

Workshop on Drone

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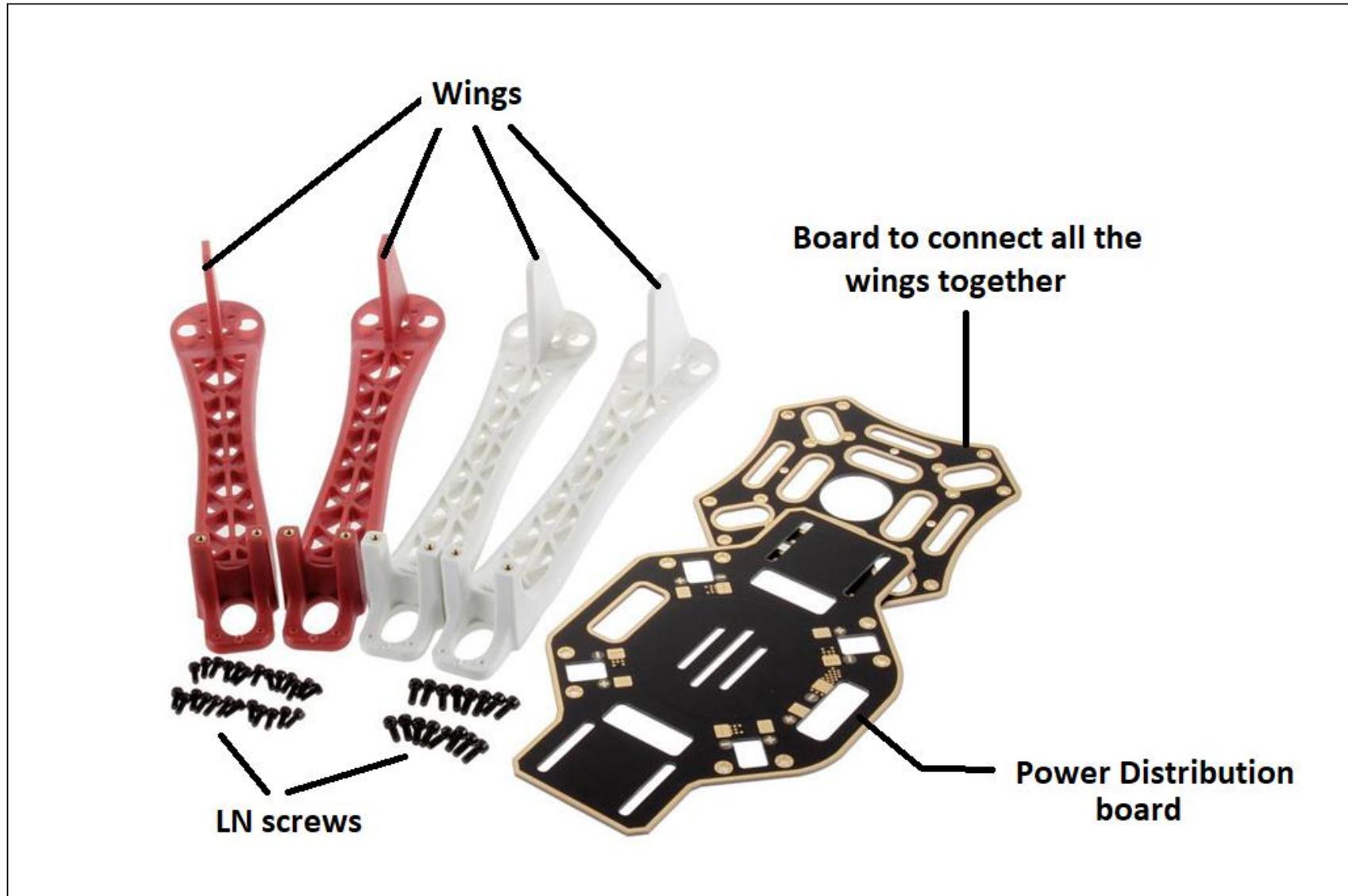
CONTENT

- Introduction to drones and their applications.
- Assembling a basic quadcopter
 - Specifications of each components
 - Interconnection diagram between each components
 - Video tutorial for Assembling the drone
- Configuration
 - Installing mission planner software.
 - Connection with the controller
 - Calibration of various sensors of the controller
- Testing
 - Testing Videos
- Question/Answer session

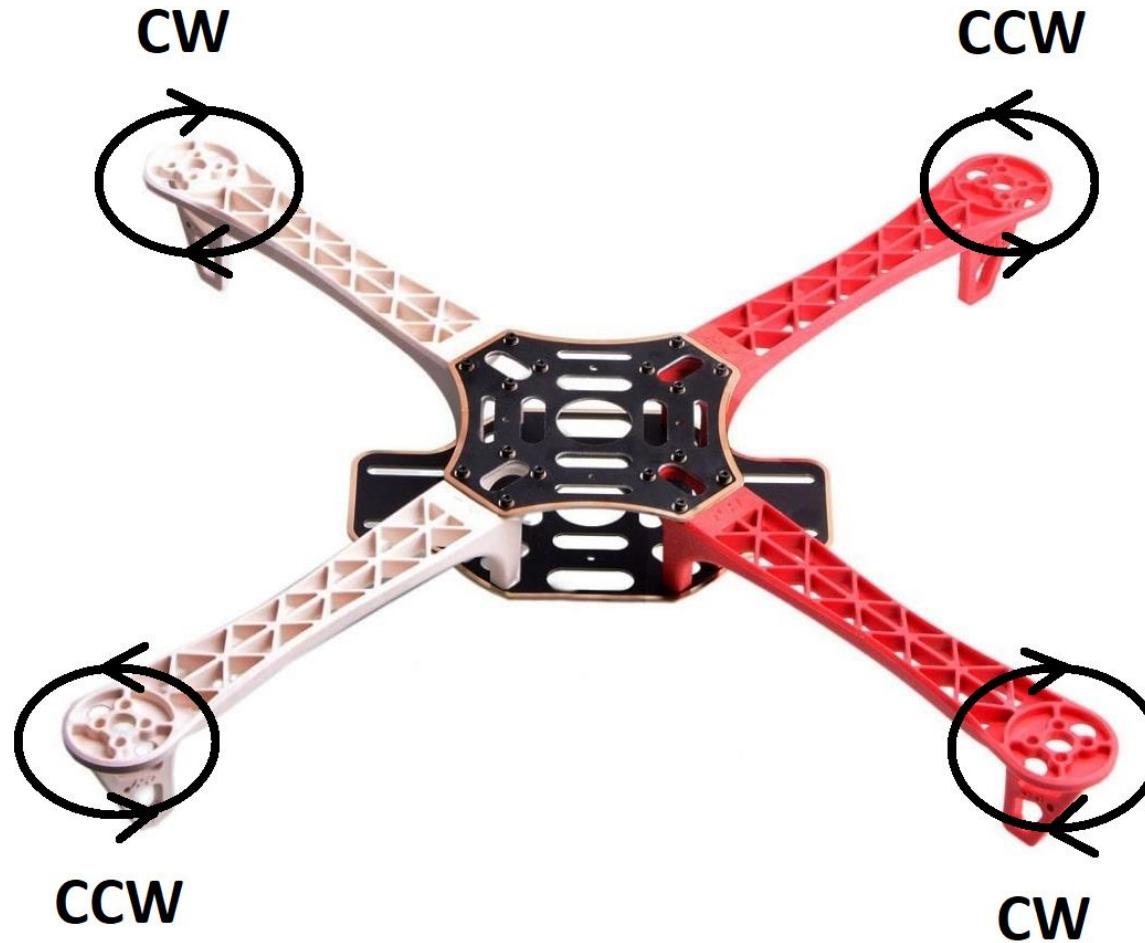
Main Components

Description	Make	Model
Frame(quad-copter 4 axis)	-	F450
Motor (1000Kv)	-	A2212/13T
ESC (30Amp)	Simonk	30A
APM Controller (2.8)	ArduPilot	APM 2.8
Transmitters and Receiver ()	Flysky	Fs-i6 2.4Ghz
Duracell Batteries for Transmitter	Duracell	Ultra (Alkaline AA)
GPS	Ublox	NEO 5pin
Battery (2200mAh 3S, ,11V)	Shang yi	B3 - 2200 mAH
Battery Chargers (B3)	imaxRC	B3 pro
Propellers pairs (CW and ACW)	-	(10*4.5inch)

