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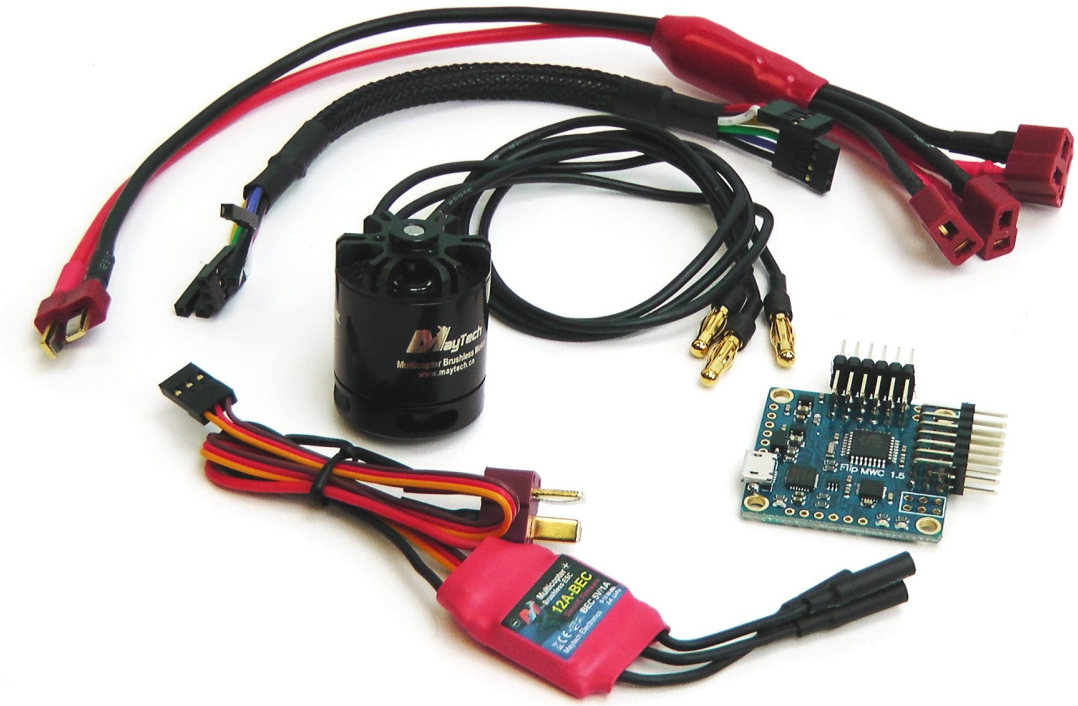
Electronics & Wiring

Flip MWC Flight Controller 1.5 for UAV



Revision 1.0 February 25, 2014 - *BETA*

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Introduction

If you are new to UAVs / drones, it is very important that you follow these guidelines carefully. Lynxmotion takes the approach that no irreversible modifications should be needed in order to assemble the product and we do our best to ensure parts can easily connect to one another. This guide assumes you have read through the MultiWii Quick Start Guide as found on the Lynxmotion website.

Note that Lynxmotion UAV assembly requires patience and close attention to detail. Unlike “plug and play” UAVs where you only need to plug in the battery, Lynxmotion UAVs can be reprogrammed, work with a variety of products (different flight controllers, motors, ESCs, batteries etc) and tend to be more powerful.

WARNING

1. UAVs are essentially flying lawn mowers and can do significant harm if a fast spinning blade contacts an object.
2. Only touch the electronics when the battery has been unplugged. Although the batteries used are low voltage, they are discharging at a very high current and as such, if you touch both the red and black lead while in use, you will receive a significant (40 amps or higher) shock.
3. It is best to assume that if the battery is plugged in, that the motors can start rotating at any time. This is a necessary precaution which most quadcopter enthusiasts follow based on experience.

STEP 1: Preparation

You should have:

- Read and completed the MultiWii Quick Start Guide
- UAV frame (assembled)
- Motors (installed or not)
- Flight controller (installed or not)
- Remote control transmitter (batteries installed) and receiver (nothing connected)
- Electronic Speed Controllers (ESCs) NOT installed
- Battery NOT installed
- Propellers NOT installed

A) ESC Throttle Calibration

-- WARNING --
Your propellers should NOT be mounted

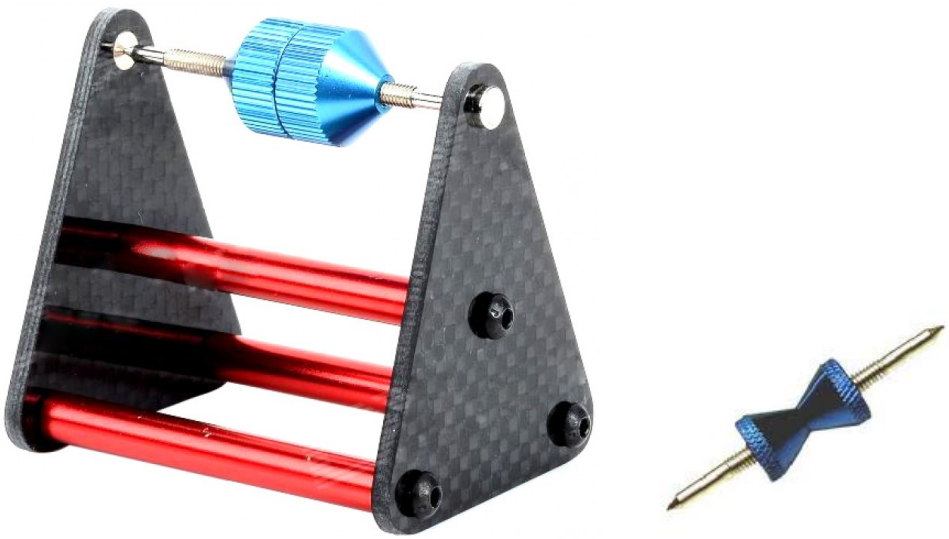
In a multi-rotor UAV, each motor is connected to its own electronic speed controller (“ESC”), which is then connected to the flight controller. The ESCs do not “know” the range of values which they will receive from the controller (each controller is different). Calibrating the ESCs provides new min / max throttle values and will also ensure that all motors start simultaneously.

