



DJI F450 FOR UGCS DDC

## ASSEMBLY INSTRUCTION

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## Required components and materials

### **Pixhawk WiFi ESP-07**

[http://www.banggood.com/2\\_4G-Wireless-Wifi-Telemetry-Module-With-Antenna-For-Pixhawk-APM-MiniAPM-Flight-Controller-p-1013677.html](http://www.banggood.com/2_4G-Wireless-Wifi-Telemetry-Module-With-Antenna-For-Pixhawk-APM-MiniAPM-Flight-Controller-p-1013677.html)

### **Spektrum 2.4Ghz DSMX Remote Receiver**

<https://www.aliexpress.com/item/620pcs-Dupont-Wire-Cable-Jumper-Pin-Header-Connector-Housing-Kit-Male-Crimp-Pins-Female-Pin-Connector/32765198055.html>

### **Dupont connectors for DroPix**

<https://www.aliexpress.com/item/620pcs-Dupont-Wire-Cable-Jumper-Pin-Header-Connector-Housing-Kit-Male-Crimp-Pins-Female-Pin-Connector/32765198055.html>

### **DJI Flamewheel F450 ARF or similar class vehicle**

<http://www.kopterworx.com/dji-flamewheel-f450-arf-v2-e300.html>

### **Lipo 4s 4000mAh GensAce or similar class battery**

<http://www.kopterworx.com/lipo-4s-4000mah-gensace-tbs.html>

### **DroPix board with soldered connectors**

[https://drotek.com/shop/en/drotek-parts/478-dropix-flight-controller.html#/34-connectors-soldered\\_angle\\_connector](https://drotek.com/shop/en/drotek-parts/478-dropix-flight-controller.html#/34-connectors-soldered_angle_connector)

Or

### **Pixhawk2.1 Standard Set**

<http://www.proficnc.com/system-kits/31-pixhawk2-suite.html>

### **Drotek XL RTK GPS**

<https://drotek.com/shop/en/home/792-xl-rtk-gps-neo-m8p-rover.html>

Or

### **Here+ Rover (M8P) RTK**

<http://www.proficnc.com/system-kits/113-gps-module.html>

Please note that RTK mode will work only in conjunction with base station. If 6m precision is acceptable a cheaper onboard GPS can be used instead.

### **Power module (need to buy separately only for Dropix autopilot)**

[https://drotek.com/shop/en/drotek-parts/809-voltage-current-53v-power-supply-mounted.html?search\\_query=power&results=36](https://drotek.com/shop/en/drotek-parts/809-voltage-current-53v-power-supply-mounted.html?search_query=power&results=36)

### **GPS holder**

<https://drotek.com/shop/en/home/614-gps-folding-mount-with-2-size-poles.html>

## Step-by-step Assembly instructions

### General considerations:

- *Assembly of one drone can take approximately 3 hours*
- *When assembling, don't rush and be very careful. The most popular cause for UAV crashes, operator errors aside, are loose connectors, poorly soldered connections, loose screws and damaged wires.*
- *Apply soft threadlock for all screws to keep them from vibrating loose.*



### Unboxing

*Unbox DJI F450 airframe and read the user manual:*

[http://dl.djicdn.com/downloads/flamewheel/en/F450\\_User\\_Manual\\_v2.2\\_en.pdf](http://dl.djicdn.com/downloads/flamewheel/en/F450_User_Manual_v2.2_en.pdf)

*Read DroPix autopilot setup manual:*

<https://drotek.com/en/documentation/docs-dropix/>

## Contents of the DJI F450 airframe box:



Frame:



Arms:



Misc package:



Contents of the misc. package:



## Propellers



Propeller removal clamp, Motors and ESCs:

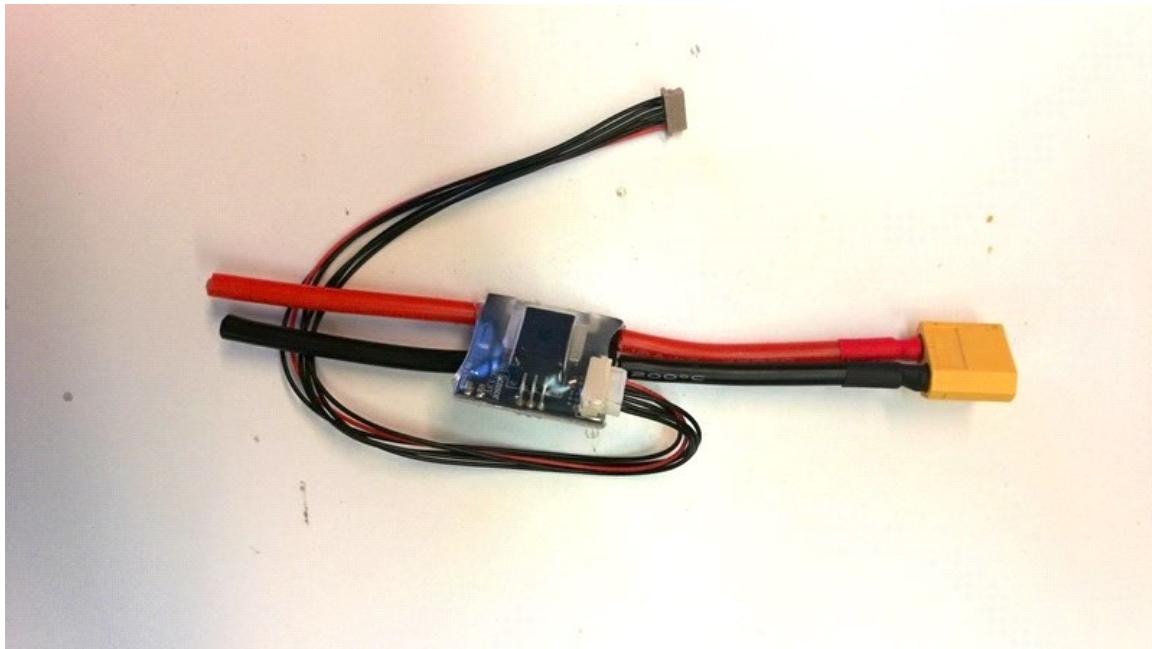


## Preparation works:

### Power module (Actual only for Dropix autopilot)

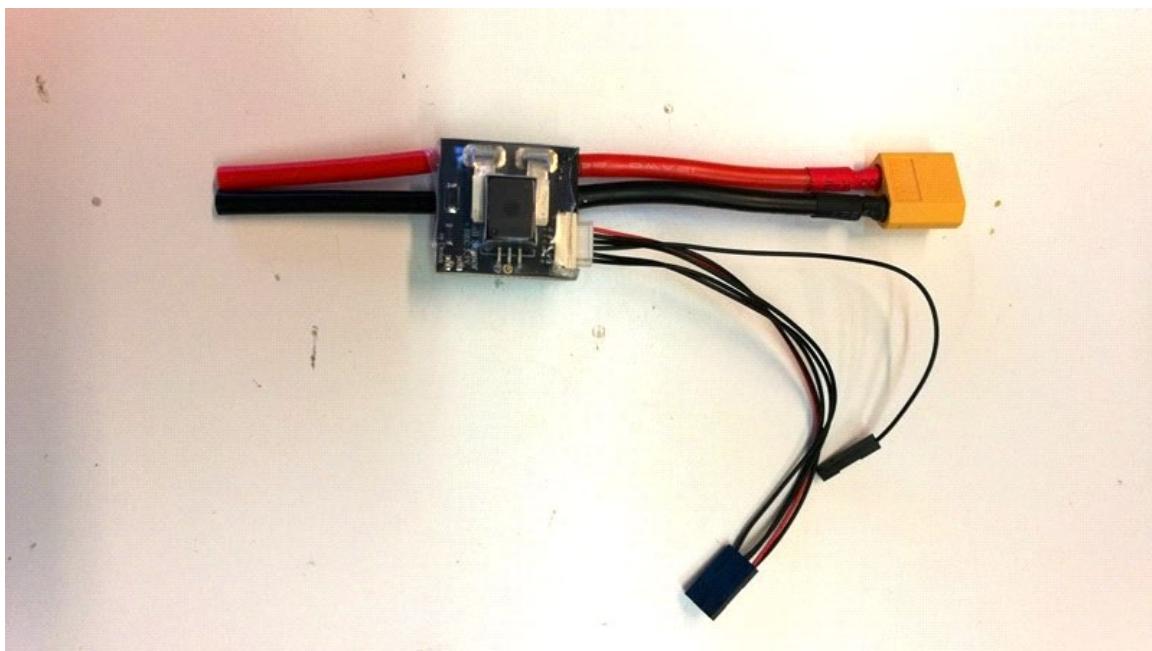
The 6 pin connector of autopilots power module should be replaced according to DroPix pinout.

Power Module (Supplied separately from airframe):

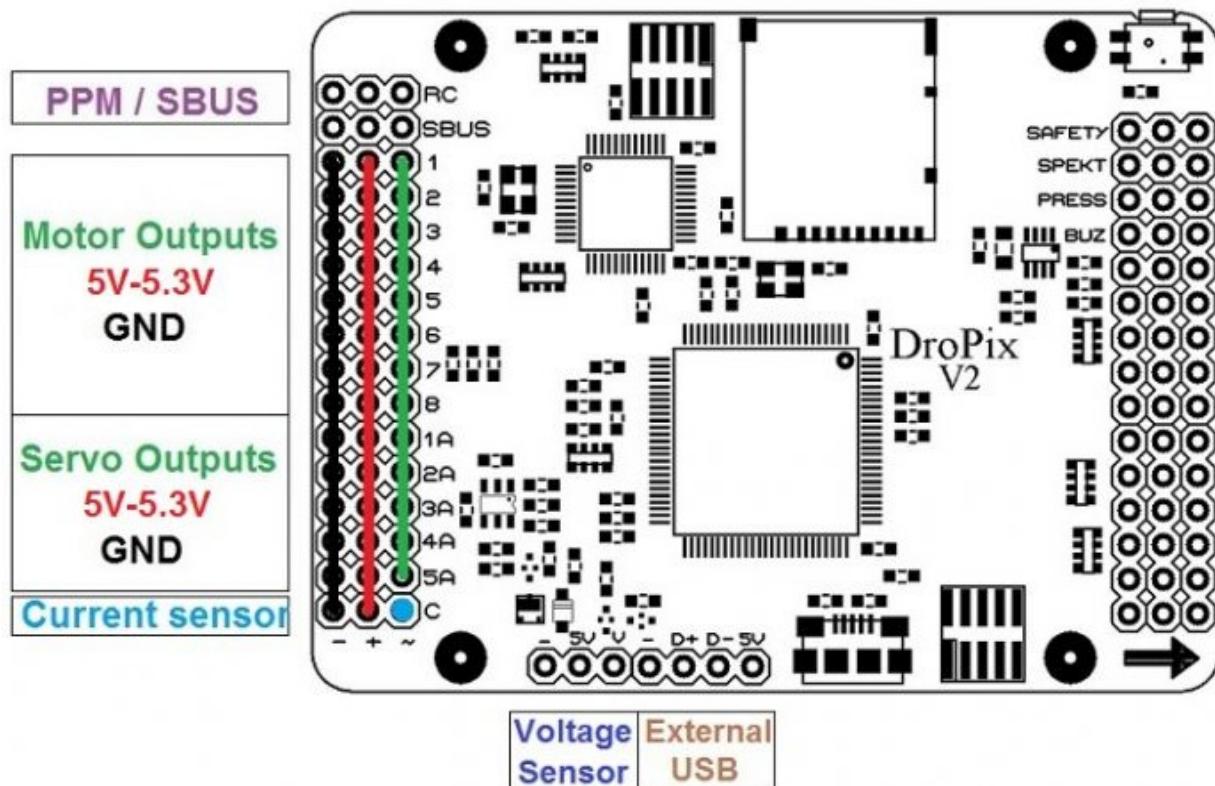


Length of the wire should be about 11 cm. On power module's PCB is the pinout description.

The result:



The wire from the power module should be connected to the AutoPilot Voltage sensor and Current sensor slots.



(Image: © DroPix)

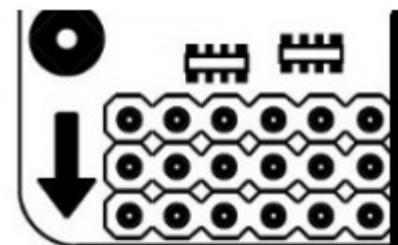
### Pixhawk WiFi ESP-07 module (telemetry) connection wire for Dropix autopilot

The wire is not supplied and should be built or purchased separately.

Connector with white mark (on left side in picture below) connects to Wi-Fi module. The other end of wire (on right side of the picture) should be connected to autopilot. Recommended wire length should be about 18 cm.



Telemetry module should be connected to the first 4 pins on the S1 row AutoPilot (5V, GND, TX, RX):



S4 S5	⇒	5V GND TX RX TX RX
S1	⇒	5V GND TX RX CTS RTS
S2	⇒	5V GND TX RX CTS RTS

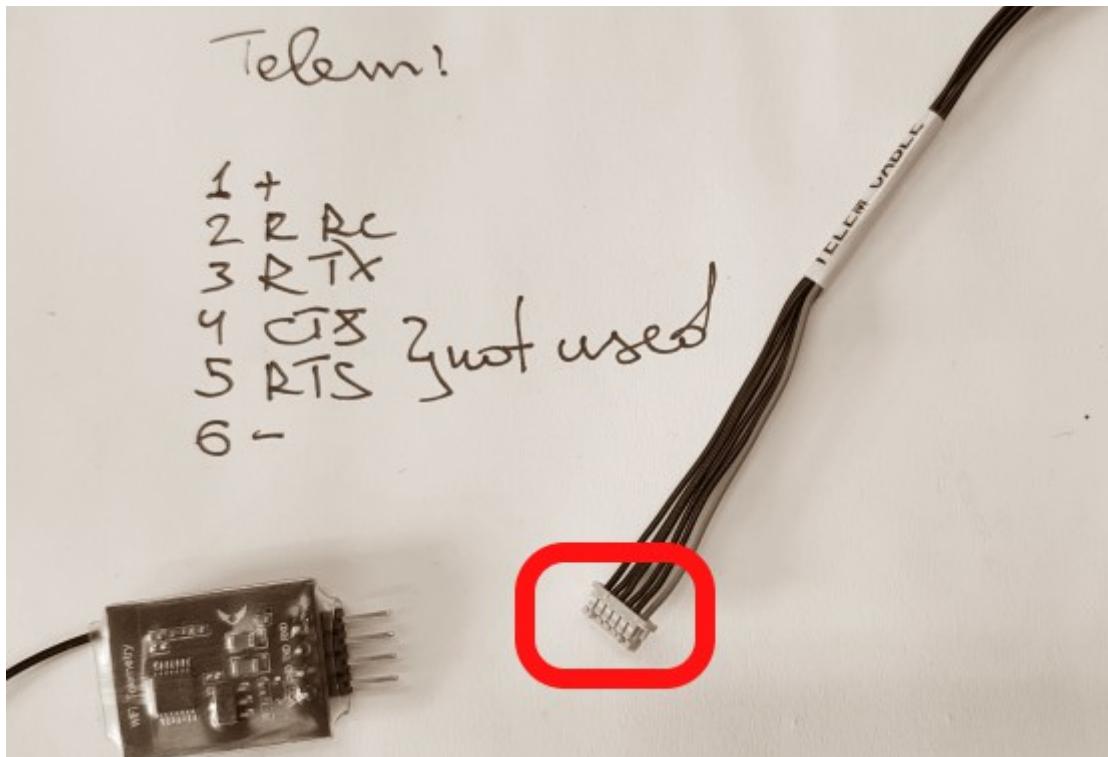
(Image: © DroPix)

WiFi telemetry pinout:

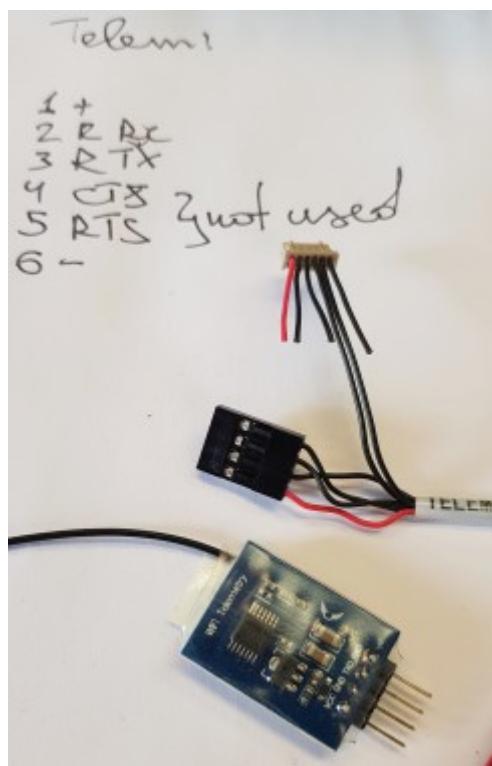


**Pixhawk WiFi ESP-07 module (telemetry) connection wire for Pixhawk2.1 autopilot**

Telemetry cable, supplied with autopilot. Modification is needed. Marked with red connector should be changed to DuPont 4 pin connector.



Pin numbering begins from red wire. To WiFi telemetry module we need +,-,R RC, R TX. WiFi telemetry module pinout is marked at it.



Result should be.

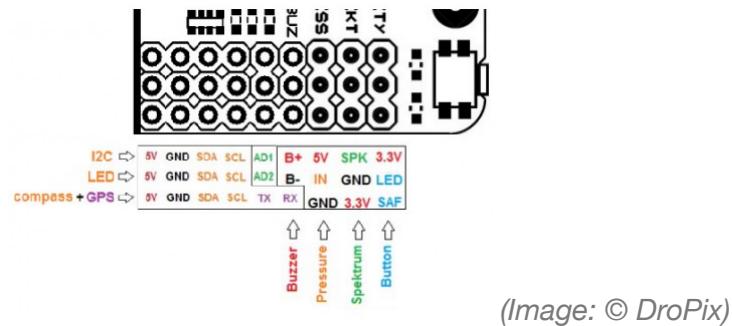


Remote controller receiver (satellite) connection wire for Dropix autopilot.