Frame (quad-copter 4 axis) - F450



Directions of motors w.r.t the frames



MOTORS (A2212/13T)

- kV rating : 1000 kV
- Operating voltage : 12V
- Idle Current: 0.5 A
- Motor Dimensions: 27.5 x 30mm
- Shaft Diameter: 934;3.17mm
- Shaft diameter : 3.175mm.
- Weight: 47 g



Electronic Speed Controller (Simonk 30A)

- Output:
 - 30A continuous;
 - 40Amps for 10 seconds
- Input voltage: 2-4 cells Lithium Polymer
- BEC : 5V, 3Amp for external receiver and servos
- Max Speed:
 - 2 Pole: 210,000rpm;
 - 6 Pole: 70,000rpm;
 - 12 Pole: 35,000rpm
- Weight: 32gms
- Size: 55mm x 26mm x 13mm



Connections of ESC

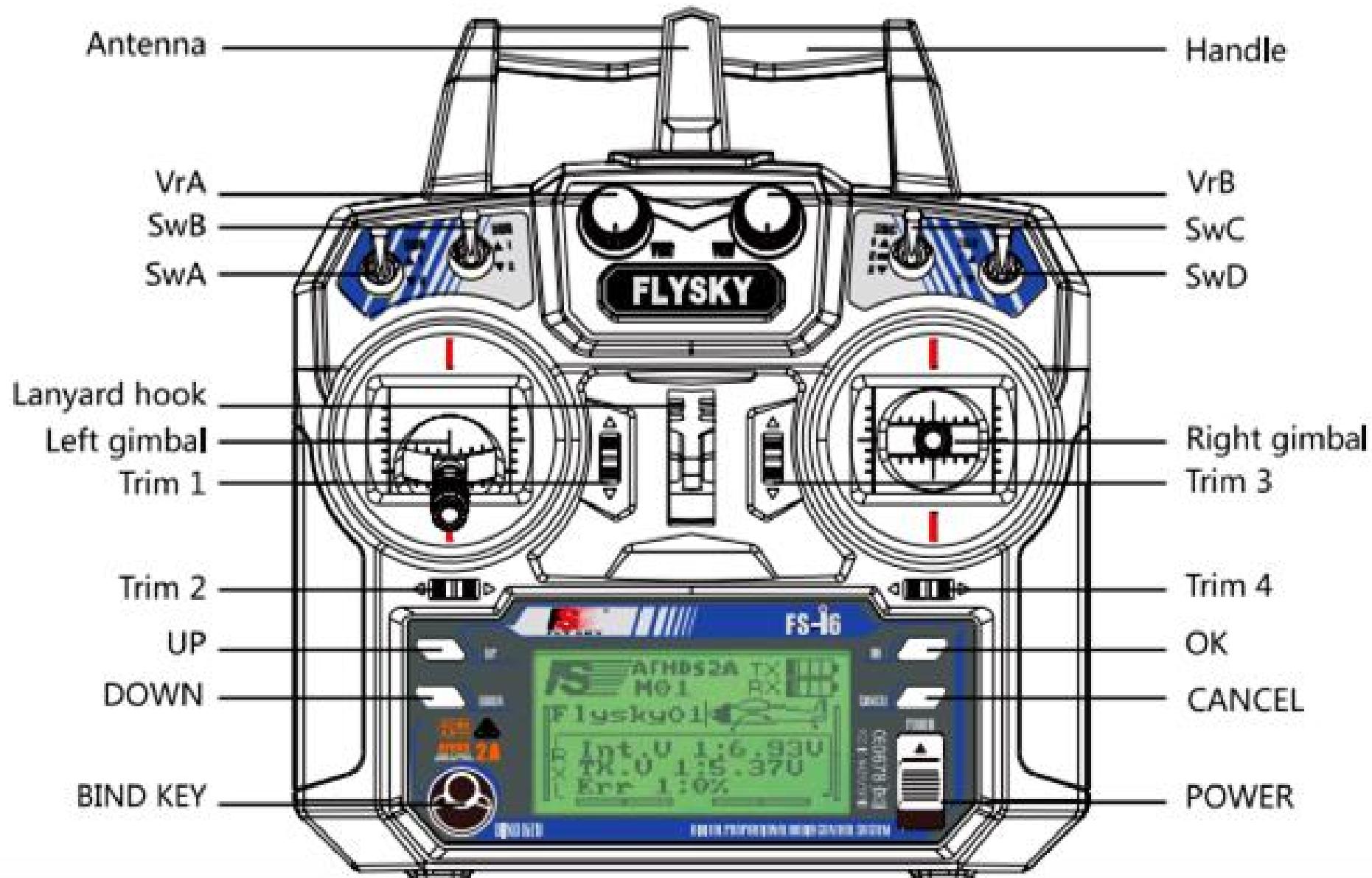


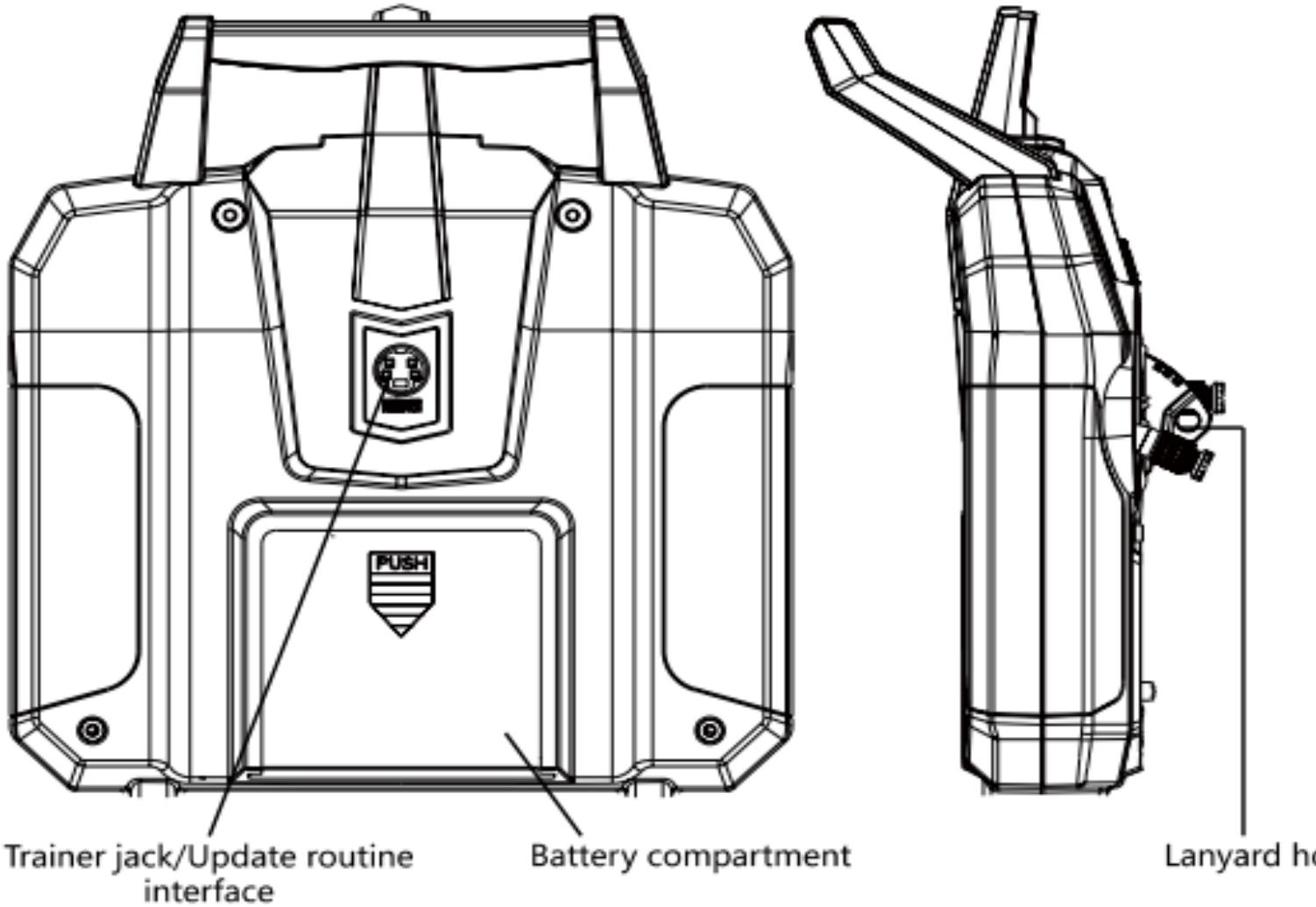
Connection type	Wire Colour	Function
Power	Red	7.4 to 14.8V
	Black	Ground
BLDC Motor Connections	Three Blue Wires	BLDC ESC connections
Servo Connector	White	Throttle Input
	Red	5V, 2Amp Out
	Black	Ground