1. Connect one of the motors to one of the ESCs (it does not matter which of the three wires from the motor connects to which of the three wires on the ESC)
2. Connect the ESC’s RC cables to your receiver’s throttle channel.
3. Turn ON your transmitter and push your throttle stick to the highest (max) position.
4. Connect the battery to your ESC’s power input
5. You will hear 3 beeps coming from the motor (confirming max position has been set), then wait 1s for a short beep (to indicate it’s now waiting for min value)
6. Immediately lower the throttle stick to the minimum position.
7. You will hear 2 beeps that confirm the minimum value has been set.
8. If you hear a long beep, it means the minimum throttle value has been set. If not, you will need to do the procedure again from the step 2.
9. Disconnect the receiver and the battery from the ESC
10. Set aside that motor + ESC combination
11. Repeat steps 2 to 11 for each ESC + motor

Each ESC has three bullet connectors which connect to those of the motor.
Switch any two to reverse the motor’s direction (With battery unplugged)

B) Propeller (“Prop”) Balancing

Not all propellers are made perfectly, especially those which are made using injection molded plastic. These propellers may not be perfectly balanced and can have more weight on one side than the other. An unbalanced propeller will lead to vibration in the motor, which is transferred to the frame and ultimately to the electronics and sensors. If the sensors are receiving erratic information, the drone will not fly as well as it could.



Magnetic Prop Balancer (propeller fits between V-sections as on right)

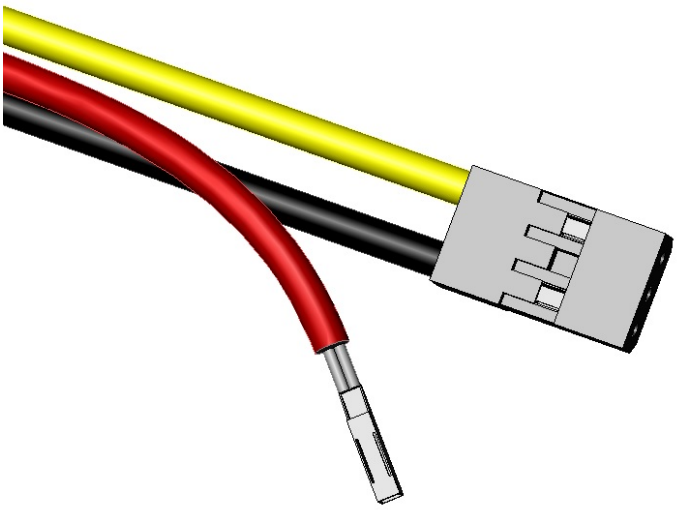
A prop balancer is ideal; these are simple, relatively inexpensive devices which allow your propeller to turn freely about its center so you can see if one side weighs more than the other. If you do not have one, a really inexpensive way of balancing a propeller is to place a nail through the center hole of the propeller and balance the top and bottom of the nail so that the propeller is horizontal. When you let go, if the propeller stays perfectly horizontal, it means the weight of either blade is identical and the propeller is balanced. However if one side drops, that means the side which has fallen weighs a bit more than the other and the prop is not balanced. Two things can be done to balance the prop:

1. Add a little bit of weight to the lighter side. This can be in the form of a small piece of clear Scotch tape. If you require several pieces, it’s best to evenly distribute the tape to minimize the effect on the propeller’s profile.
2. Use sandpaper to remove weight from the heavier side. It’s important to note that you should ONLY remove weight on the underside of the prop, closest to the center (this minimizes the effect on the aerodynamics.

NOTE: Never remove weight from the ends of the prop or modify the leading or trailing edge.

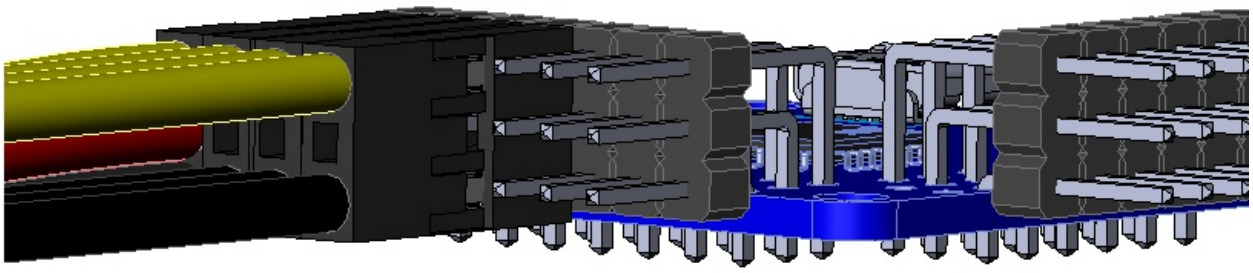
C) ESC Wire Preparation

Each ESC has a build-in BEC (battery eliminator circuit) that provides 5VDC to the red wire on the R/C connector and is used to power the receiver from the main battery. This eliminates the need for one battery for the receiver / controller and another for the motors. Only one ESC needs to provide power to the flight controller / receiver.



Remove the red (power) wire from three out of four ESC connectors.
Wrap the exposed pin with electrical tape or heat shrink.