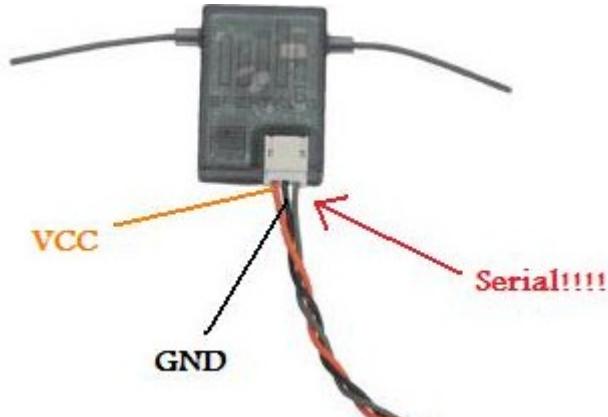
*The wire is not supplied and should be purchased separately or built from components in-house.  
Recommended wire length should be 18 cm.*



RC module should be connected to the Spectrum slot on the autopilot:



RC satellite pinout:



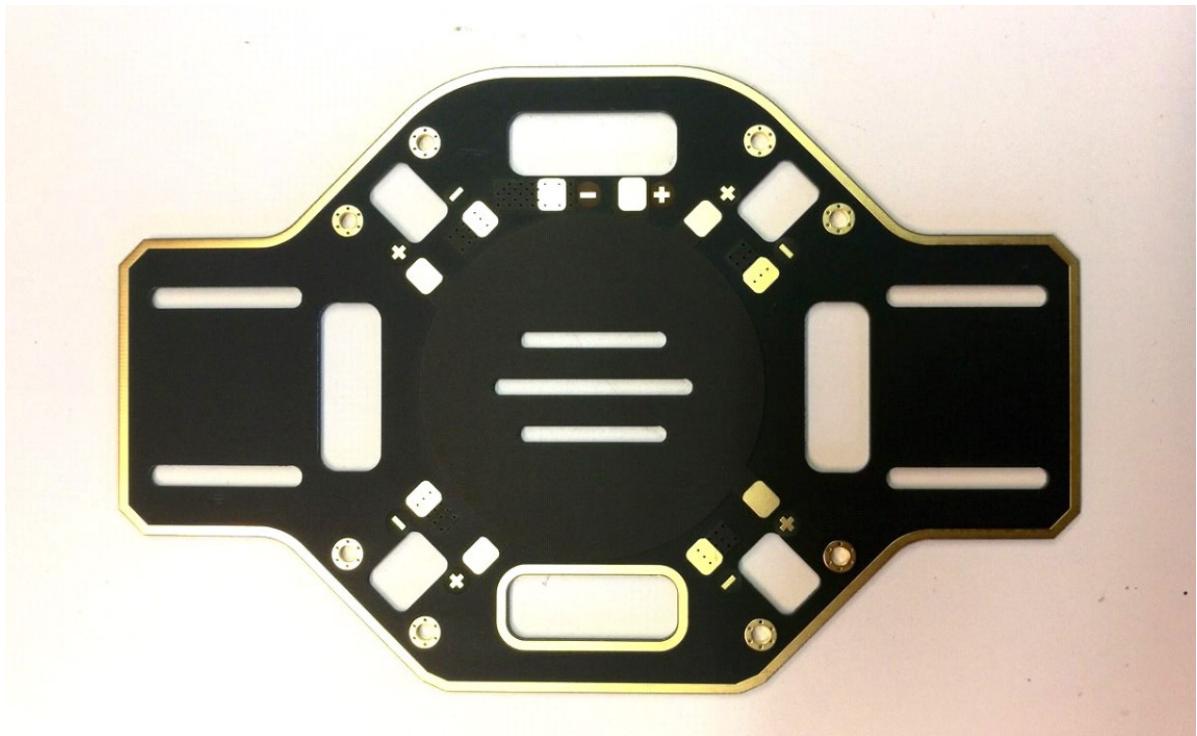
### Battery connection wire

*Solder an XT60 connector to two AWG14 wires from DJI F450 airframe set. This will be the wire that supply power to the payload.*



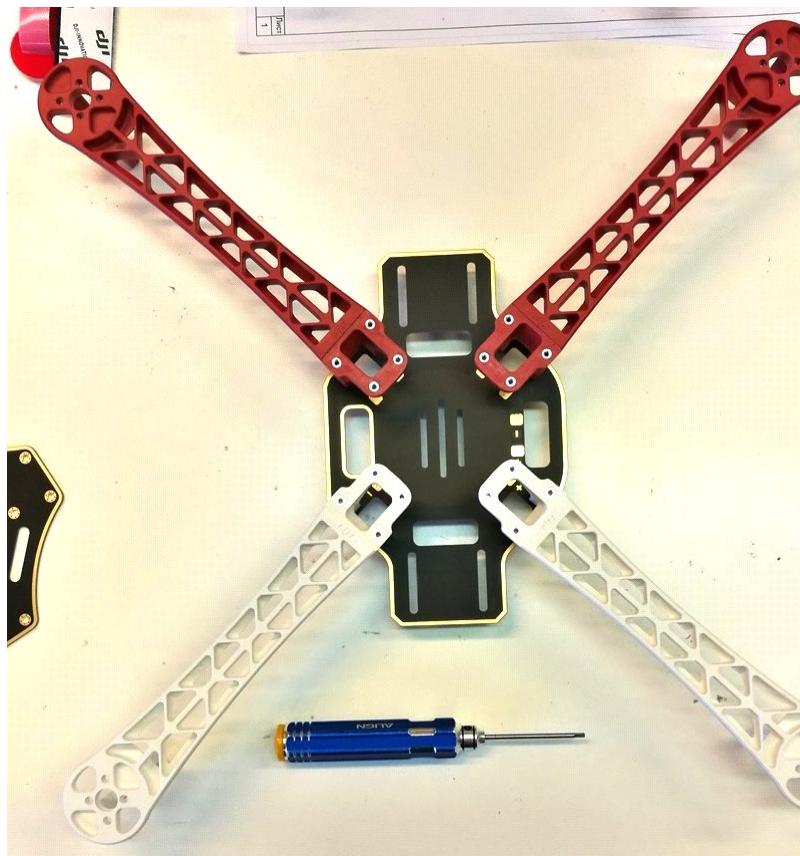
## Assembly

Autopilot is placed inside the frame and the wires are pulled through the frame arms. To complete this procedure please follow the steps below.



Frame bottom plate. Main power input should be connected on the center right side terminals.

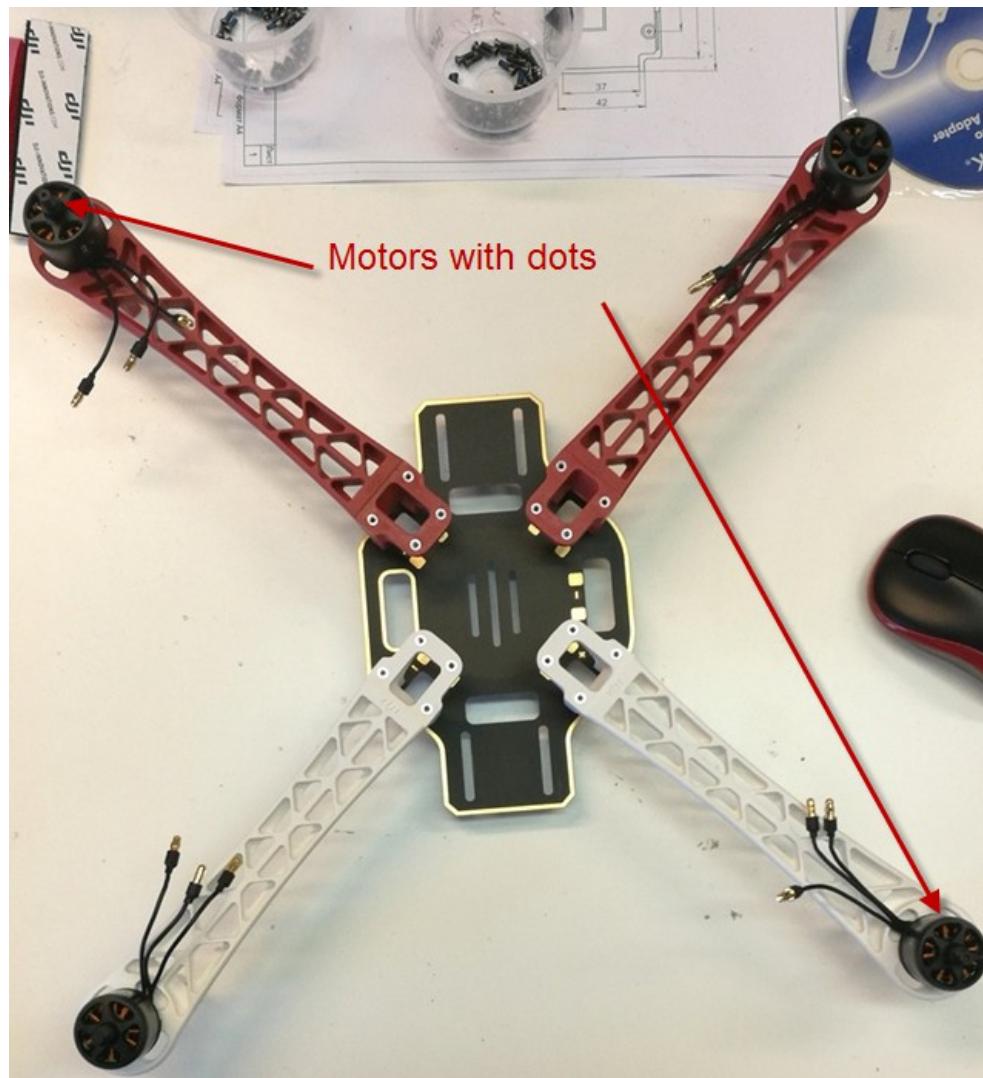
First step is to attach arms to the bottom plate of the frame:



Next step is adding the motors. Make sure that the directions on all of the motors are correct. This indicated by a dot on propeller mounting axis.



At this point, the frame should look like this:

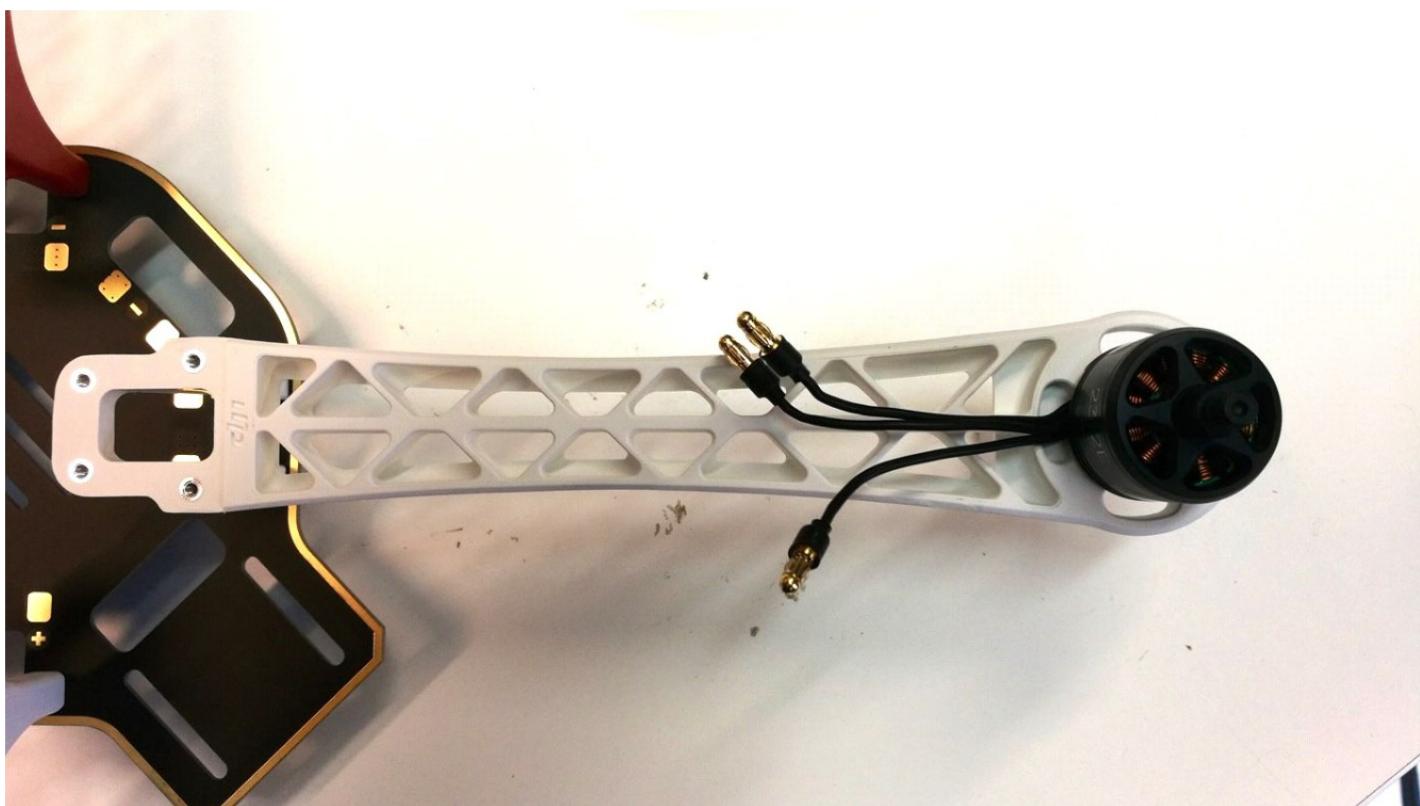


*Motors on left red arm and right white arms should be marked with a dot on the shaft.*

*Left red arm:*



*Right white arm:*

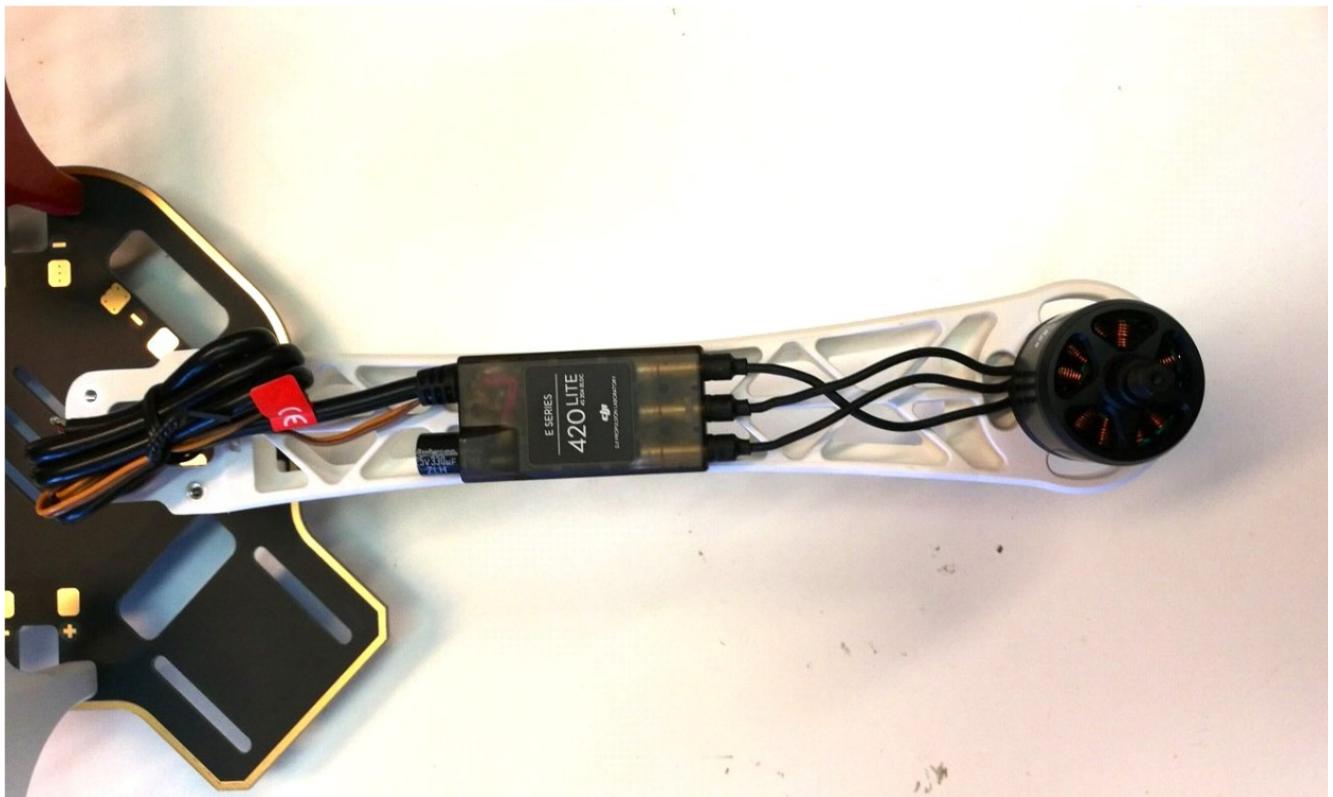


Next, ESCs (Electronic Speed Controllers) need to be mounted on each arm using double-sided tape.



Once the ESC is mounted on the arm, connect the motor wires to the ESC. The sequence does not matter at this point, later the motor direction will be tested and it can be changed by changing any two wires places:

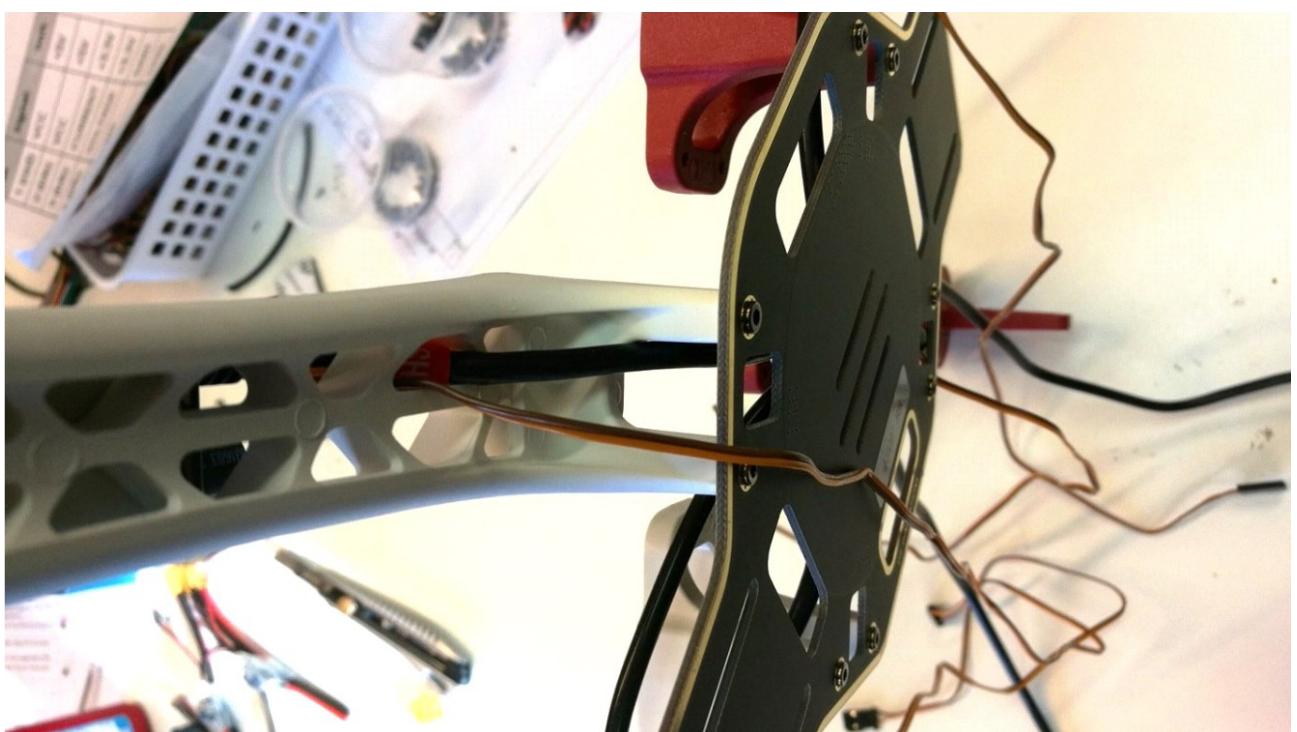
ESC mounted on arm



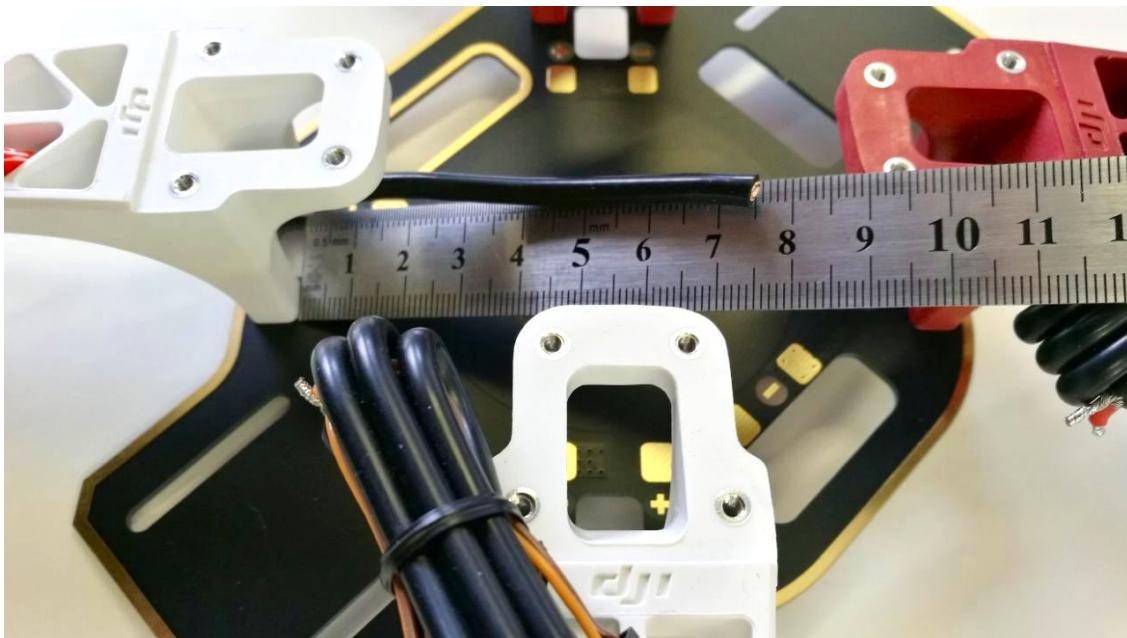
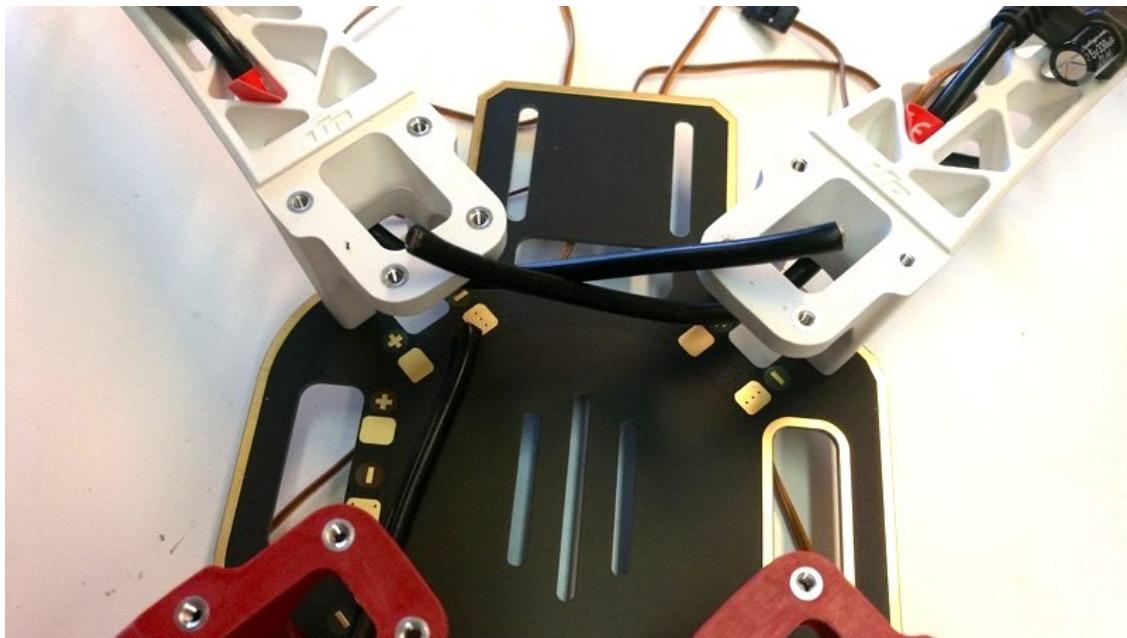
In addition to the double sided tape, secure each ESC to its respective arm with a zip tie. At this step tie only two ESCs: the one on the left white arm and on right red arm. The other two ESCs will be secured with zip ties once the WiFi and RC satellite modules are placed.



