UxV/35 Hexacopter Application Notes

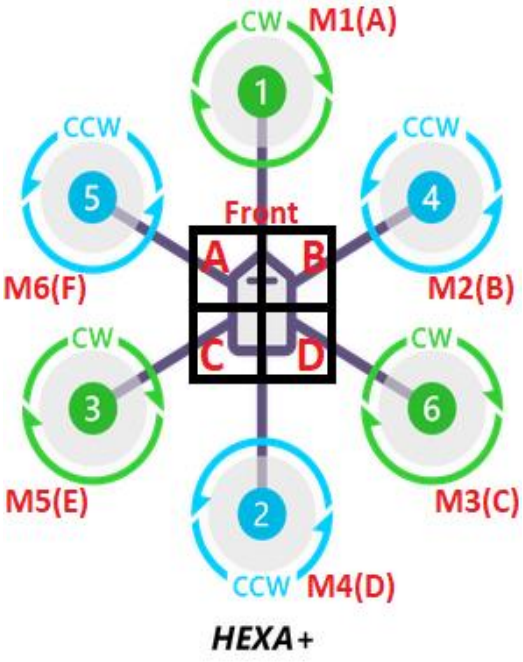
Summary

This document will summarize the process of building a UxV/35 based hexacopter, a multirotor featuring six total motors. The unique aspects of constructing a UxV/35 hexacopter such as components, assembly and programming will be emphasized. While this document will feature a micro-hexacopter aircraft as an example, keep in mind that the information provided in this document can apply to UxV/35 hexacopters of any size as long as the arrangement of key components remains the same.

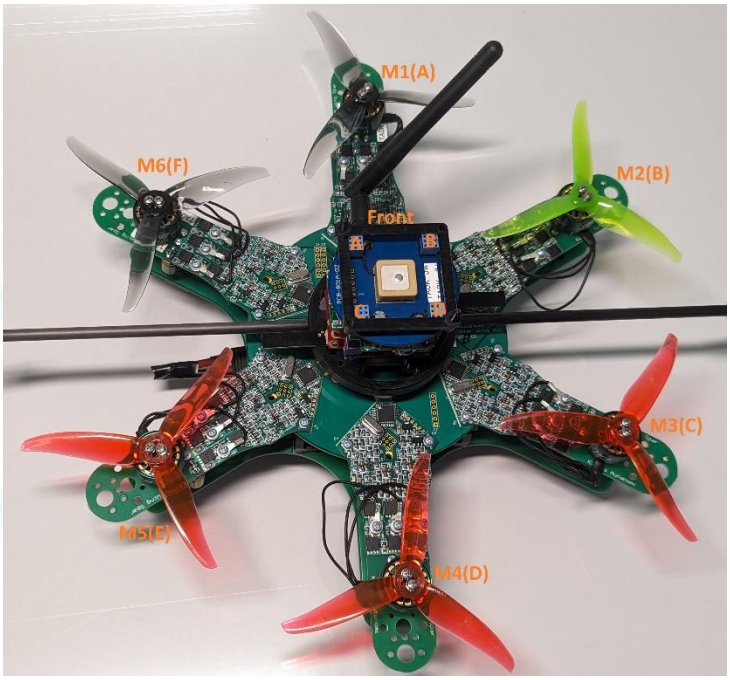
Key Information

Layout

Flight tested UxV/35 Hexacopters have utilized the HEXA+ layout of motors.
The role of labels found below will be explained in detail within following sections.



Hexa+ Frame Type



Flight Tested UxV/35 Microhexacopter

<u>The following elements of any hexacopter built using this document must match the photo</u>:

1. Frame Type (HEXA+)
2. Motor signal order (M1=1, M2=4, M3=6…)
3. Motor spin direction
4. UxV/35 stack orientation

Example Build Process – UxV/35 Micro Hexacopter

The following steps will guide the reader through the assembly and configuration of the UxV/35 Micro Hexacopter. This example hexacopter utilizes specific UxV/35 components with integrated frame, 18650 battery holders and flight basket gimbal system in order to simplify the construction of a flight ready aircraft.