TRANSMITTER (Fly sky fs-i6)

- Model type : Quadcopter
- RF range : 2.408 - 2.475GHz
- Bandwidth : 500 KHz
- Bands : 135
- RF power : Less than 20 dBm
- Protocol : AFHDS 2A
- Modulation type : GFSK
- PS2/USB Port : Yes (Micro-USB)
- Power input : 6V DC 1.4AA*4
- Weight : 392g
- Size : 174 x 89 x 190 mm
- Color : Black

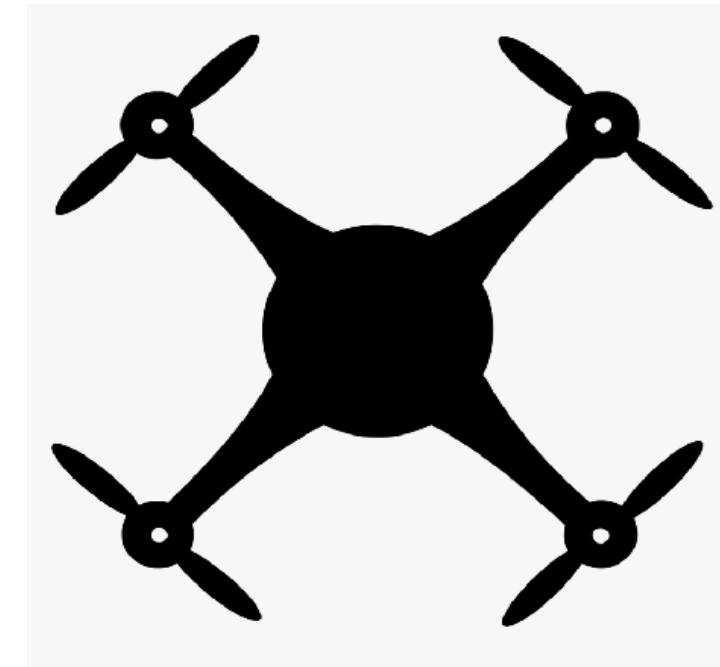
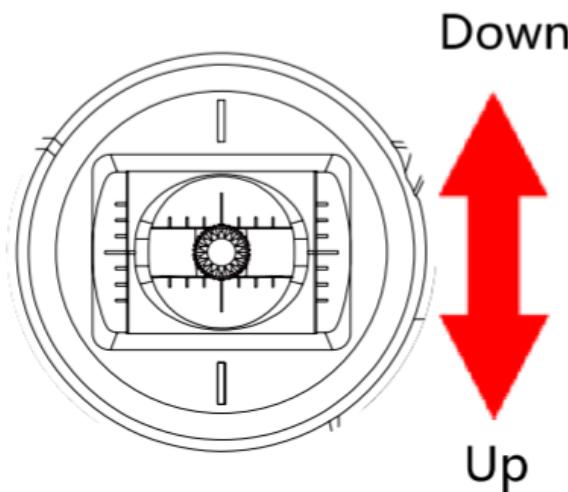






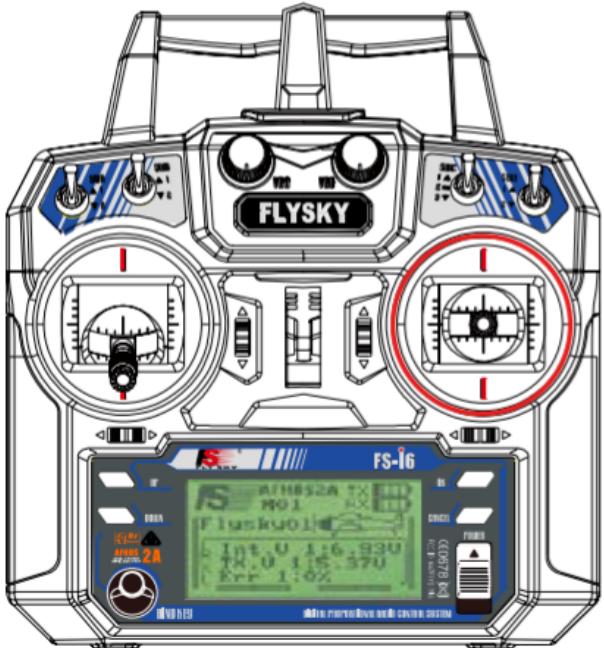
FUNCTION OF EACH STICK

Pitch (Right Stick Up/Down)

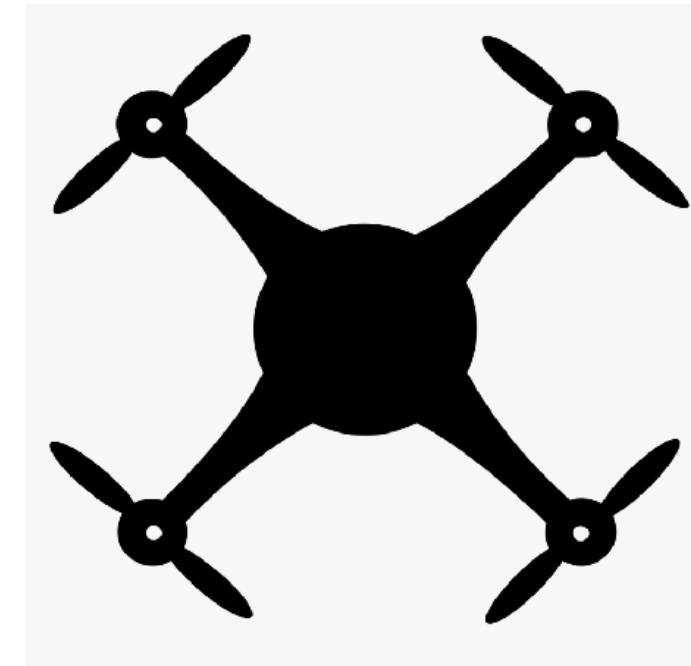
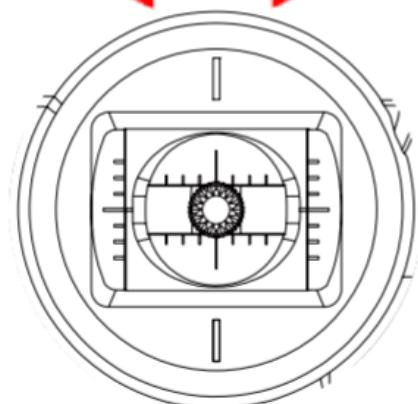


FUNCTION OF EACH STICK

Roll (Right Stick Left/Right)