Pull the ESC power supply wires through the hole in the place where the arm connects to the base mounting plate:



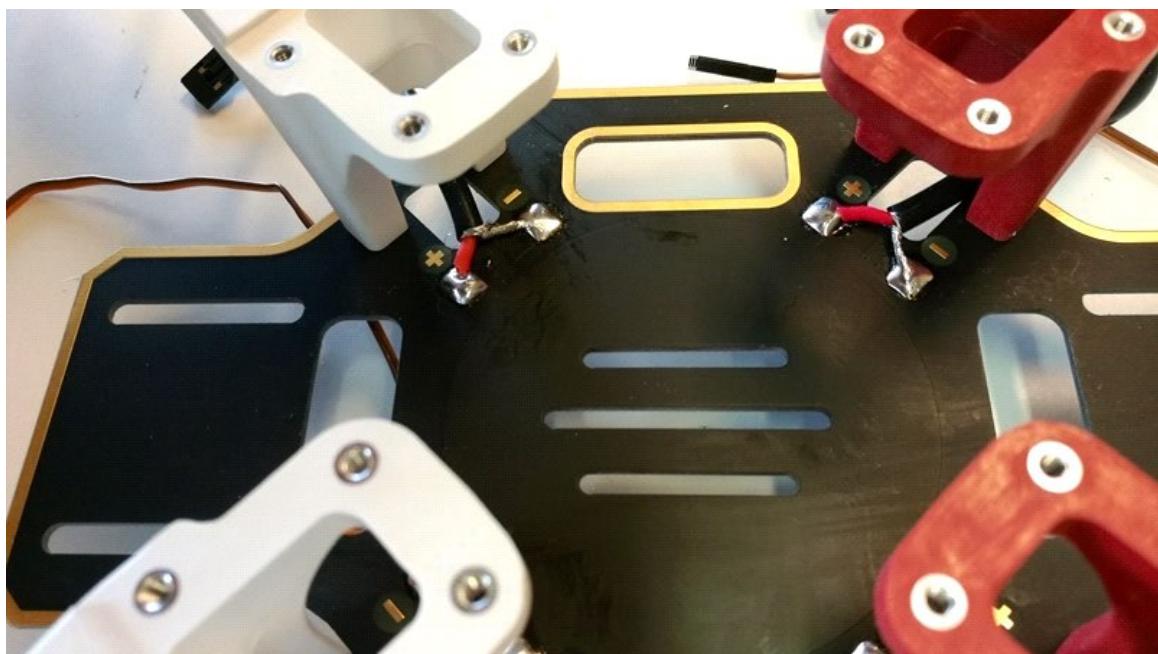
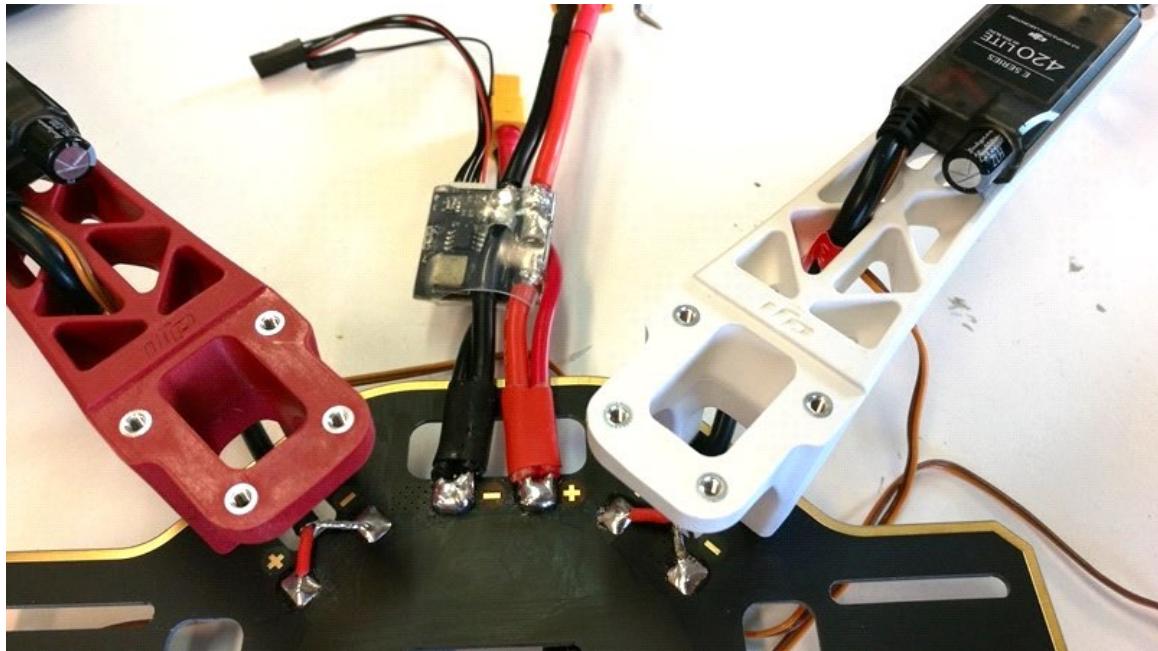
Cut off any excess wire for the power supply wires. Suitable wire length is approximately 7-8cm:



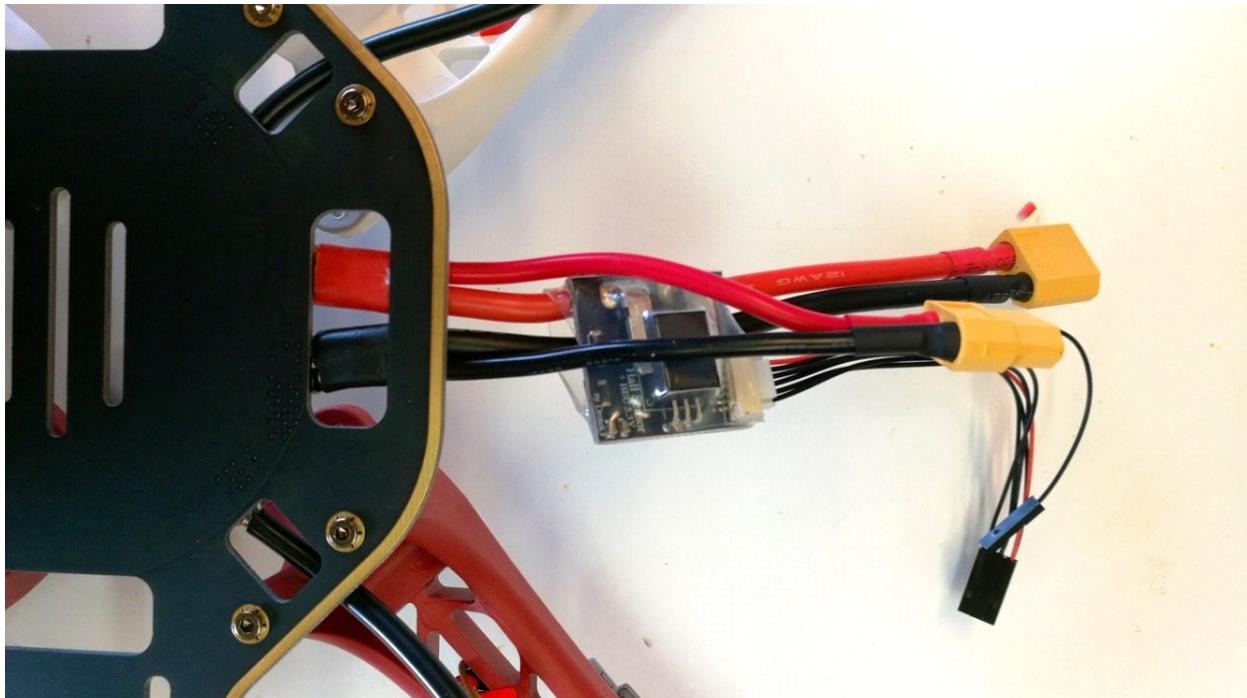
Next step is soldering the wires to the frame base plate. Solder the ESC power supply wires of each arm to the “+” and “-“ terminals located at the mounting point each arm.

The payload power supply wire together with the power module need to be soldered to the main power terminal of the base plate located on the center right side of the base mounting plate.

After the wires are soldered, apply insulation material such as protective lacquer or hot glue to make sure that no non-insulated contacts are exposed. Please check next paragraph is you are using Pixhawk2.1 autopilot.



Power module and payload connection wire soldered onto base plate (Dropix Autopilot):



Power module placement and payload connection wire soldered onto base plate (Pixhawk2.1 Autopilot):

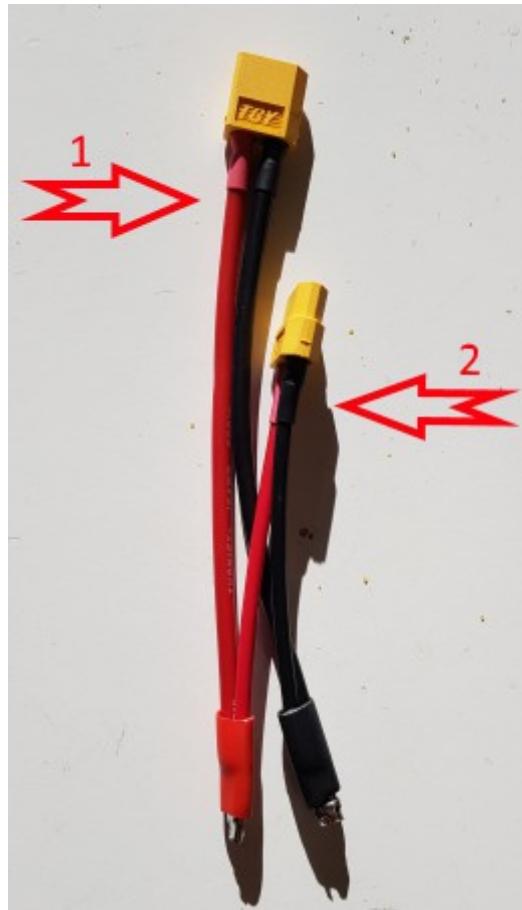
Power2 Cable. Supplied with autopilot, modification not needed.



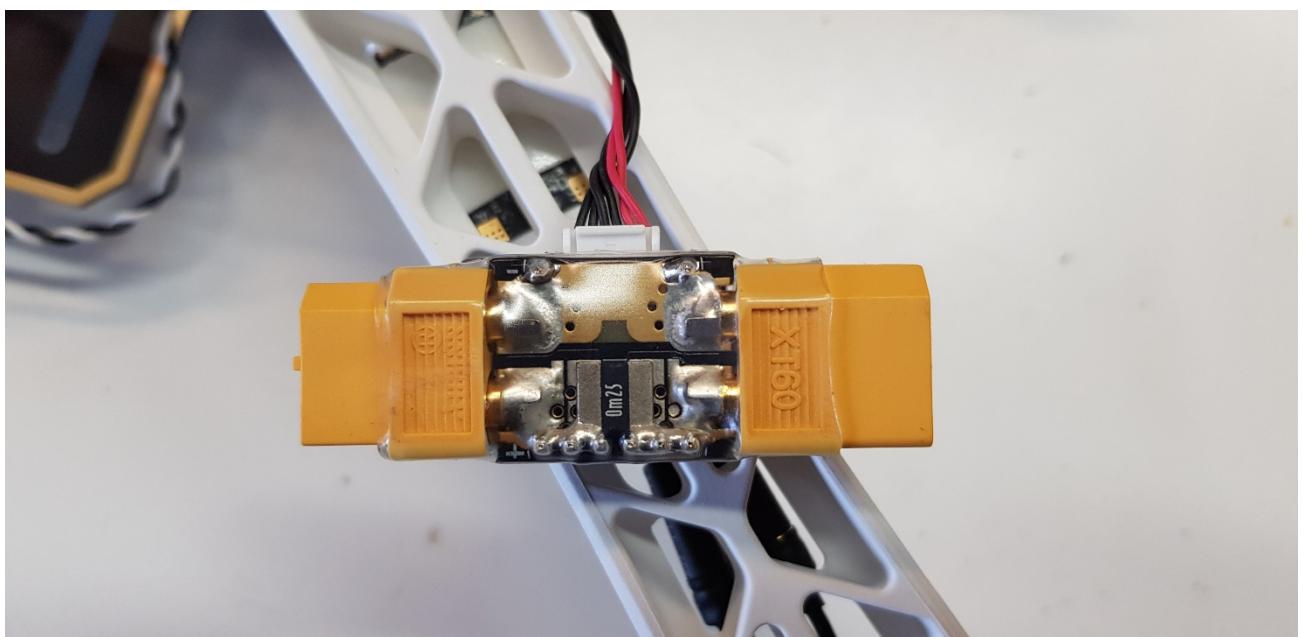
Power Cable. Need to be soldered.

N1 Wire length is 18cm, AWG12 with XTC60 male connector at the end.

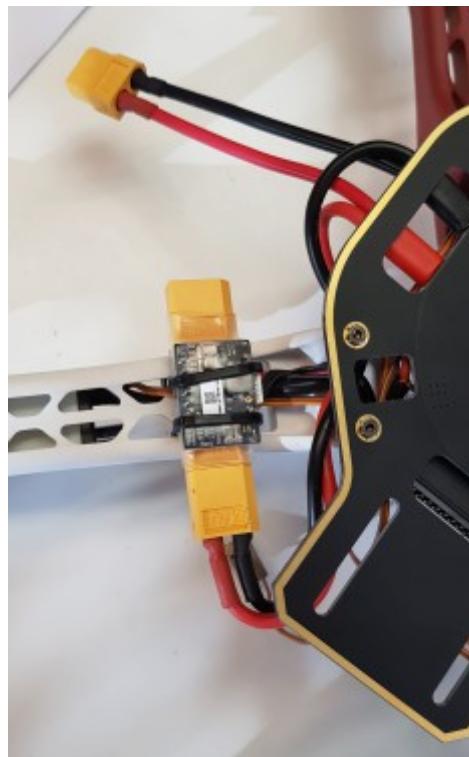
N2 wires are supplied with F450 airframe (AWG14). Need to be soldered XTC60 female connector.



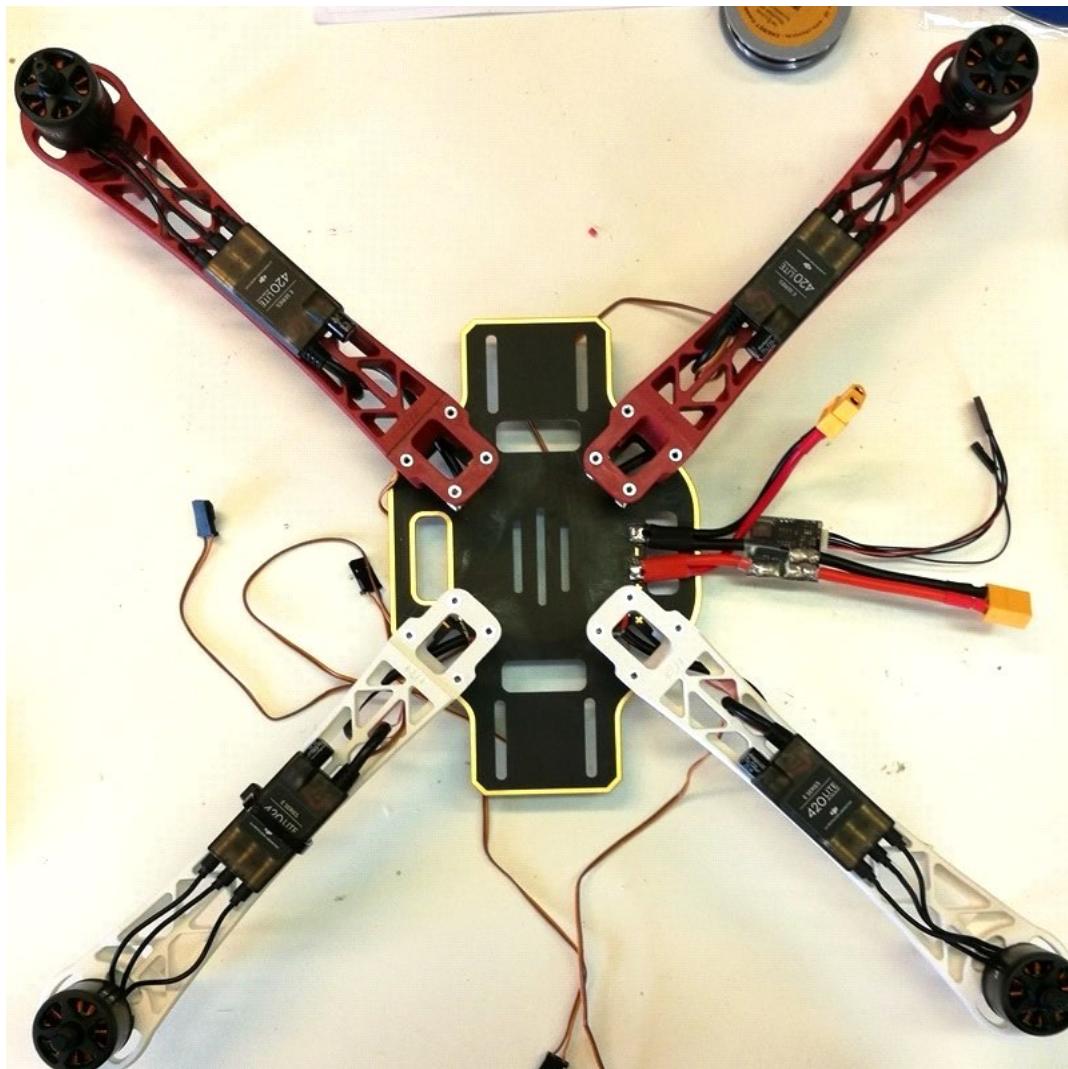
Power Module, supplied with autopilot Pixhawk2.1 standard set.



