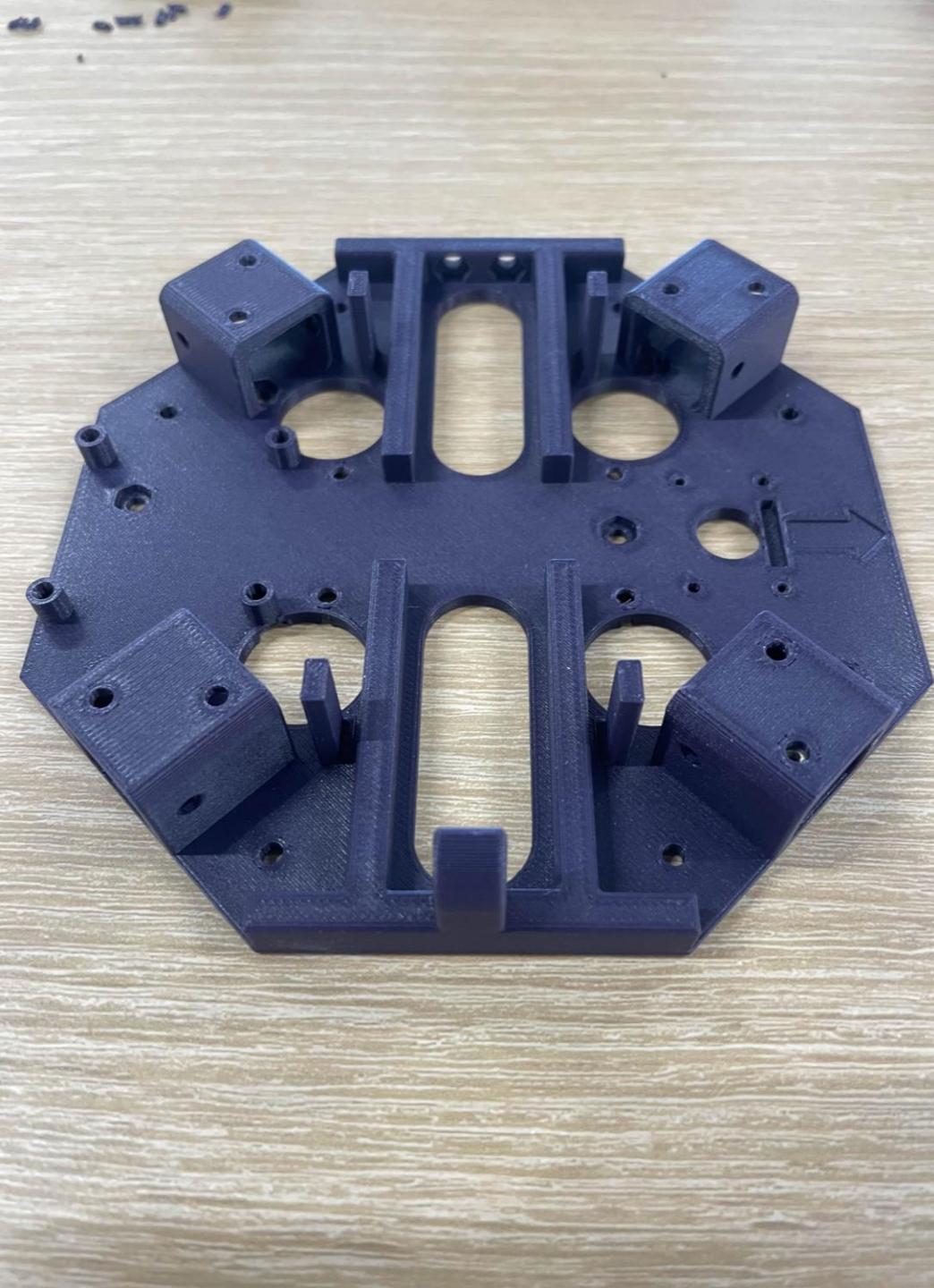
- Remove the supports from every part
- Be careful not to damage the parts
- Supports might be covering screw/nut holes. Use Allen key to push them out



Technique #1

- Sometimes, the nut will not fit in the recessed hole. To resolve this:
 - Insert a screw into the hole
 - Thread the screw until it contacts the nut
 - Tighten the screw, and the nut should be pulled into the recessed hole





Base Plate Setup

Get the following parts ready:

- Base plate
- Arm x4
- Battery bracket x2

Inset the Nuts and Bolts into the Bottom

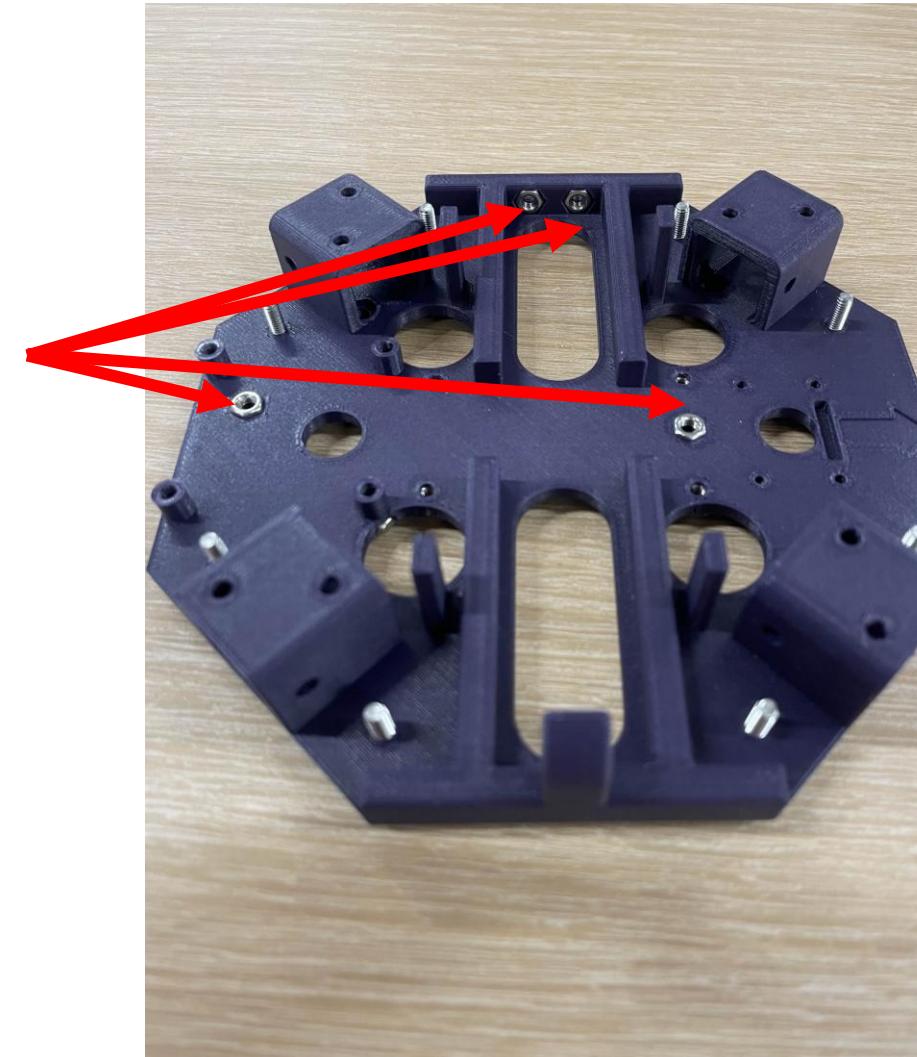
- M3*10mm: 8
- M3 Nuts: 8
- M2 Nuts: 4
- The M3*10mm bolts should be screwed all the way into the part at the places shown in the picture, and face upward

Don't overtighten



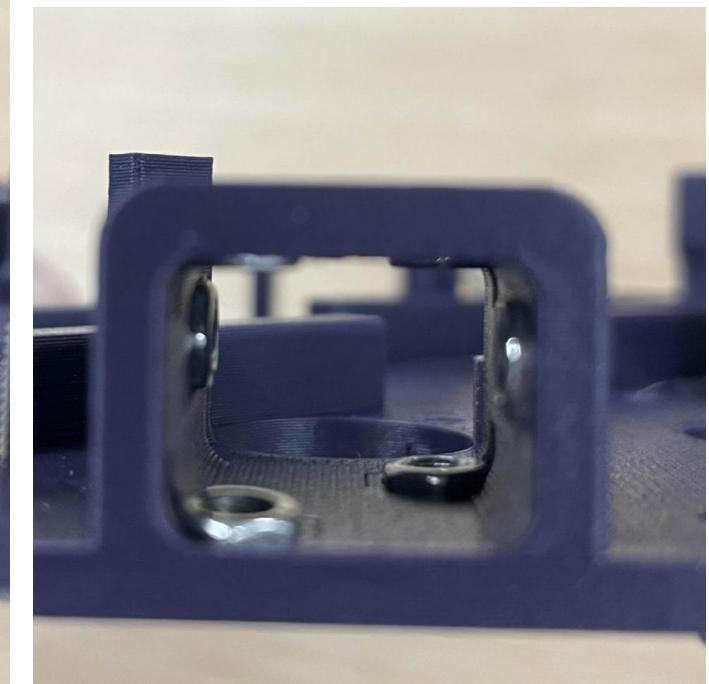
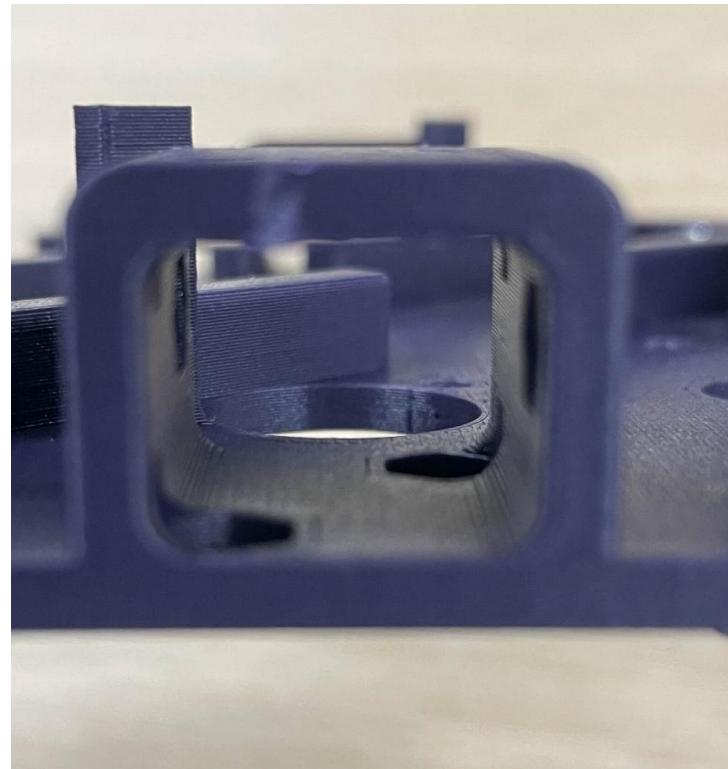
Insert Nuts into Top of Baseplate

- M3 Nuts: 4



Insert Nuts into Arm Connectors

- M3 Nuts: 6x4
- There are 4 arm connectors, each requiring 6 Nuts
- You will likely need to use “Technique #1” when inserting the nuts
- Using your pinky finger to keep things in place is very helpful



Connect Arms

- M3*6mm: 4x4
- Place the arms over the arm connectors, and screw in 4 M3*6mm bolts for each arm
- Tip: Using a finger to hold the nut in place while tightening the bolt will prevent the nut from coming loose