Left Right

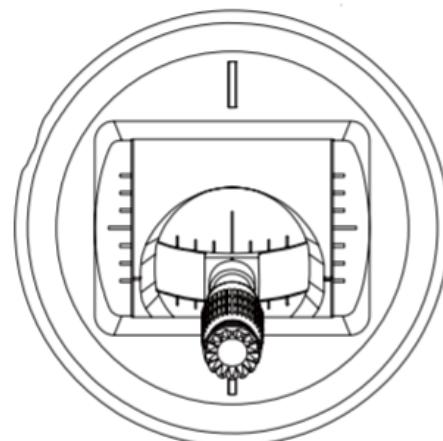


FUNCTION OF EACH STICK

Yaw (Left Stick Left/Right)



Left Right

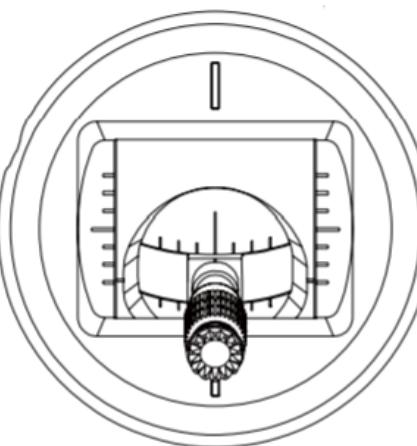


FUNCTION OF EACH STICK

Throttle (Left Stick Up/Down)



Throttle Up



Throttle Down



Receiver (Fly sky fs-ia6)

- Channels : 6
- RF range : 2.408 - 2.475GHz
- Bandwidth : 500 KHz
- Bands : 135
- RF power : Less than 20 dBm
- Rx sensitivity : ~105 dBm
- Protocol : AFHDS 2A
- Modulation type : GFSK
- Power input : 4 – 6.5 V DC
- Antenna length : 26 mm x 2
- Weight : 7g
- Size : 40 x 21 x 15 mm
- Color : Black

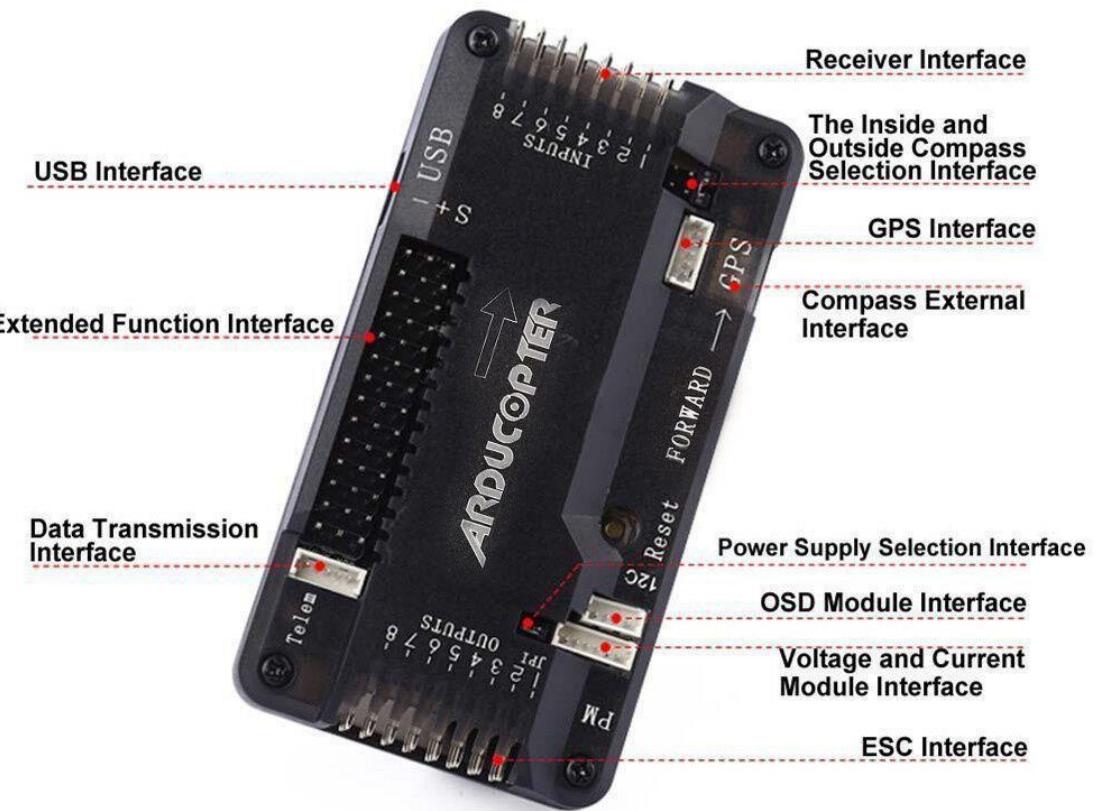


Binding Transmitter and Receiver (Fly sky fs-i6)

- A pair of transmitter and receiver are pre-bound while manufacturing.
- However, if you are using another transmitter or receiver, follow the below steps :
 - Connect the supplied bind cable to the B/VCC port the receiver.
 - Insert power into any other port.
 - Hold the ‘BIND KEY’ while powering on the transmitter to enter the blind mode.
 - Remove the power and bind cable from the receiver. Then connect the power cable to the B/VCC port.
 - Test by giving little throttle, the motor should rotate. If this does not happen, repeat the above process.

Controller (ArduPilot APM 2.8)

Model	: APM 2.8
Power supply	: LP2985-3.3.
Input Voltage (V)	: 12~16 VDC
Sensors	: 3-Axis Gyrometer Accelerometer High-performance Barometer
Processor	: ATMEGA2560 and ATMEGA32U-2
Dimensions (mm)	
LxWxH	: 70 x 45 x 15
Weight (gm)	: 82
Shipment Weight	: 0.085 kg
Shipment Dimensions	: 9 x 3 x 2 cm



GPS MODULE

- Model : FPV Ublox NEO-M8N
- Receiver Type : 72-channel Ublox M8 engine.
- Main Chip : Ublox NEO-M8N
- Sensitivity : Cold starts: -148 dBm. Hot starts: -156 dBm.
- Position Accuracy : Autonomous: 2.5 m SBAS: 2.0 m
- Acceleration : <4g
- Navigation Update Rate : up to 18 HZ.
- Operating Temperature Range : -24°C ~ 84°C
- Tracking Sensitivity : -167 dBm.
- Capture Time : 0.1s Average
- Dimensions (mm) LxWxH : 50 x 12.8 (Dia x W)
- Weight (gm) : 28
- Cable Length : 30 CM
- Supply Voltage (V) : 1.4~3.6



Battery (2200mAh 3S, 11V) (Shang yi B3)

- Battery Type: Lithium Polymer 2200mAh 3S 25C
- Capacity: 2200 mAh
- Number of cells : 3S
- Total supply voltage : 11.1V
- Size: 24 x 34 x 108mm
- Discharge Rate : 25 C
- Burst Rate : 50C
- Weight : 183g