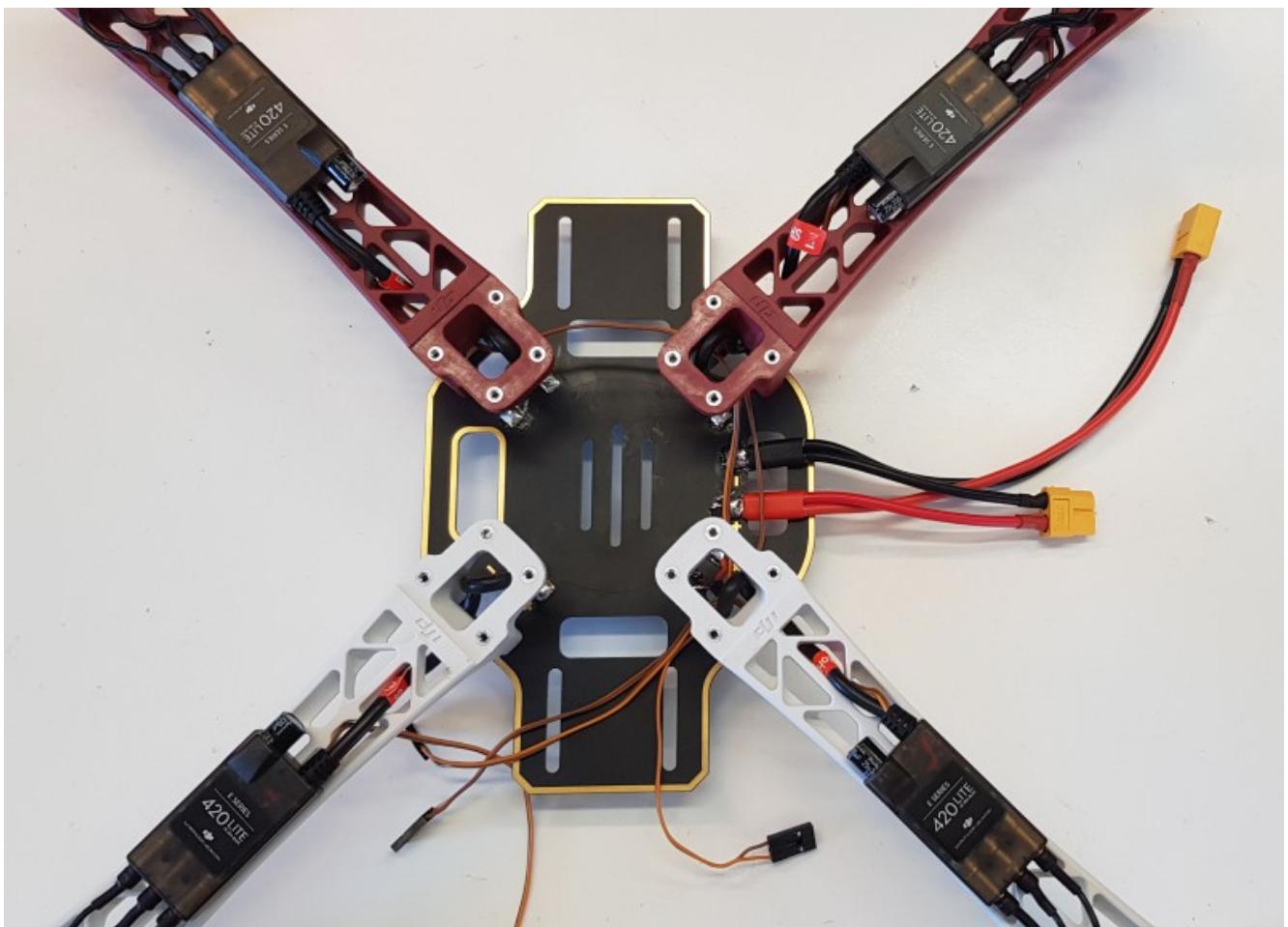
Power module mounting at right white (motor B) F450 arm.



At this point, the frame should look like this (Dropix autopilot):

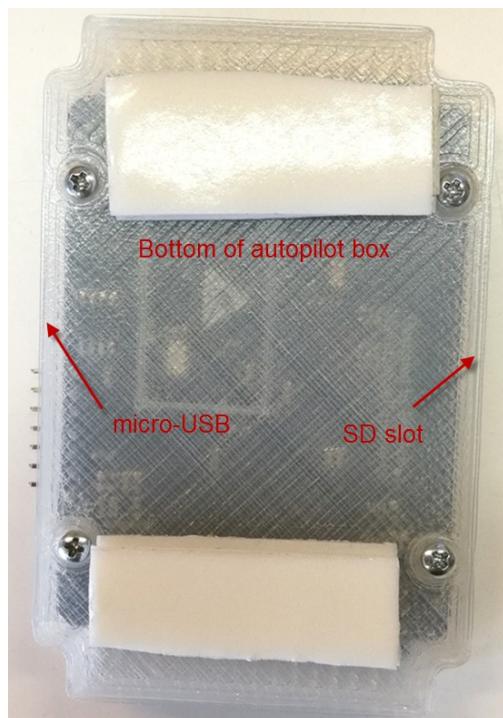


At this point, the frame should look like this (Pixhawk2.1 autopilot):



The autopilot box needs to be mounted to the base plate using vibration dampers or several layers of double-sided tape.

Bottom side of autopilot's box (Dropix):

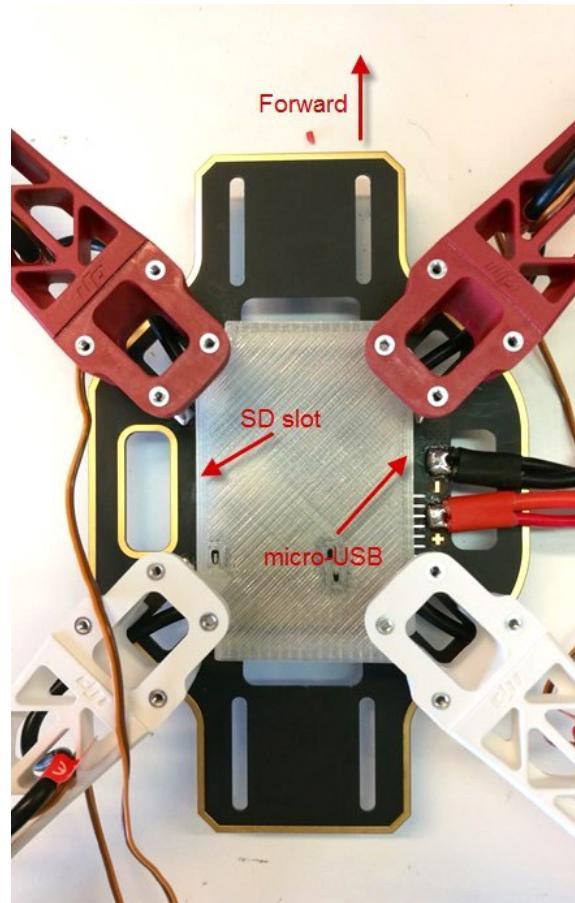


Bottom side of autopilot's box (Pixhawk2.1):

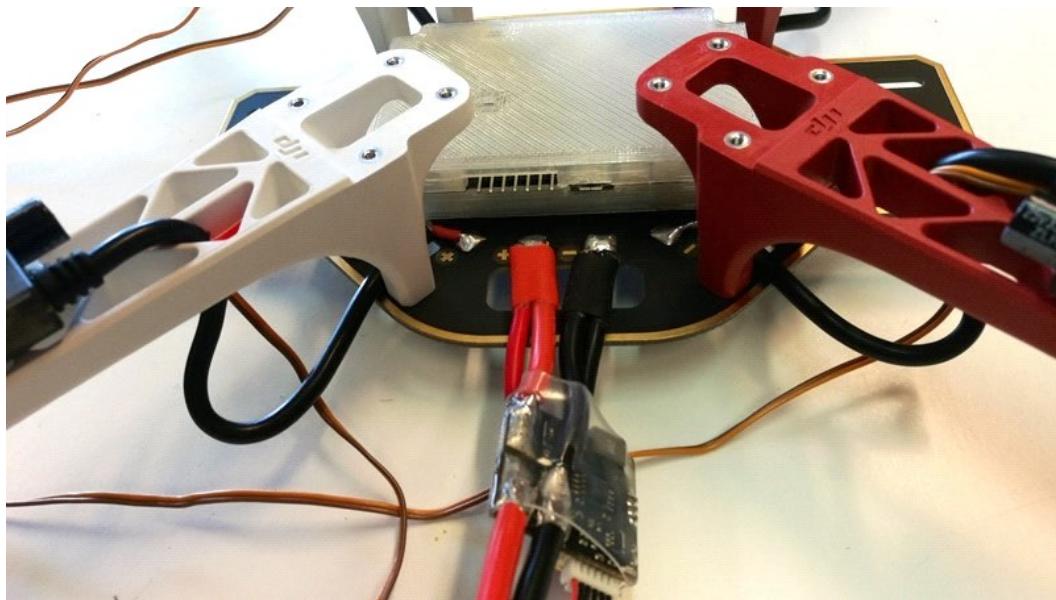


Autopilot should be placed at the very centre of the plate (Dropix):

*Autopilot must be oriented on base mounting plate in such a way so that the SD card slot is on left side and micro-USB connector on right side of the airframe.*

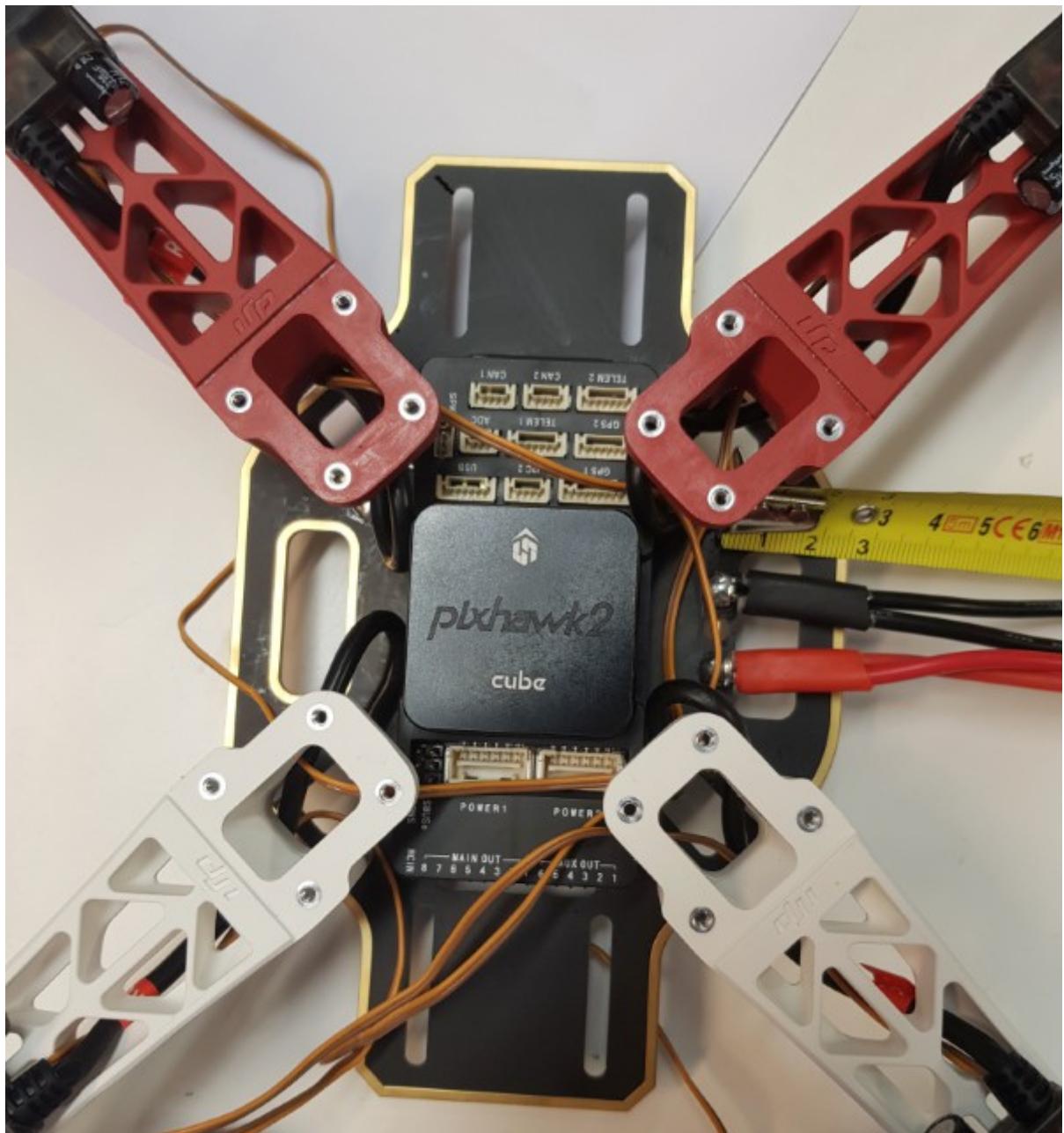


Autopilot micro-USB port and Power module pins should be accessible from the right side (Dropix).

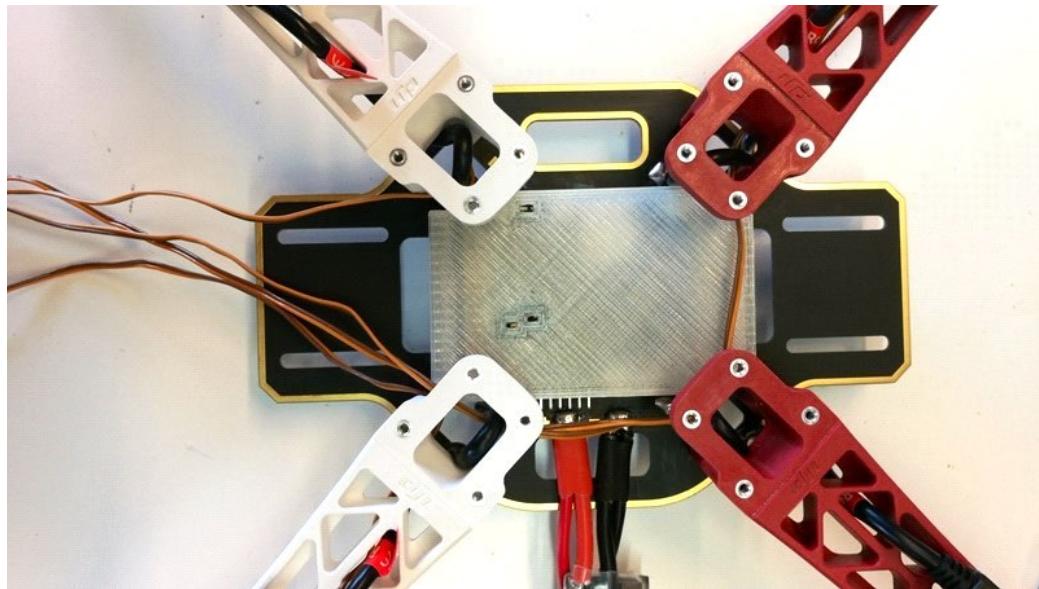


Autopilot should be placed at the very centre of the plate (Pixhawk2.1):

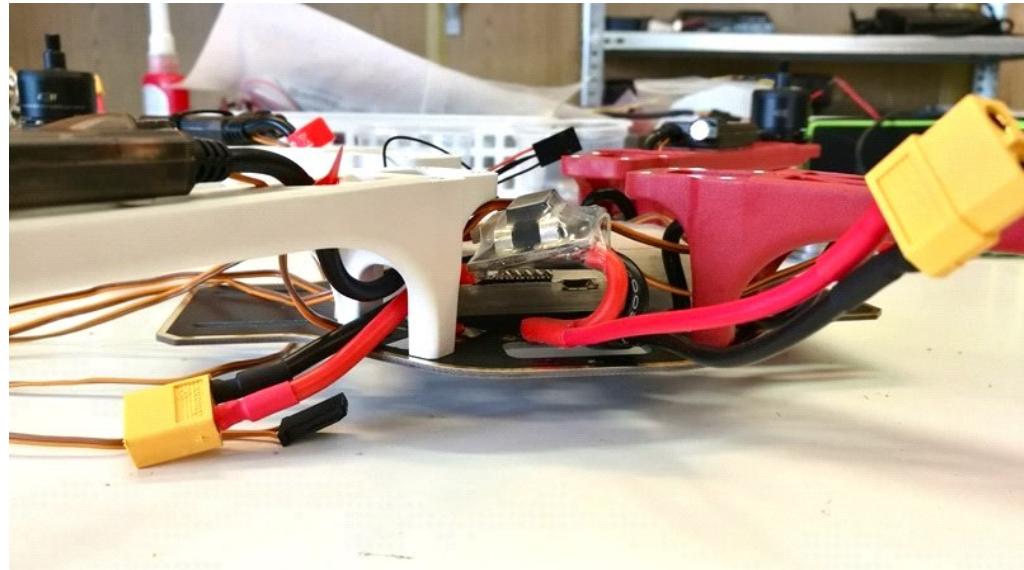
*Autopilot must be oriented on base mounting plate in such a way as at the picture.*



Place the ESC PWM wires as shown in the picture:

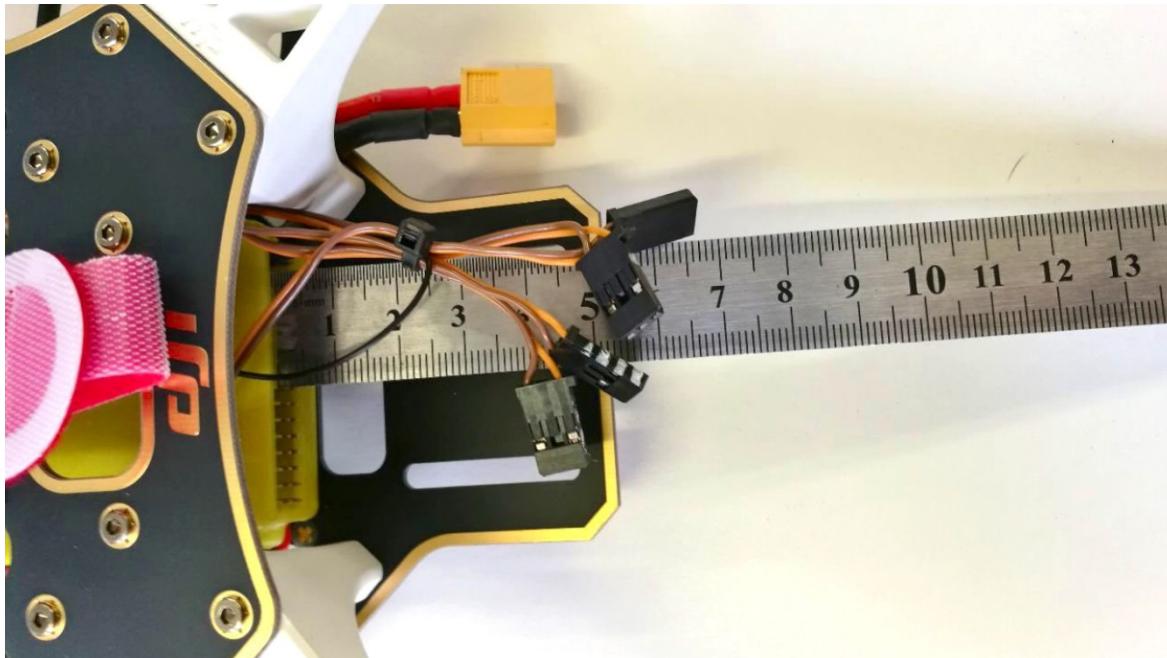


Pull the main power connector through the hole in the right white arm:

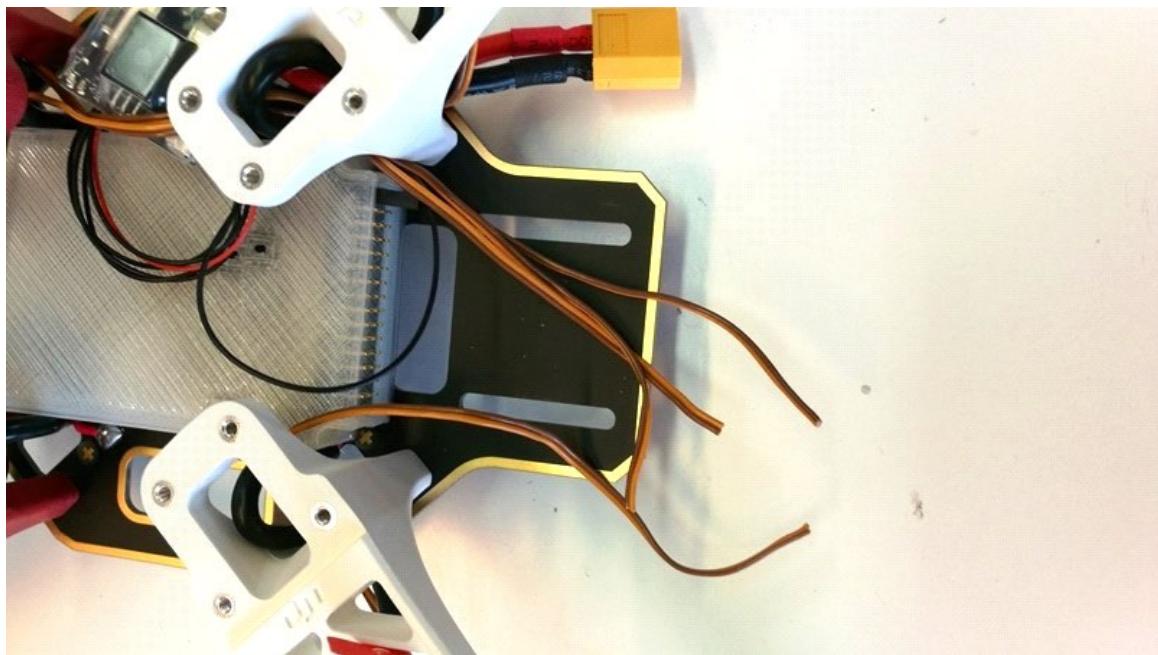


Next step is to shorten ESC PWM wires to avoid unnecessarily long wires.