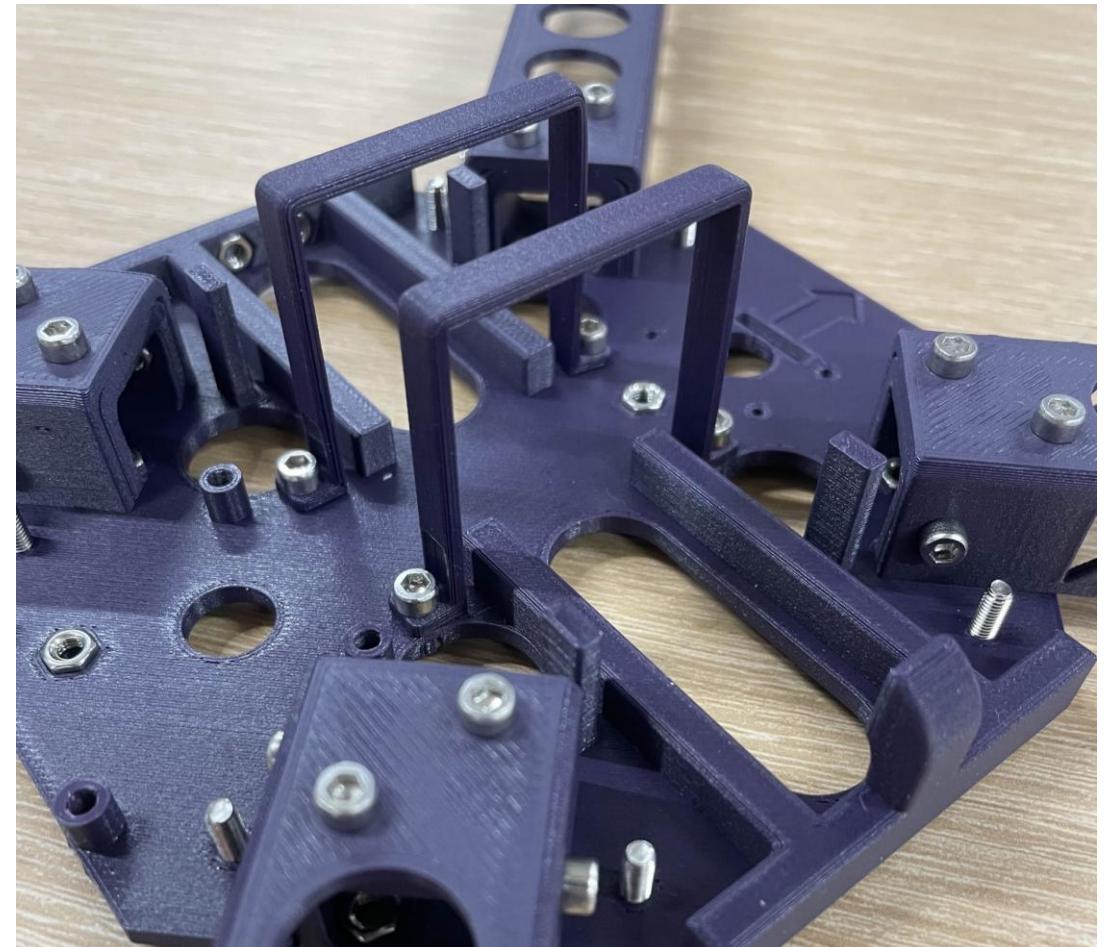


Current Progress



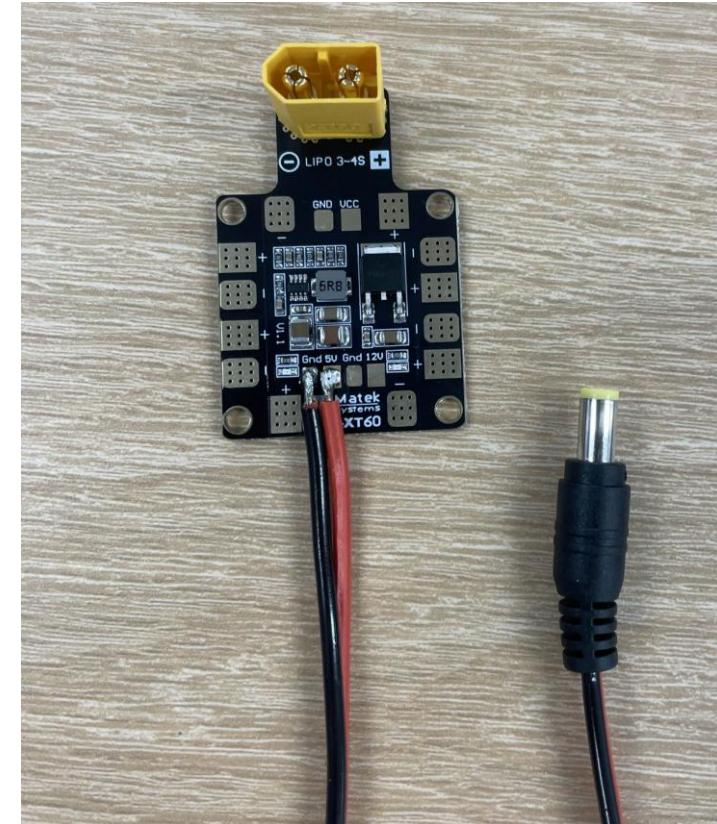
Connect Battery Brackets

- M3*6mm: 4
- Tip: Use a finger to make sure the nut doesn't fall out
- Note: The bracket might twist if tightened too much, don't overtighten the bracket



Set Up Power Distribution Board (PDB)

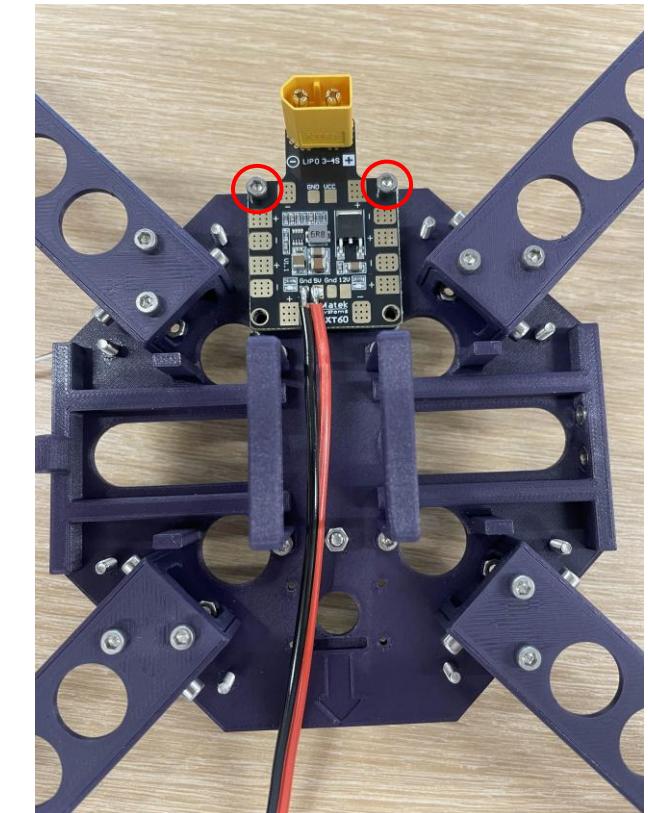
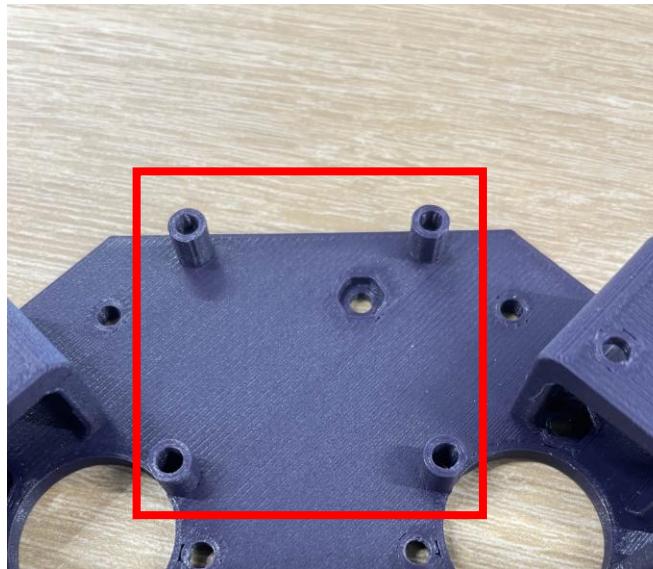
- Solder the battery connector to the PDB
 - Make sure positive and negative are on the right terminal
- Solder the 12V Arduino power connector to the 12V port on the PDB



NOTE: Shown here the power connecter is soldered to 5V. This is a mistake. Solder to the 12V connection

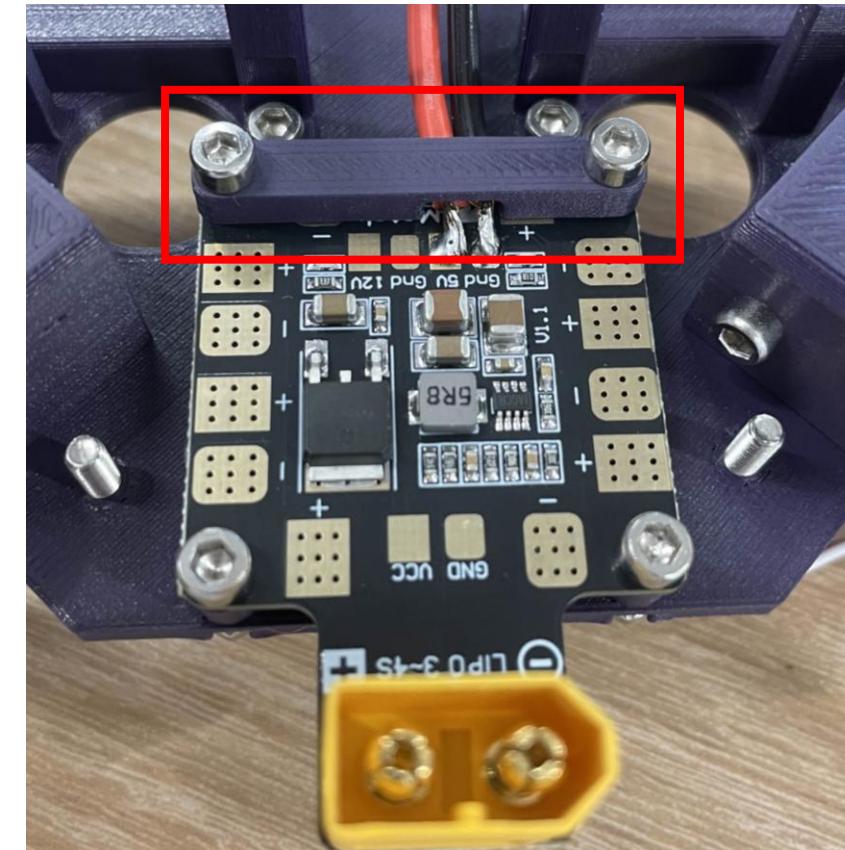
Connect PDB

- M3*10mm: 2
- The PDB should rest on the four raised cylinders on the base plate
- Put the bolts in the top two holes of the PDB, as seen in the image
- Warning: don't overtighten - the PDB can snap.



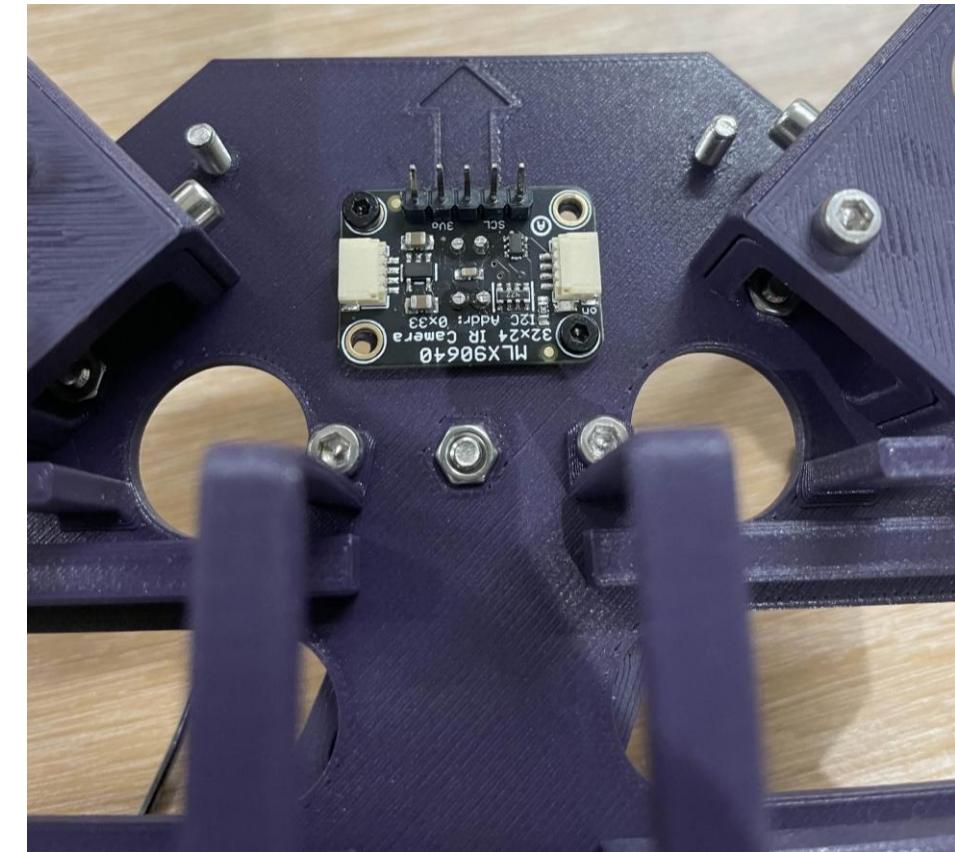
Connect PDB

- M3*14mm: 2
- Place the “PDB_Wire_Holder” over the 12V wires and screw it down using the M3*14mm bolts
- Warning: don't overtighten
- the PDB can snap



Add Thermal Sensor

- M2*6mm: 2
- You only need 2 of the holes
- Make sure you put bolts into the diagonal holes of the thermal sensor