UxV/35 Components

Part Number	Component Name	Quantity
KA1004-01	UxV/35 Multi-Const. GPS, Baro, Comp	1
KA1003-01	UxV/35 STM32F4 Mission Controller	1
KA1094-01	UxV/35 ESC Bridge	1
KA1079-01	UxV/35 915 Mhz Telemetry Radio	1
KA961-01	UxV/35 FRSKY Flight Radio	1
KA970-01	UxV/35 Flight Basket #1 Axis Gimbal	1
KA1043-01	UxV/35 Double Height	1
PCB-794A-01	UxV/35 Hexacopter Battery Wing	1
PCB-795B-01	UxV/35 Hexacopter Wing Hub	1

3rd Party Components

Function	Component Name	Quantity
Motor	Toka 1408 4100kV	6
Propeller	Propellers (3 CW, 3 CCW) 4in. diameter	6
18650 Battery	Molicel P28B	8

Note: this document does not propose that the above motor and prop combination is optimal for this or other hexacopter aircraft. Future revisions will include guidance about selecting motor and prop combinations that best fit the size and weight of your aircraft.

Hardware Components

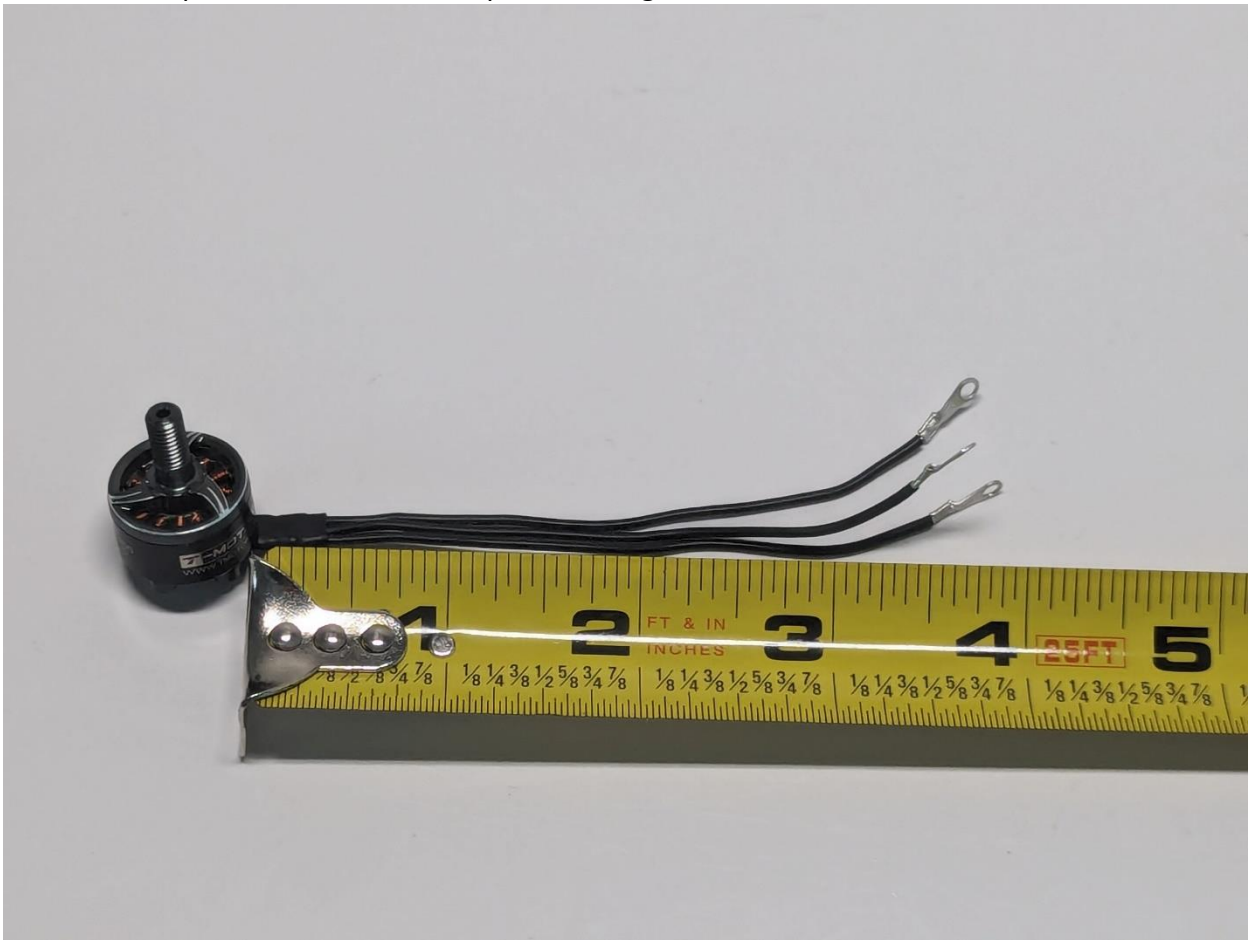
Part Name	Component Name	Quantity
MCH-014792	Delrin Cage	1
CON-827	2-56 Ring Lug (Motor Wire Tongue)	18
CON-516	6-32 x 3/16 Nylon Pan Head	6
CON-1287	2-56 x 3/16 Pan Head W/Locking Tooth	30
HRD 1181	4-40 Nylon Screw	2
HRD 1182	4-40 Threaded Rod (~4.5 in.)	2
HRD-1149	M2 4mm Length Pan Head Screw	24
HRD-1150	M2 Split Lock Washer	24
PLS-058	Pin Protector	1