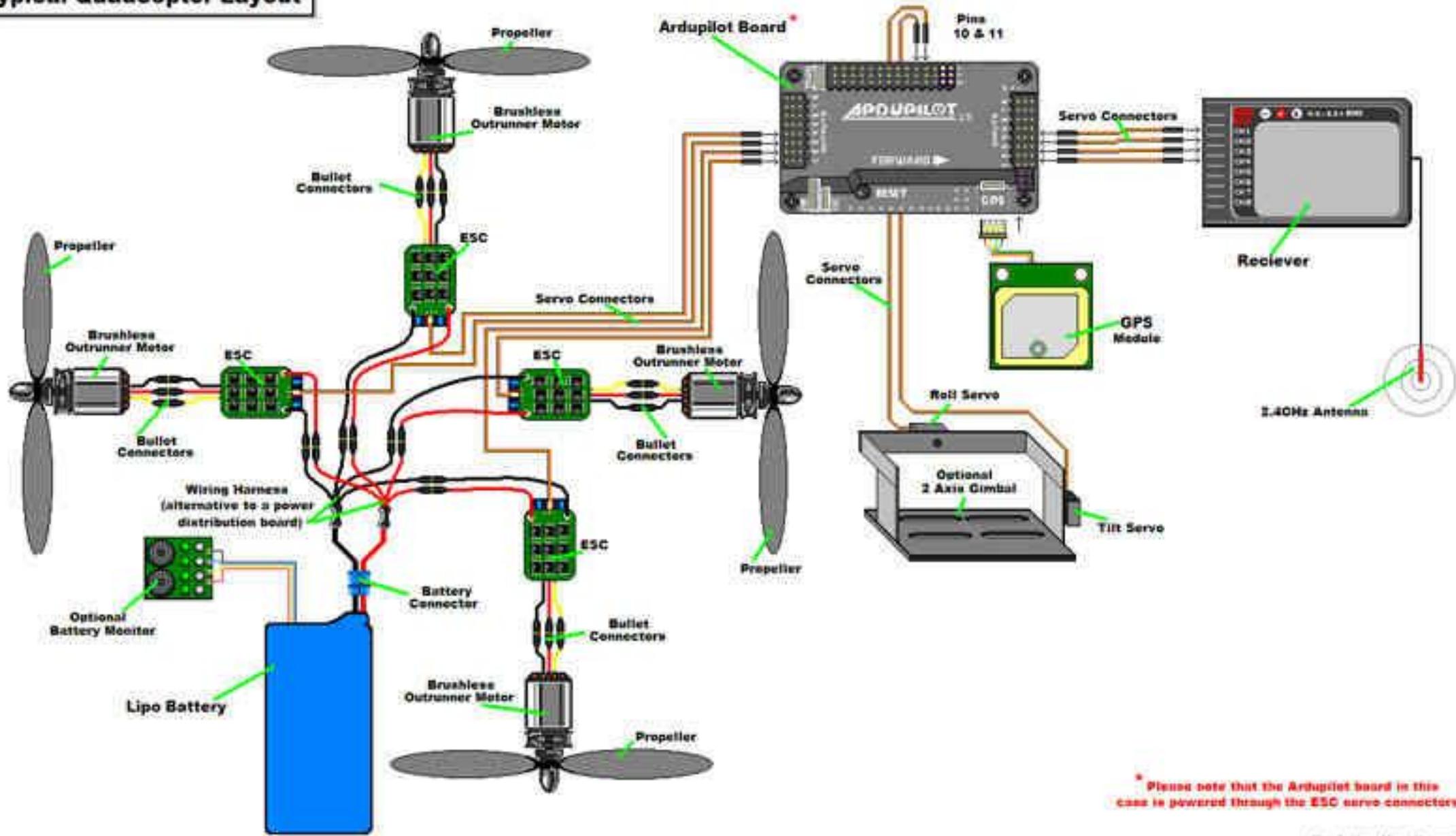
Battery Charger

- AC Input : 100~240V, 50~60Hz
- Battery Type : Li-Poly
- Cell Count : 2~3 Cells
- Charge Current : 1.2A Max
- Cell Cut Off Voltage : 4.2V 0.02V
- Circuit Power : 11W 10%
- Dimensions : 88x57x35mm
- Weight : 103g
- Plug : US 2 Pin Plug



Overall Interconnection Diagram

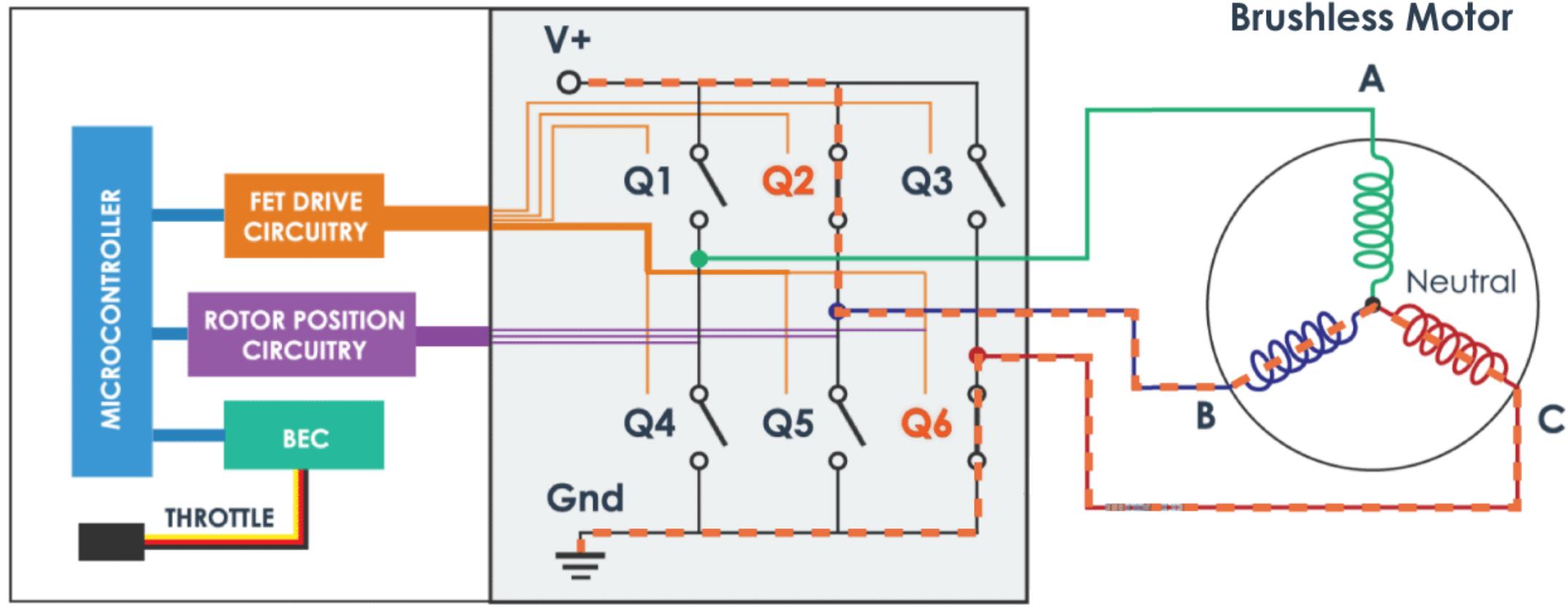
Typical Quadcopter Layout



* Please note that the ArduPilot board in this case is powered through the ESC servo-connectors

CONNECTION BETWEEN ESC AND MOTOR

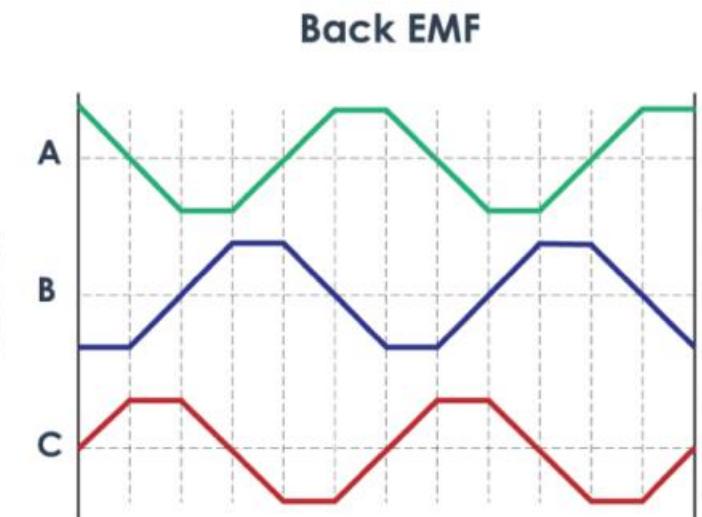
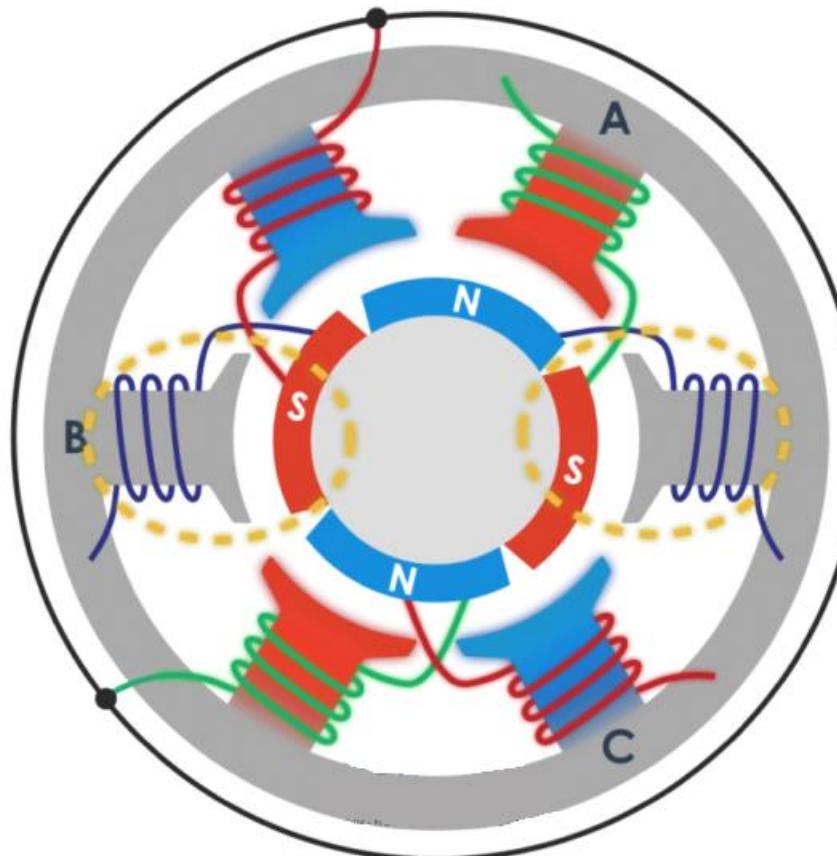
ELECTRONICS SPEED CONTROLLER



