

Kairos Micro Stack UAS Build Procedure

April 18 2024

Introduction

This document will walk through assembling a Kairos Micro Stack SUAS and all calibration steps required to get to a first flight test.



Parts List:

- 4 Propellers (2 CW 2 CCW)
- 4 Motors
- 1 Mission Controller
- 1 GPS Board
- 1 Telemetry Radio (Optional)
- 4 Single Motor ESCs
- 1 Quad ESC Hub
- 1 FRSKY Flight Radio
- 1 ESC Power Carrier
- 1 Motor Frame
- Assembly Screws Bag

Step 1:

Install motors on the frame.

Components:

- Motor Frame
- 16x 2mm screws and lock washers
- 4x motors



Tighten the screw until it is snug with no gap between screw, lock washer, and frame.



Repeat this step 3 times.

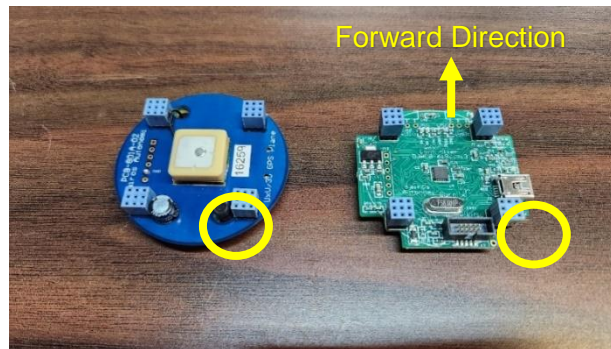


Step 2:

Assemble the upper stack

Components:

- GPS/Baro Board
- Mission Controller Board
- Telemetry Radio Board (Optional)



Each UxV board has one keyed connector. These keyed connectors must align when connecting two boards. These keyed connectors also help identify the forward direction as they signify the back right on a UxV/35 drone.

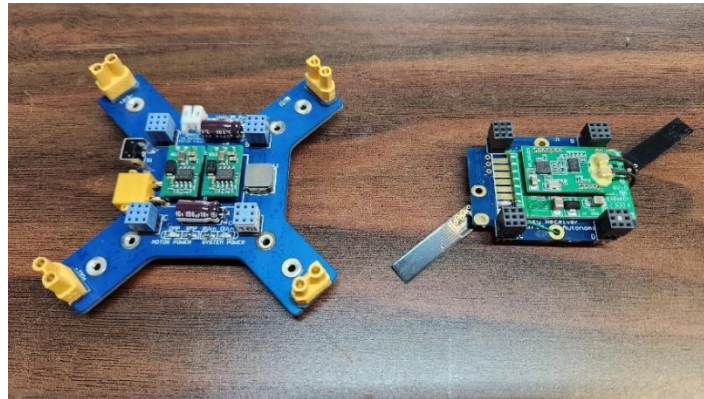
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Step 3:

Assemble the lower UxV stack.

Components:

- ESC Power Carrier Board
- FRSKY Flight Radio Board



Install the flight radio onto the carrier board after aligning the keyed UxV connectors.

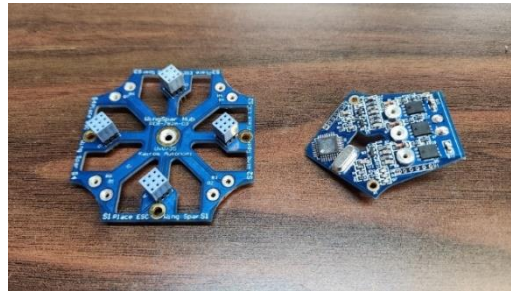


Step 4:

Assemble the ESC Hub.

Components:

- Quad ESC Hub
- 4x Single Motor ESCs
- 8x 2-56" by 1/8" Screws
- 8x Lock Washers
- 6-32" Nylon Screw



Install the ESC onto the hub in the shown orientation. Carefully press down onto the ESC to prevent damage to the UxV/35 connector.

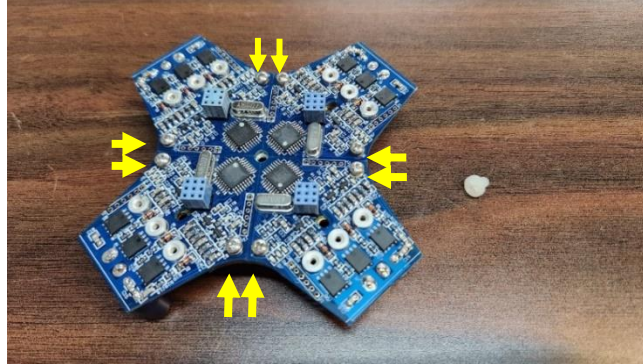


When complete, the ESC should fully contact the hub.