Hardware Preparation

This step preps the ESC Hub assembly, as well as the motors themselves for stacking.

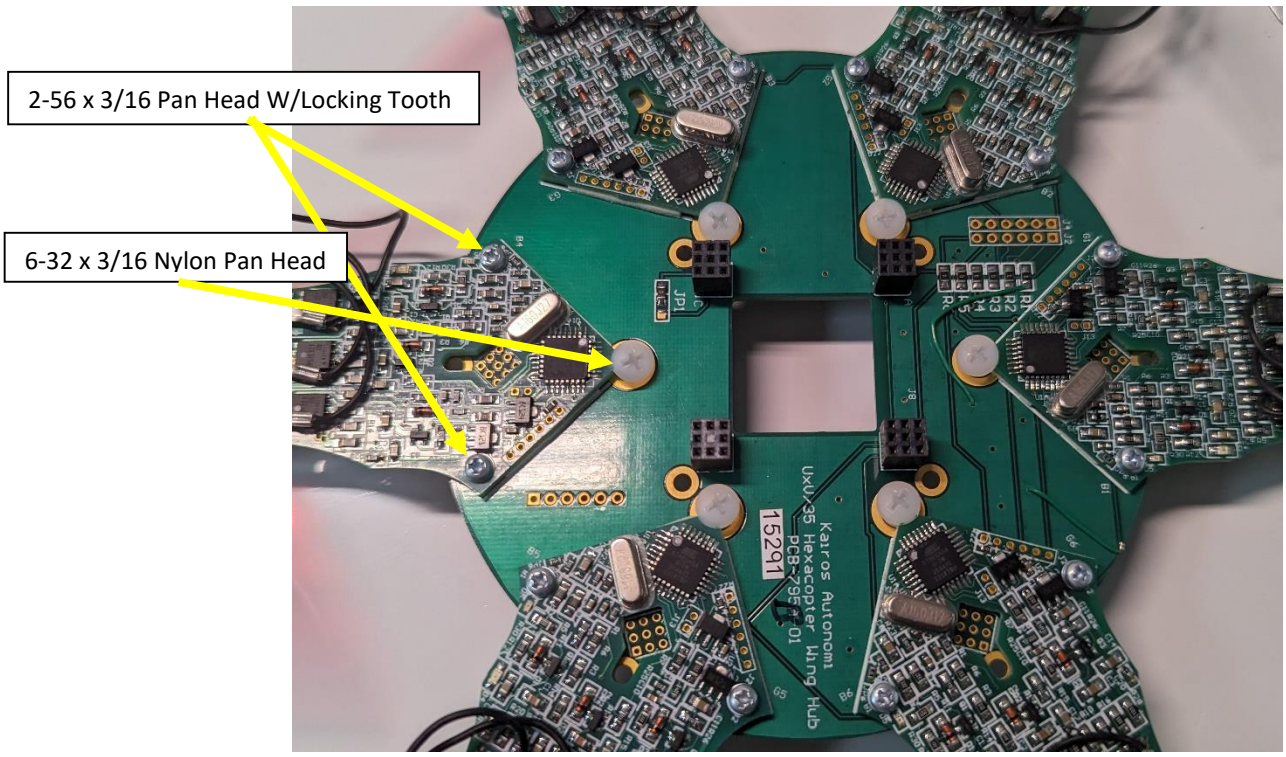
Motor Preparation

The motors must be prepared such that they can be used with the UxV/35 ESC bridge. This requires terminating each of their three wires using a CON-827 2-56 Ring Lug. For use with the Micro Hexacopter, the wires are crimped to a length of ~4 inches as shown below.