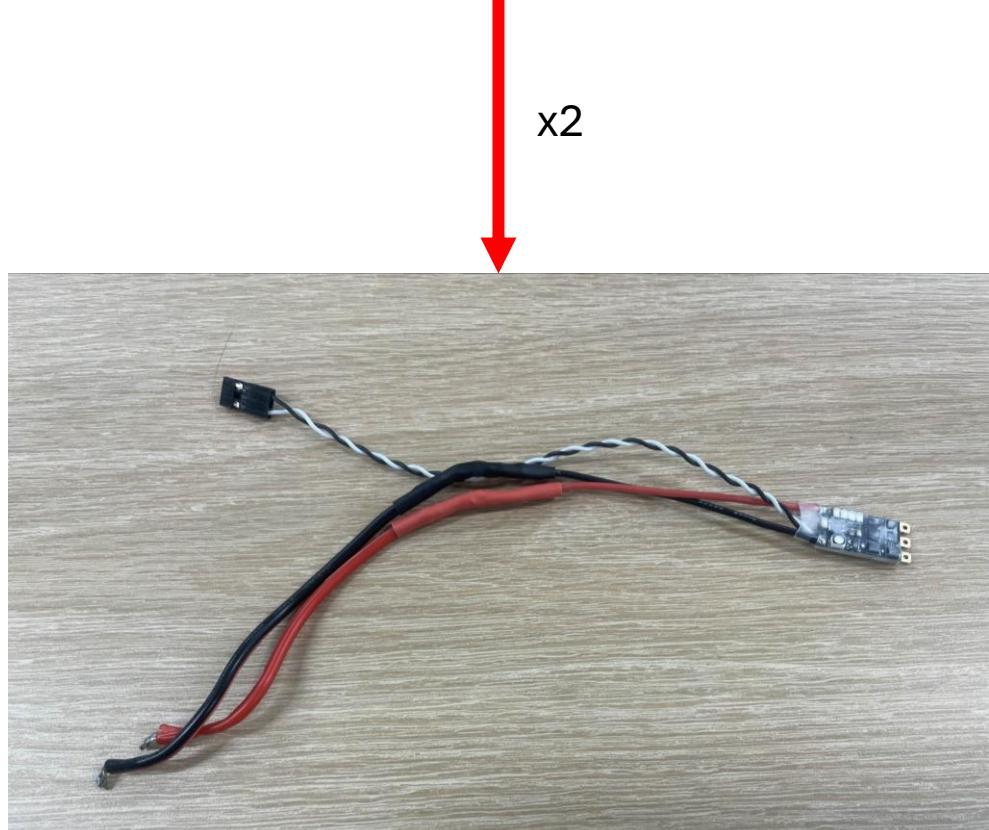
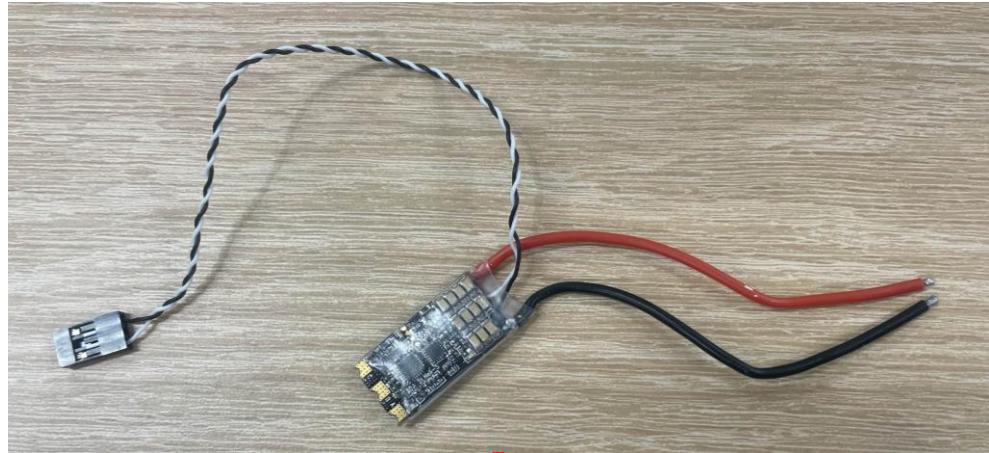
Add Landing Legs

- M3*8mm: 2*4
- Screw in the M3*8mm bolts as shown in the image (make sure about 1mm pokes out the other side)
- This will help with aligning and screwing in the landing leg
- Screw in the landing leg into the base plate in the holes/orientation shown in the image
- Repeat for all 4 landing legs



Prepare Electronic Speed Controllers (ESC)

- ESC's: 4
- Solder on wire extensions to **two** of the ESC's ground and power cables



Attach Motors to ESC's

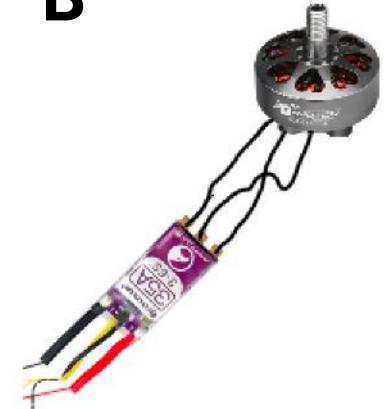
- Motors: 4
- Short ESC: 2
- Long ESC: 2
- Configuration A:
 - Solder one short ESC and one long ESC following the wire layout for configuration A
- Configuration B:
 - Solder one short ESC and one long ESC following the wire layout for configuration B
- Label the ESC motor combination for future reference

A



Short: 1
Long: 1

B

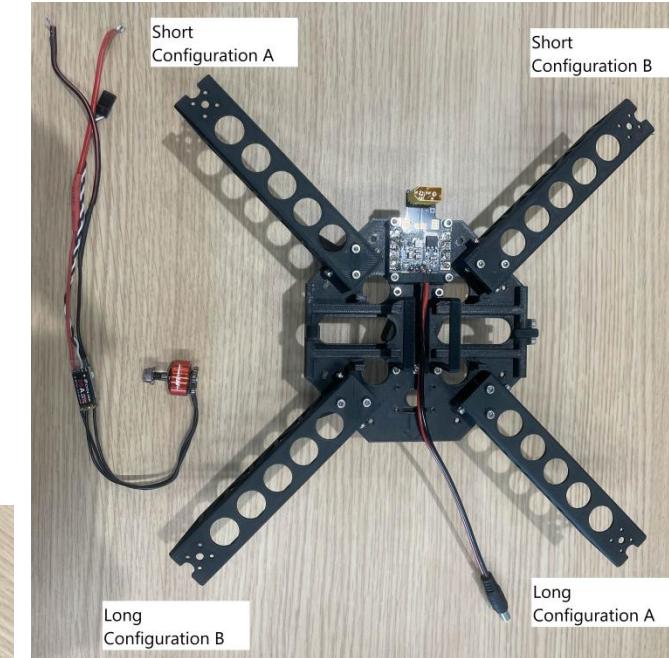
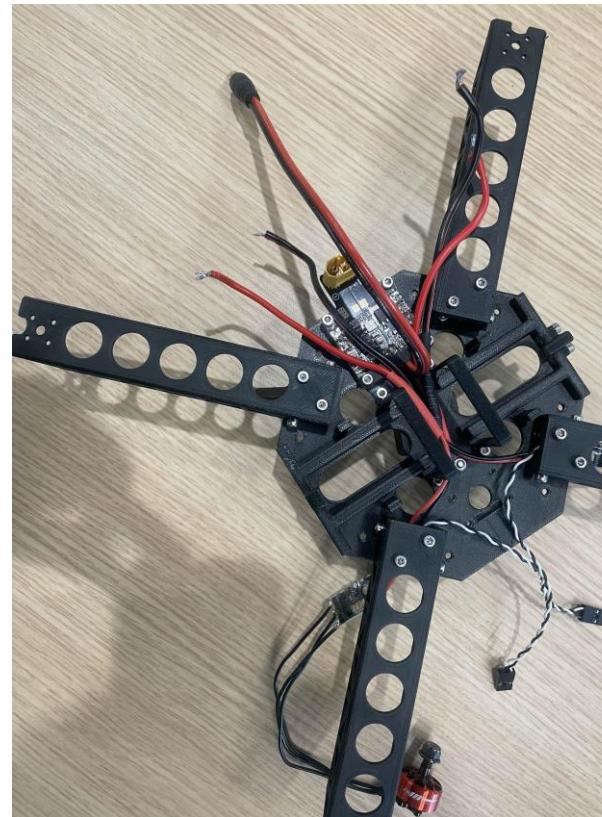


Short: 1
Long: 1



Mount Long ESC's on Frame

- First pass the long ESC's through the appropriate arm holes and direct the power and ground cables through the middle of the base plate
- Pass the black and white signal wires through the same hole and set them to the side



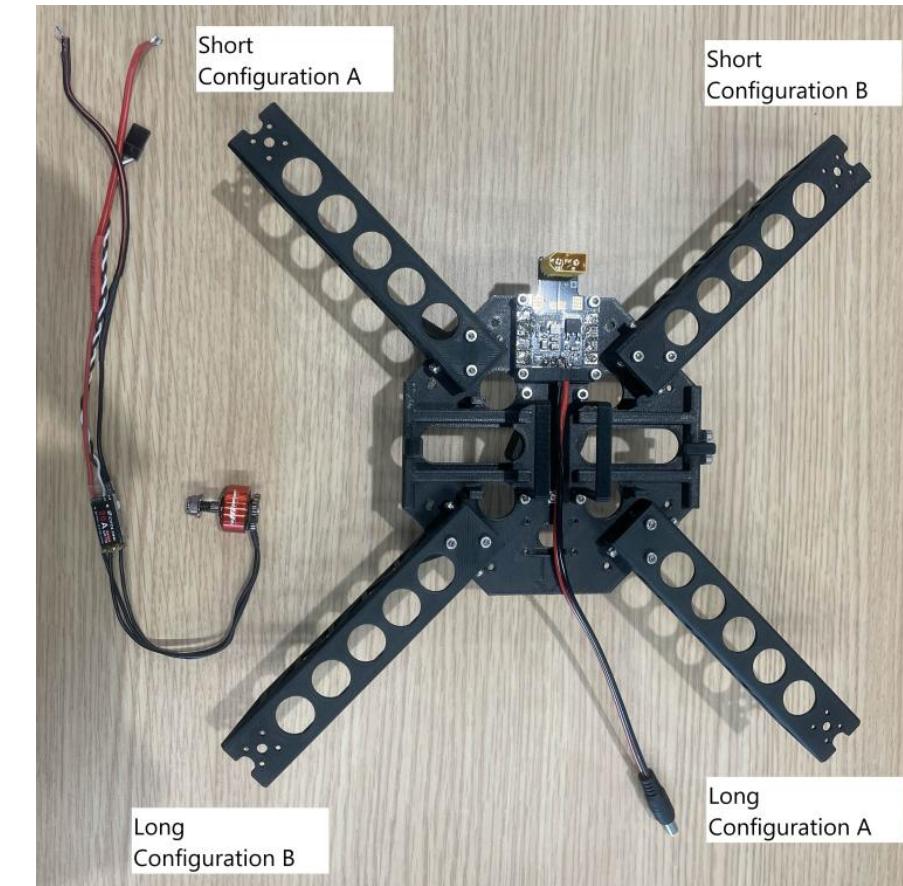
Tape Down ESC Wires

- First align the power and ground cables from the long ESC's in the center of the base plate so they lie flat
- Next using electrical tape, tape down the wires like the image shown to the right



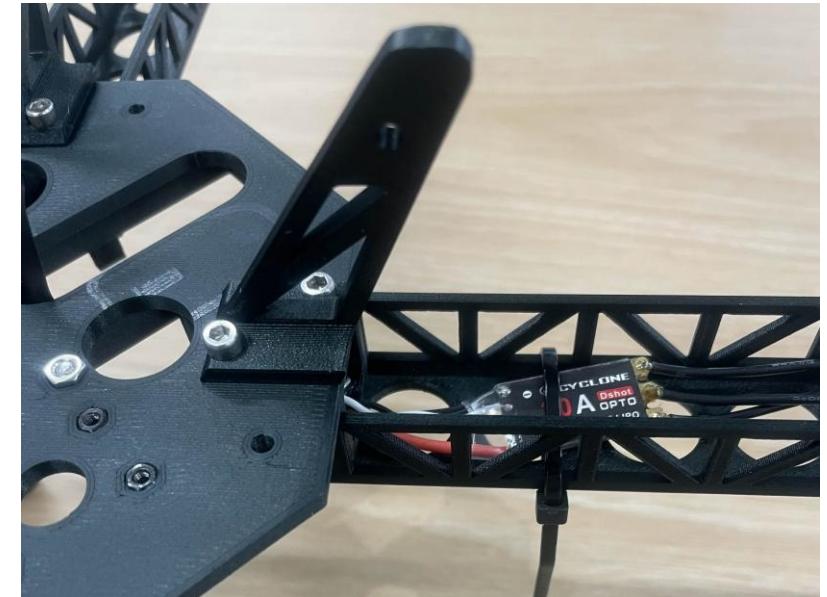
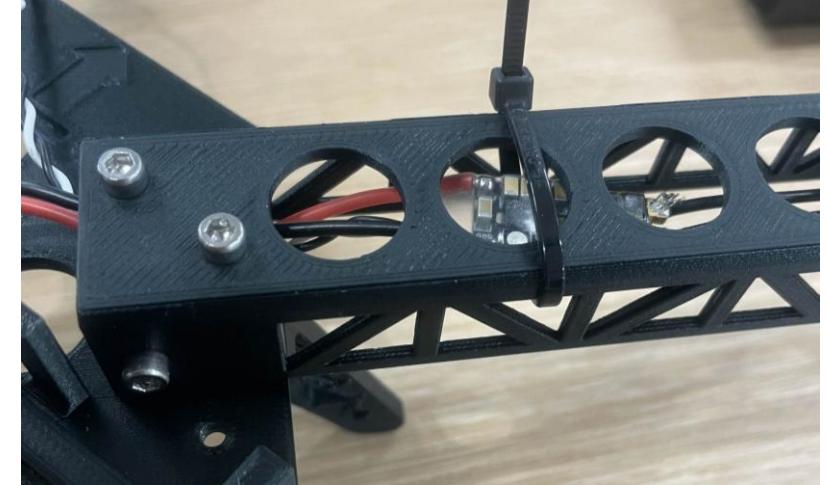
Mount Small ESC's to Frame

- Pass the correct small wired ESC through the appropriate arm hole according to the image