Approximate resulting length of ESC PWM wires:



Cut the ESC PWM wires:

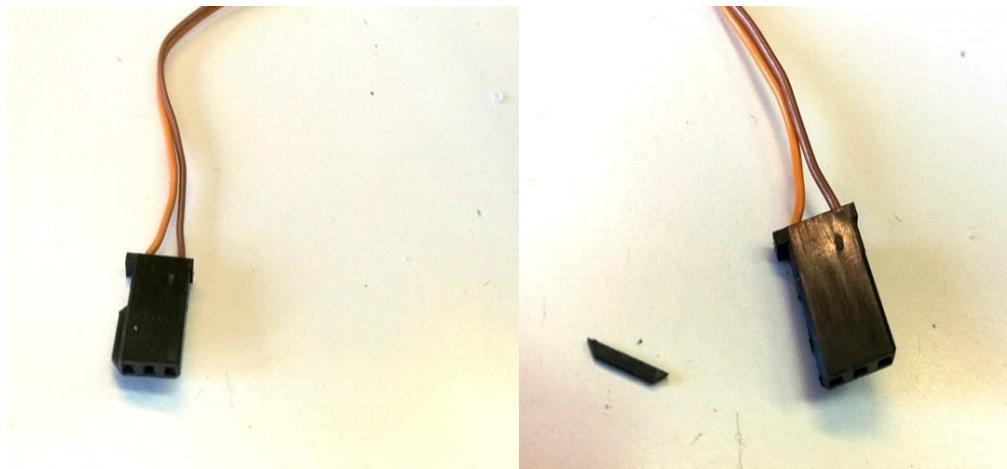


Attach the connector pins:

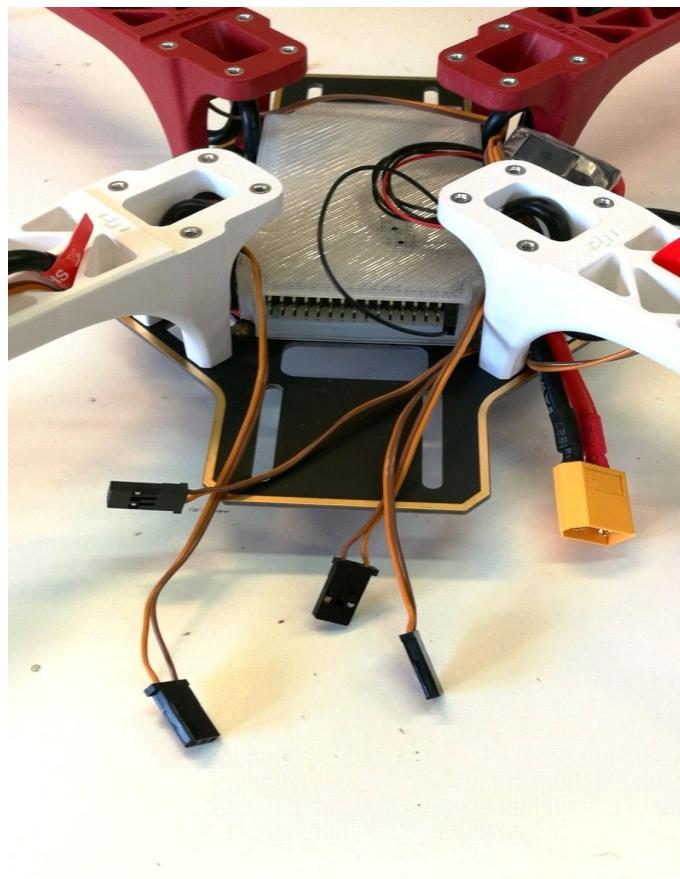


*Plug wires with their pins into the plastic plugs. Some 3 pin servo connectors like this will have a plastic rail which, depending on the autopilot box, can keep the wire from being plugged in fully.*

If necessary, cut off the excess plastic rail from the wire plugs.

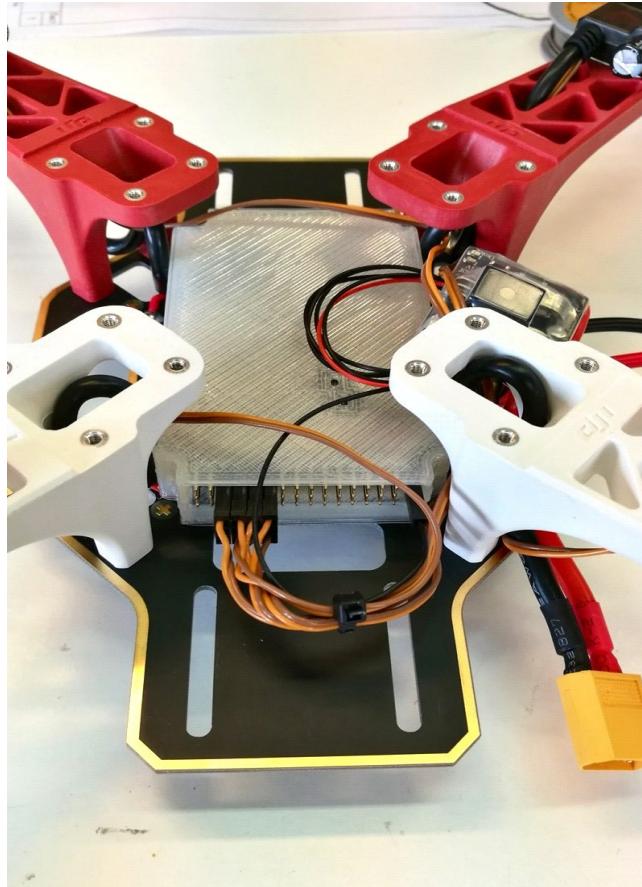


Now the frame should look like this:



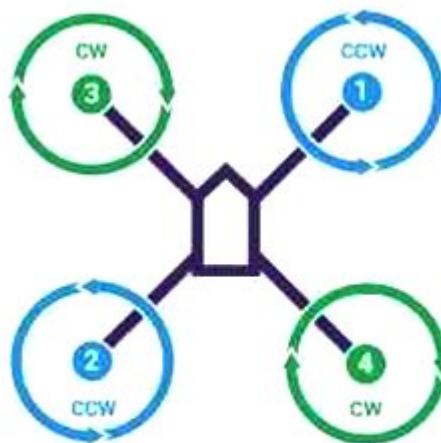
*Connect the ESC wires to the autopilot according to the pinout.*

Fix the wires together with a zip tie.



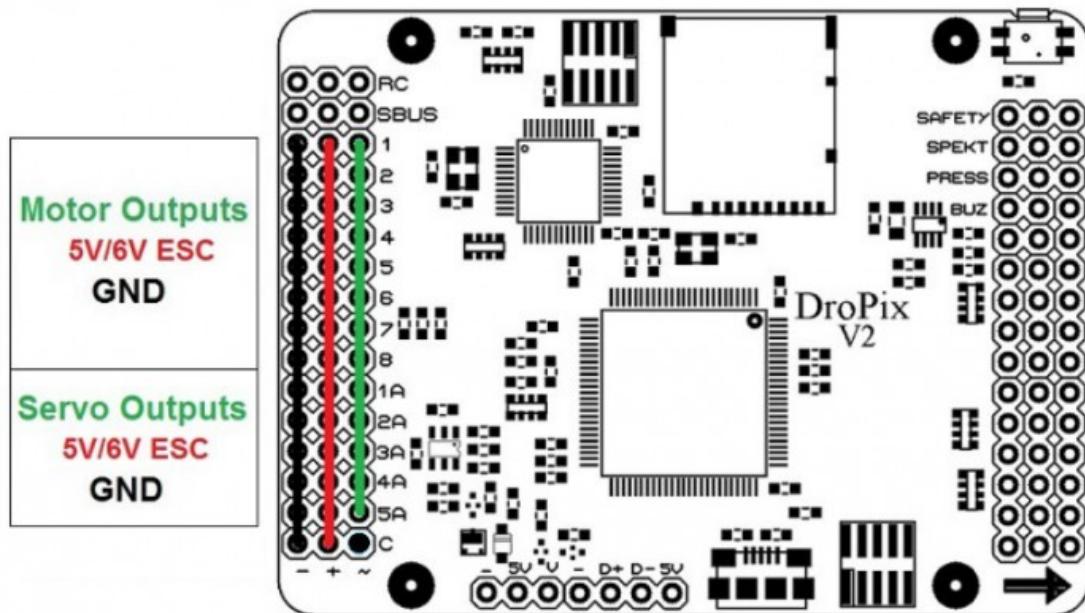
The frame type of DJI F450 is a QUAD X. Below are the motor numbers and their directions. The ESC wires from respective motors should be connected to the autopilot motor output pins according to the schematic below.

For example, the top left motor is designated by the number 3. So the ESC PWM wire from this motor should be plugged in the autopilot motor output slot with a corresponding number – 3.



QUAD X

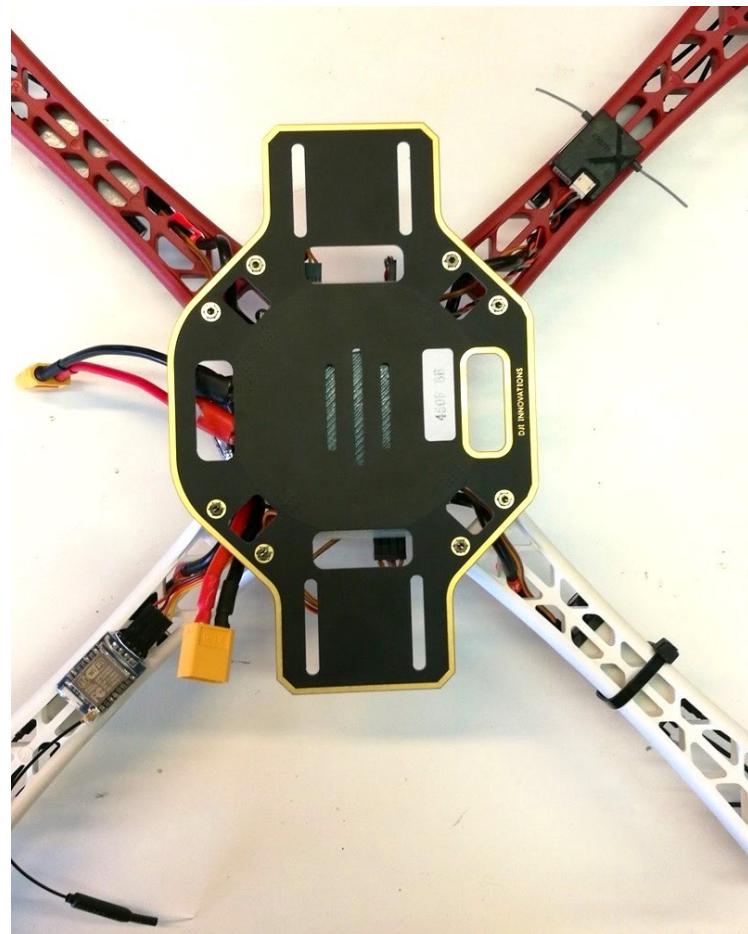
(Image: © Ardupilot)



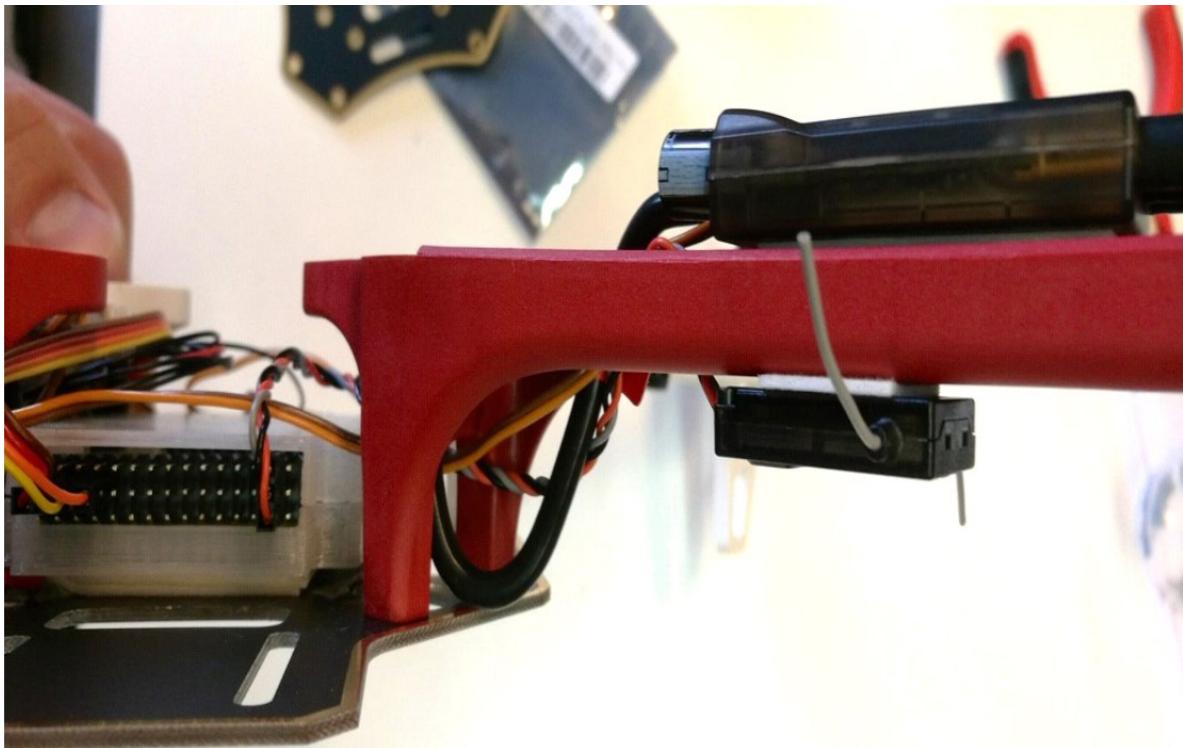
(Image: © DroPix)

Next step is to attach the Wi-Fi and Spektrum receiver modules to the arms. This is done using double-sided tape. Looking from the top, the Spektrum receiver should be mounted on the left top arm and the Wi-Fi module should be mounted on the right bottom arm.

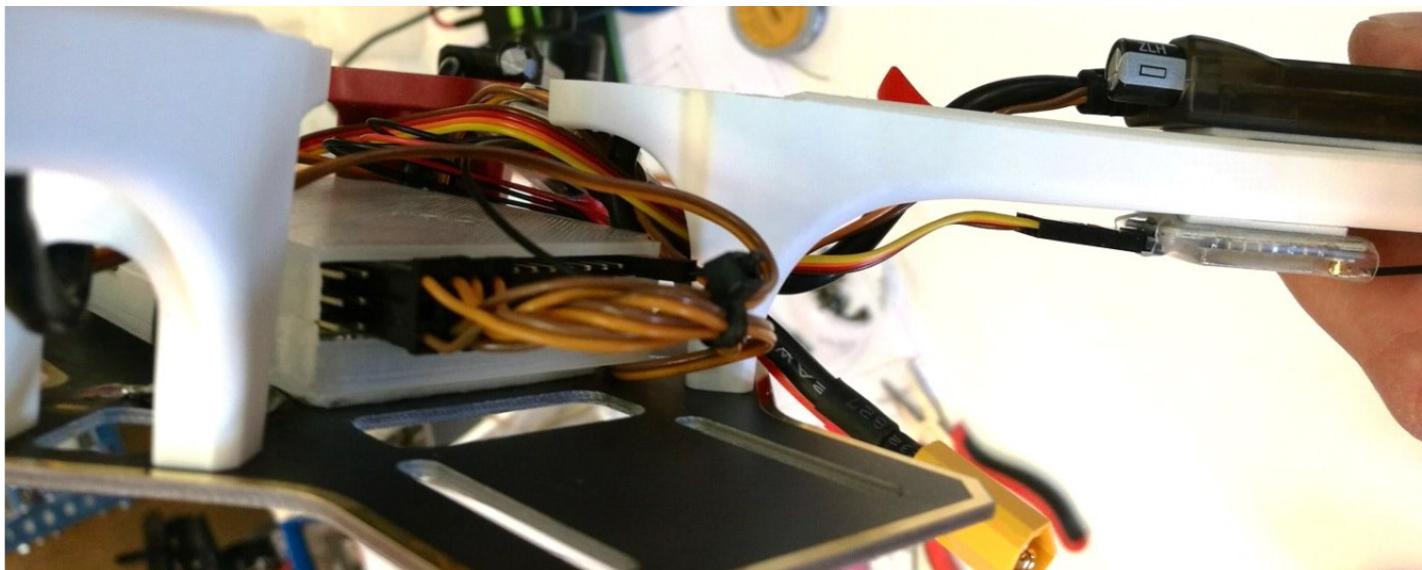
Wires should be connected to their respective ports on the autopilot.



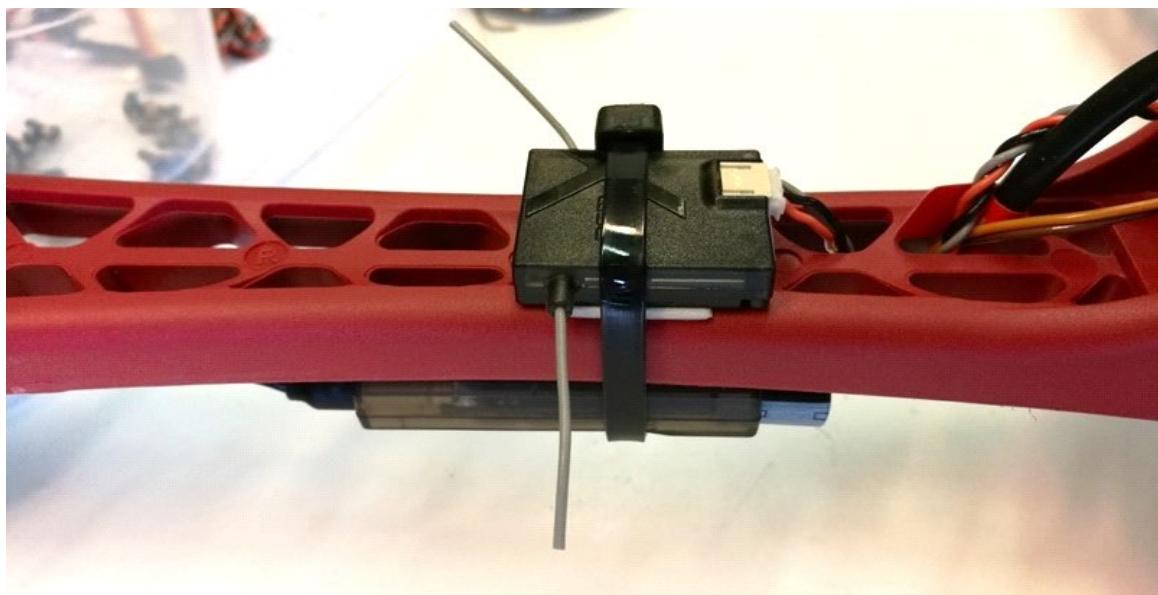
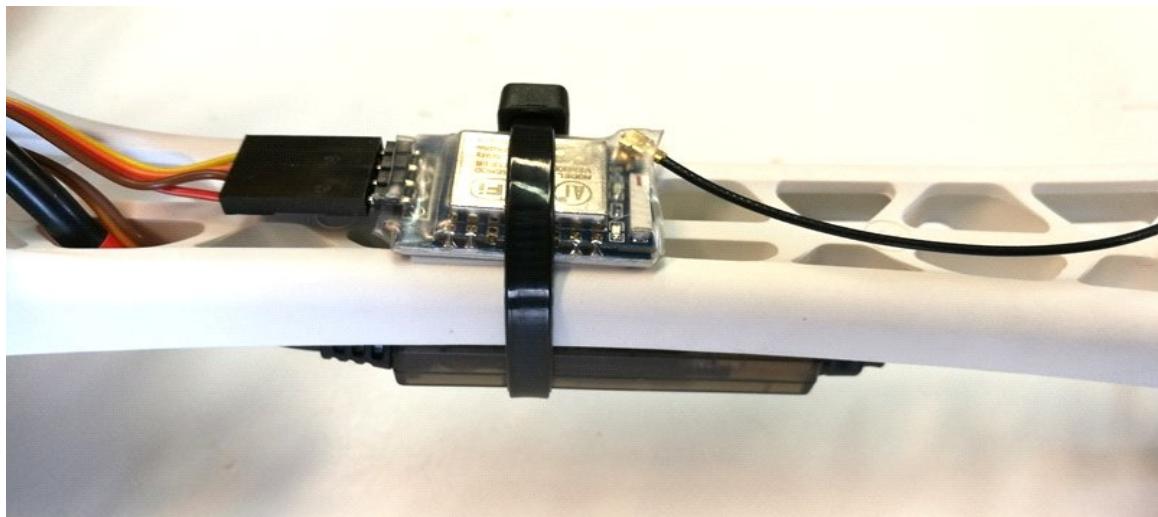
Spektrum RC receiver placement:



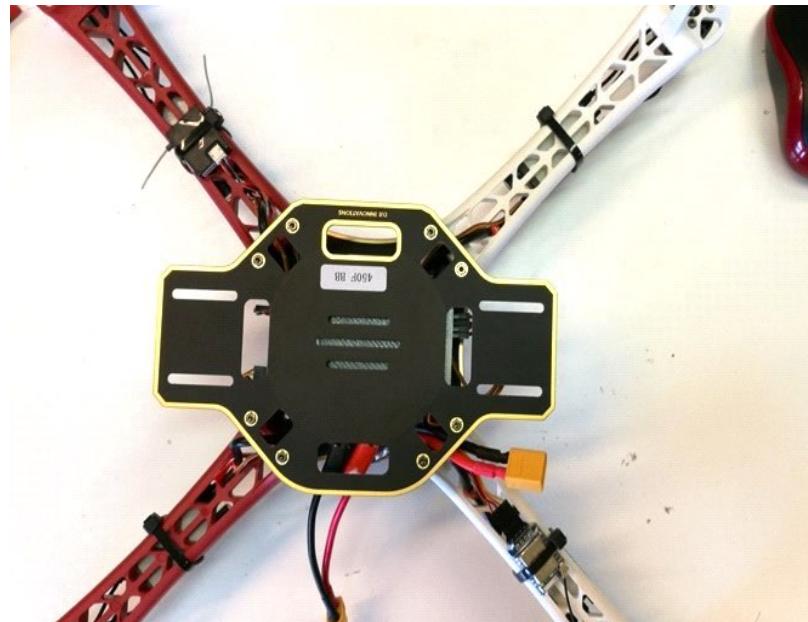
Wi-Fi telemetry module placement:



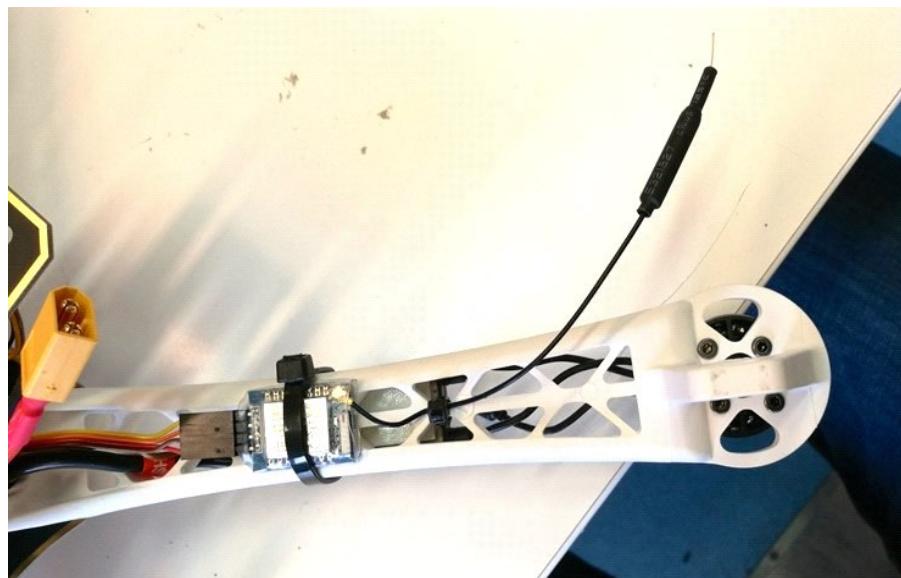
Use a zip tie to fix Wi-Fi and RC modules with the ESCs to the arm:



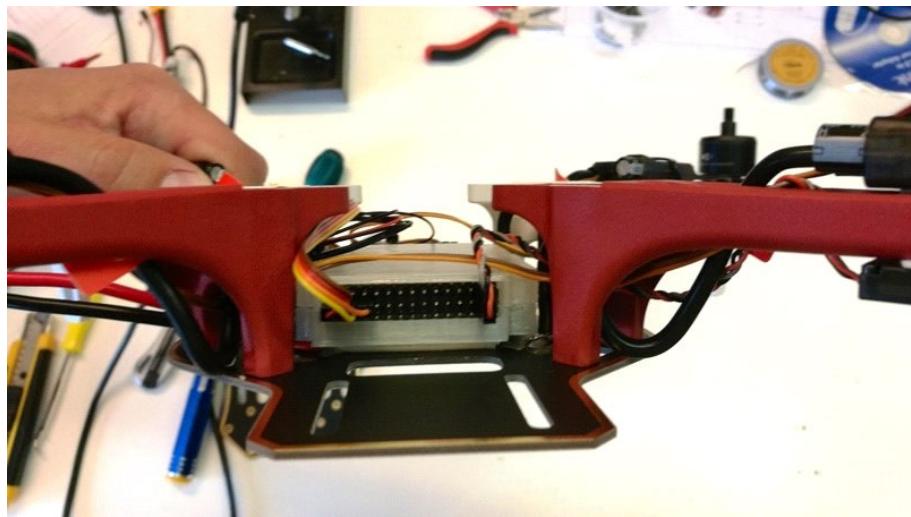
At this step the frame should look like so:



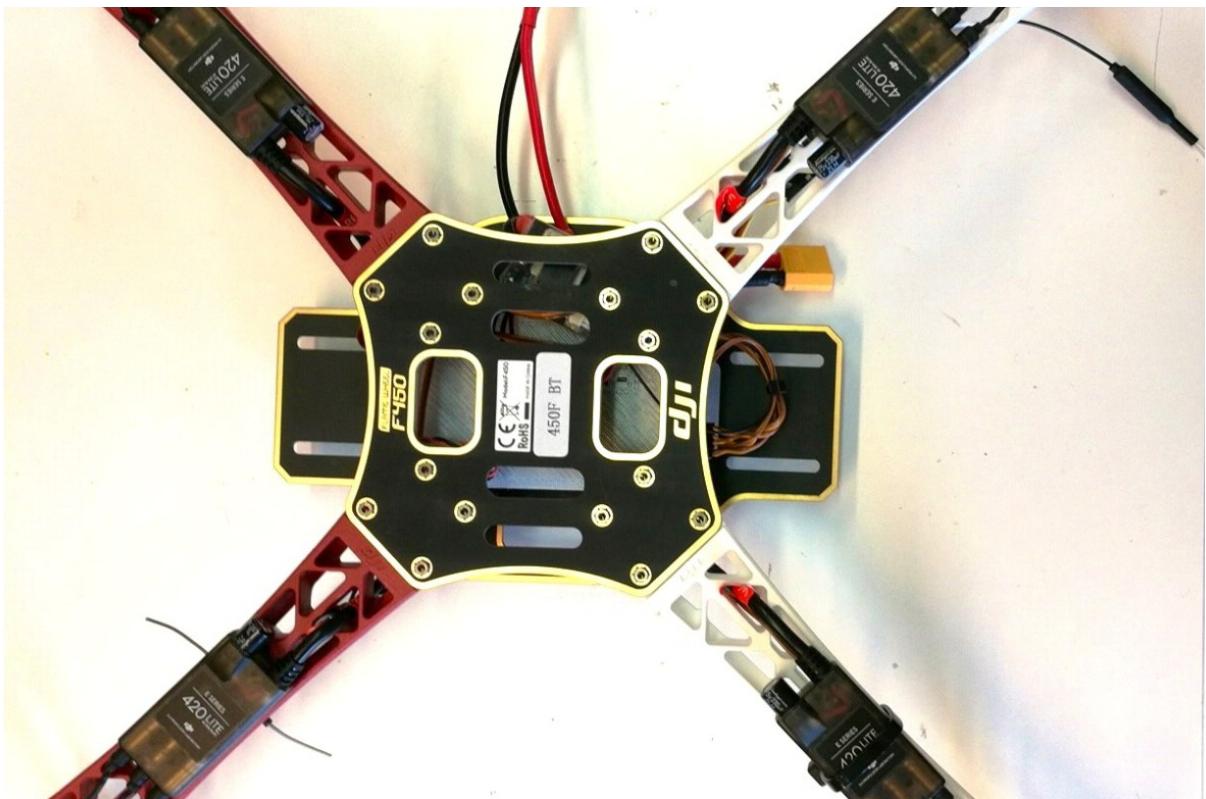
Use a cable tie to fix the Wi-Fi antenna to the arm of the copter:



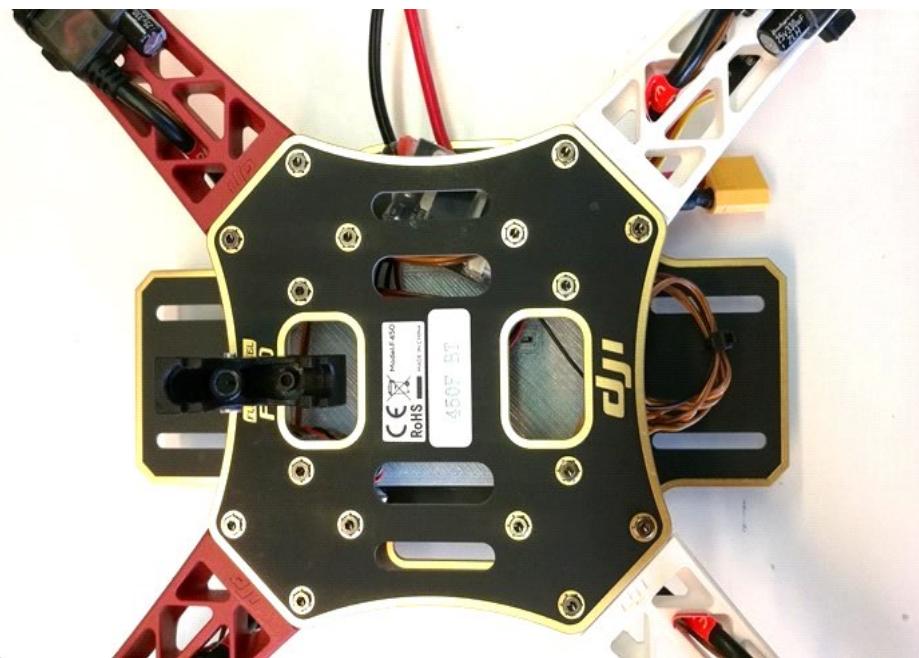
The RC and Wi-Fi modules should be connected to the autopilot:



The top plate of the air frame can now be attached:

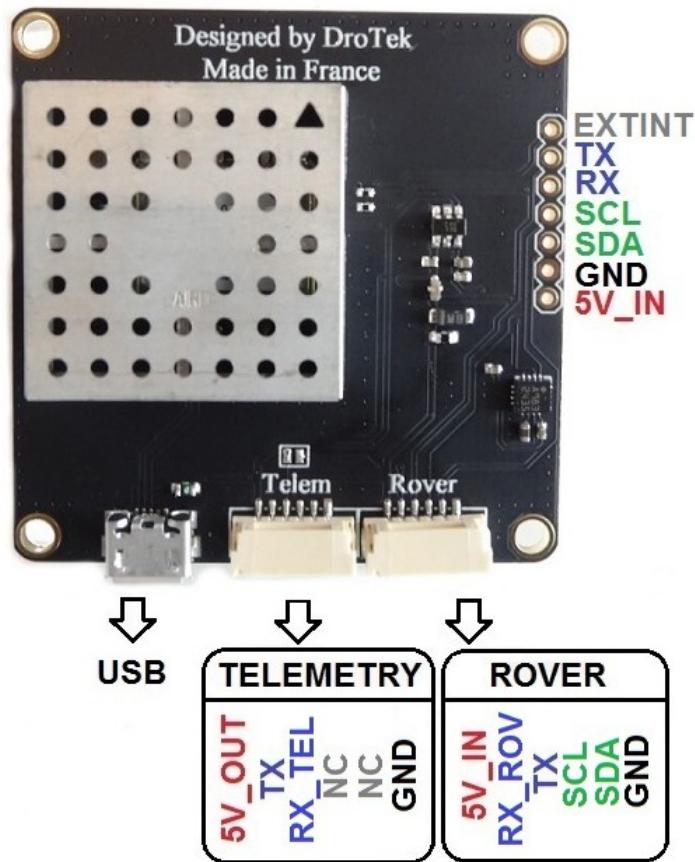


Fix with GPS bottom mount to the top plate:



## Drotek XL RTK GPS

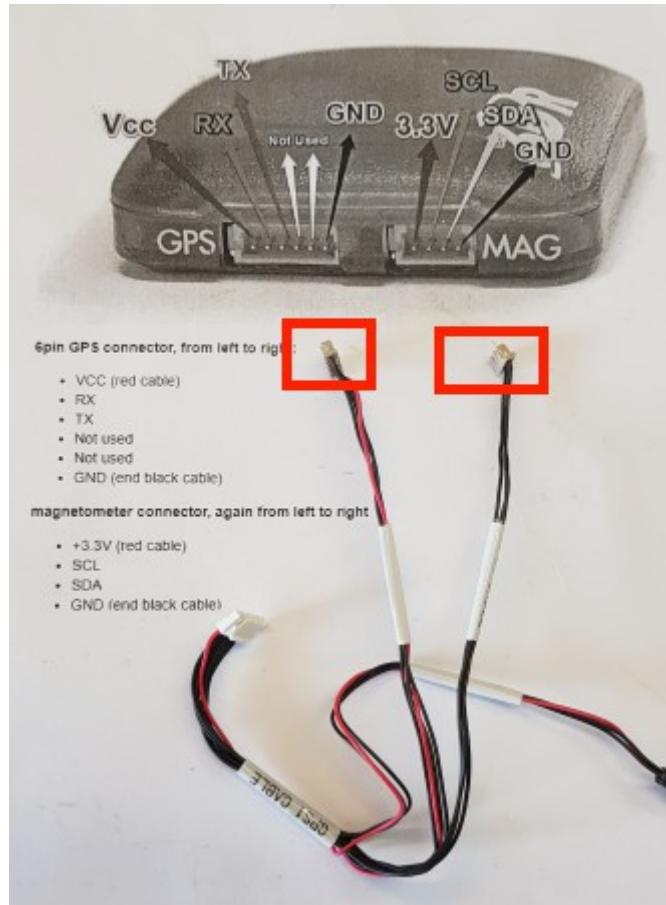
The wire to the autopilot should be connected to the Rover port of the GPS unit.



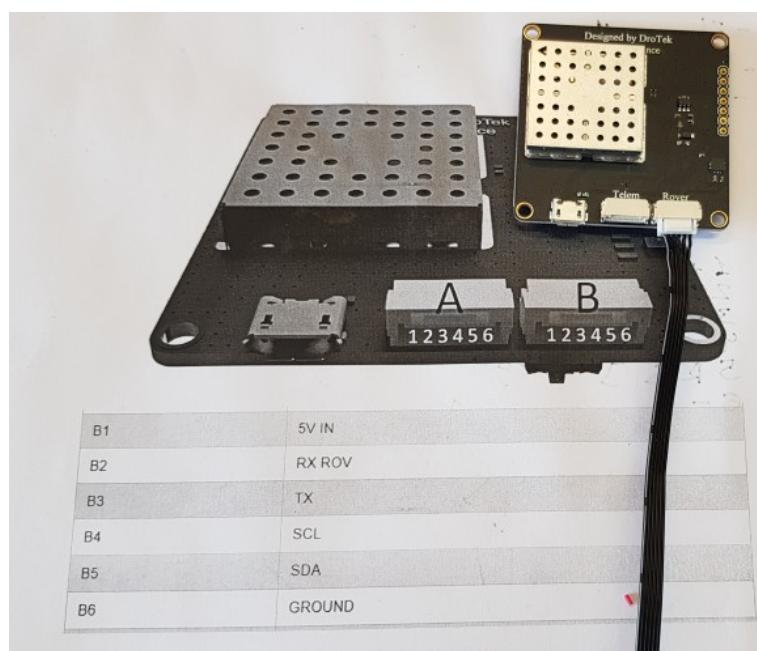
(Image: © DroTek)

## Drotek XL RTK GPS wire modification for Pixhawk2.1 autopilot

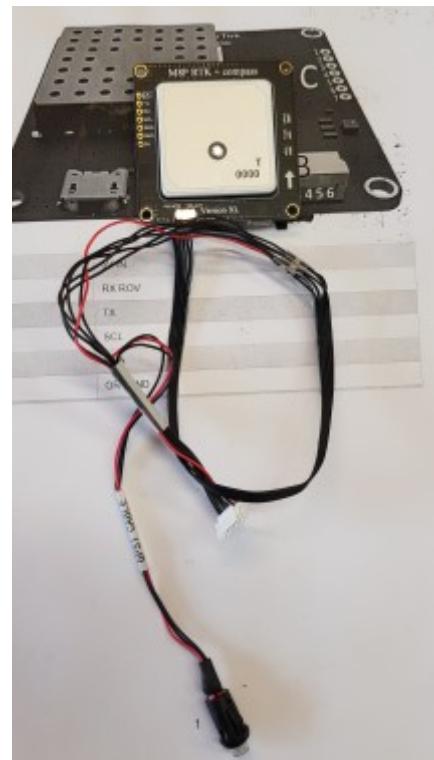
GPS1 cable, supplied with autopilot and Drotek XL RTK GPS. Modification is needed. As we use different GPS module. Marked with red connectors should be removed and wires soldered with GPS cable wires. Connectors pinout is at the picture below.



GPS module with cable and its pinout. Cable is supplied with GPS module.

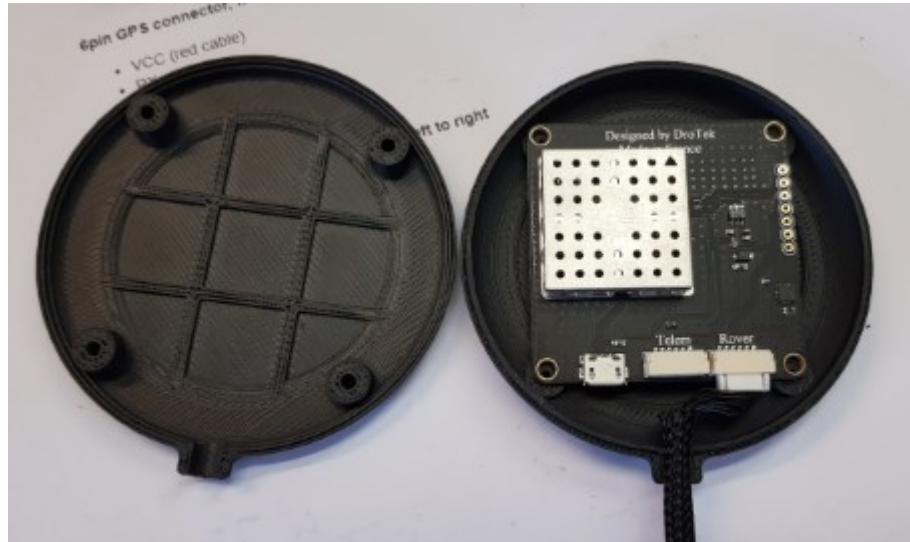


GPS1 cable and GPS cable after modification.



## Drotek XL RTK GPS mounting

A case for GPS units is not provided by the manufacturer, it should be 3D printed.



The mast of the GPS unit needs to be fixed to the mounting plates using glue or epoxy. After that the GPS unit itself should be fixed to the mounting plate at the top of the mast using double-sided tape.