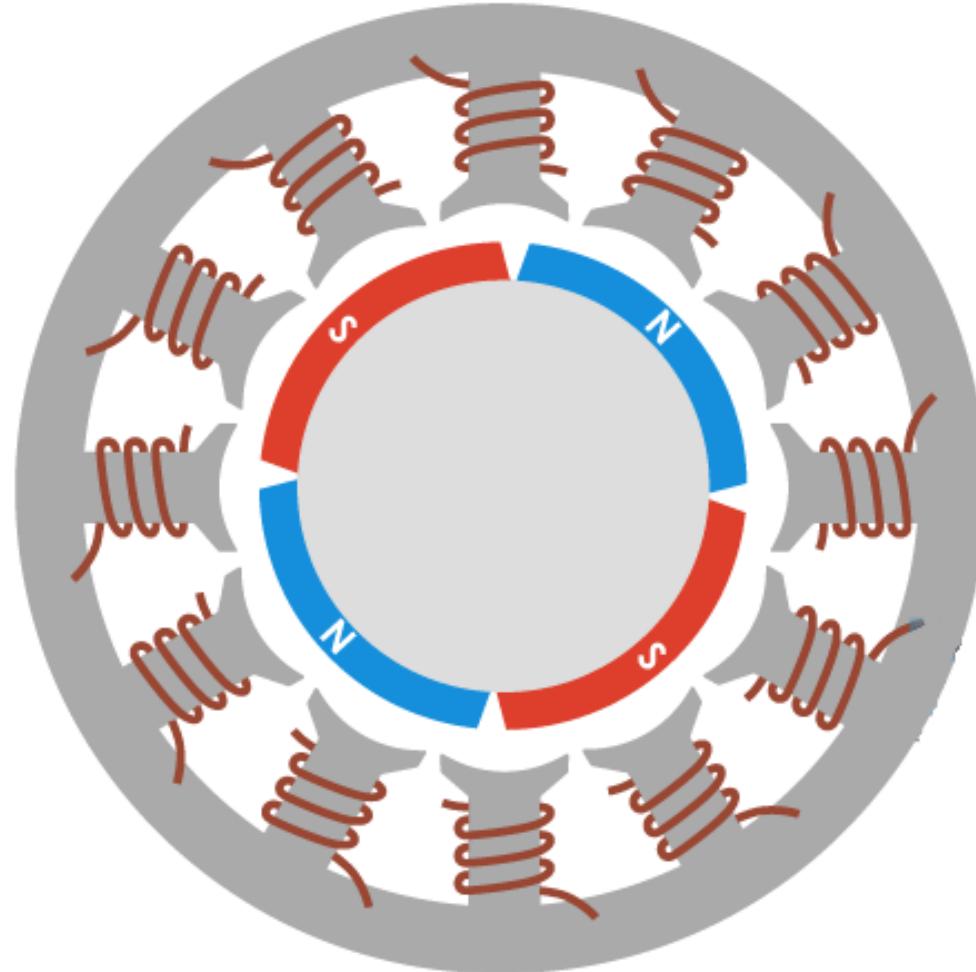
SIMPLIFIED ILLUSTRATION

Sensing the back EMF

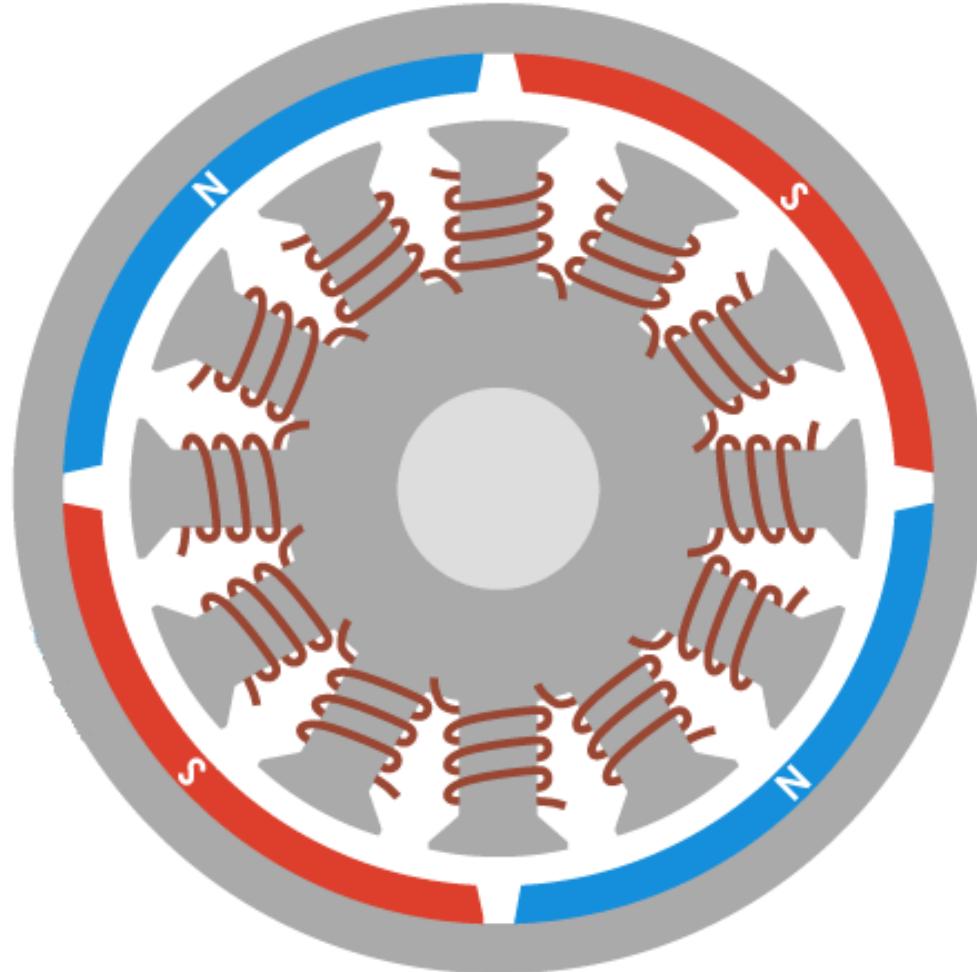
- ESC senses the back EMF from the motor in order to determine the motor position.
- Based on the acquired motor position, ESC activates different phases to rotate the motor.