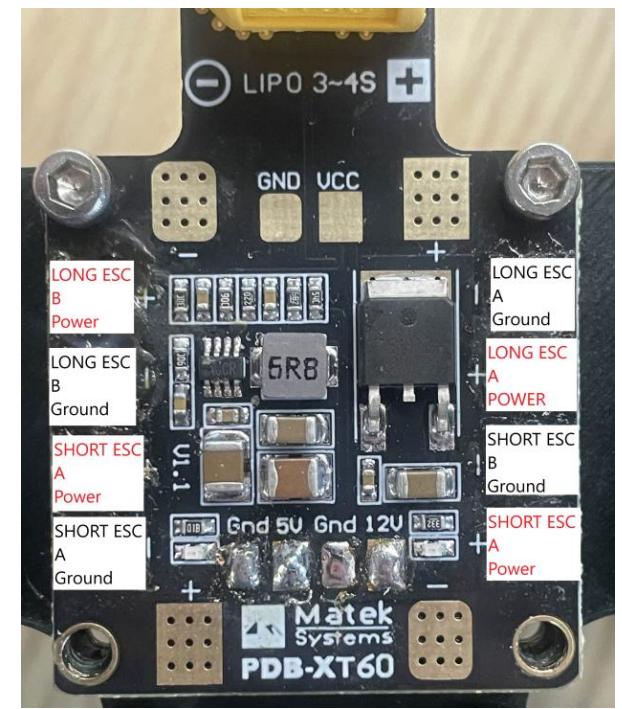
Attach ESC's to Arms

- Use small zip ties and attach the ESC's about one inch from the edge of the base plate



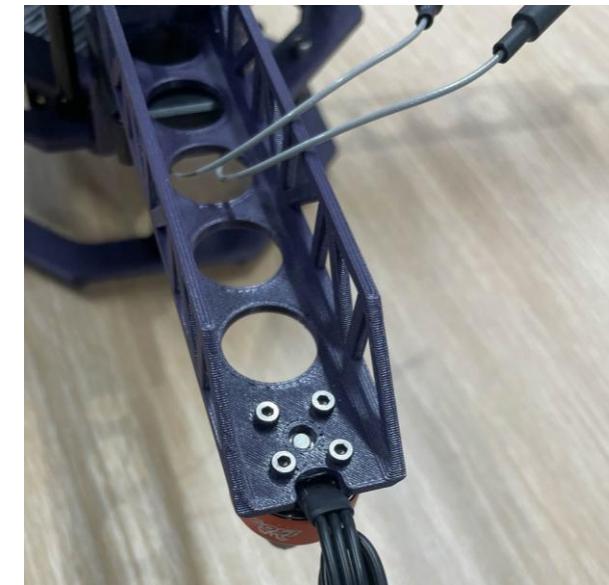
Solder ESC's to PDB

- Follow the schematic for the best layout of the wires
- The finished product should look like the image to the right



Add Motors

- M2*5mm: 4*4
- Turn the drone upside down
- Screw in the motor (make sure it's tight - the motors need to not come loose during flight)
- Make sure the wires point away from the drone body



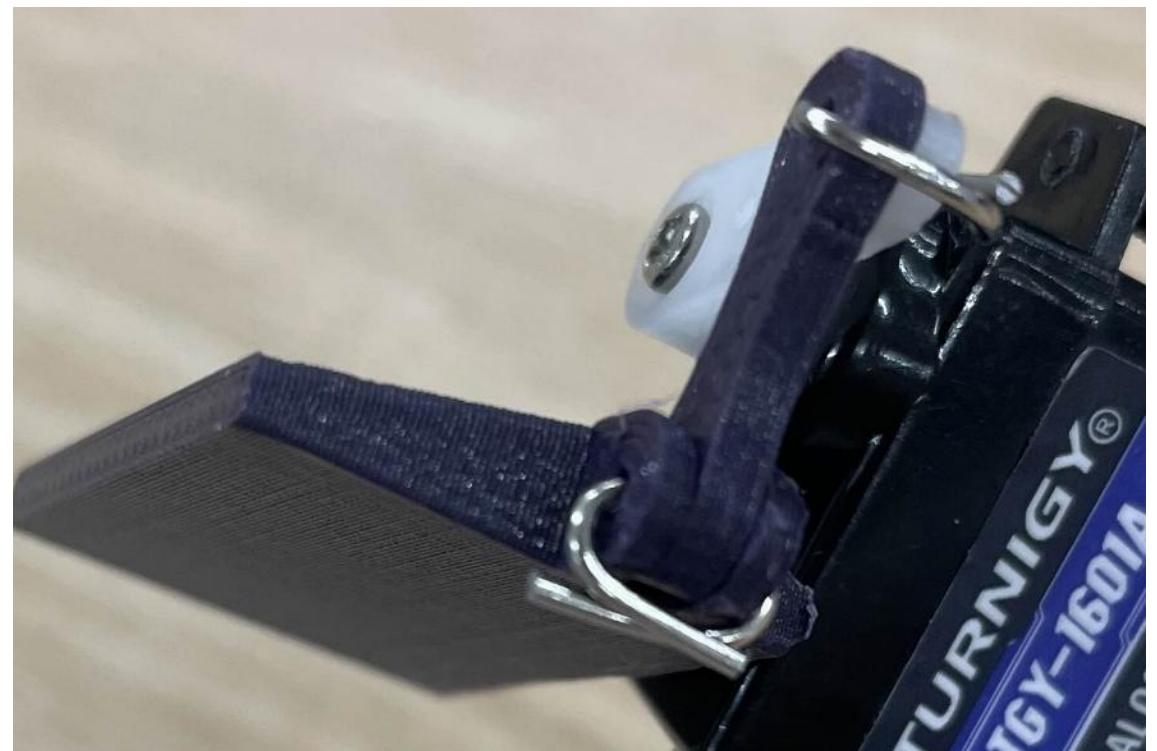
Building The Payload Mechanism

- Get the following parts ready:
 - Payload_Mount
 - Flat_Head_Pin
 - Servo_To_Flat_Head_Pin
 - Paperclip
 - Servo



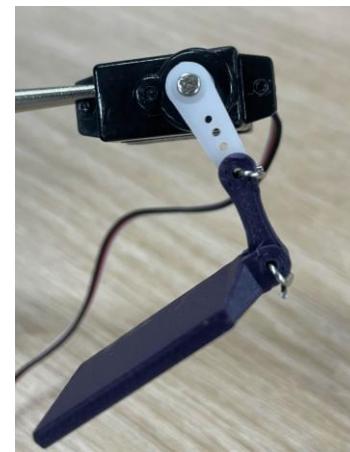
Connect Pin and Linkage

- Using the paper clip and some wire cutters, connect the “Flat_Head_Pin” to the “Servo_To_Flat_Head_Pin”
- The “Servo_To_Flat_Head_Pin” should slide easily into the “Flat_Head_Pin,” and a paperclip should be fed through the central hole, bent around, and finally cut to form a strong connection
- Make sure the connection isn’t too tight or else the mechanism won’t be able to move



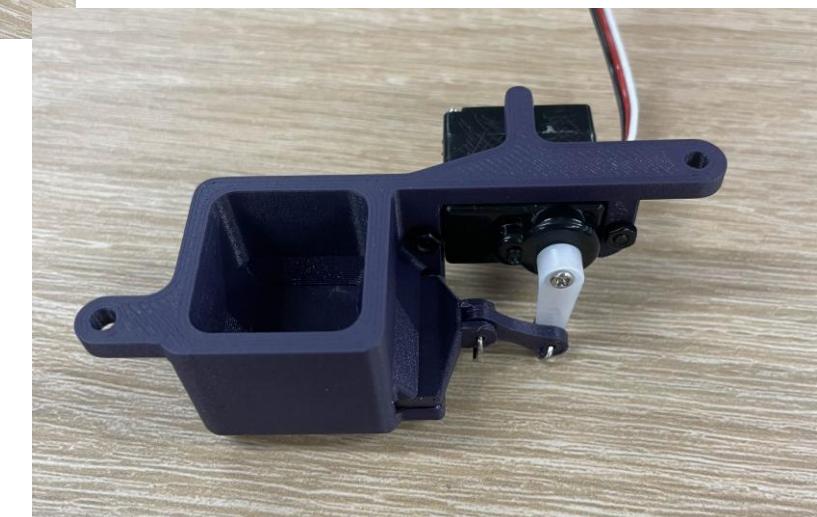
Connect the Pin and Linkage to the Servo

- Now connect the piece from the previous step to the servo
- WARNING: Make sure the “Flat head pin” is oriented correctly, it had a long side and short side, make sure the short side is facing the servo
- Perform the same connection technique with the paper clip as the previous step



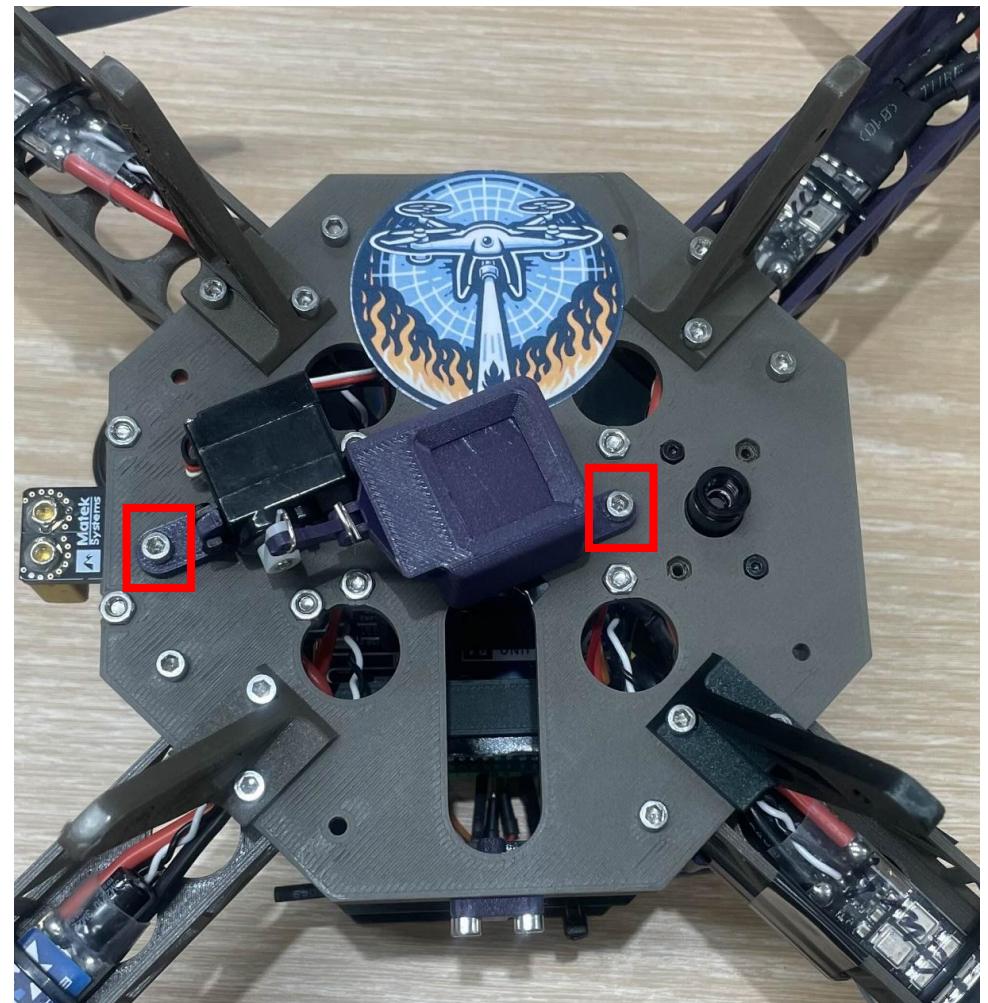
Connect Servo to Payload Mount

- M2*6mm: 2
- M2 Nut: 2
- Insert the “Flat head pin” into the payload mount
- Next you might need to move the servo around to get it to line up with the holes
- Finally screw in the M2 bolts and nut
- Warning: Don’t overtighten, the servo is very fragile



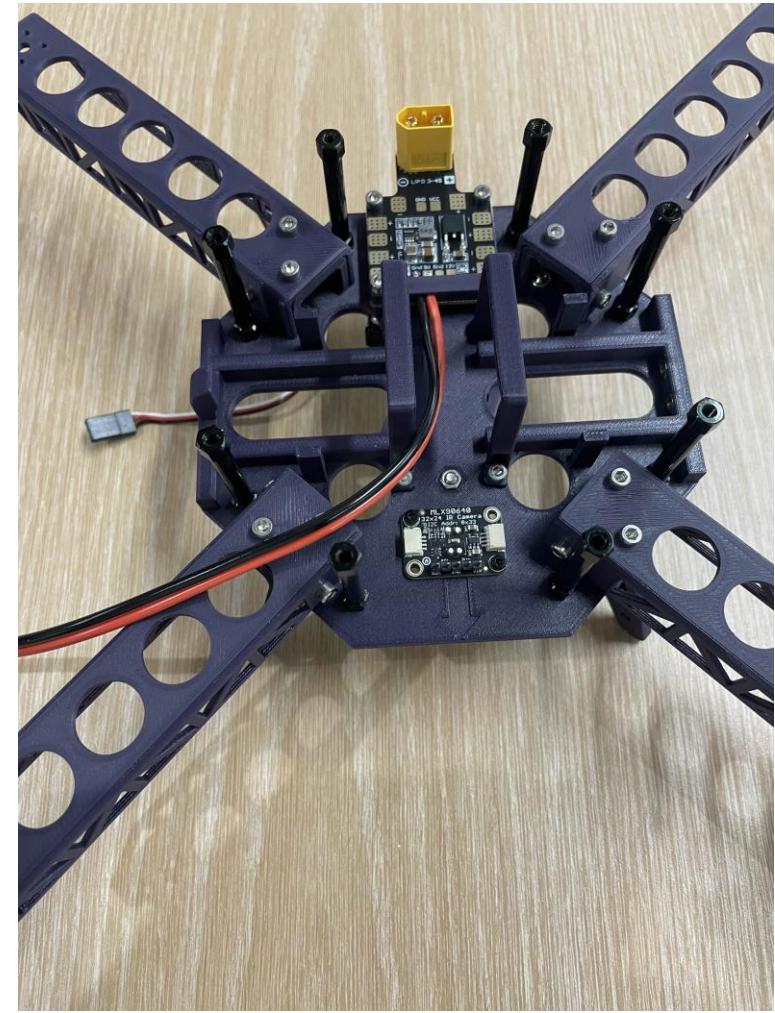
Connect Payload Mechanism to Baseplate

- M3*8mm: 2
- Note: You will know it's connected correctly when the payload door is in the center of the drone