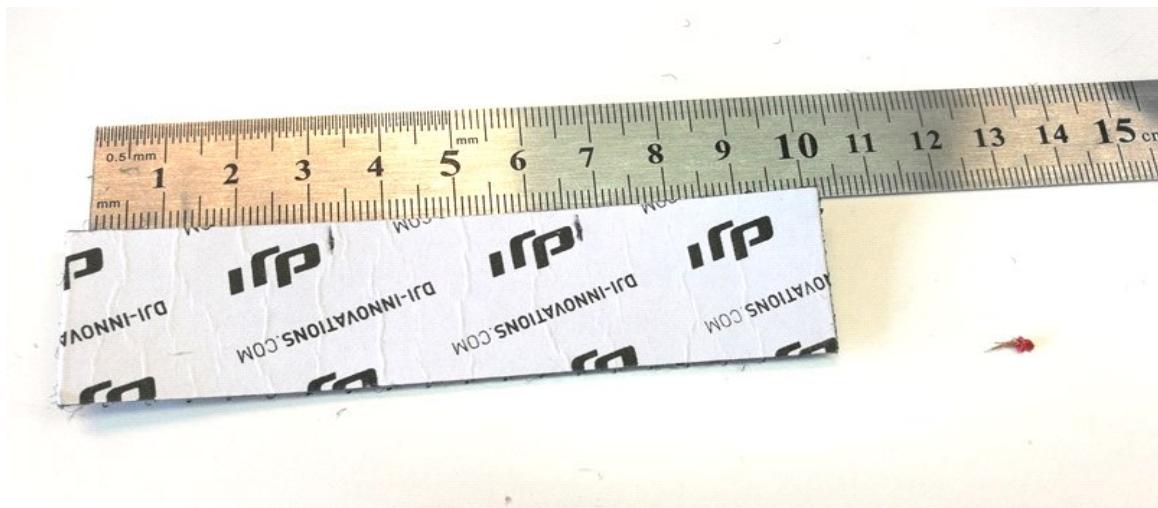
## Here+ Rover (M8P) RTK GPS mounting

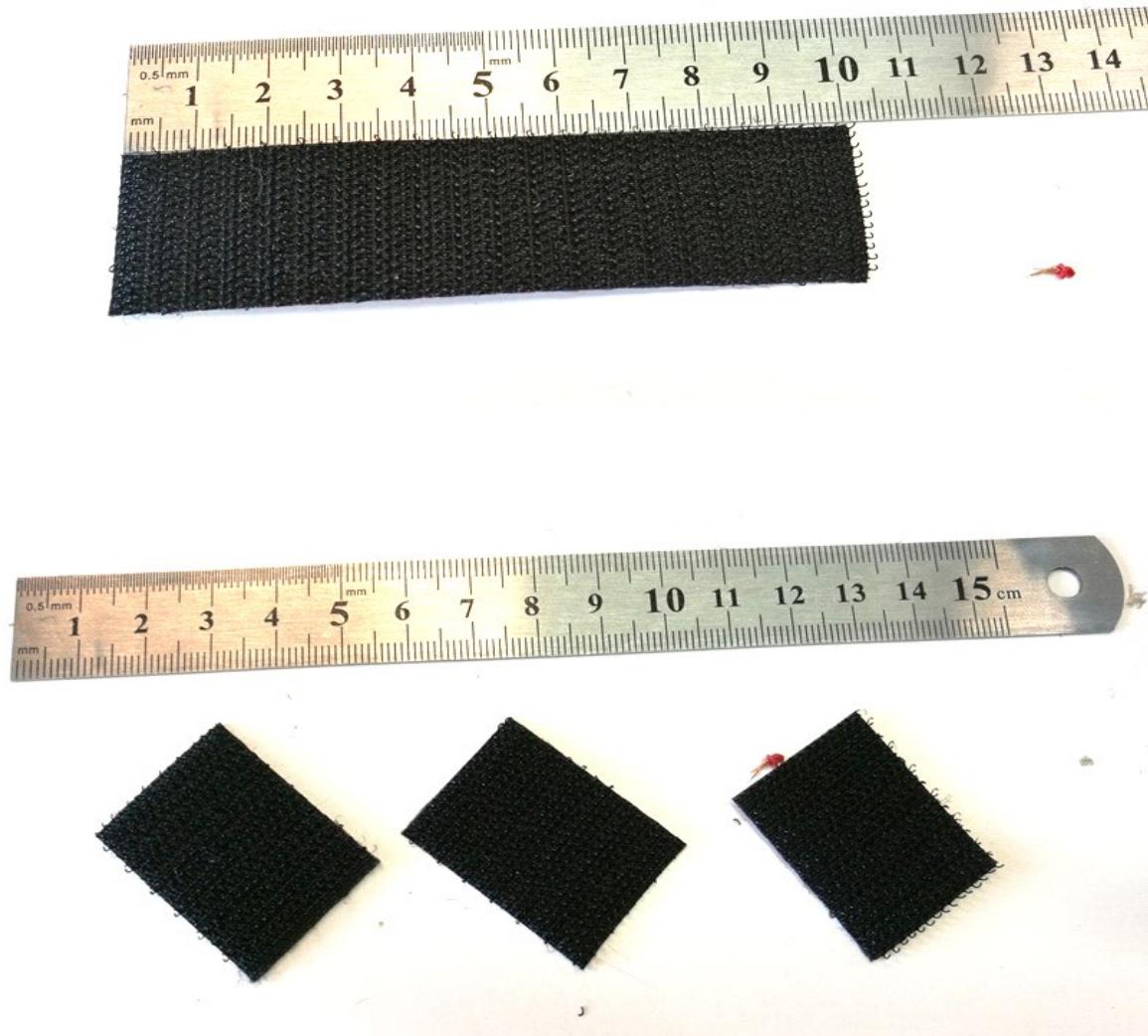
If fully suitable for Pixhawk2.1 autopilot, don't need any modification. It already has case and wire for Pixhawk2.1.

Wires from the GPS unit should exit on the rear side.

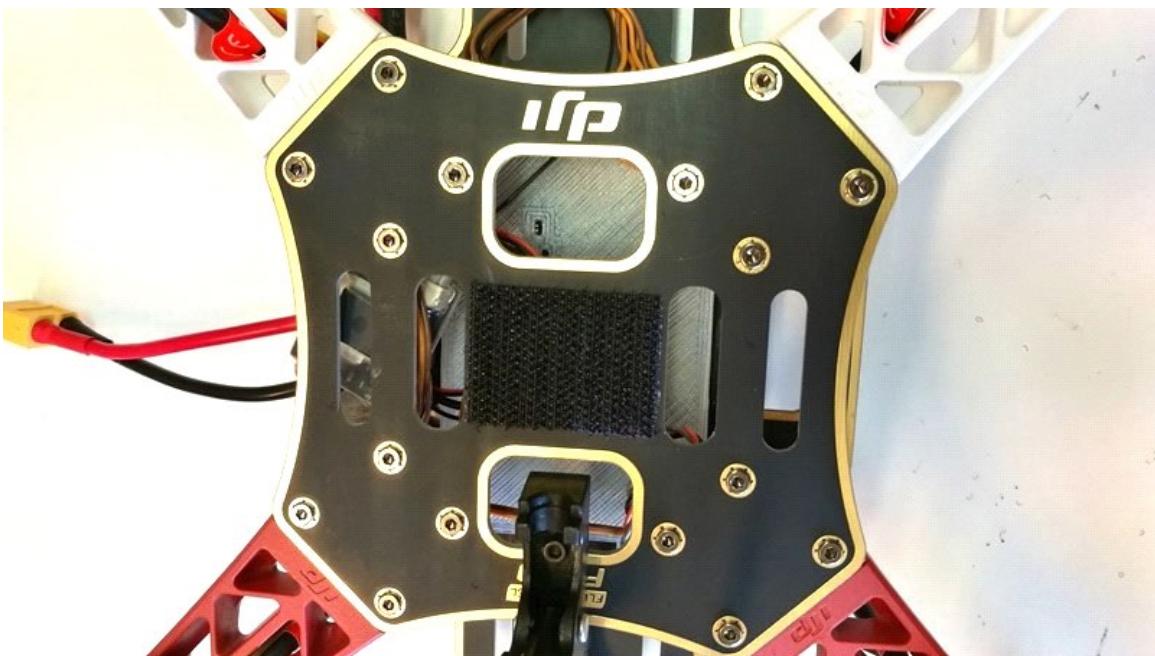


Cut the provided velcro tape in three parts.

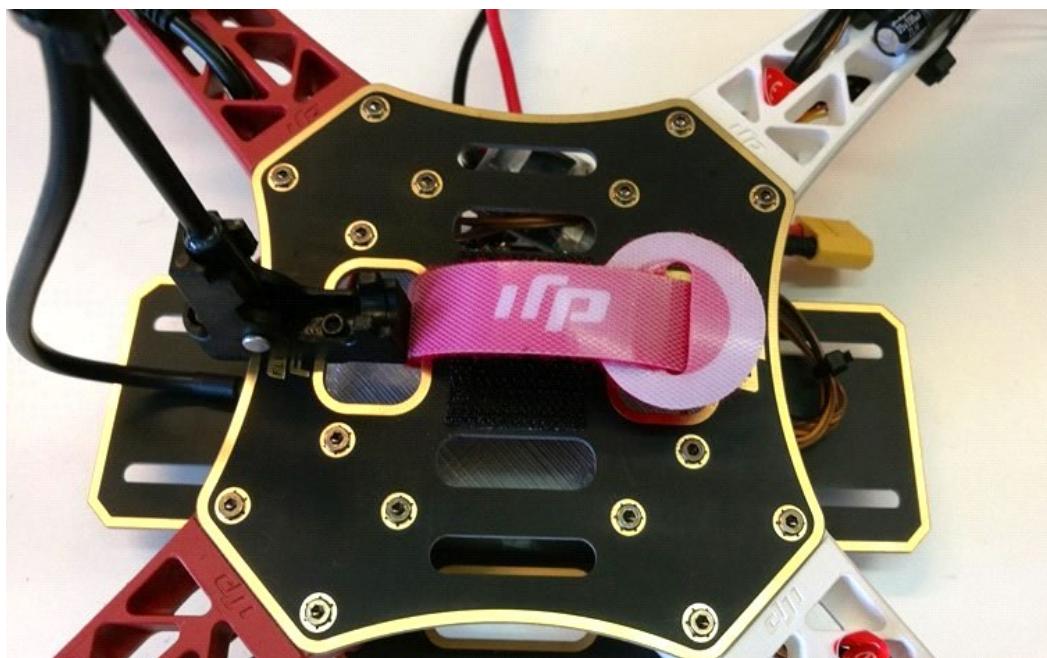




Tape the Velcro to the top plate of the frame like shown in the picture:



Put battery band through the designated holes of the top plate:



*Regarding batteries – we recommend using LiPo 4 cell 4000 mAh GensAce or analog.*

## Firmware and Parameters

*In general standard ArduPilot's firmware can be used.*

*For better flight control with RTK GPS, it is suggested to use upgraded ArduCopter-3.5.1 version, that can be downloaded in **UgCS GitHub repository**: <https://github.com/ugcs/Ardupilot/releases>.*

*Along with the upgraded ArduCopter's firmware, also example of parameters used for flight with standard GPS and RTK GPS are published in the **UgCS GitHub repository**.*

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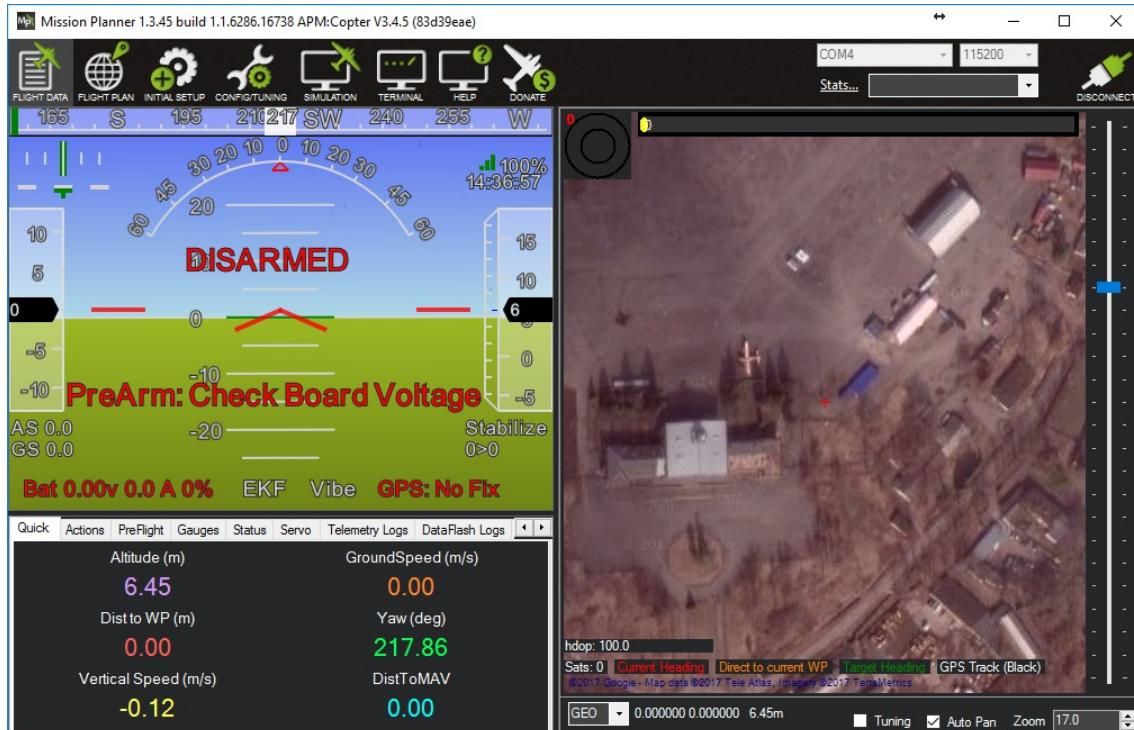
**NOTE: we can't guarantee that provided firmware upgrade and parameters are correct for your flights! Use with caution!**

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## Calibration and Parameter configuration

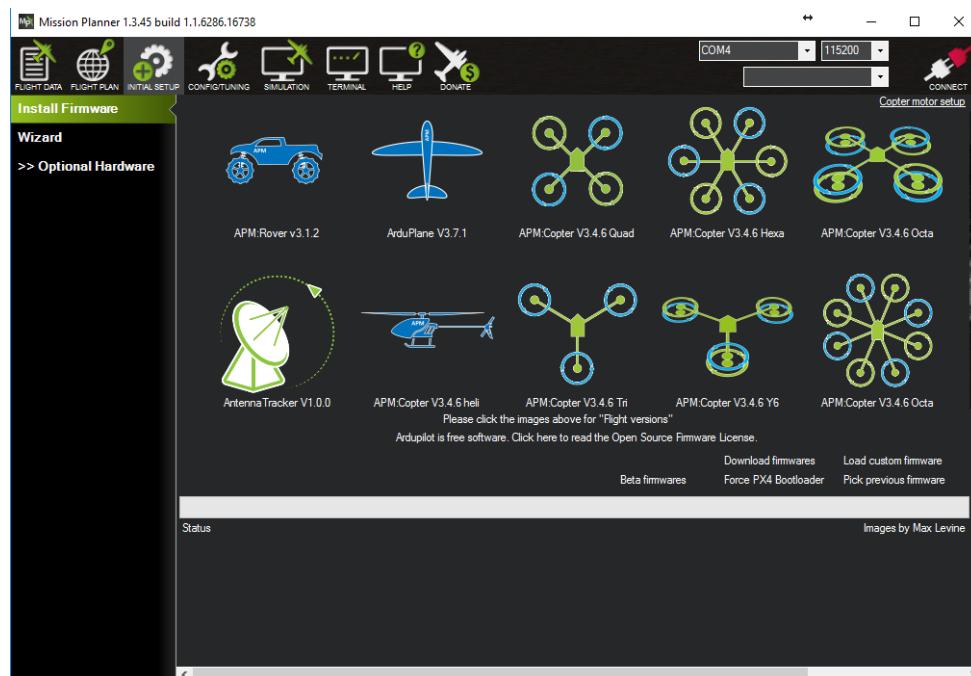
Check and calibrate the assembled frame. For reference the Ardupilot “First Time Setup” documentation can be used <http://ardupilot.org/copter/docs/initial-setup.html>.

Using a USB wire, connect the autopilot to computer running Mission Planner and check whether it is possible to connect to the drone using Mission Planner.



Mission Planner screenshot

Disconnect Mission Planner from the drone (USB wire should still stay connected) and flash the autopilot with APM:Copter custom firmware, modified for RTK-GPS. The firmware can be downloaded in **UgCS GitHub repository**: <https://github.com/ugcs/Ardupilot/releases>



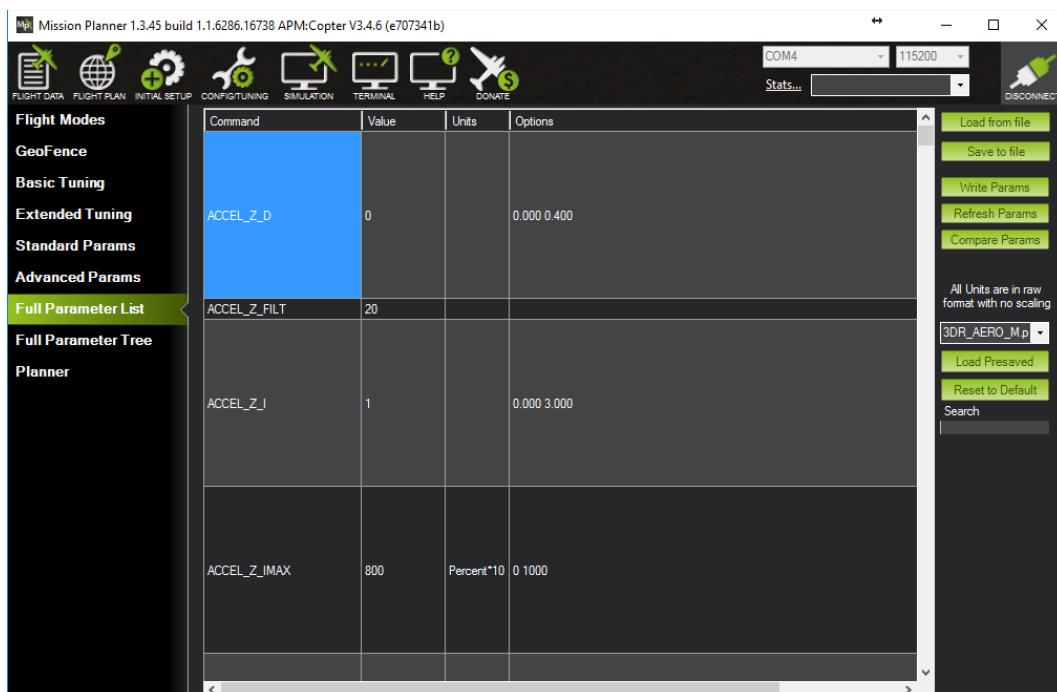
Mission Planner screenshot

After the firmware flashing is done, connect Mission Planer to autopilot and upload autopilot parameters by accessing:

Mission Planer → Config/Tuning → Full parameter list → Load from file.

The parameter file “f450-3.5-rtk\_changes\_only.param” can be downloaded in **UgCS GitHub** repository: <https://github.com/ugcs/Ardupilot/releases>.

When parameters are loaded don't forget to save them – push the button "Write params".

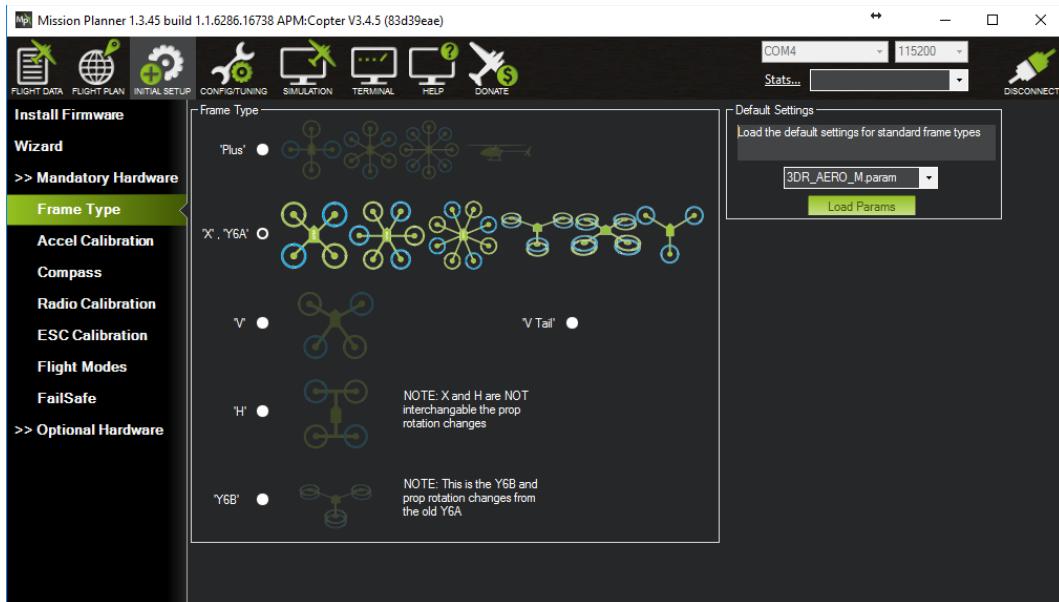


Mission Planner screenshot

## Manual Parameter Configuration:

The parameter `SYSID_THISMAV` needs to be changed. Its value should be equal to last digits of Wi-Fi telemetry IP address (it can be found on sticker of the telemetry module). After the parameter is changed – save by pressing “Write Params” button again.