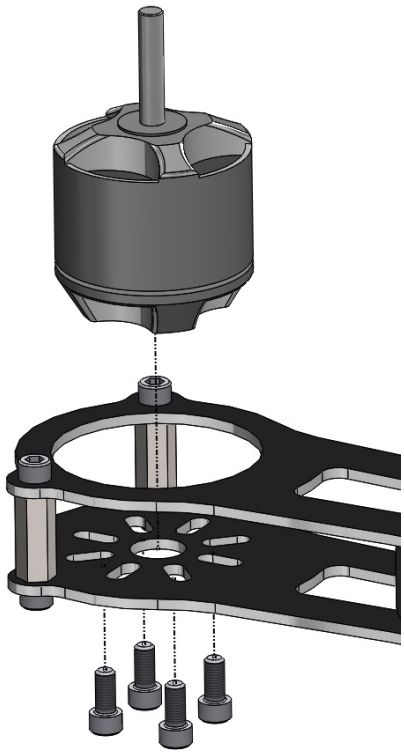
The red (power) wire from the other three (out of four) ESCs should be removed from the plastic case, so only one ESC (of all four) should have the red pin still inserted. In order to remove the pin from the plastic case, gently lift the center plastic tab which holds the metal crimp in place (this is easiest with a thin knife such as an exacto blade) and pull the crimp out of its slot. It is best to keep the connector on the wire in case you want to use it later. Use shrink tube or electric tape to insulate each of these three exposed pins to prevent shorting (do NOT connect them together).



Notice that only one ESC connector has the red wire connected.
It does not matter which ESC has the red wire connected.

D) Motor Installation

In rare cases, it may be important to balance a motor. However, motors purchased through Lynxmotion should not need to be balanced. You can now mount the motors to the frame. If needed, you can disconnect (and then reconnect) the ESC. We suggest running the wires through the arms. It is best to orient the connector / wires along the UAV's arm when orienting the motor.



Exploded view of a typical motor mount assembly

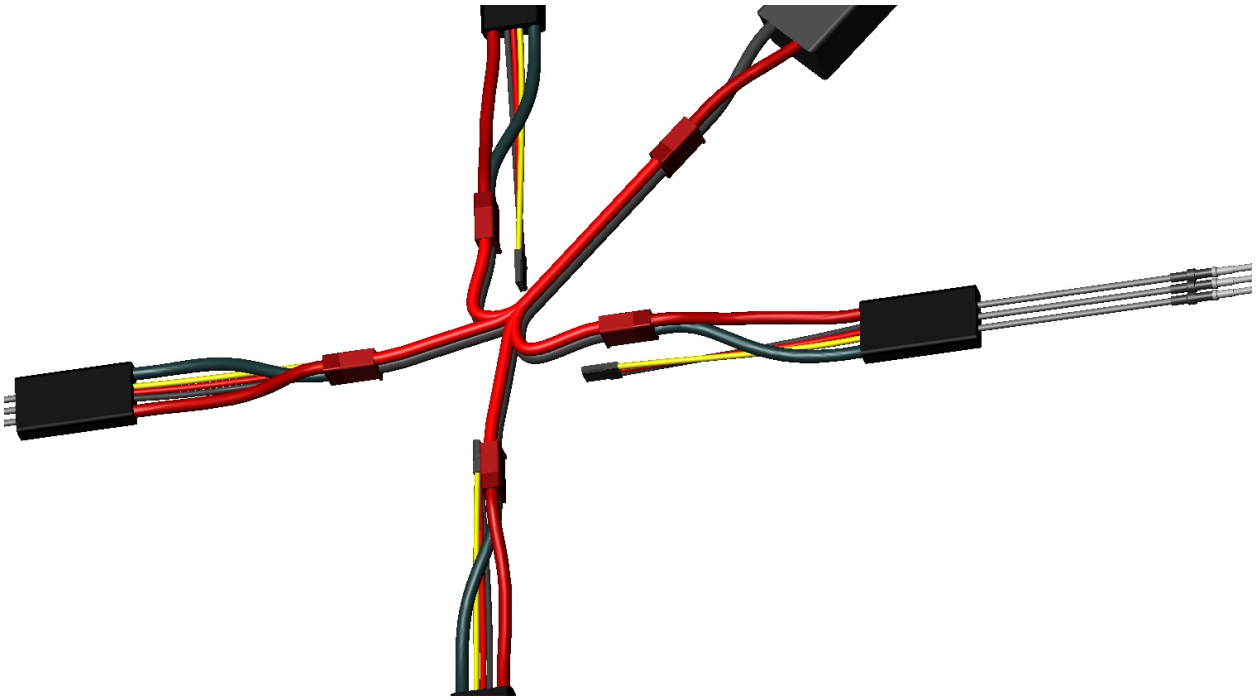
E) Battery Straps

Lynxmotion UAV kits include velcro straps to secure the battery in place. There are one or two slots on the bottom of the central frame designed to hold these straps in place. Feed one end of the velcro through the slot in the lower frame, then, feed it between the bottom and mid plates and through the slot on the other side (the soft part of the velcro should be facing upward inside the frame). The velcro should go through the loop and back onto itself. Pull on the strap to confirm that it's secure.

STEP 2: Connections

A) Power Harness

Each ESC needs to be powered directly from the battery. As such, a power distribution board (PDB) or power wiring harness is used to split the battery to four separate connectors. Plug in each of the ESCs to one connector on the harness. We suggest running this harness between the center middle and lower middle plates before you make the connections. Note that the fifth connector connects to the battery. You can remove the top plate if it's easier for you, but be sure to reattach it when done.