Add Spacers to Baseplate

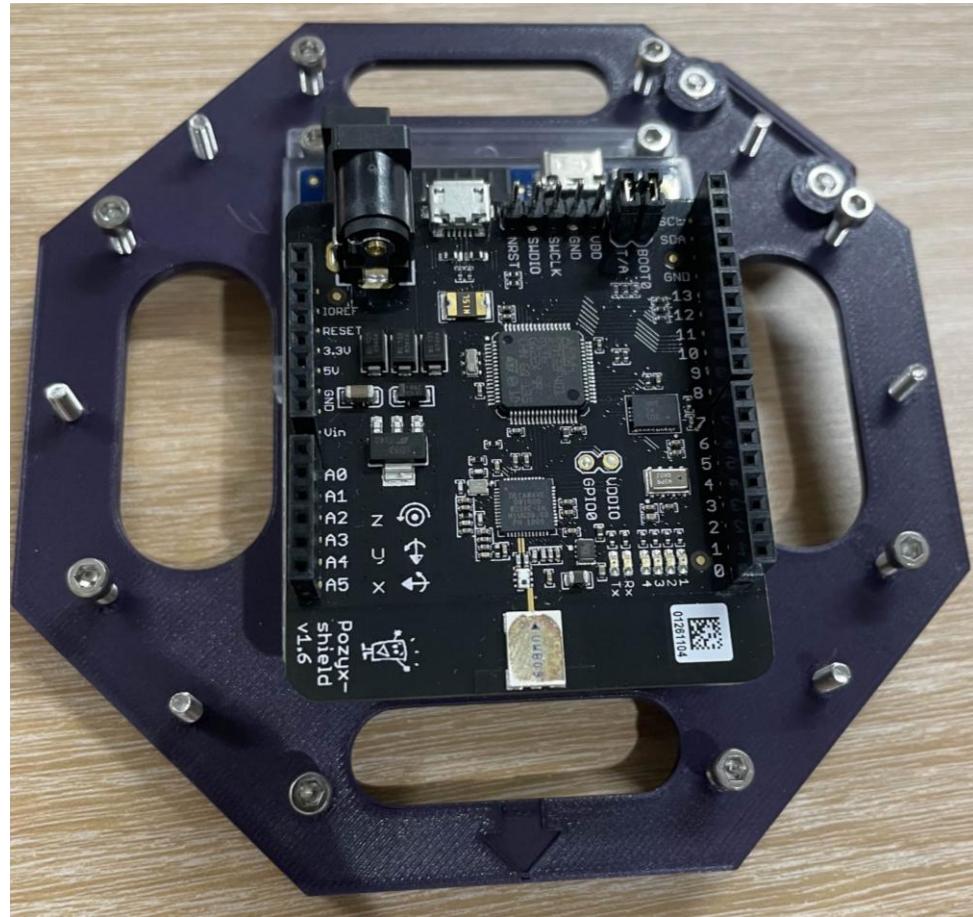
- 40mm spacers: 8
- Add the spacers to each of the upward facing bolts on the baseplate
- Use your hands to screw them onto the bolts and just hand tighten them



Note: ESC's and Motors are not shown in this image.

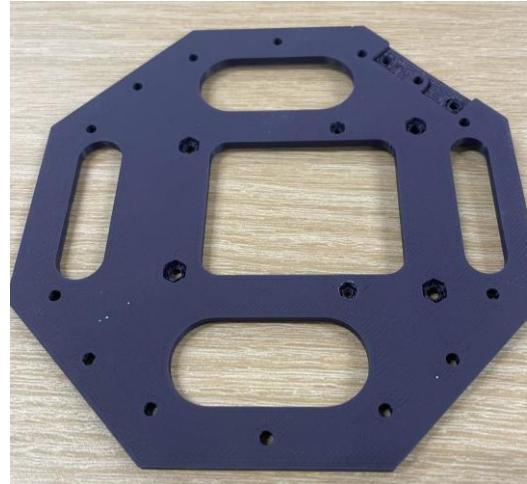
Prepping Top_plate

- Get the following parts ready:
 - Top_Plate
 - Reciever_Holder
 - Arduino and Pozyx



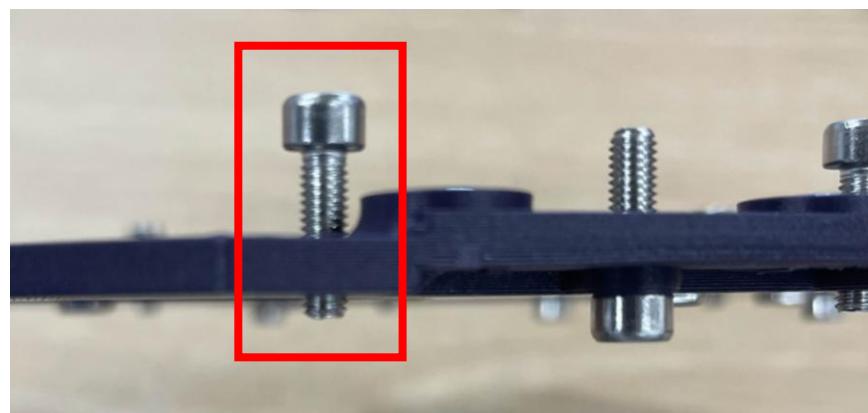
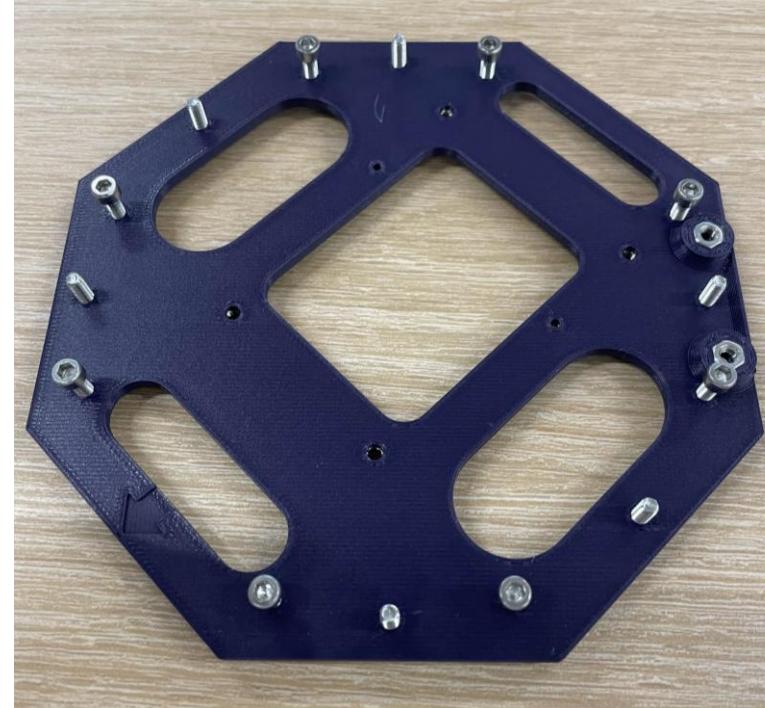
Adding Bolts/Nuts to the Bottom of Top_Plate

- M3*10mm: 6
- M3 nuts: 4
- M2 nuts: 2
- Make sure the M3*10mm bolts are being threaded the whole way and are in the correct holes shown in the image with red circles



Adding Bolts/Nuts to the Top of Top_Plate

- M3*10mm: 8
- M3 nuts: 2
- Make sure when screwing in the M3*10mm bolts that you only let about 1 mm of the bolt poke out the other side



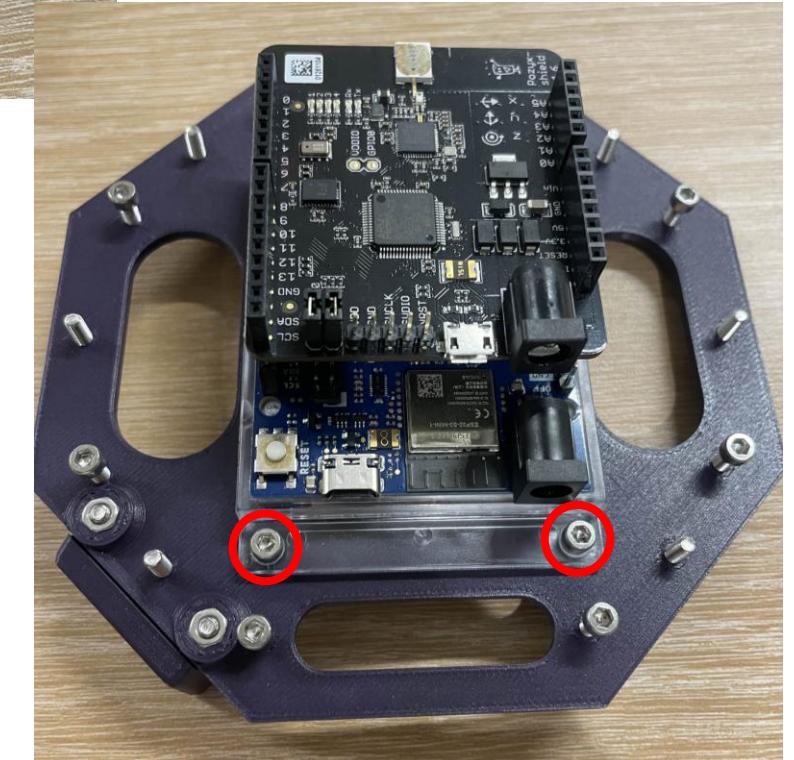
Connecting the Reciever_Holder

- M3*8mm: 2
- Connect the receiver holder as shown in the image



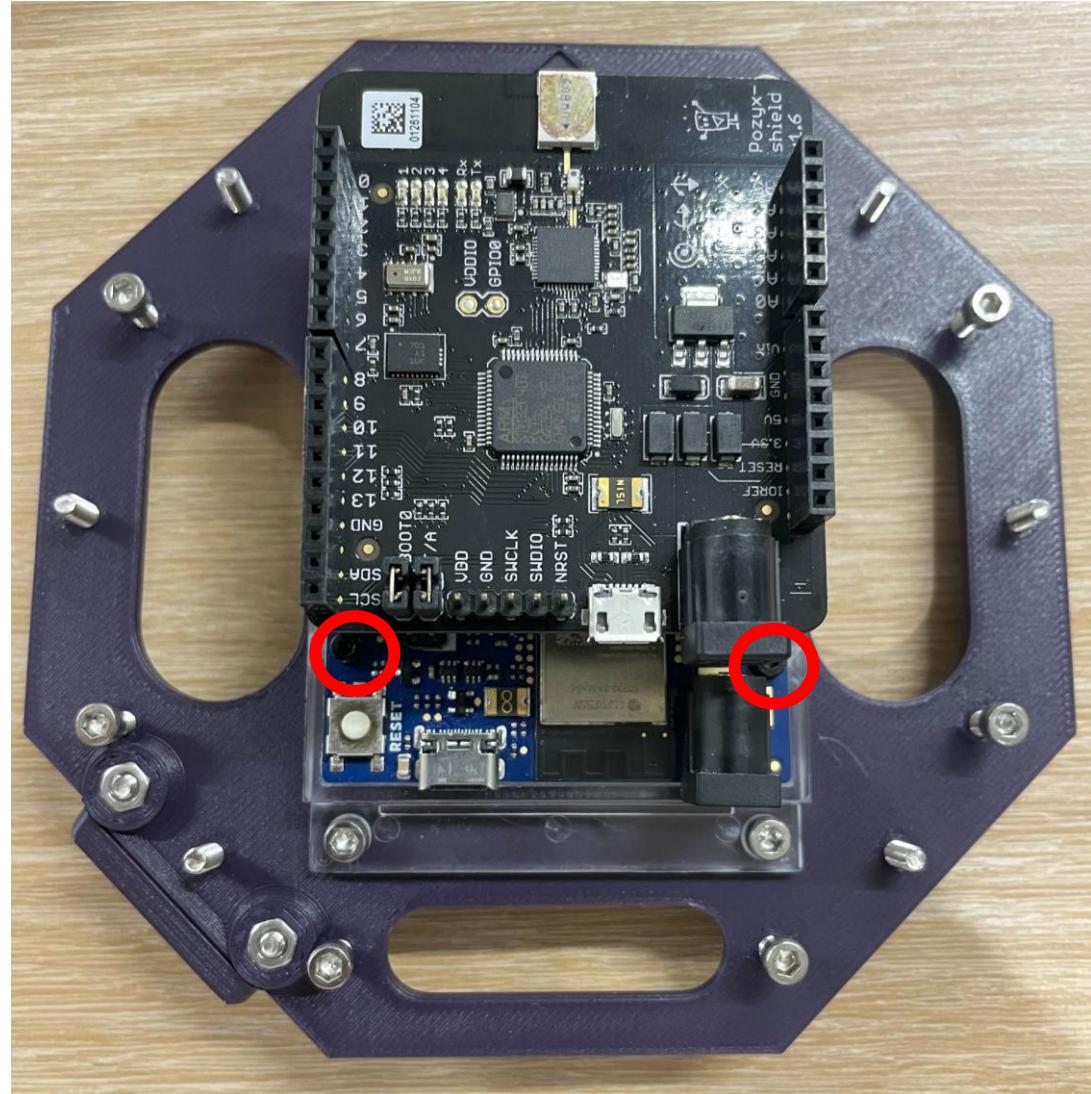
Adding the Arduino

- M3*8mm: 2
- The M3 bolts you will be adding are for the holes in the Arduino case, as shown in the image
- Don't overtighten - the plastic can snap