ESC Hub assembly

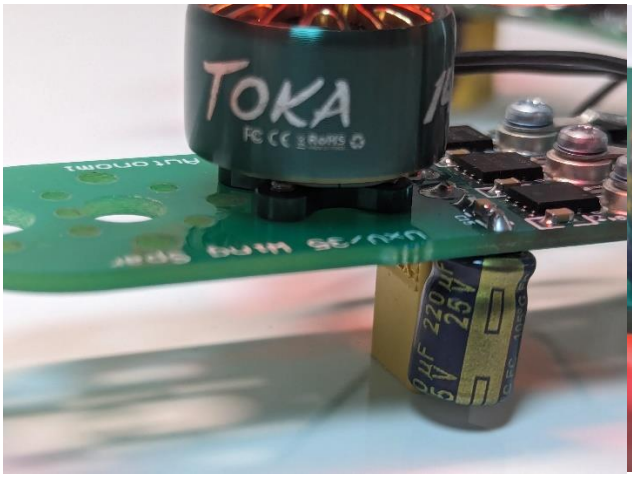
Mount the six total UxV/35 ESC Bridge components to the Hexacopter Wing Hub. Shown Below.



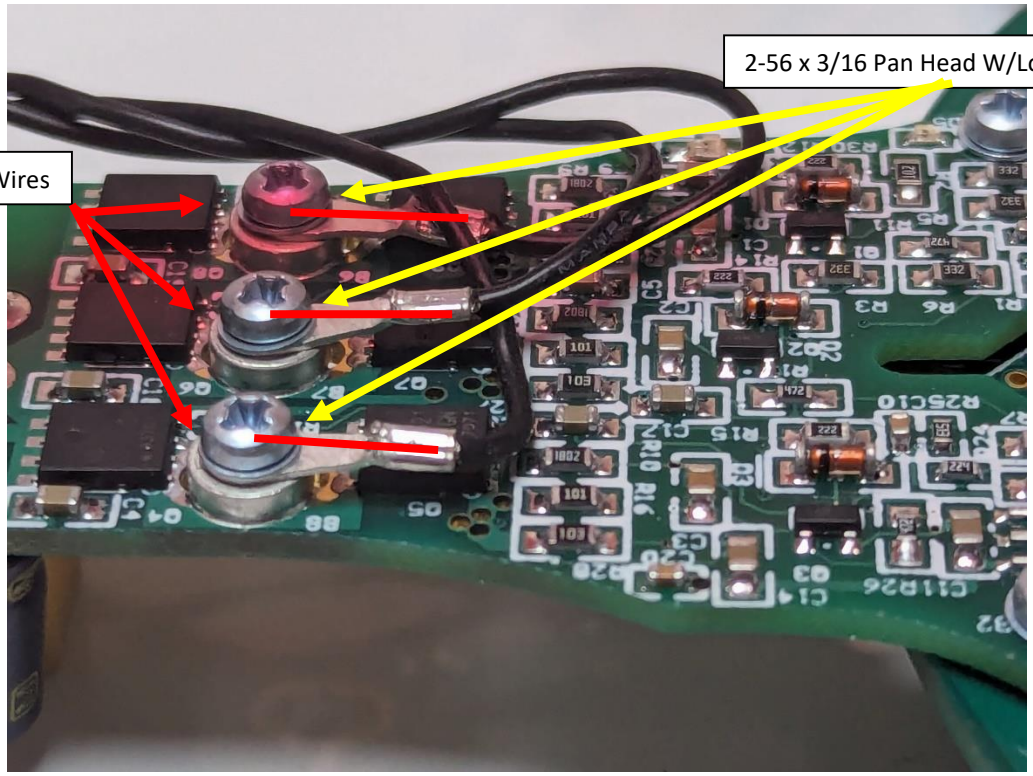
The assembled Wing Hub with all ESC Bridge present is shown above. Note that all screws are present and fully hand tightened.

Motor Mounting

The Motors must be mounted to the ESC bridge, and motor wires secured to the motor wire terminals of each ESC bridge.



The positioning of motors on the frame will vary. Changes in the motor, prop or stack ordering may result in the position of the motor along the ESC bridge to change.