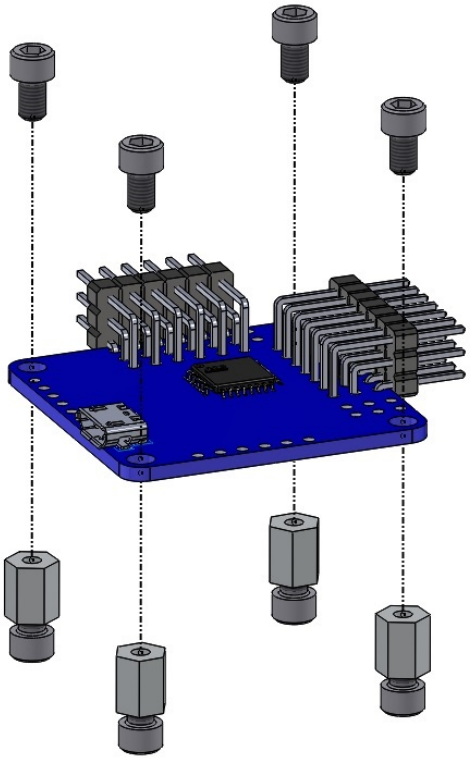


Quadcopter power wiring harness connects to each ESC as well as the battery.

You might be wondering why there is no On/Off switch included with the kits? The safest way to know that the UAV motors won't spin up accidentally is to remove power completely by unplugging the main battery. A switch can be accidentally touched when someone is around, causing the propellers to turn at high RPM.

B) Install Flight Controller

Ensure all of the R/C cables from all of the ESCs protrude from the center plate and can easily be accessed. You can now install the flight controller to the frame using the screws provided. The USB connector on the controller (FLIP / MultiWii) faces the FRONT of the copter (this may not be the case for all flight controllers).



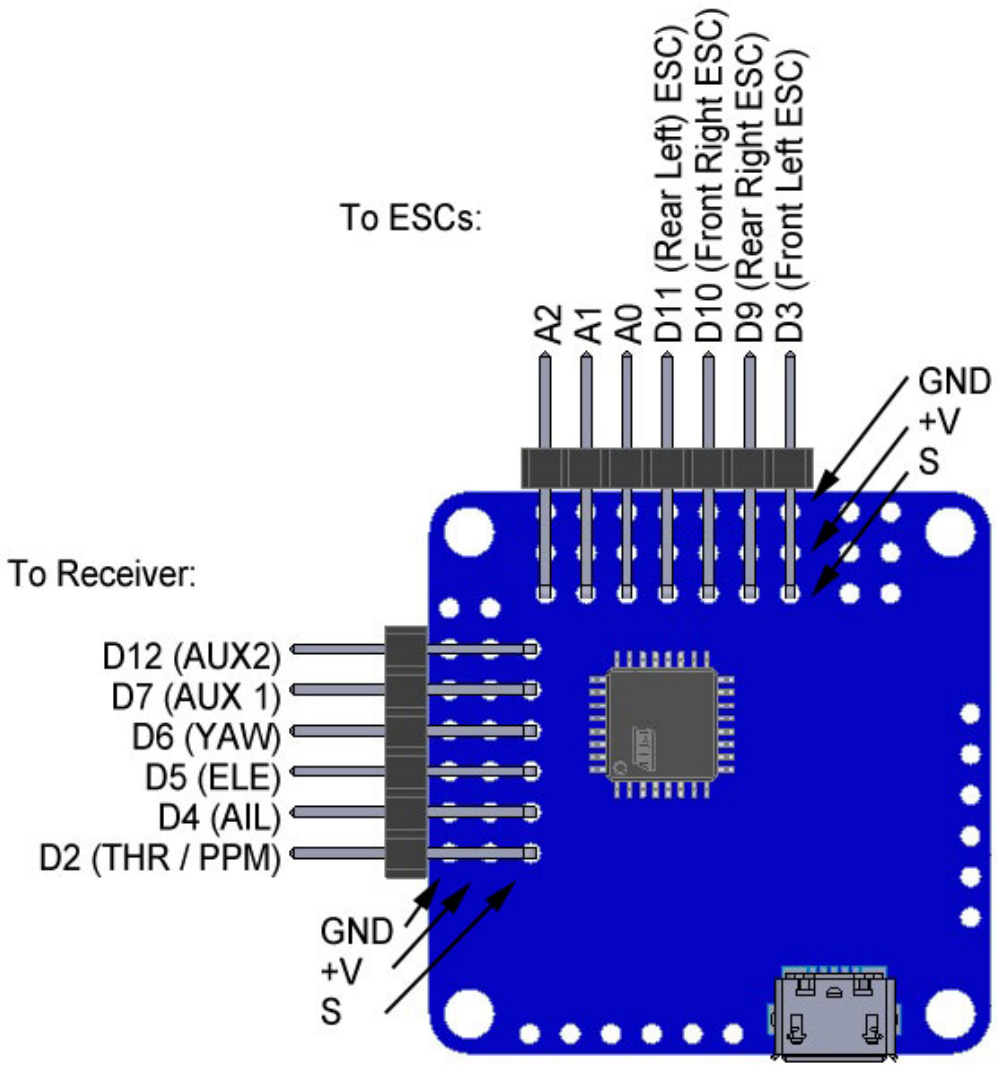
Exploded view of the MultiWii Flip typical assembly

C) Orientation check

Connect the MultiWii to the computer and open the GUI (as explained in the Lynxmotion MultiWii Quick Start Guide). Hold the UAV in your hand and move it around and look at the 3D model to confirm it's moving correctly. Re-calibrate the accelerometer / gyro again once it has been installed on the frame (as described in the MultiWii Quick Start Guide).

D) ESCs -> Flight Controller

The ESCs can now be connected to the flight controller. Since the pinout on the FLIP flight controller is now hidden on the underside of the board, a view from the top is provided below.