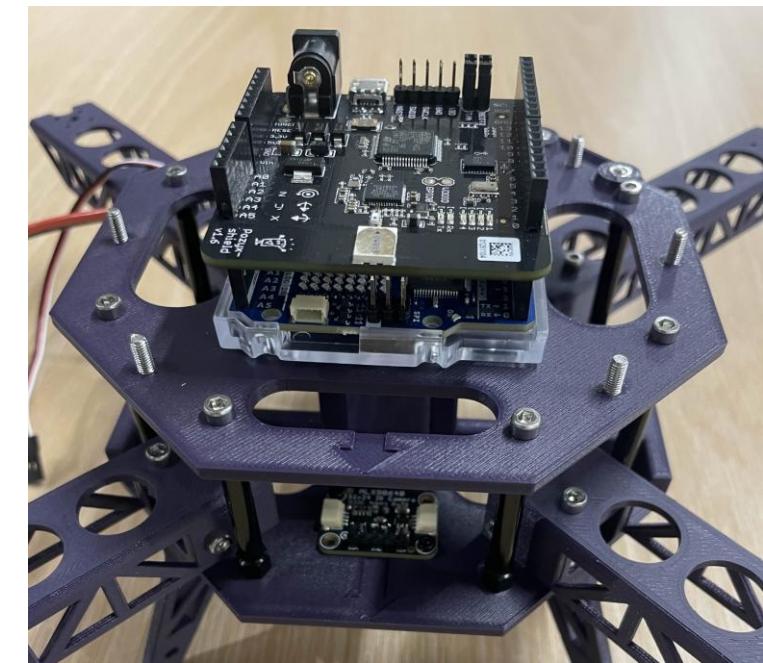
Adding the Arduino

- M2*12mm: 2
- Add the M2*12mm bolts in the locations shown on the image
- **WARNING:** Make sure not to over tighten - you will crack the Arduino



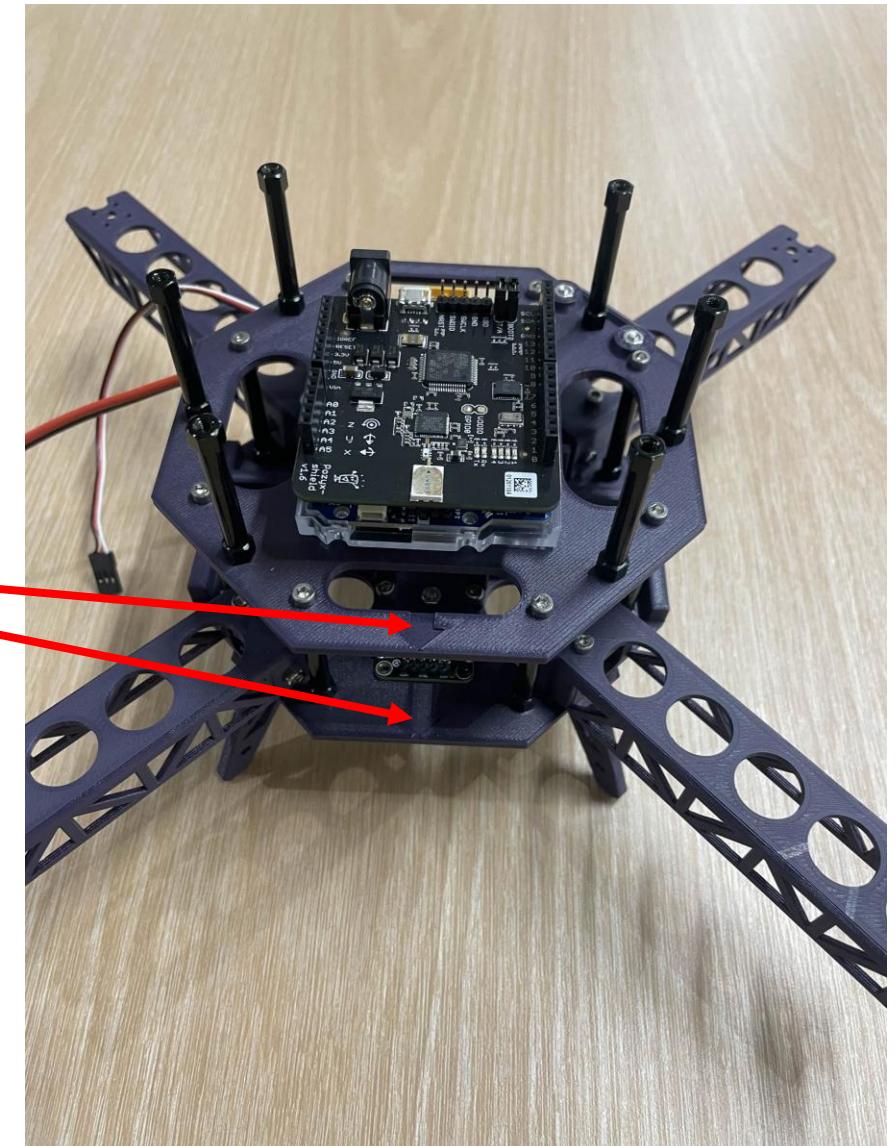
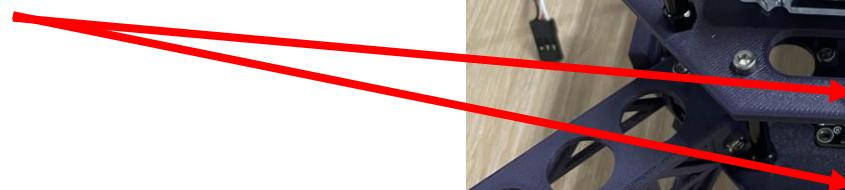
Stacking the Top_Plate and Baseplate.

- Align the tips of the bolts on the Top_Plate with the 40mm spacers on the baseplate
- Screw in the bolts all the way



Add Spacers to Top_Plate

- 40mm spacers: 6
- Make sure the arrows of the different levels line up
- Hand screw and tighten the 40mm spacers into the upward facing



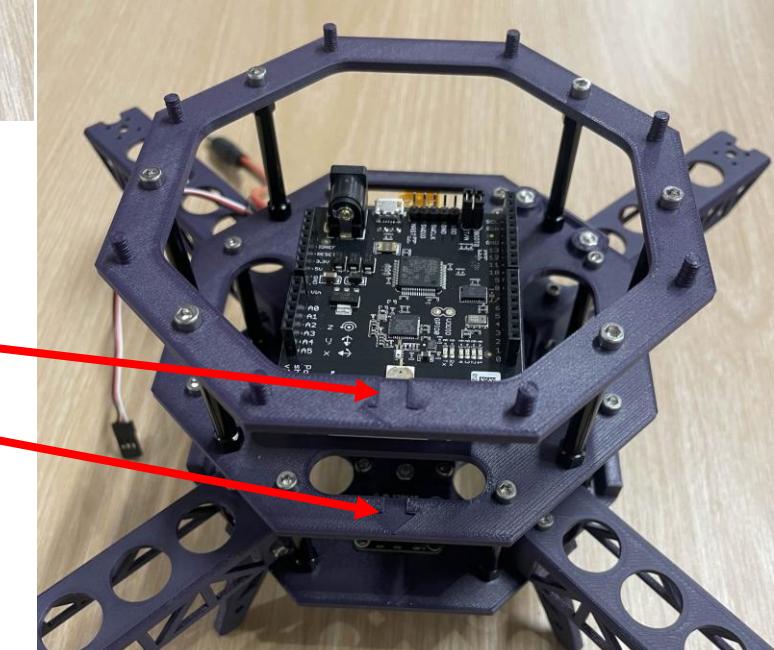
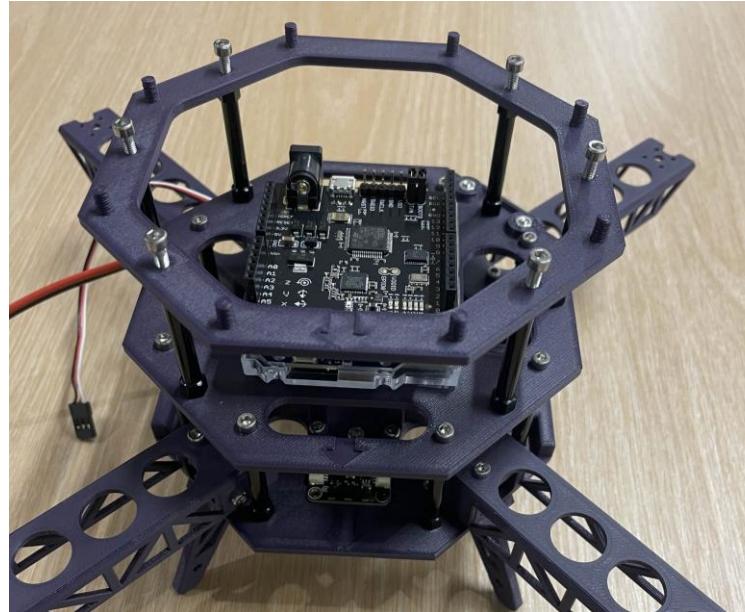
Prep Shield

- M3*10mm: 6
- Make sure the bolts are facing the same way as in the picture. They should be pointing down. Make sure only about 1mm is poking out of the bottom



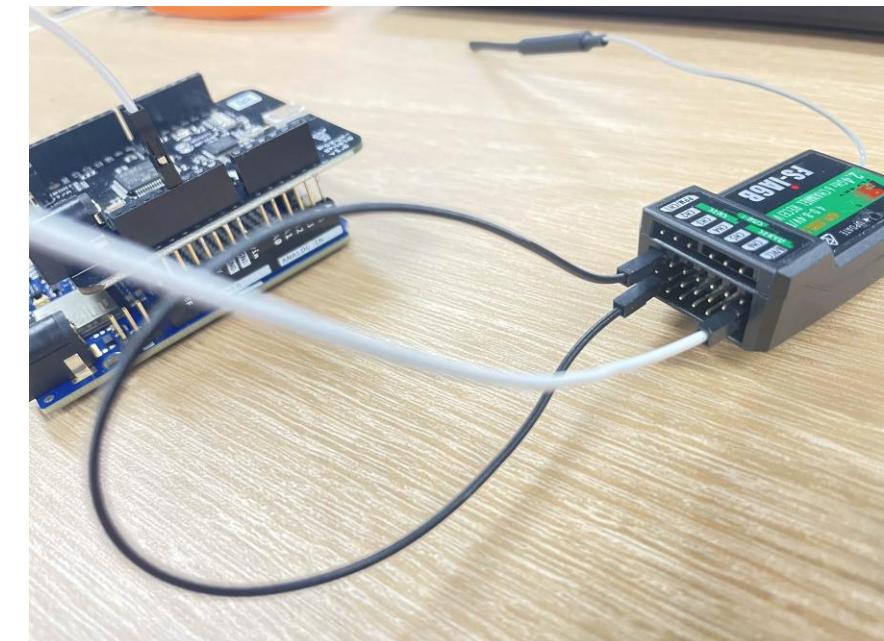
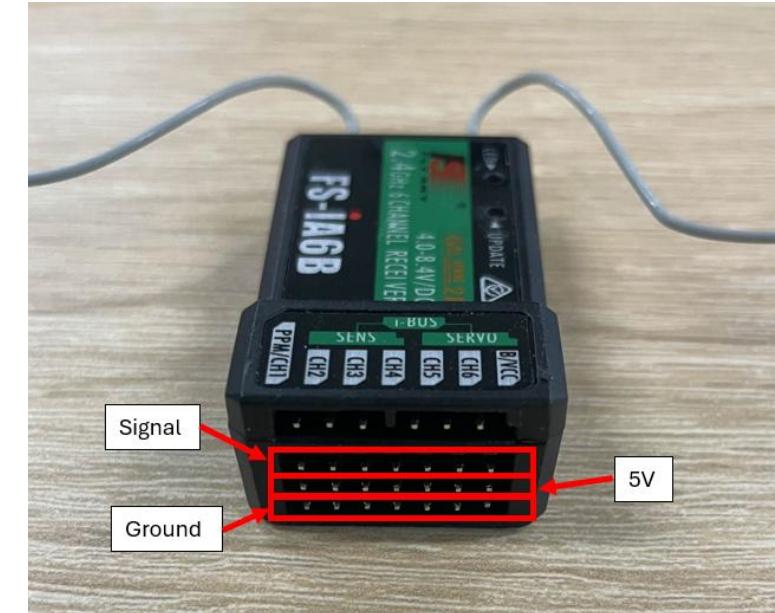
Connect Shield

- Line up the screws with the spacer holes
- Make sure the arrows line up on the different levels



Receiver Pairing

- Connecting the signal and ground pins and powering the 5V rail using the Arduino will allow the receiver to enter pairing mode
- Pair the controller you are using with the receiver now