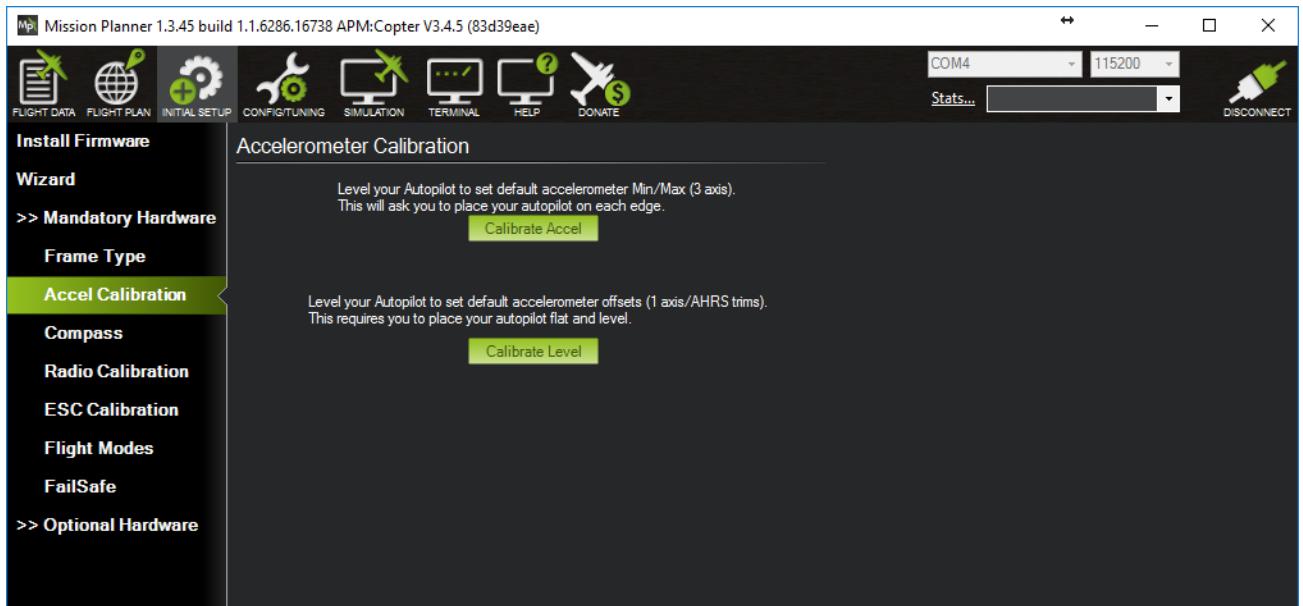
Check that the correct frame type is selected. In our case the “X” frame should be selected.



Mission Planner screenshot

## Calibration Accelerometer

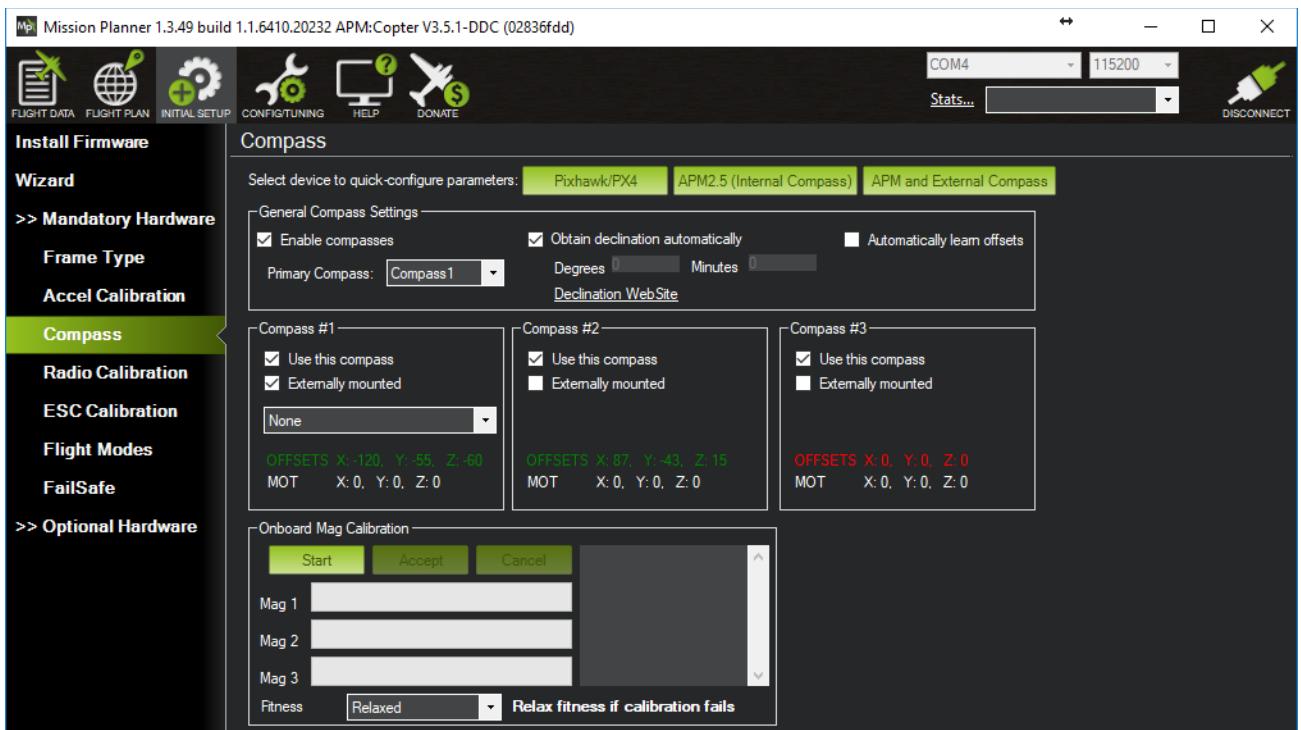
Next step is to calibrate the accelerometer. This procedure is described in detail here:  
<http://ardupilot.org/copter/docs/common-accelerometer-calibration.html>



Mission Planner screenshot

## Compass calibration

Calibrate the compass using live calibration method (off-board calibration) as described here:  
<http://ardupilot.org/copter/docs/common-compass-calibration-in-mission-planner.html#offboard-calibration-aka-live-calibration>



## Radio calibration and RC transmitter binding

Calibrate Radio as described here: <http://ardupilot.org/copter/docs/common-radio-control-calibration.html>

Before radio calibration don't forget to bind the RC transmitter. In case of using Spectrum DX8 or similar RC transmitter please copy the existing profile and give it an easily recognizable name.

In our case the first manually configured profile was DDC1. This profile was then copied and renamed according to last two digits of each vehicle IP: DDC2,..., DDC10, DDC11, etc.

To bind vehicle with the IP 192.168.0.110 use DDC10 profile.

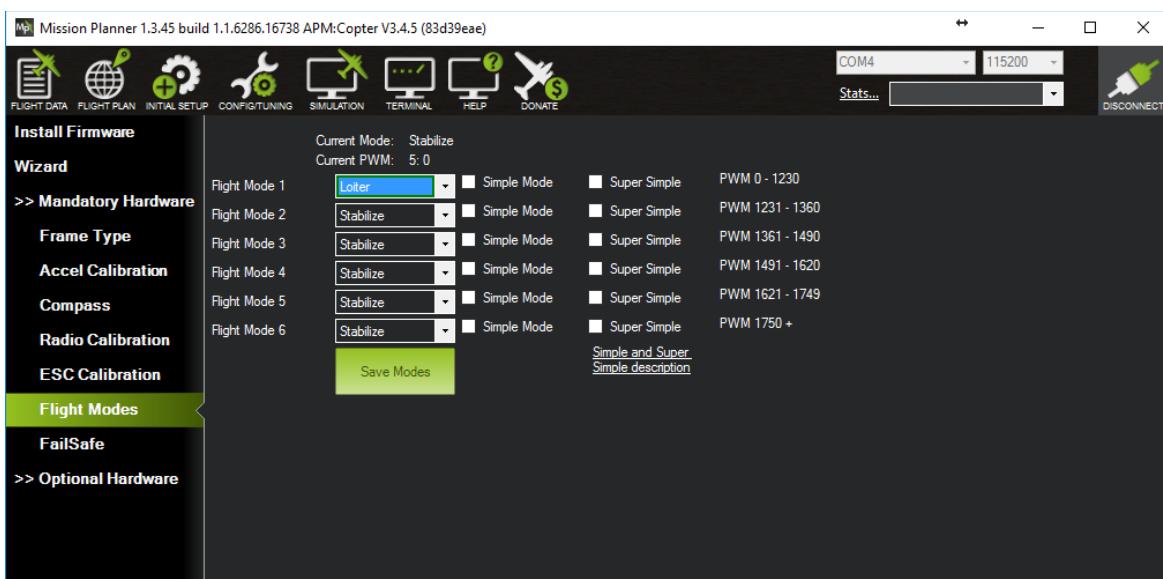


Mission Planner screenshot

The ESCs are pre-calibrated, therefore calibration of ESCs is not necessary.

## Checking Flight modes

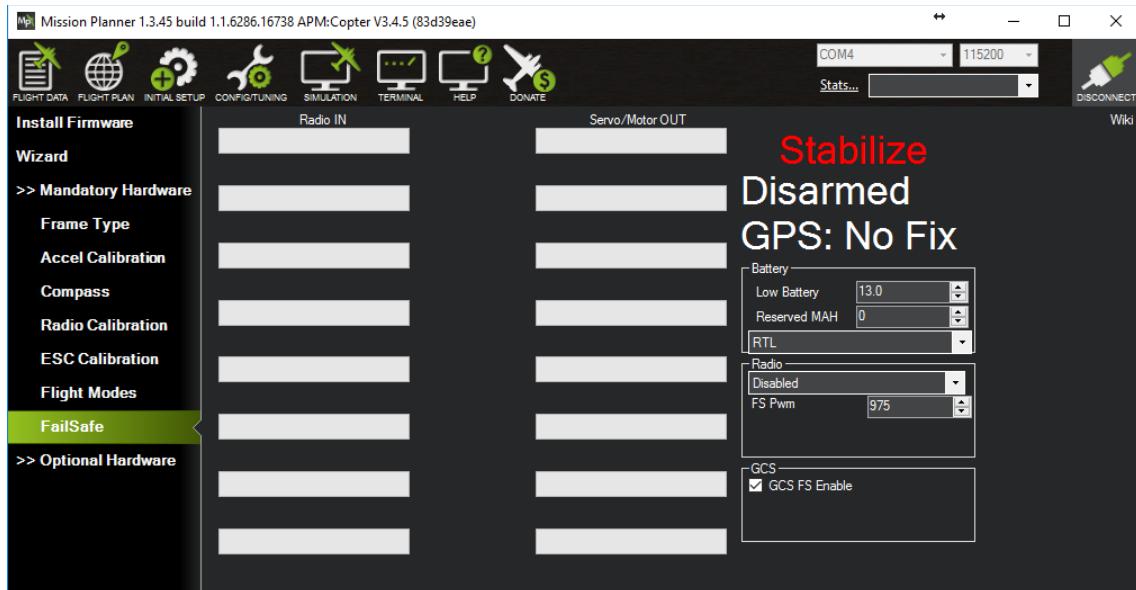
Flight mode 1 should be Loiter, others should be Stabilize.



Mission Planner screenshot

## Setting FailSafe

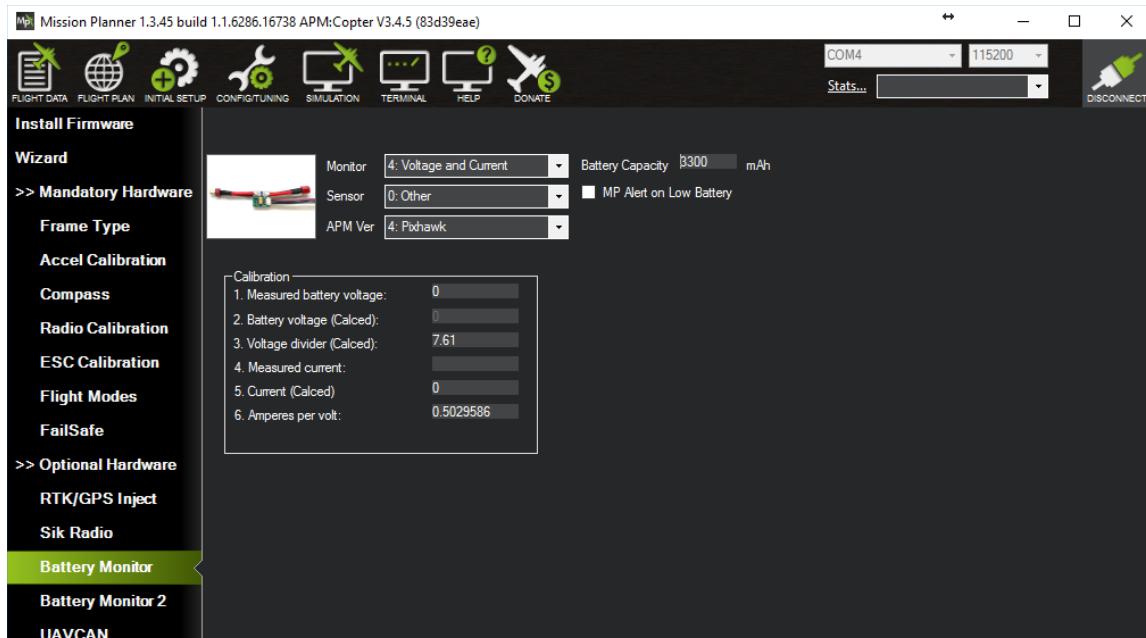
Set the FailSafe actions for Low Battery voltage as RTL and set a battery voltage threshold. In our case it is set to 13 volts.



Mission Planner screenshot

For safety purposes during the first manual flight, please enable RC failsafe action. Currently it is set to Disabled.

## Checking Battery Monitor settings:



Mission Planner screenshot

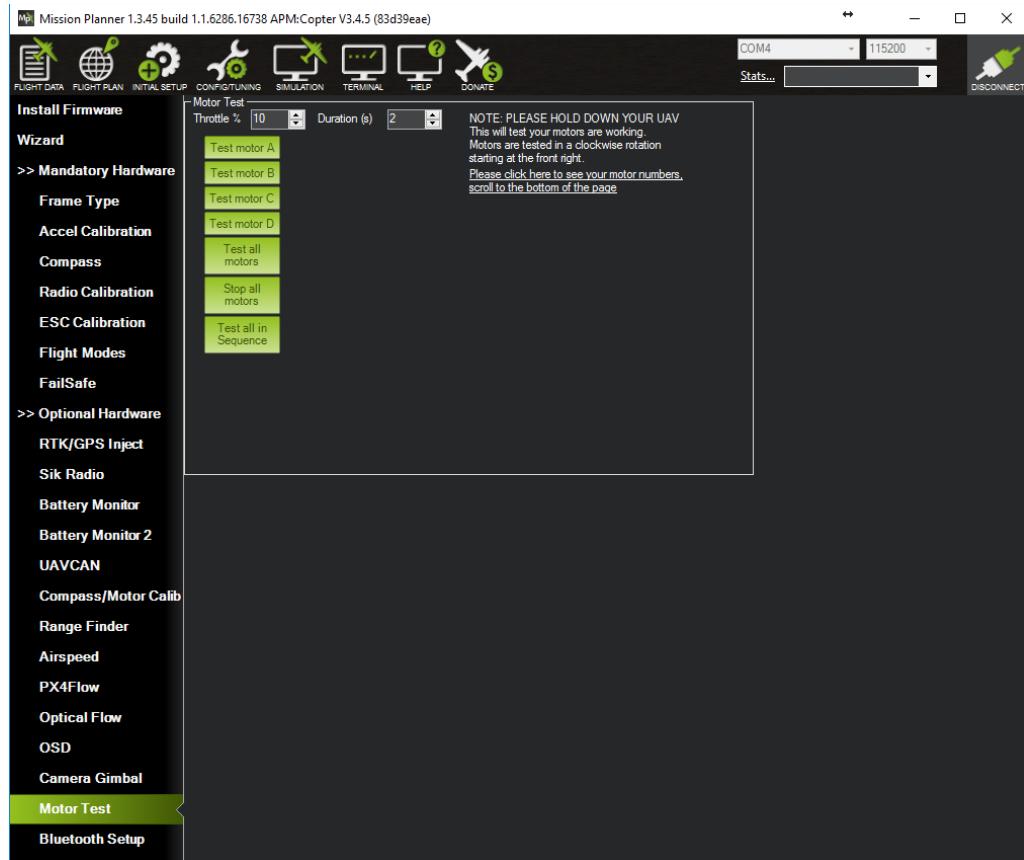
Pass the Motor test. To fulfill this test propellers should be removed and the battery connected. Raise the throttle percent to 10%. Press "Test Motor A". Forward Right motor should start to spin for 2 seconds.

B – Backward Right Motor

C – Backward Left Motor

## D – Forward Left Motor

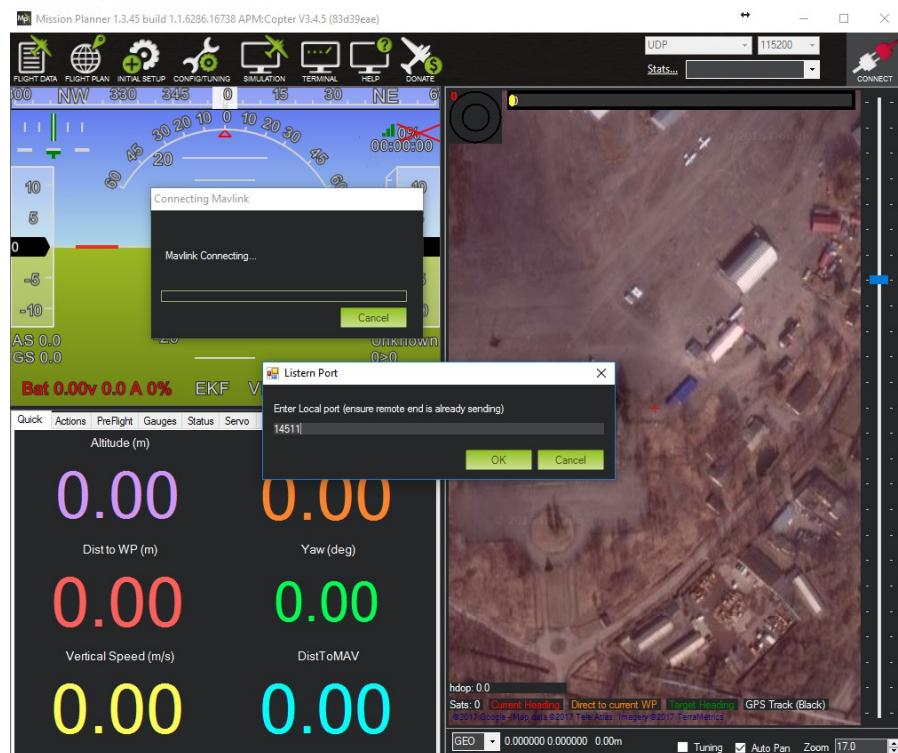
**NB!** Make sure that the motor directions are correct and correspond to the schematic shown earlier in this manual. If a motor is spinning in the opposite direction, remove two of the three motor wires that plug into the ESC and flip them.



Mission Planner screenshot

## Checking telemetry via Wi-Fi

Connection type: UDP, Port should be used from the telemetry module sticker.



Mission Planner screenshot

## First flight

During the first flight it has to be checked whether manual (stabilize and loiter) and auto modes work correctly. Before the flight, make sure that you are able to switch between the modes using the RC transmitter. It is also useful to add a RTL mode that can be switched on using the remote.

Using the RC, arm the drone and slowly take off in Stabilize mode. When the drone is sitting safely in the air, switch the mode to Loiter and observe behavior. If the drone has trouble keeping its position, recalibrate the compass.

To check auto mode, switch the autopilot to Guided mode and click – Arm, Takeoff and Land.