Inrunner BLDC

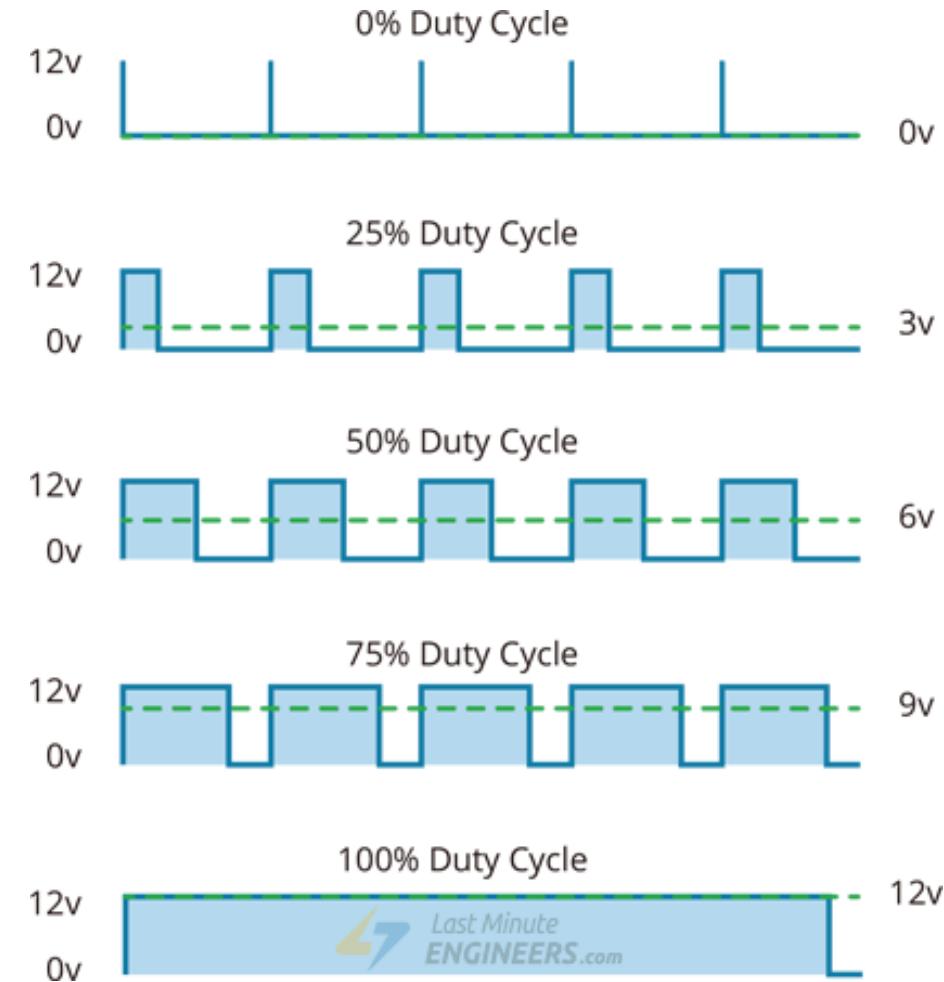


Outrunner BLDC

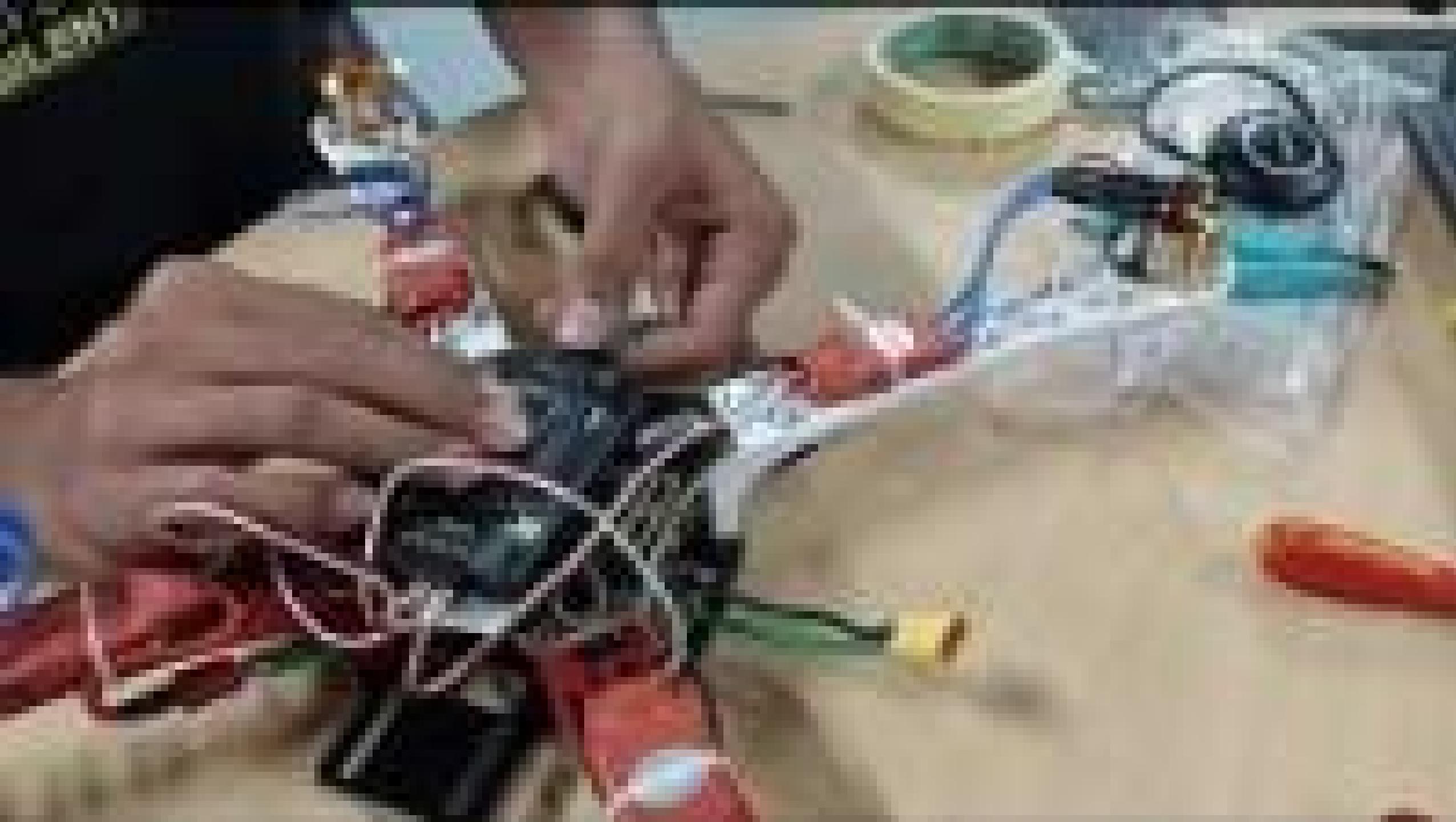


SIGNAL FROM CONTROLLER TO ESC

- PWM Signal is sent from the controller to the ESC module in order to control the speed of the motor.
- Lesser the Duty cycle of the PWM signal lesser is the RPM of the motor.
- Max. RPM achieved at 100% Duty cycle.



Video tutorial for Assembling the drone



CONFIGURATION OF DRONE

Installing Mission planner on UBUNTU20.04

STEP 1: Install Mono

- `sudo apt install mono-runtime libmono-system-windows-forms4.0-cil libmono-system-core4.0-cil libmono-winforms2.0-cil libmono-corlib2.0-cil libmono-system-management4.0-cil libmono-system-xml-linq4.0-cil`
Or full Mono: (In case upper command does not work use this one.)
- `sudo apt install mono-complete`

STEP 2: Download Mission planner

Download MissionPlanner.zip using the below steps:

- Get the latest zipped version of Mission planner here:
<https://firmware.ardupilot.org/Tools/MissionPlanner/MissionPlanner-latest.zip>
- Unzip in the appropriate directory
- Open terminal, go into the directory where you unzipped your mission planner.
- Run Mission planner using the command:
`mono MissionPlanner.exe`.