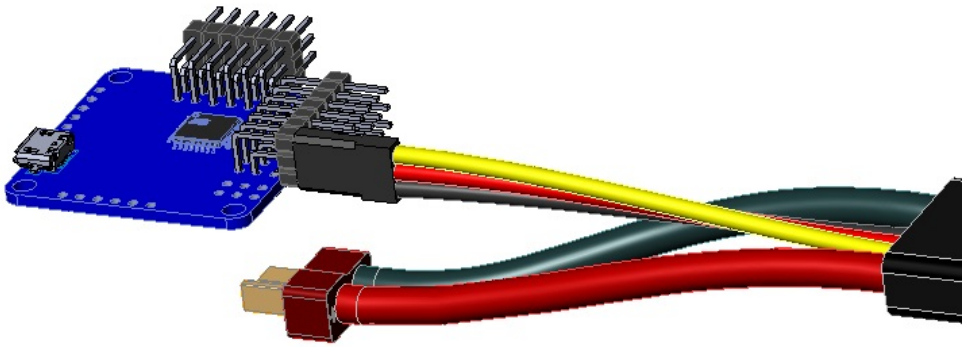


MultiWii Flip Pinout

Connect the ESCs to the flight controller, ensuring the white / yellow signal (S) pin is at the top.

For a quadcopter:

- Front left ESC -> D3
- Rear right ESC -> D9
- Front right ESC -> D10
- Rear right ESC -> D11



Yellow / signal pin is connected to the top pin.

As indicated in the ESC wire preparation step, only ONE of the ESCs should have the red wire connected.

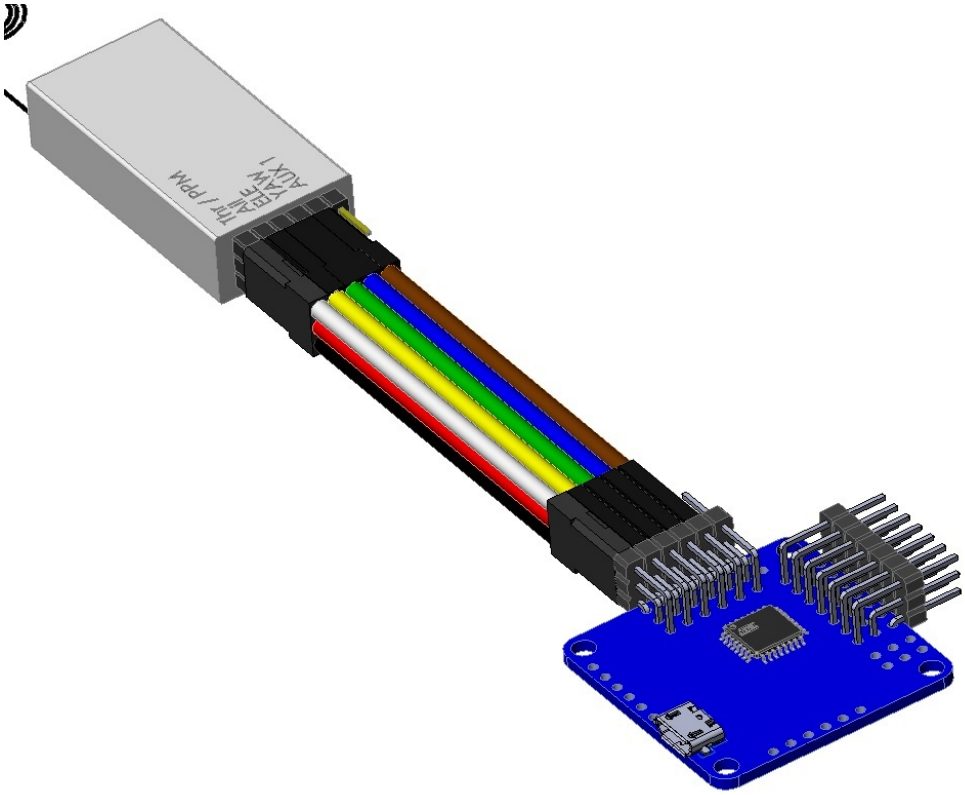
E) Receiver -> Multiwii

The R/C hobby receiver you are using should have at least four or five channels. The pinout of R/C hobby receivers is not always identical, though they should have the following pin assignment, normally associated with model airplanes:

- Throttle (THR)
- Aileron (AIL)
- Elevator (ELE)
- Rudder (YAW)
- There are also usually auxiliary outputs (AUX).

In the diagram below, the pins of the receiver are protruding horizontally, though some receivers may have them vertically. The receiver cable provided as part of the Lynxmotion kits includes one three pin connector which provides power, GND and one signal. The other cable starts as a 1x4 pin and terminates as four 1-pin connectors; this is done in the event that your receiver does not have the pinout in the “usual” order. Use the other end of this cable to match the pinout of the MultiWii to the pinout of the receiver:

- D2 (THR) -> THR (throttle)
- D6 (YAW) -> YAW
- D5 (ELE) -> ELE (elevator)
- D4 (AIL) -> AIL (aileron)
- AUX1 -> AUX 1 (if using a 5ch+ system)



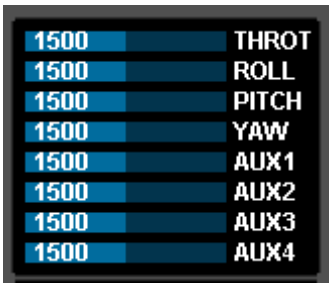
Receiver to MultiWii. Note that not all connections may line up perfectly as above

Once again, the flight controller should be mounted to the frame with the USB port facing the front of the UAV to ensure the orientation of the sensors is correct.