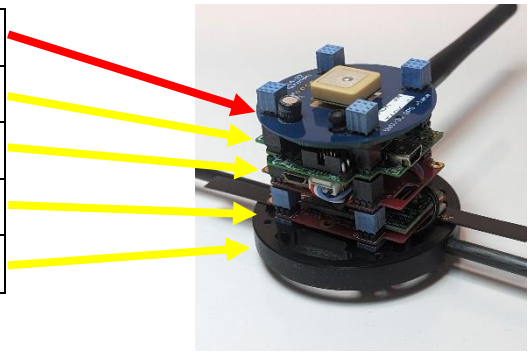


With motors mounted to the ESC bridge, secure the motor wires to the ESC bridge. Note that all three motor wires are exactly parallel, ensuring there is no chance of contact.

Flight Systems Stack

The electronics that control the aircraft can now be stacked together. This will require the GPS, Mission Controller, Telemetry Unit, Radio Receiver and Flight Basket Gimbal UxV/35 components. The suggested ordering of these components is shown below.

KA1004-01	GPS, Baro, Compass
KA1003-01	Mission controller
KA1079-01	915 Mhz Telemetry Radio
KA961-01	FRSKY Flight Radio
KA970-01	Flight Basket Gimbal

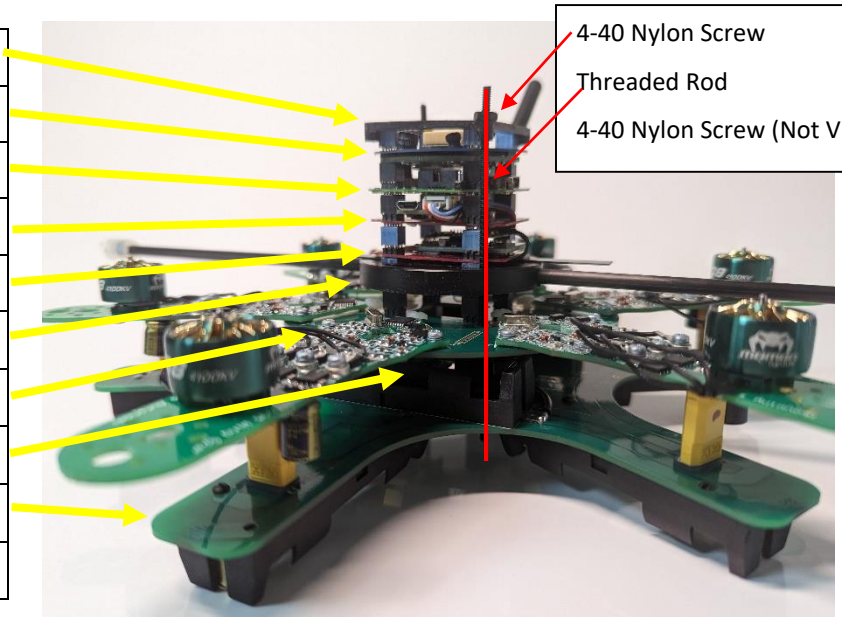


Hardware selection such as motors, props, and frame may influence the required ordering of Flight System components. The basic requirements of the Flight system stack order are that the GPS unit is topmost and that props will not hit any component.

Complete System Assembly

With all individual UxV/35 components in their final state, the entire aircraft is ready for assembly.

MCH-014792	Delrin Cage
KA1004-01	GPS, Baro, Compass
KA1003-01	Mission controller
KA1079-01	915 Mhz Telemetry Radio
KA961-01	FRSKY Flight Radio
KA970-01	Flight Basket Gimbal
PCB-795B-01	Assembled Wing Hub
KA1043-01	Double Height
PCB-794A-01	Hexacopter Battery Wing
PLS-058	Pin Protector (Not Visible)



Threaded rods are placed in opposite corners of the Delrin cage. After passing each threaded rod through the entirety of the stack, secure the rod on both sides using 4-40 Nylon Screws.