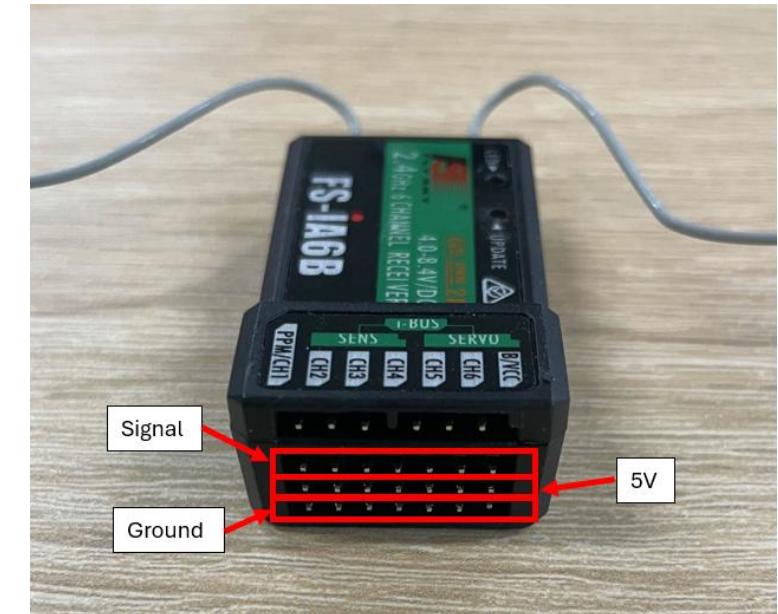
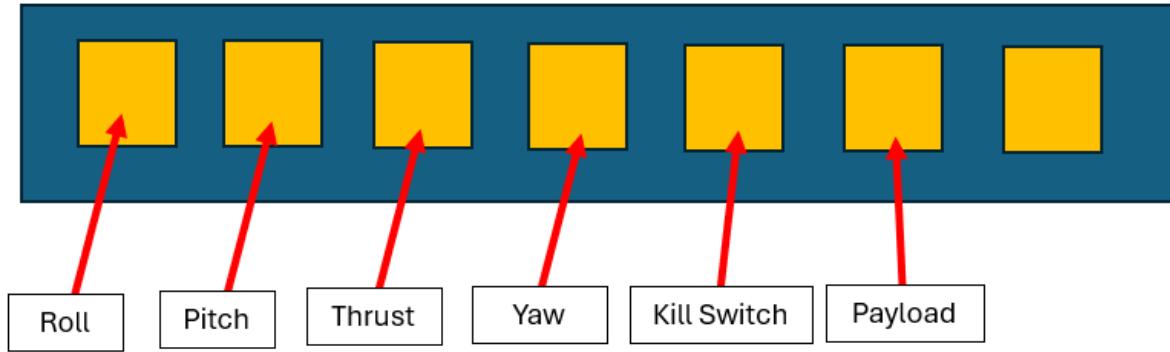
Add the Receiver

- Pass the receiver through the drone
- You will need to force the receiver through the holder. It will require a little bit of force, but should then slide easily into place



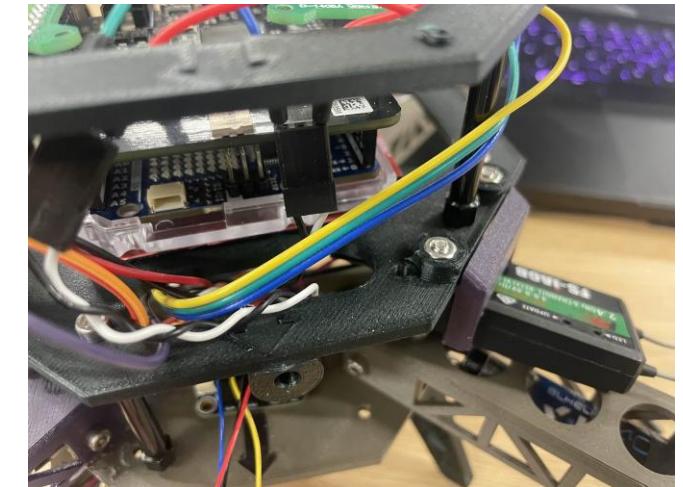
Wiring Receiver

- Attach female to male wires into the signal rail of the receiver
- Take note of what each pin represents. This will be used when wiring the Arduino
- Also add a female to male wire to the 5V and ground rail



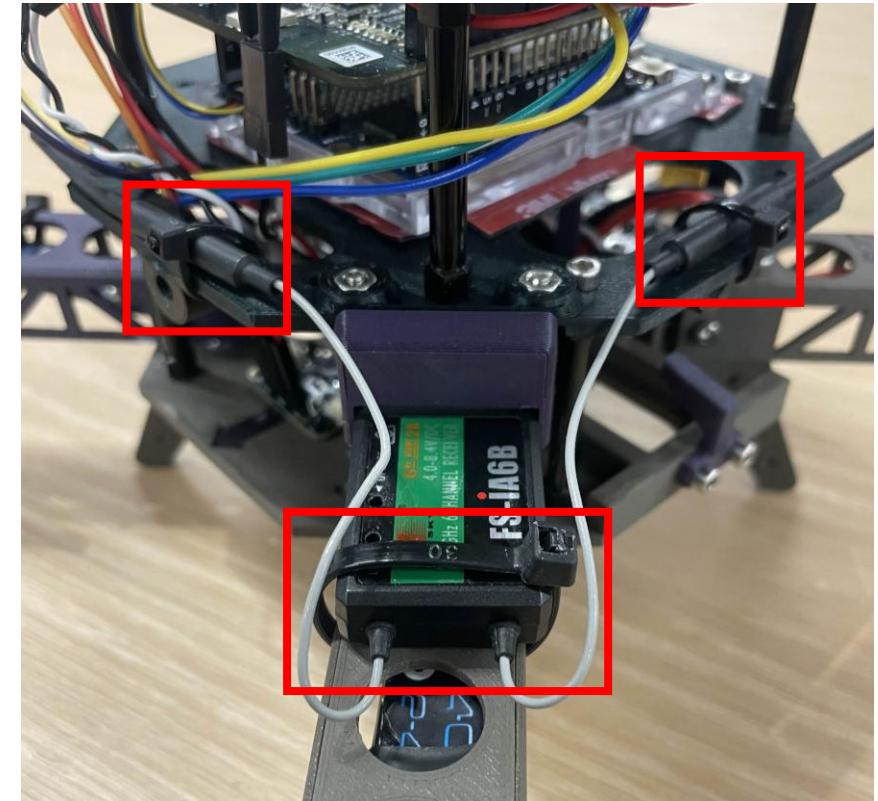
Wiring of Receiver

- To the right is an image of a fully wired receiver
- Pass the wires, both the signal power and ground, up the nearest hole in the top plate. These will be connected to the Arduino later



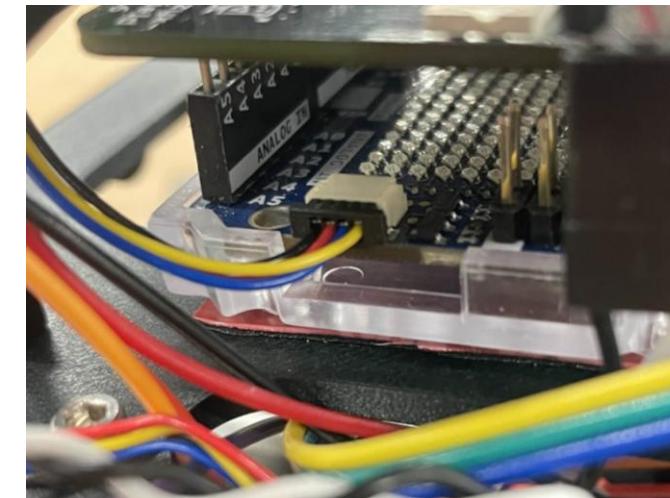
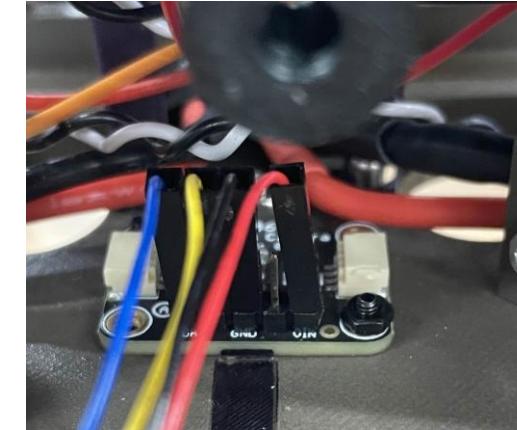
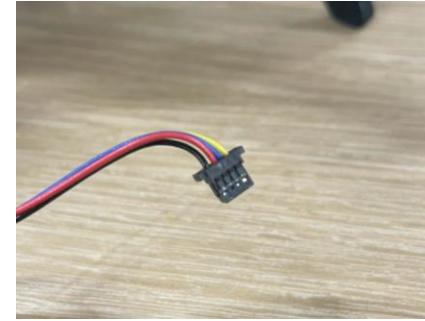
Tie Down the Receiver / Antenna

- Apply 3 zip ties in the locations shown
- The zip tie on the receiver itself should also be the zip tie that holds the ESC in place



Wiring Thermal Camera

- Take the I2C Cable, and connect the colored pins in the same spots is the image shown
- Pass the Arduino connection part of the wire through the nearest hole in the top plate
- Connect the wire to the Arduino in the location shown



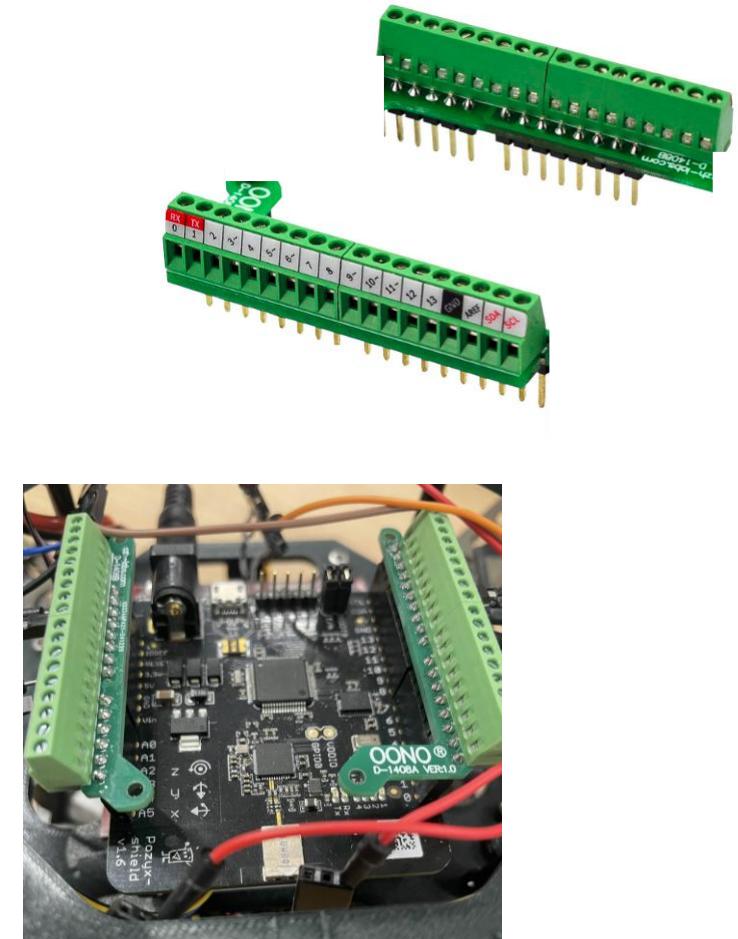
Create a Multi-Ground Cable

- Solder together a 5 male headed ground cable



Add Terminal Block to Arduino

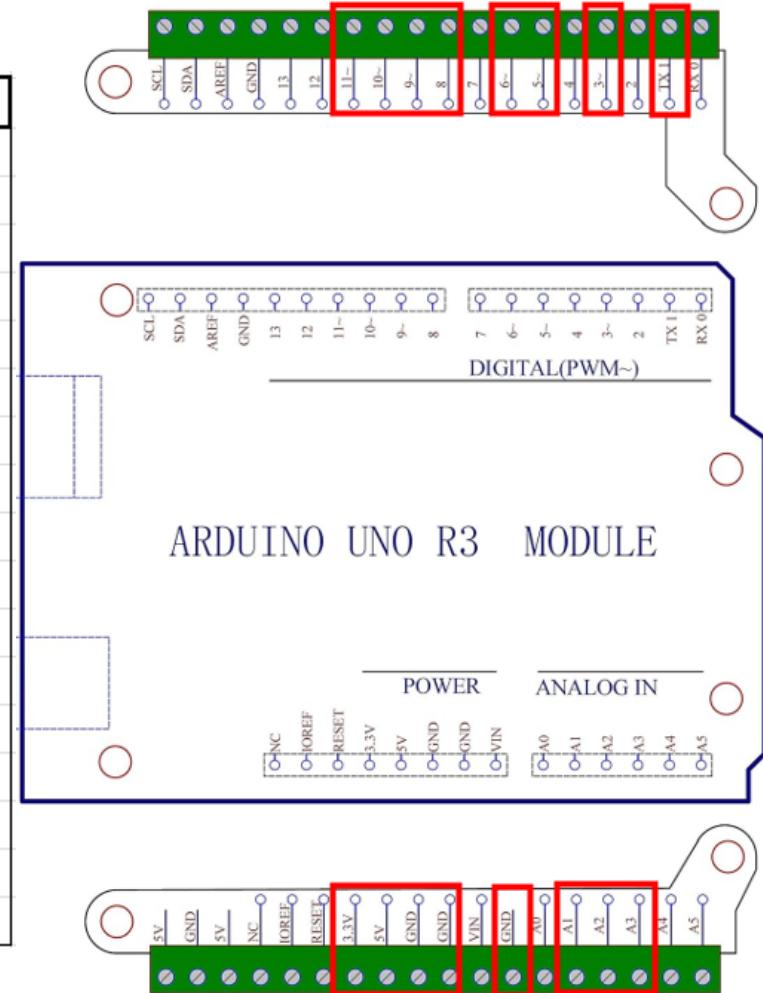
- Insert the terminal block into the Arduino
- This will allow for the pin connections to be solid and not fall out during flight