F) Channel Directions

-- WARNING --
Your propellers should NOT be installed

You can now verify all channels to be sure they move correctly. Open the MultiWii Conf. GUI and locate the following window:

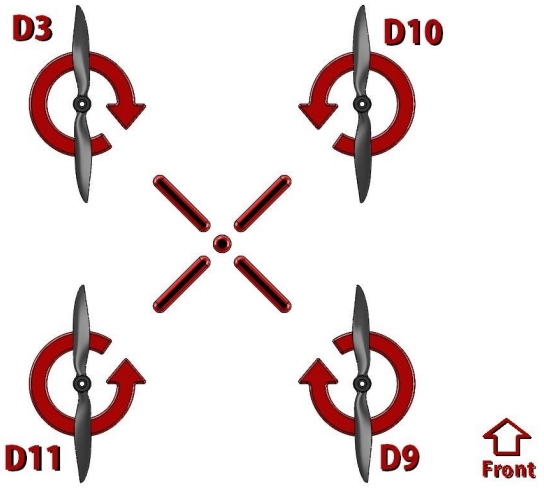


1. Power the transmitter (*ALWAYS POWER THE TRANSMITTER FIRST, BEFORE THE RECEIVER*)
2. Connect the drone's battery (which will provide power to the electronics)

Now that the FLIP flight controller has been installed, refer back to the MultiWii Quick Start Guide and re-calibrate the accelerometer. To ensure the controller has been properly configured:

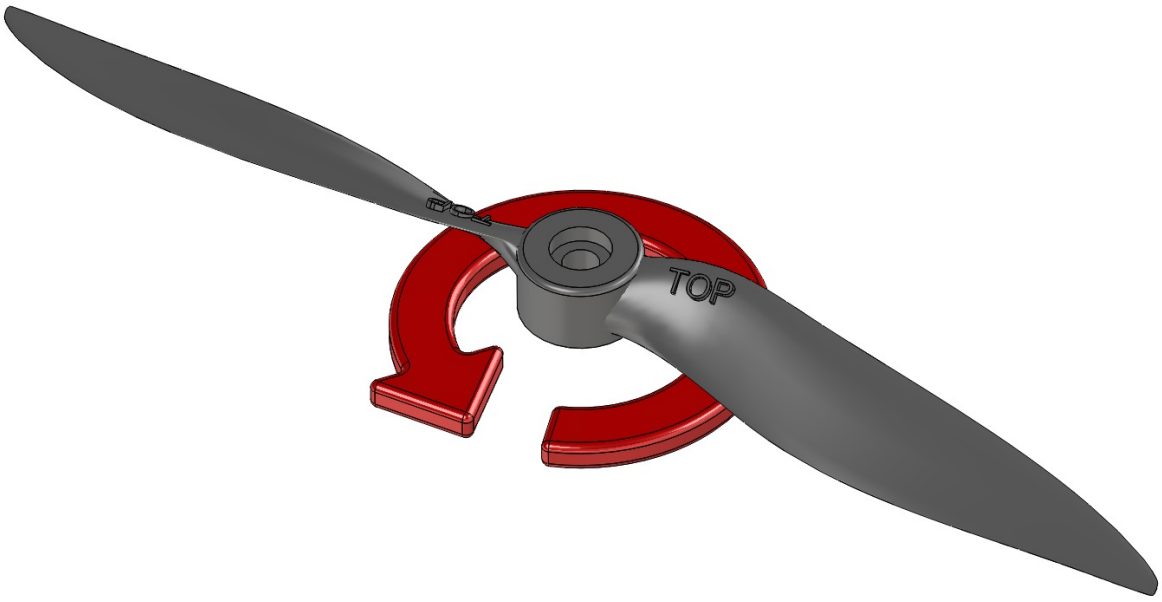
- Move the throttle stick down, the THROT value should decrease
- Move the throttle stick up, the THROT value should increase
- Roll stick left = ROLL value should decrease
- Roll stick right = ROLL value should increase
- Pitch stick down = PITCH Value goes down
- Pitch stick up = PITCH Value goes up
- Yaw stick left = YAW Value goes down
- Yaw stick right = YAW Value goes up