Configuration of Flight Controller

While UxV/35 Mission Controllers come out of the box with ArduCopter (Multirotor version of Ardupilot) the aircraft must be configured for use with the specific motor quantity, layout and aircraft size that is being used. To complete this stage, the following materials are required:

- Assembled UxV/35 Microhexacopter
- USB A → USB Mini-B Cable (3+ Feet in length)
- Computer with Mission Planner Software

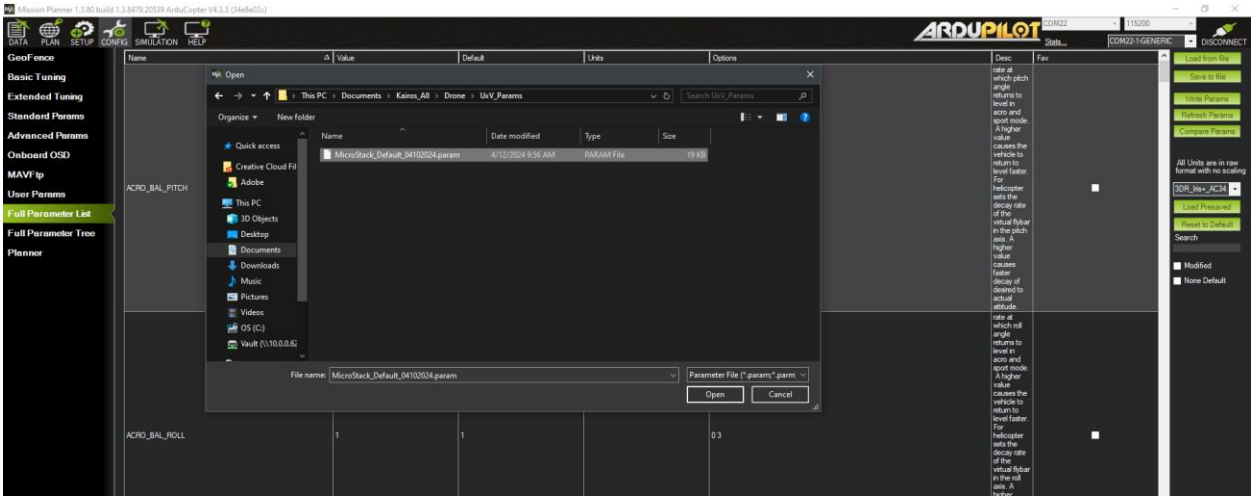
Parameter File

To configure the UxV/35 Mission Controller for the example Micro Hexacopter used in this document, the following parameter file is used:

MicroHex_1.0.param

(Internal Use: V:\KA Drone\UxV35-Hexacopter\MicroHex_1.0.param)

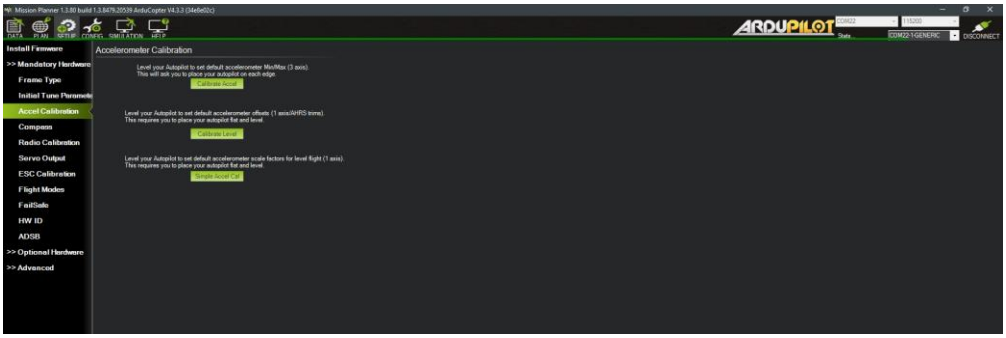
- Download the above .param file to a known location.
- Power up the Micro Hexacopter mission controller by connecting USB Mini-B.
- Navigate to **Config>Full Parameter List>Load From File**. (**Select Downloaded File)**
- **Write** Params and confirm that the status window say that the write was successful.
- Power off the Drone, Power Back on the Drone.