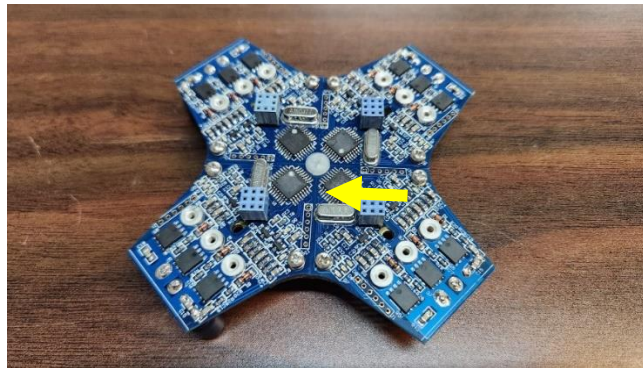
Repeat this step 4 more times.



Now begin installing the 8x 2-56" screws. Loosely install all 8 before tightening them down in a star pattern to keep the boards aligned.



Lastly, install the 6-32" nylon screw into the center location. Do not overtighten this screw as it will easily strip.



You should now have 4 main assemblies.

- Frame with motors
- Upper UxV stack
- Lower UxV stack
- ESC hub



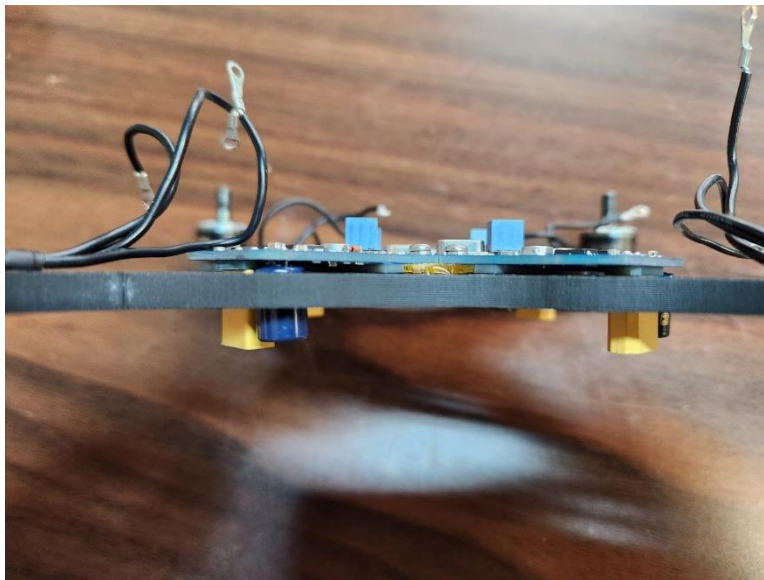
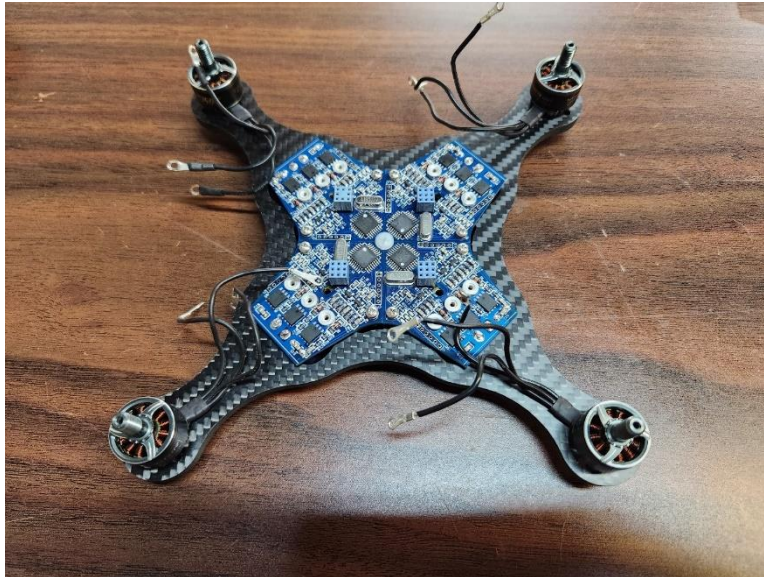
Step 5:

Install the ESC hub and Lower UxV stack around the frame.

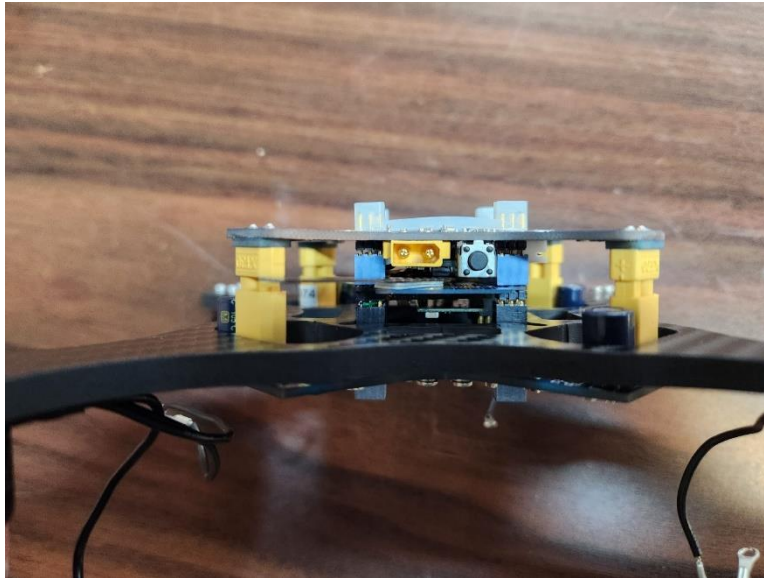
Components:

- Motor frame
- ESC hub
- Lower UxV stack

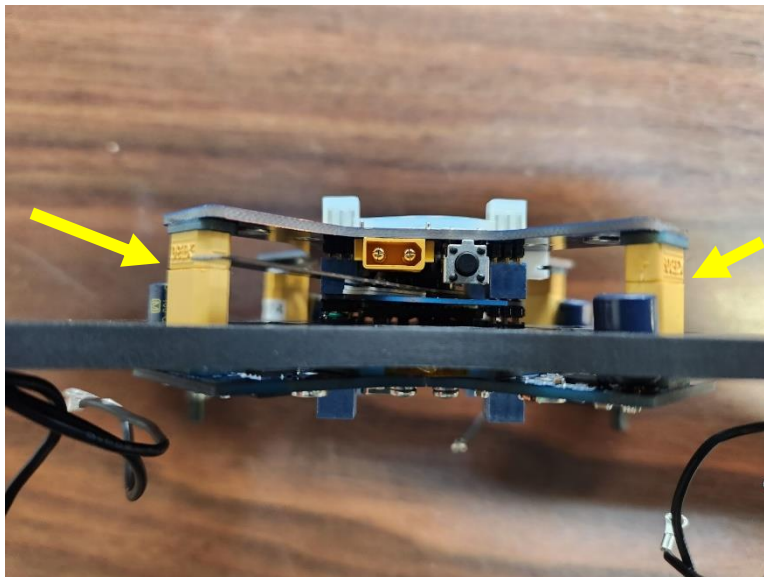
Begin by installing the ESC hub onto the motor frame.



Now install the lower UxV stack. Make sure to align the keyed connectors on the UxV boards. Begin by identifying that each connector is loosely aligned. Then slowly press the two stacks together keeping them as parallel as possible. If they are not connecting, check for any misaligned connectors or obstructions and do not force them together.

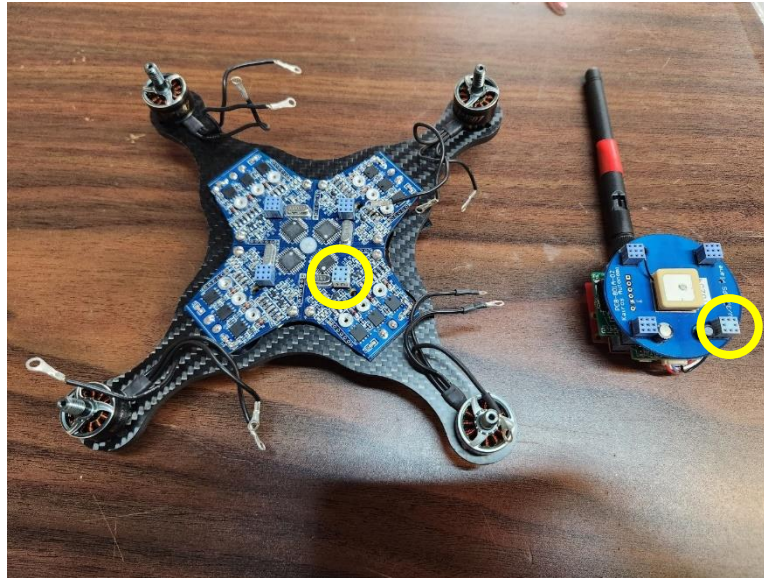


The 4 yellow xt30 connectors should be fully connected when done.

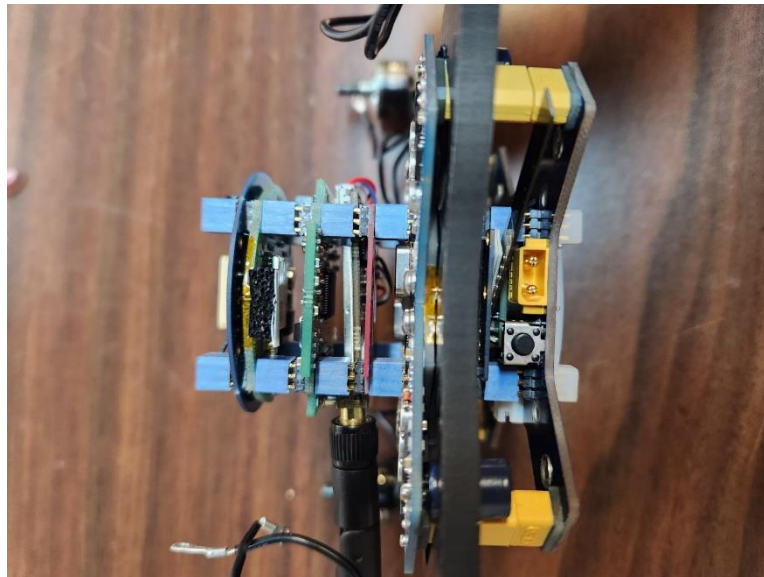


Step 6:

Install the upper stack. Once again, use the keyed connectors to determine the correct orientation.