G) Install Propellers

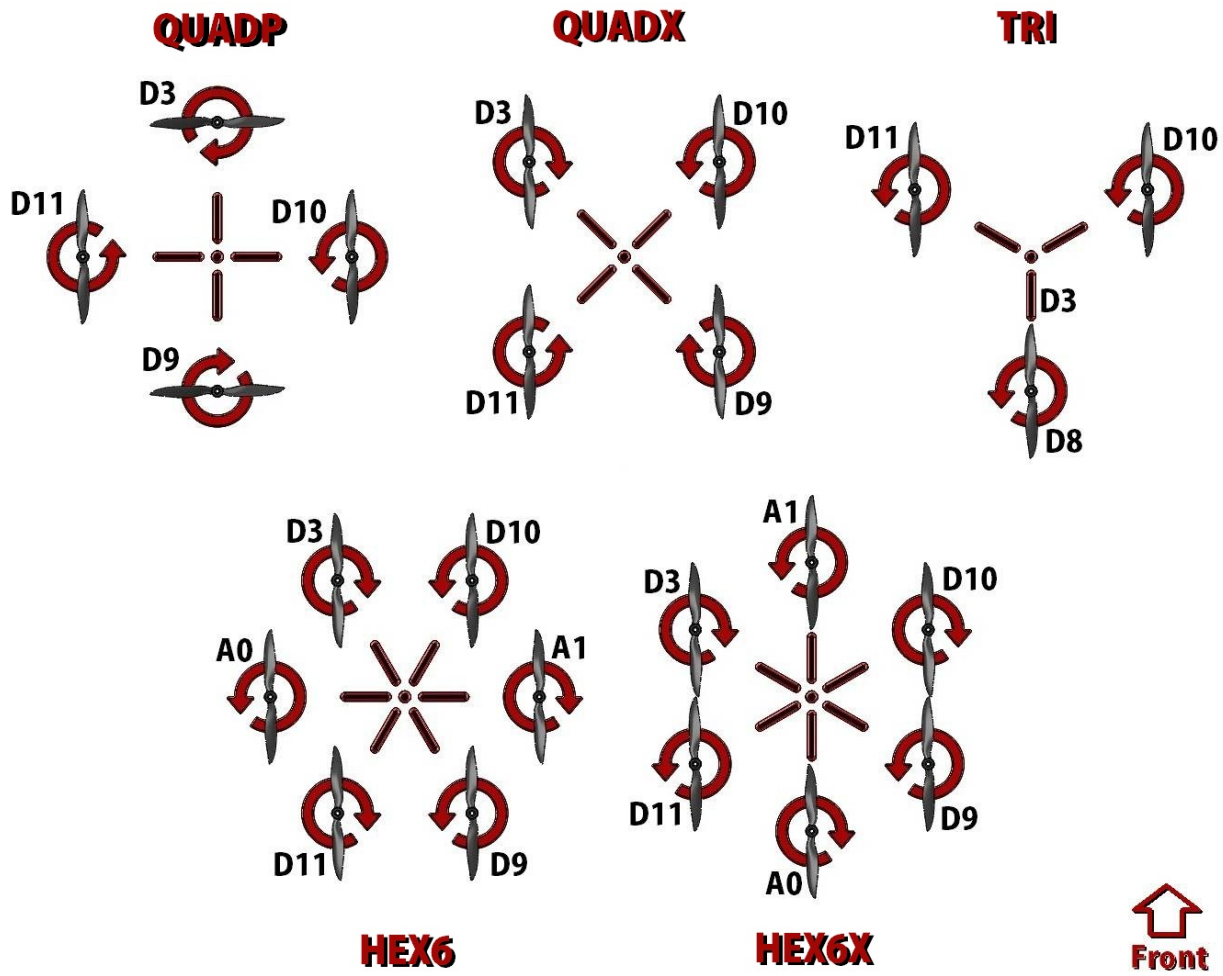


Example of propeller mounting on a standard quad

Notice the direction of each arrow around the pin number above; this indicates the direction that propeller should turn. The leading edge is the one at the top of the propeller, and the trailing edge (usually very thin) is the one at the “rear”. The propeller must also be installed in the right orientation on the motor, the “top” of the propeller is the one with the lettering, and you will normally find the propeller’s diameter and pitch molded into the prop (ex. 10 x 4.5) closer to the leading edge, toward the center. Treat the propeller as you would a screw / thread; would rotating it in the desired direction cause it to move up or down?

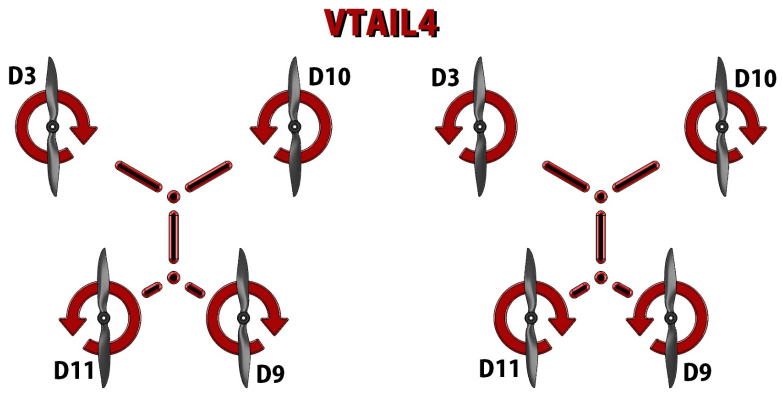


Ex: The propeller connected to D10 rotates Counter clockwise.
Rotating it Counter clockwise causes the propeller to “thread” upwards (push air downwards)



Common propeller orientation and pinout for FLIP MultiWii Controller

Note that the direction of rotation for the Quad X configuration may change from drawing to drawing; the important part is the respective orientation (D3 and D9 should rotate the same way, as should D10 and D11).



Common propeller orientation and pinout for FLIP and VTail config

In a VTail, the two rear propellers still need to be pushing air DOWNWARDS. Therefore despite the motor being upside down, the propeller should have the top facing up.

Notice the top of the propeller is still facing upwards in the V-tail

H) Receiver Placement

The receiver does not weigh much, but it's important that it be secured to the frame. Centering the receiver along the frame is always ideal, though most of the time this is where the flight controller needs to be placed. We suggest the receiver be secured to a top plate or just in front of the flight controller using tie wraps and/or tape.

I) Battery

At this point, everything except for the battery should be installed and connected. The battery itself should ideally be located underneath the UAV towards the center of the UAV so that the UAV does not have a tendency to pitch forward / backward or roll left or right. You can connect the battery using the provided velcro strap(s).

J) Cleaning up Wires

Some tips to cleaning up your wiring:

- Each ESC should ideally be located on the copter's arm beneath the propeller wash to help it cool off. You can use tape, tie wraps or other means to secure each of them in place.
- Any long wires should be tied up and taped to the frame so they don't get tangled in the blades.
- Receiver Antenna:

- Keep it as far away from electrical devices as possible, especially the power distribution section, batteries and anything that can conduct electricity etc.
- Never cut, fold, twist or knot the antenna wire
- Consider using a clear plastic tube in order to keep the antenna straight

Step 3: Location

You can now plan your first flight. Location and weather conditions are very important and despite your best effort, you can expect to crash a few times.