Calibration of Mission Controller

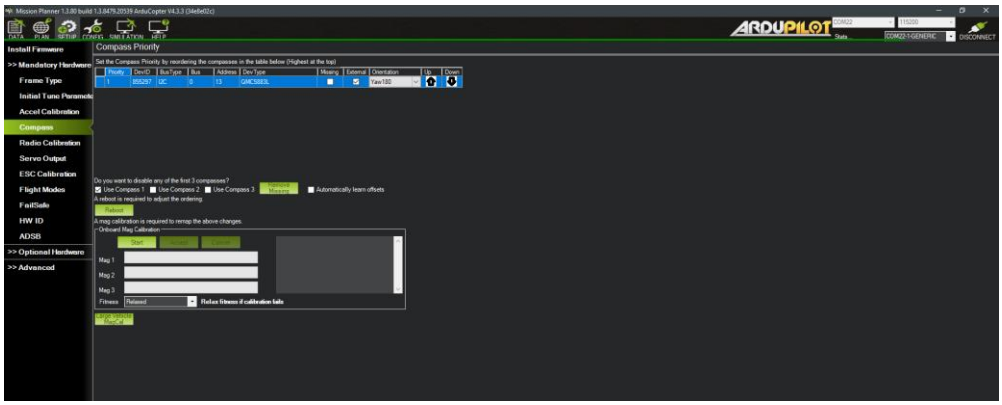
Accel Calibration

- Navigate to **Setup>Mandatory Hardware>Accel Calibration**.
- Select **Calibrate Accel** and follow its instructions to calibrate the accelerometer in each orientation.
- Once complete, place the drone on a level table and select **Calibrate Level**.



Compass Calibration

- 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%.



Note: Percent progress that is displayed may reset to 0% during the compass calibration, this is normal. Continue the calibration until successful.

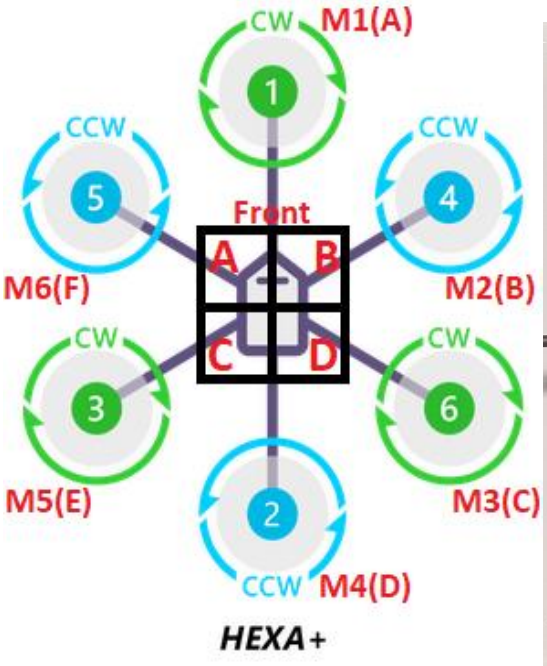
Motor Direction

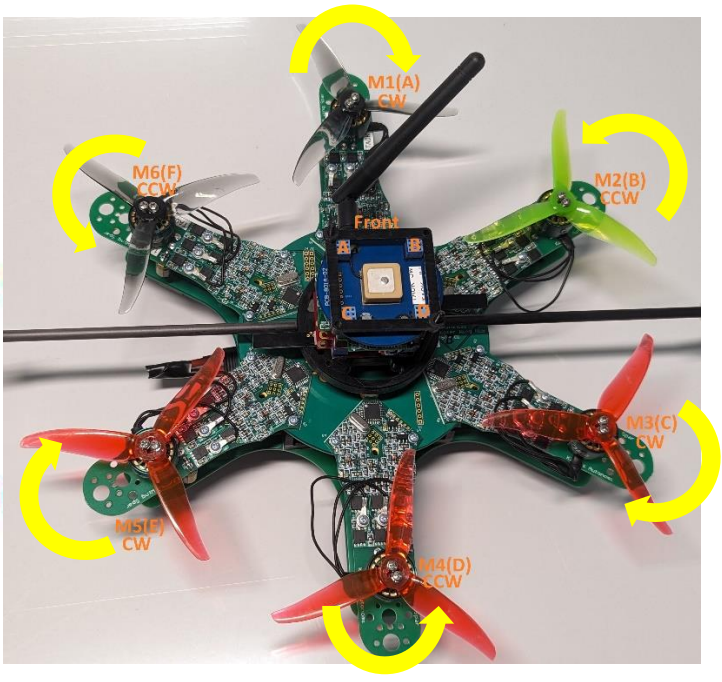
- Reconnect the drone to Mission planner
- Navigate to the Motor Test page under **Setup>Optional Hardware>Motor Test.**
- Increase the **Throttle% = 15%** and leave the **Duration = 2 seconds**.