Check that the full stack is connected. Each blue UxV connector should contact the PCB above.



Step 7:

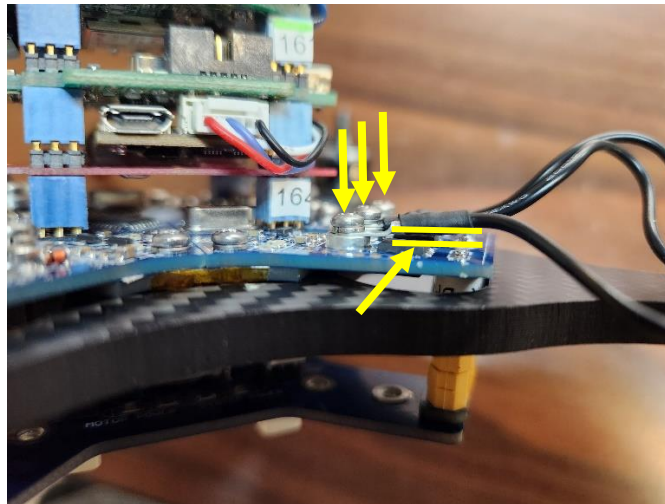
Install the motor wires onto their corresponding ESC.

Components:

- Assembled drone
- 12x 2-56" screws and lock washers

Locate the 3 mounting locations for the motor wires on the ESC. Using a locking washer with each screw, screw down the motor wires to the ESC. The order of the motor wires on the ESC does not matter at this time as we will test motor directions at a later step.

Make sure that there is a gap between the motor wire connector and ESC components after tightening. Carefully bend the motor wire connector up if it is contacting.



Step 8:

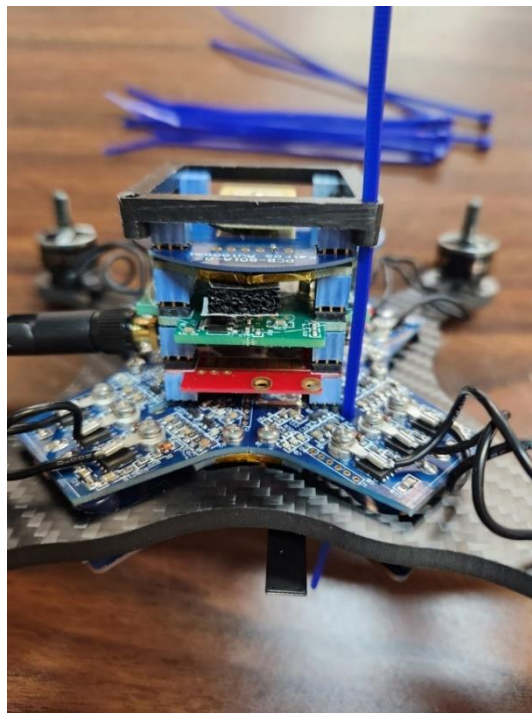
Secure the UxV full stack.

Components:

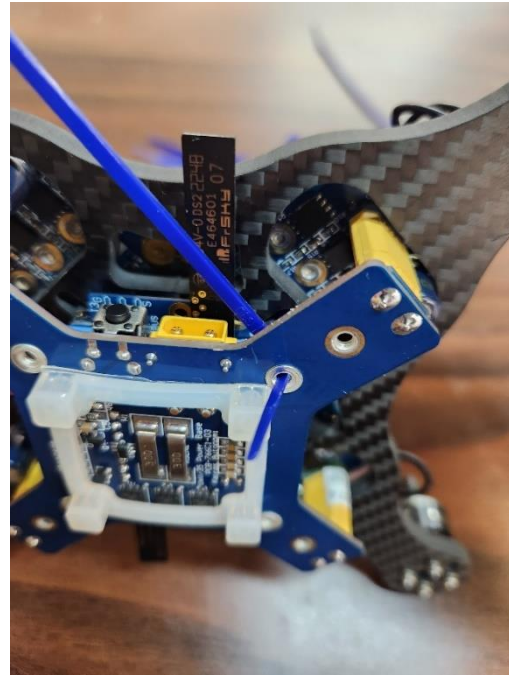
- Assembled drone
- 12x Zip ties
- UxV/35 Cage



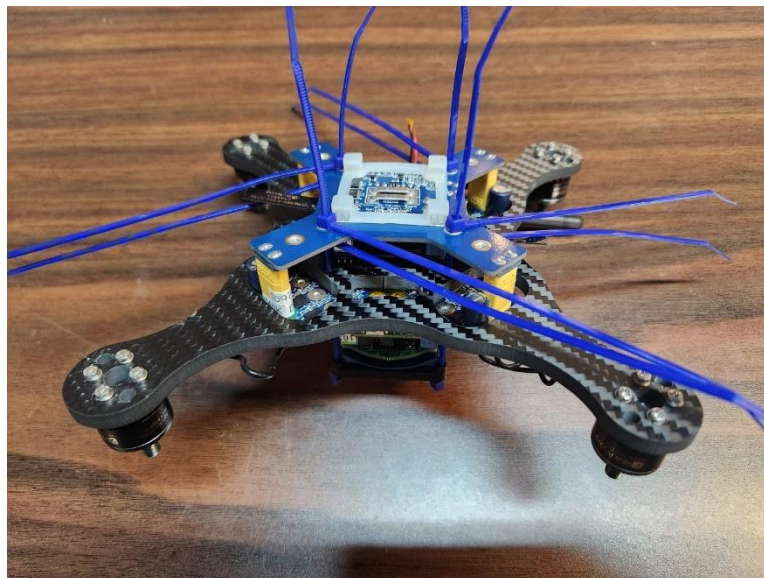
Place the cage on the top of the UxV stack and thread the first zip tie down the stack.