An empty baseball field is a great place for a first flight

- It is best to avoid flying in areas around water (near a river, pond etc).
- Snow is NOT ideal since the UAV is an open design and water can damage the electronics and motors. Fling in temperatures of less than 0C may cause issues.
- You should fly the UAV on a day with as little wind / adverse weather conditions as possible; a sunny, warm and windless day is best.
- Some ideal locations include:
  - Empty football, soccer or baseball field
  - Empty park in an area with as few trees as possible
  - Open, grassy field with no trees (or trees only in the distance).
  - Model R/C flight club (payment may be required, but you might meet other enthusiasts as well)
- Some secondary locations include:
  - Large parking lot with NO cars (if there is even one car in the lot, Murphy's Law demands that the UAV ram it at full speed)
  - Large empty gymnasium (be prepared to pay for damage)
  - Empty lot (careful for small shrubs and other debris close to the ground)
  - Large back yard or farm (with permission)
  - Golf course (with permission)

Flying in a confined area such as a room is strongly discouraged simply because you don't know how the UAV will react the first time. Should you have absolutely no other alternative, we suggest

you create “anchors” which can be made using string and extend from the landing gear to anchor points on the floor. Ensure the length of string is enough to allow the UAV to hover, but is short enough to prevent it from hitting objects in the room. You should also put something relatively soft under the flight area such as a thin carpet.

Restrictions on Flying UAVs

Calling your local (largest) airport and asking to speak with someone in the control tower is the best approach. They may not be up to date with UAV restrictions, but they will be the main authority in the area tracking of your UAV and it’s important to keep them informed. When you call, indicate to them that you would like permission to fly a small UAV under (example) 200 feet and specify where. You would be surprised just how large an area a control tower can pick up on radar. Depending on air traffic (which can be dependant on the day of the week, time of day, weather etc), they may or may not tell you to “go ahead”. There are certain areas outside of radar range where only aircraft flying above a certain altitude need to be kept track of (farm areas are a good example).

An aircraft control tower should be informed & aware of your UAV

When it comes to objects in the air, your local control tower sees and controls everything, and often with modern technology, they can pick up objects as small as birds. Should your UAV show up on the radar of a manned aircraft, and that pilot calls the control tower to see what it is, the control tower would have already been informed. See if they have any suggestions or would prefer you call them every time you fly.

Trying to reach most government organizations such as the FAA takes an incredible amount of time and patience, and often times the person responding simply refers you to a poorly phrased line in a regulations guide which may or may not seem relevant to your situation. Your local municipal government likely knows little about UAV flight restrictions and would likely only know something if an incident (injury or property damage) occurred in the past.

A transponder allows each aircraft to be picked up by radar and assigned a specific code which describes that aircraft. Almost no small UAVs have a transponder as it adds significant weight, the UAV will be visible to all aircraft (which is not necessarily good) and there is a yearly fee. The FLIP MWC flight controller does NOT have a transponder.

Step 4: Pre-Flight Checklist

At this point, all connections on the UAV should be made (except for the battery). The following steps will help you prepare for the first flight. The transmitter should be turned off. If you are new to multi-rotors, it's important to note that despite your best efforts, it is highly likely that you will crash on your first few tries. Don't be discouraged; the frame is quite resilient, and although you may break a few props, there are spares included in the kit, and can be purchased separately (and are very inexpensive). There are also crash kits available in the event that you break some of the G10 plates.

1. Turn on your transmitter (the transmitter should always be turned on before the UAV)
2. Move the joysticks to neutral (centered) position.
3. Place the UAV on as level a surface as possible (if the surface is not level, the UAV may not want to arm) and orient the front facing AWAY from you.
4. Plug in the UAV's battery and step back
5. Arming / disarming the Controller: Move the left joystick to the bottom right and hold; this will start the motors and set them to the idle speed. The UAV is now ready to fly, but do *not take off*.
6. Disarm the motors: Move the left joystick to bottom left and hold. The motors should stop rotating.
7. Unplug the battery
8. Turn off the remote control.

Place the UAV at a distance with the front facing away from you

Now that you can arm and disarm the motors, arm them once again - they should start to rotate. Check (VERY CAREFULLY) that the rotors are all pushing air downwards (but don't actually take off). If a rotor is pushing air upwards, you will feel it from above, and this needs to be corrected. Practice steps 1 to 9 above until it becomes second nature.

Range Test

It is really rare that an RC transmitter manufacturer will indicate the range of the remote control. As such, we strongly suggest doing a range test. Start with fresh / fully charged batteries in the remote control, and a charged battery on the receiver.

Before EACH flight, we strongly suggest you do a range test. The range test works best when you have someone to help. The purpose of a range test is to send a signal to the receiver and see a reaction, this is usually done by arming / disarming the motors, moving away and trying again. You can start 100 feet away from the model and have your helper raise their arm when the motors spin up, and lower their arm when they stop.

Joystick mode

If you are flying for the first time and your remote control allows it (check the user guide), we suggest setting it to exponential mode. The difference between the two modes is:

- Standard: Standard joystick mode linearly adds throttle.
- Exponential: Exponential mode means that small joystick movements at the center won't have much effect on the UAV's behavior.

Flying

- When you first fly the aircraft, it's best to throttle up so the UAV is airborne quickly. Hovering at about 2 to 3 feet off the ground is best to avoid ground effects.
- Levelling the UAV may not cause it to stay in place due to momentum
- Try to simply hover in place and avoid any sudden movements with the joystick.
- The battery will last around 10 to 20 minutes depending on maneuvers

Crash Checklist

In the event of a crash:

1. Stay calm and DO NOT grab the copter
2. Throttle down and disarm the motors
3. Unplug the battery
4. Turn off your transmitter
5. Collect any pieces which may have broken off
6. Visually inspect the propellers - even slight damage may mean they cannot be reused (causes imbalance leading to vibrations etc)
7. Visually inspect the frame and check for cracks or broken parts
8. Check that no screws have come loose, especially those holding the motors in place