Testing Motor Direction

When you select "Test motor A", the center-front motor will spin up. Check that this motor (Motor A) spins in the clockwise direction shown in the image below. Repeat this test for B through F making note of any motor that does not spin in the direction listed here:

- M1 (A) – clockwise
- M2 (B) – counter clockwise
- M3 (C) – clockwise
- M4 (D) – counter clockwise
- M5 (E) – clockwise
- M6 (F) – counter clockwise





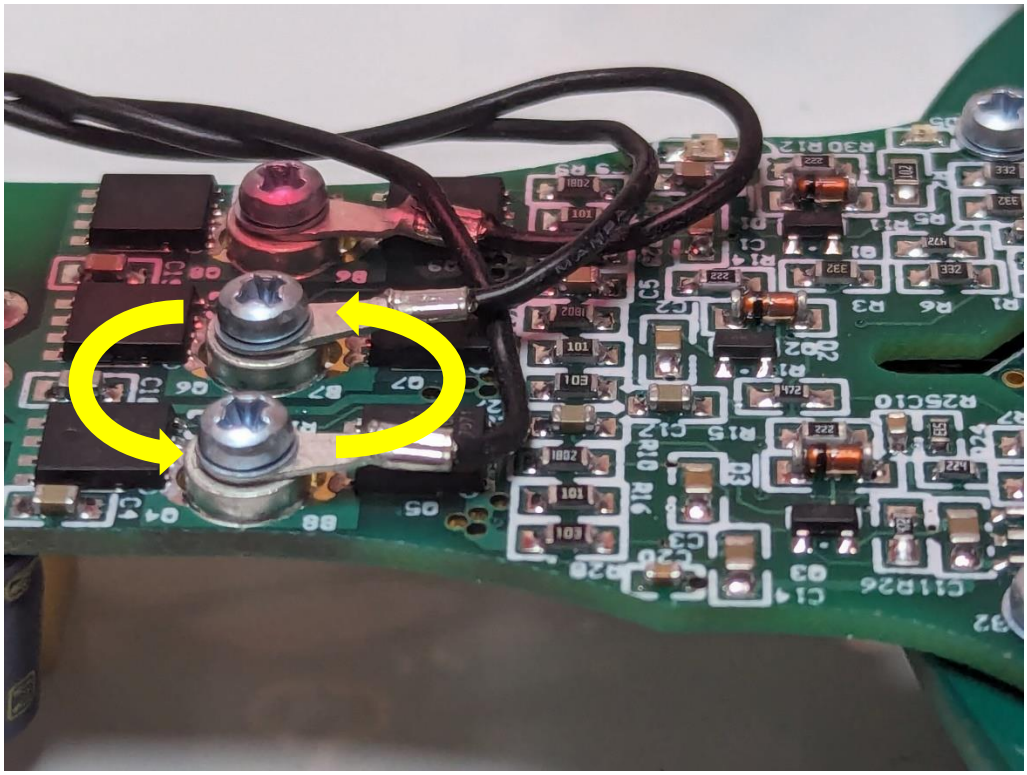
WARNING

DO NOT PERFORM BECHTOP TESTS/POWER DRONE WITH PROPS ATTACHED WITHIN NON-FLIGHT SCENARIOS, PHOTO IS FOR REFERENCE ONLY

Changing Motor Direction

If any motor needs their direction flipped, first power off the drone and disconnect the battery.

- Take any two motor wires of the motor whose direction needs to change
- Remove the screws and swap their locations on the ESC terminals
- Retighten the screws with a lock washer.



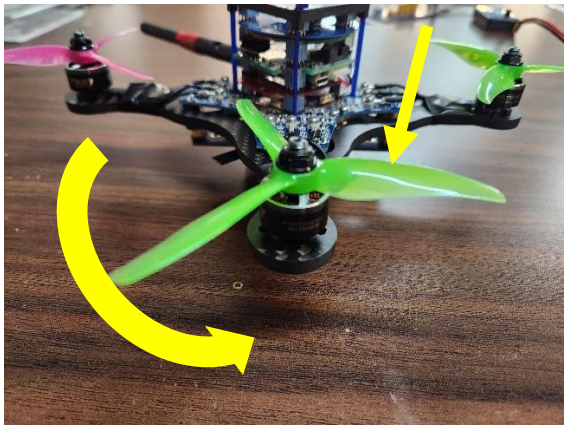
After swapping wires for all incorrect motors, power on the drone with the battery and reconnect to Mission Planner.

Run the Motor Test again to confirm that all motors are now spinning in the correct direction.

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.

Propeller Installation

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.

Version History

Name	Date/Version	Description	Reason
Nicholas Ronnie	5/22/2024	Document Creation	