Between the motor frame and ESC power carrier board thread this zip tie through a second zip tie. This zip tie will secure the motor frame to the stack.

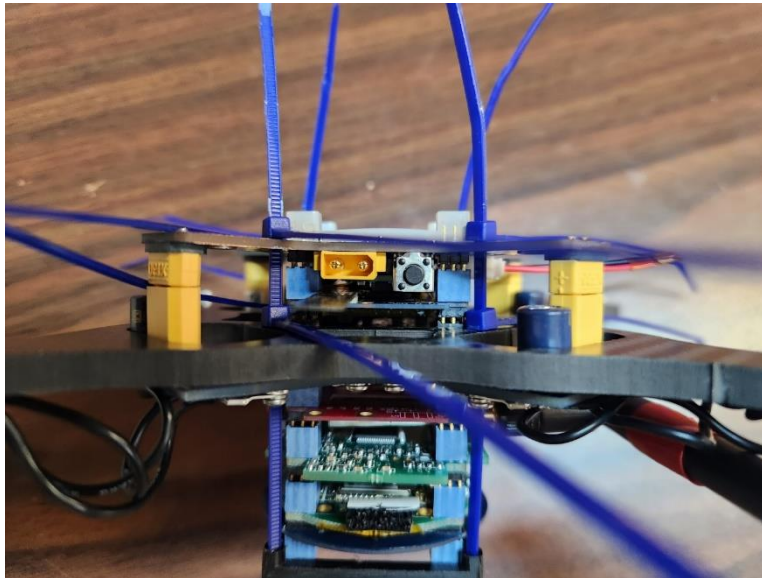


A third zip tie on the bottom of the ESC power carrier board will secure the full stack together. Repeat this step for the 3 remaining corners of the UxV cage.

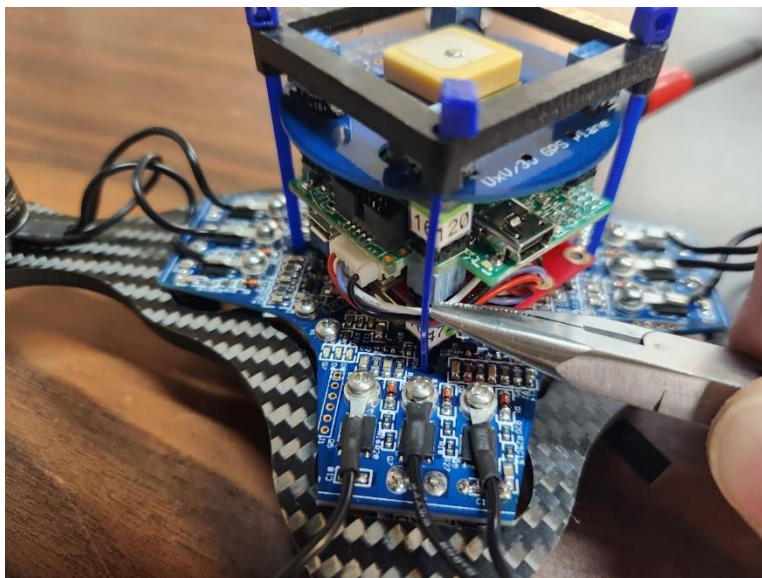


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Once all 4 corners are complete, begin tightening down the zip ties.



These zip ties are not expected to be very tight. Do not attempt to overly tighten them as this could damage the UxV connectors. The primary purpose of the zip ties and cage are to keep the UxV stack together in aggressive flight and a potential crash. Trim off the excess from all zip ties.



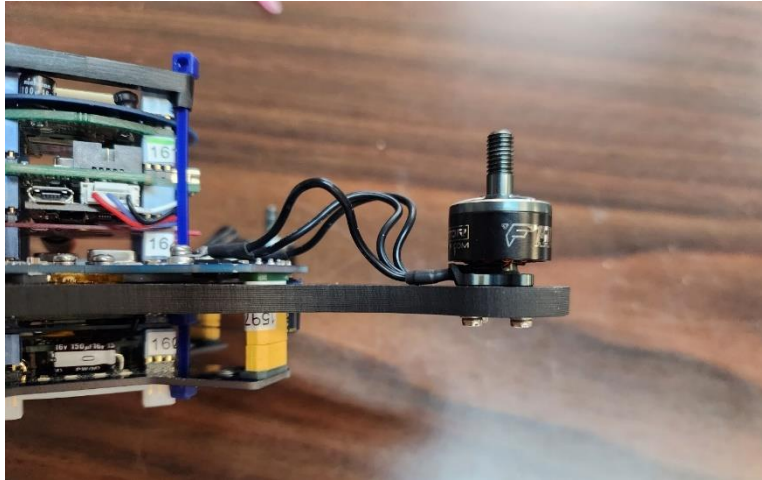
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Step 9:

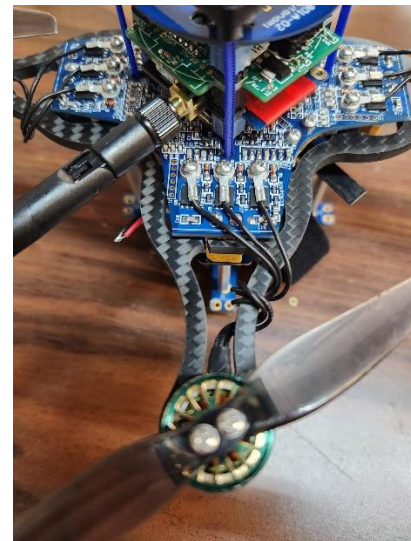
Secure any loose motor wires.

Components:

- Drone
- Electrical tape



Loose motor wires have the risk of contacting the propeller when flying. Shown above is an example of too much slack in the wires. Tape these down using electrical tape or wrap the motor wires around the frame arm if possible.



The drone is now ready to power up and connect to ArduPilot Mission Planner.

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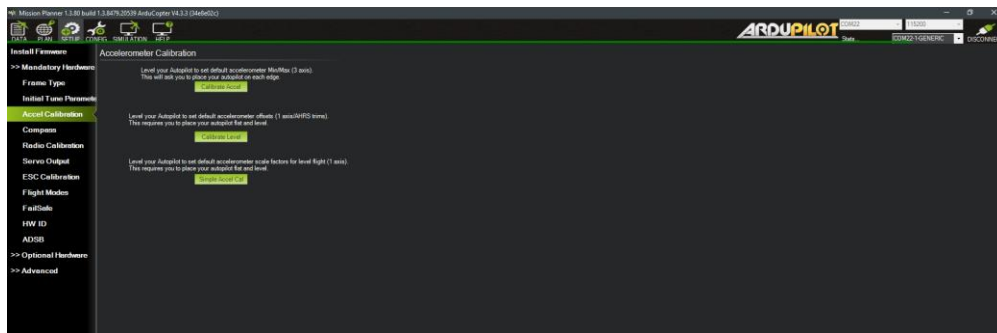
Step 10:

Complete the calibration steps and confirm motor direction.

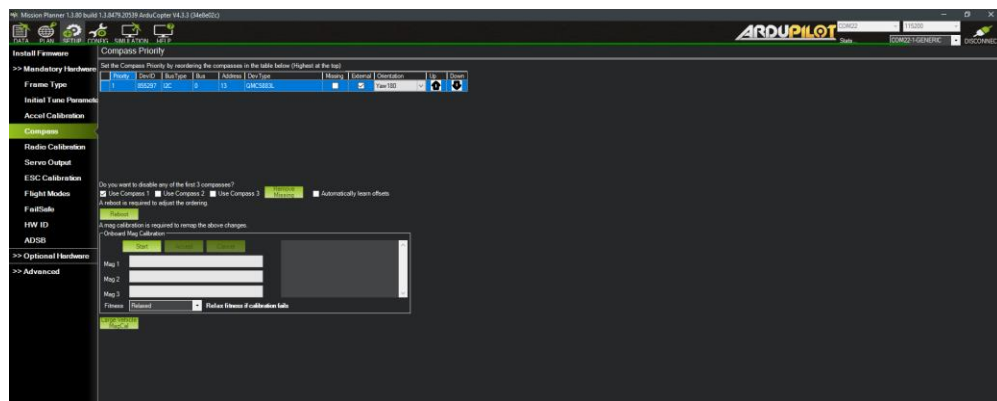
Components:

- Drone
- 4s LiPO Battery with an XT30 connector or XT30 to XT60 adapter cable
- Computer with Ardupilot Mission Planner

Navigate to Setup>Mandatory Hardware>Accel Calibration. Select Calibrate Accel and follow its instructions to calibrate the accelerometer in each orientation. After completing, place the drone on a level table and select “Calibrate Level”.