Connect Wires to Arduino

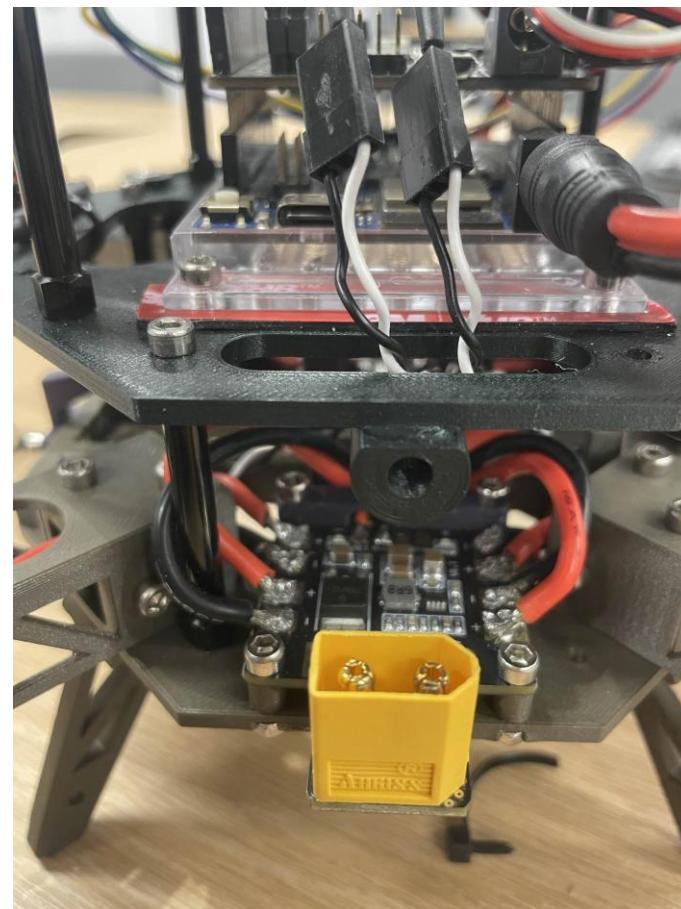
- Connect the appropriate wires using the table

Pin	Component	Purpose	Wire Type
1	Reciever	Payload	Male - Female
3	Motor 1	Signal	Male - Male
5	Motor 2	Signal	Male - Male
6	Reciever	Yaw	Male - Female
8	Reciever	Kill Switch	Male - Female
9	Motor 3	Signal	Male - Male
10	Motor 4	Signal	Male - Male
11	Servo	Signal	Male - Male
3.3V	Servo	Power	Male - Male
5V	Reciever	Power	Male - Female
Ground	Multi Ground Wire	Ground	Male - Male
Ground	Servo	Ground	Male - Male
Ground	Reciever	Ground	Male - Female
A1	Reciever	Roll	Male - Female
A2	Reciever	Pitch	Male - Female
A3	Reciever	Thrust	Male - Female



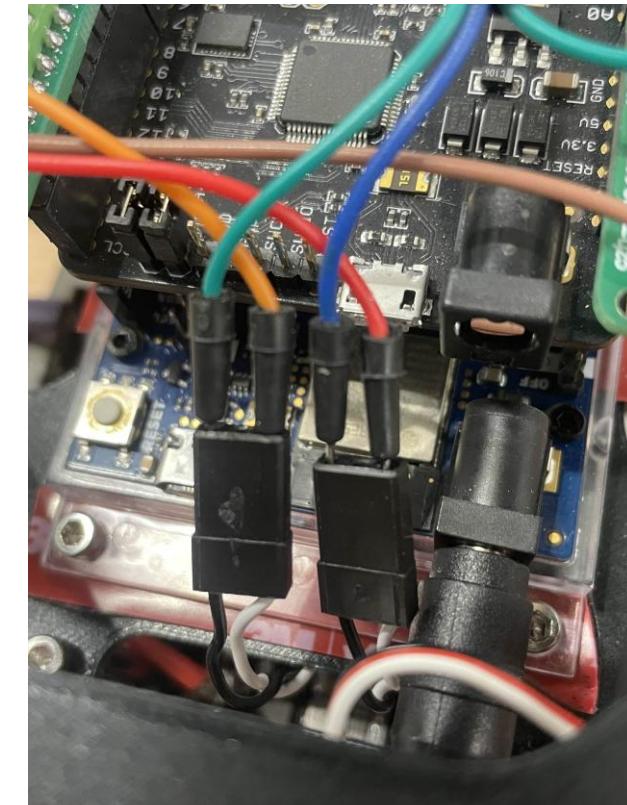
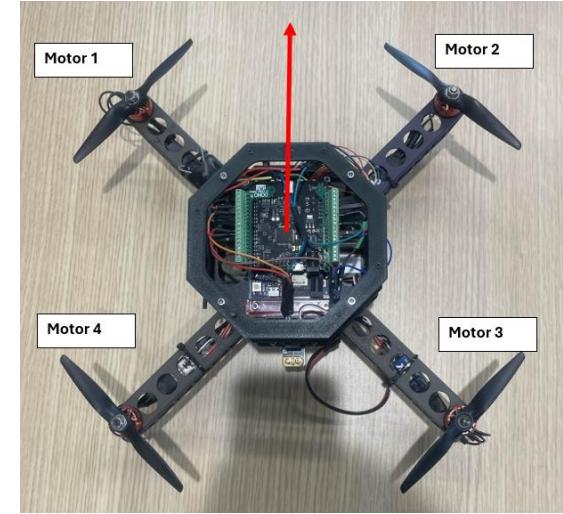
ESC Signal wires

- If you haven't done so already, pass the ESC signal wire up through the base plate



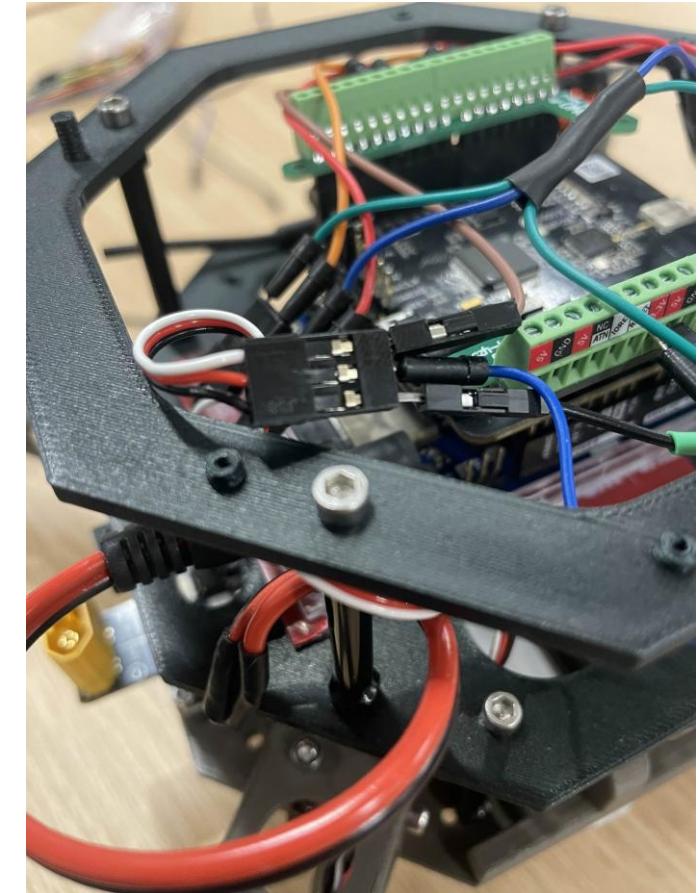
Connect ESC Signal Wires

- Using the picture in the top right corner, ensure the right ESC signal wire gets connected to the right wire. Double check take table two slides ago
- Attach the signal wire to the white wire from the ESC
- Attach the multi ground pin to the black wire from the ESC



Wire Up Servo

- Pass the servo wire from the payload up through the top plate
- Connect the ground wire to black
- Connect 3.3V to red
- Connect servo signal to white



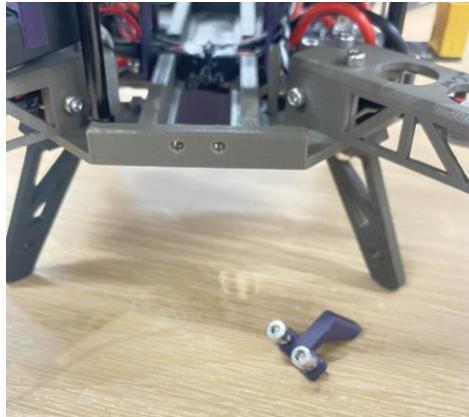
Set up Power Cable to Arduino

- Connect the 12V power cable to the Arduino as shown



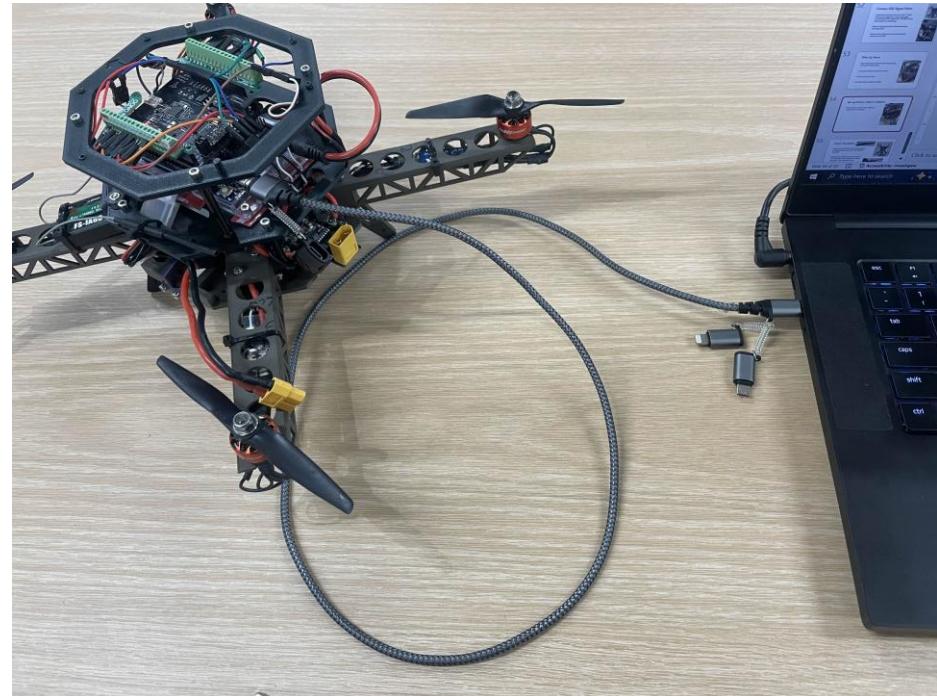
Insert Battery

- First remove the battery holder
- Insert the battery with the power cable facing right
- Slide the battery all the way in and place the voltage sense connector somewhere secure
- Reattach the battery holder

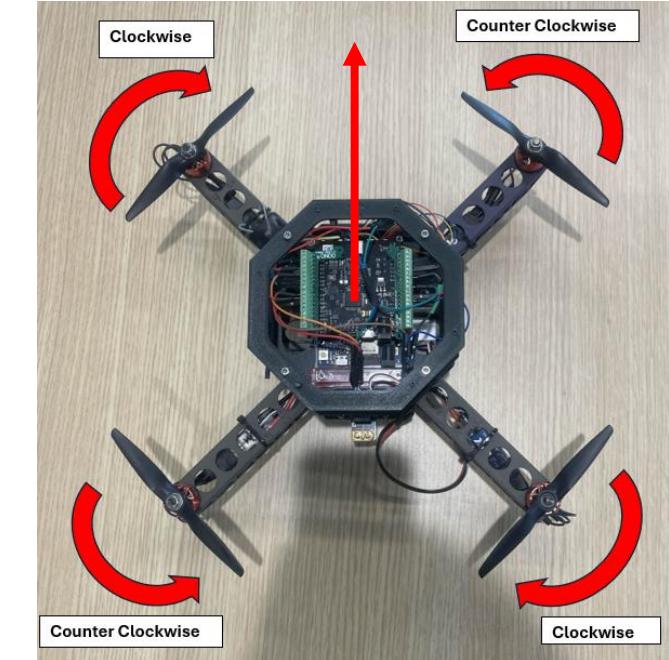


Upload Code

- Connect the type C cord to the Arduino and attach the other end to your computer
- Upload the “Fire_Fighters_MANUAL_FLIGHT_Drone_Code” to the drone



Attach Propellers



- Attach the 2 CCW and 2 CW propellers to the drone as shown in the image to the right
- Tighten down the motor nut until you can hold the motor and push on the propeller and it doesn't move.



How to Connect Battery

- Only when you are ready to connect the battery, as in you are in a safe place to do so incase something goes wrong, connect the battery like the image shown



Enjoy The Drone!