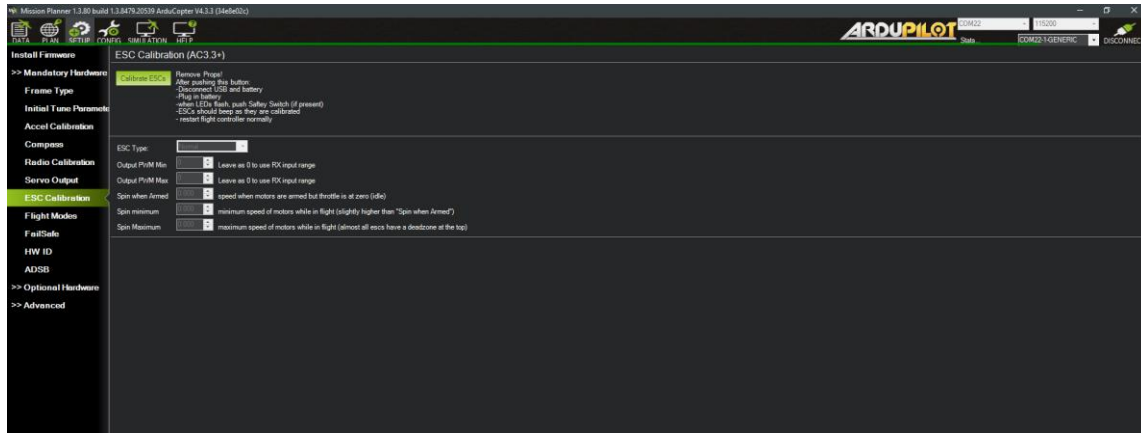
Navigate to Setup>Mandatory Hardware>Compass. Select “Start” in Onboard Mag Calibration. Pick up the drone and battery and begin spinning the drone in different orientations until the progress bar reaches 100%.



Navigate to Setup>Mandatory Hardware>ESC Calibration. Select “Calibrate ESCs” and follow the instructions.

- Disconnect USB cable and battery
- Plug in battery and power on the drone

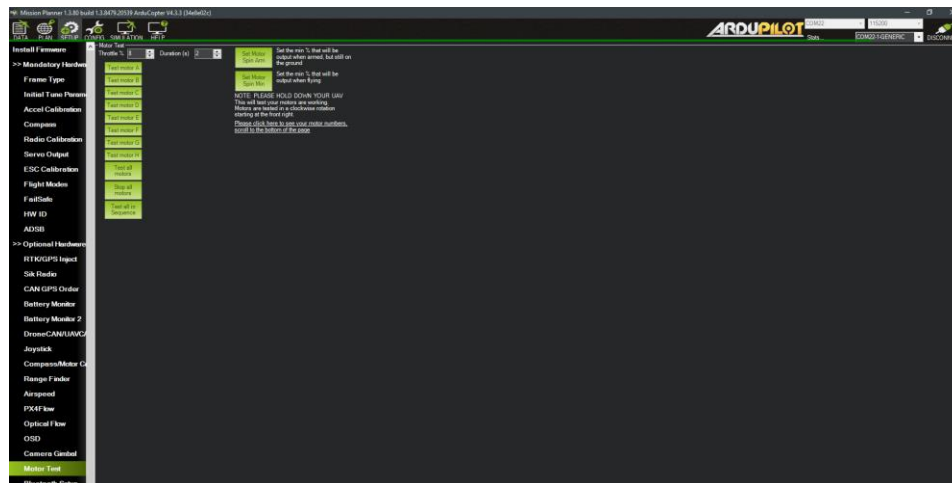
- Wait up to 1 minute as the ESCs calibrate. You will hear tones from the drone as this happens.
- Restart the drone using the power switch.



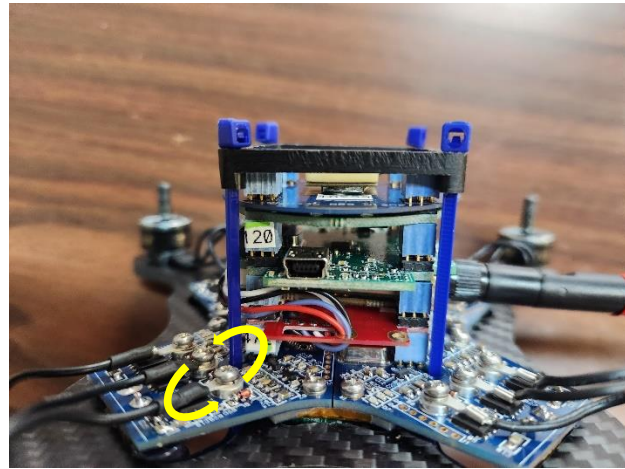
Reconnect the drone to Mission planner and navigate to the Motor Test page under Setup>Optional Hardware>Motor Test. Increase the Throttle % up to 10% and leave the duration at 2 seconds. Now test each motor A through D.

When you select “Test motor A”, the front right motor will spin up. Check that this motor (Motor A) spins in the counter clockwise direction shown in the image below. Repeat this test for B through D noting down any motor that does not spin in the direction listed here:

- Motor A – counter clockwise
- Motor B – clockwise
- Motor C – counter clockwise
- Motor D - clockwise



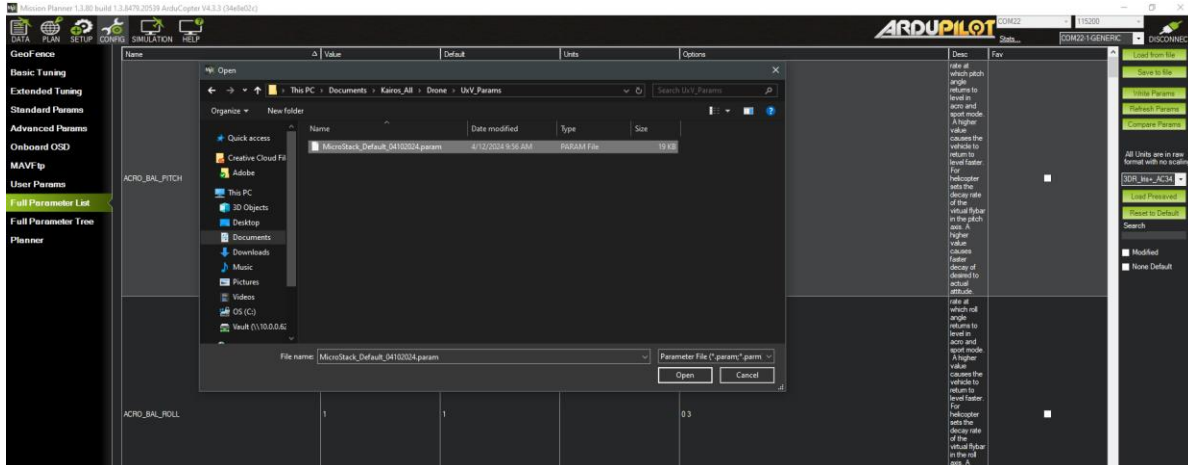
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If any motor needs their direction flipped, first power off the drone and disconnect the battery. Then take any two motor wires, remove the screws and swap their locations on the ESC making sure to retighten the screws with a lock washer.

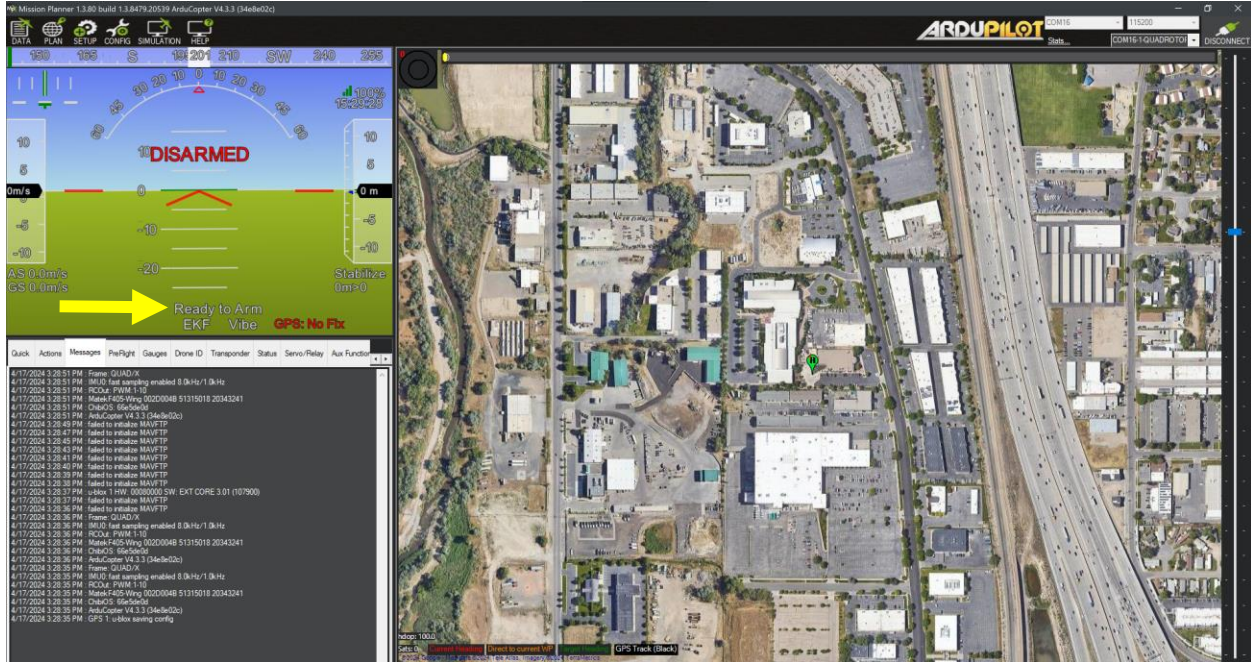
After swapping wires for all incorrect motors, power on the drone with the battery and reconnect to Mission Planner. Run the Motor Test again to confirm that all motors are now spinning in the correct direction.

The final step is to load our configuration file for the drone. Navigate to Config>Full Parameter List>Load From File. Select the file we have provided from the file explorer and select open. Select Write Params and confirm that the status window say that the write was successful.



After rebooting the drone using the power switch, reconnect to Mission Planner and the Data window should state "Ready to Arm" in the bottom center.

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Step 11:

Install the propellers.

Components:

- Assembled and calibrated drone
- 2x clockwise (CW) propellers and 2x counter clockwise propellers (CCW)

A propellers direction can be identified by the pitch. The leading edge of the propeller will be higher than the trailing edge which allows it to create lift in the upwards direction.



After installing propellers, the drone is ready for a flight test. A drone should always be hand flown in stabilize mode before attempting any missions.

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Version History

Date and Signature	Revisions	Reasons for Revision
04/18/2024 Jack R.	Document was written. (v01.00.00)	
04/22/2024 Jack R.	Document was updated. (v01.00.01)	Updated formatting
6/20/2024 Joyce C	v 2	Updated formatting



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