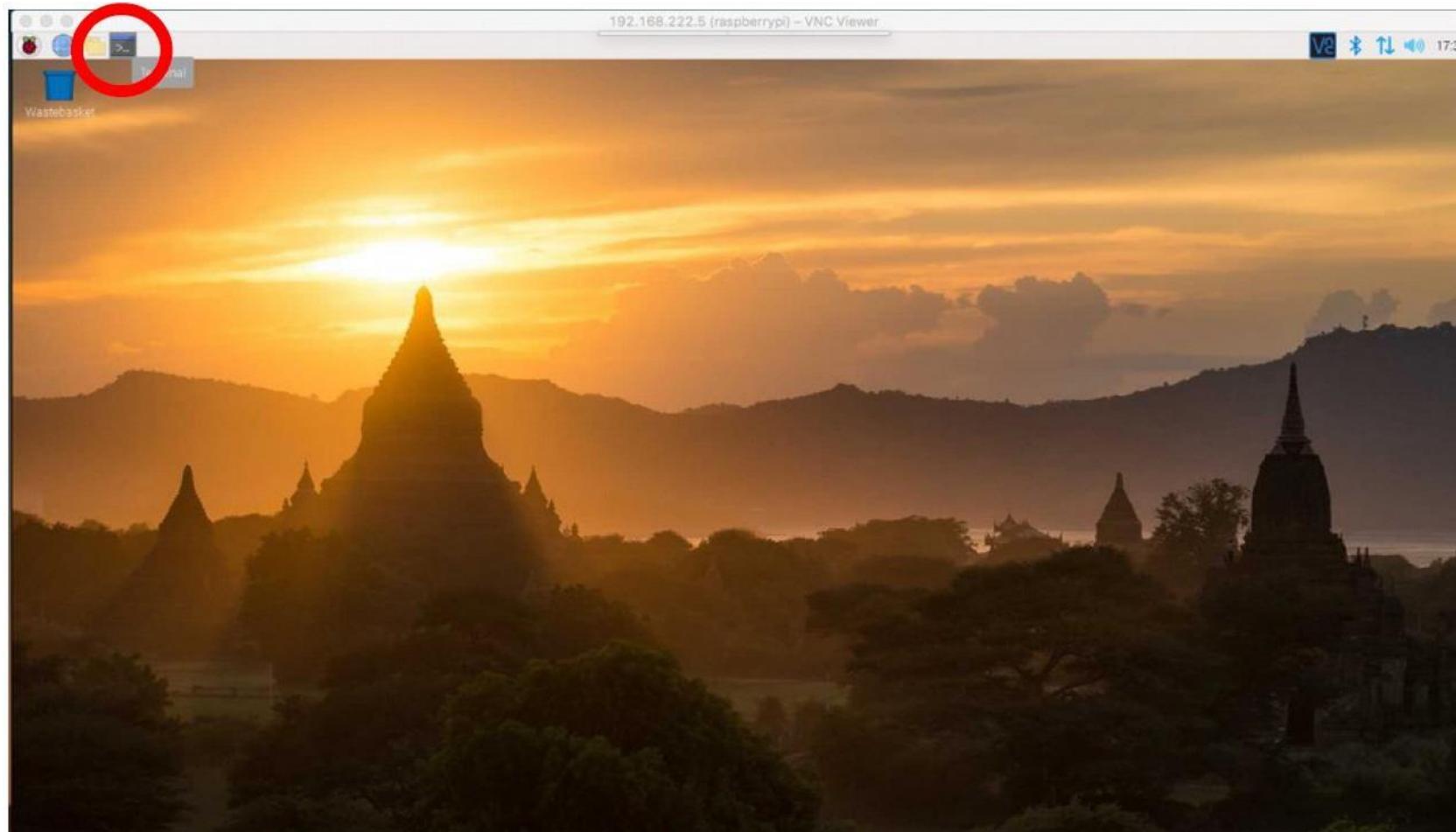
You can debug Mission Planner on Mono with the command:

```
MONO_LOG_LEVEL=debug mono MissionPlanner.exe
```

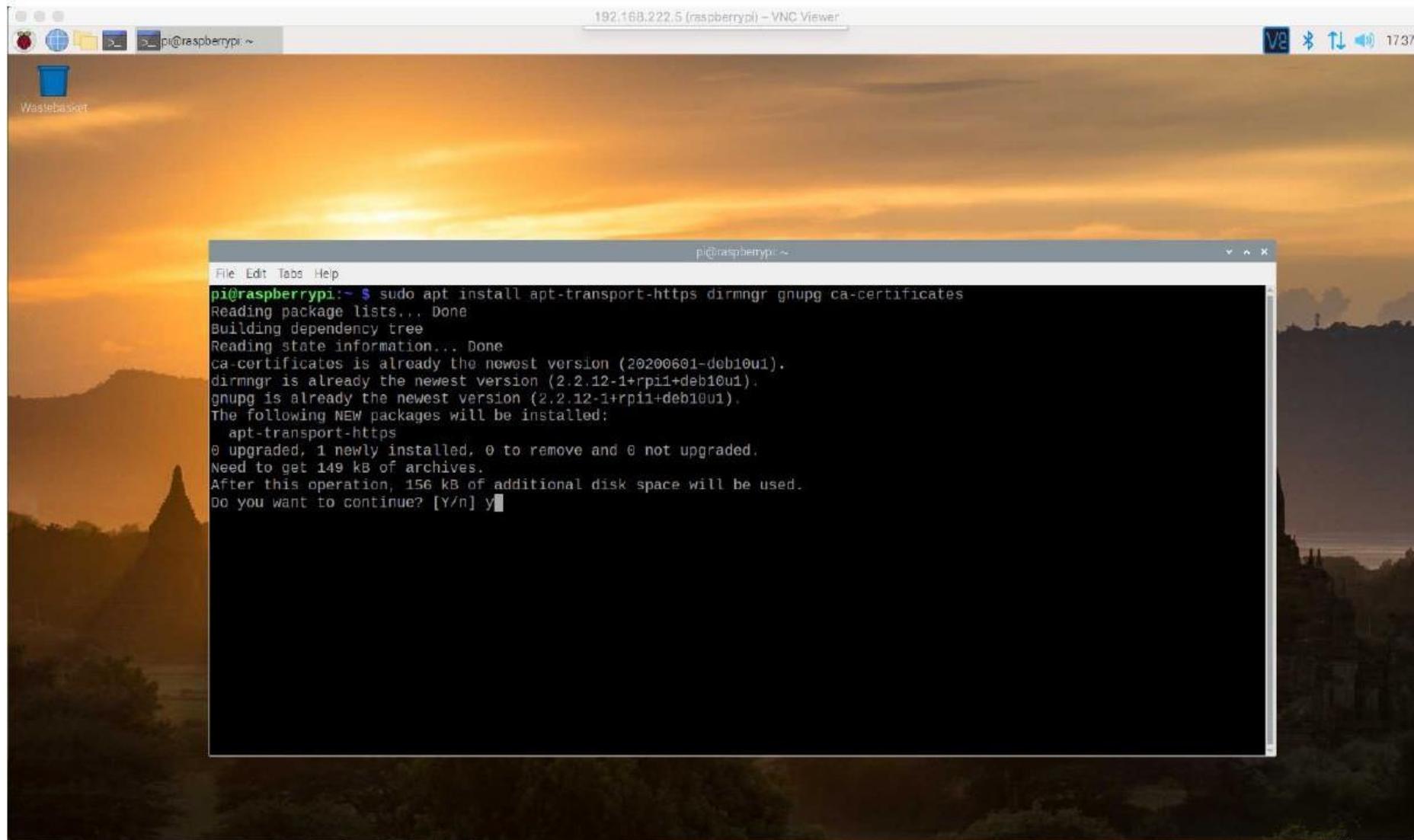
Installing Mission planner on Raspberry pi OS

STEP 1: Install Mono

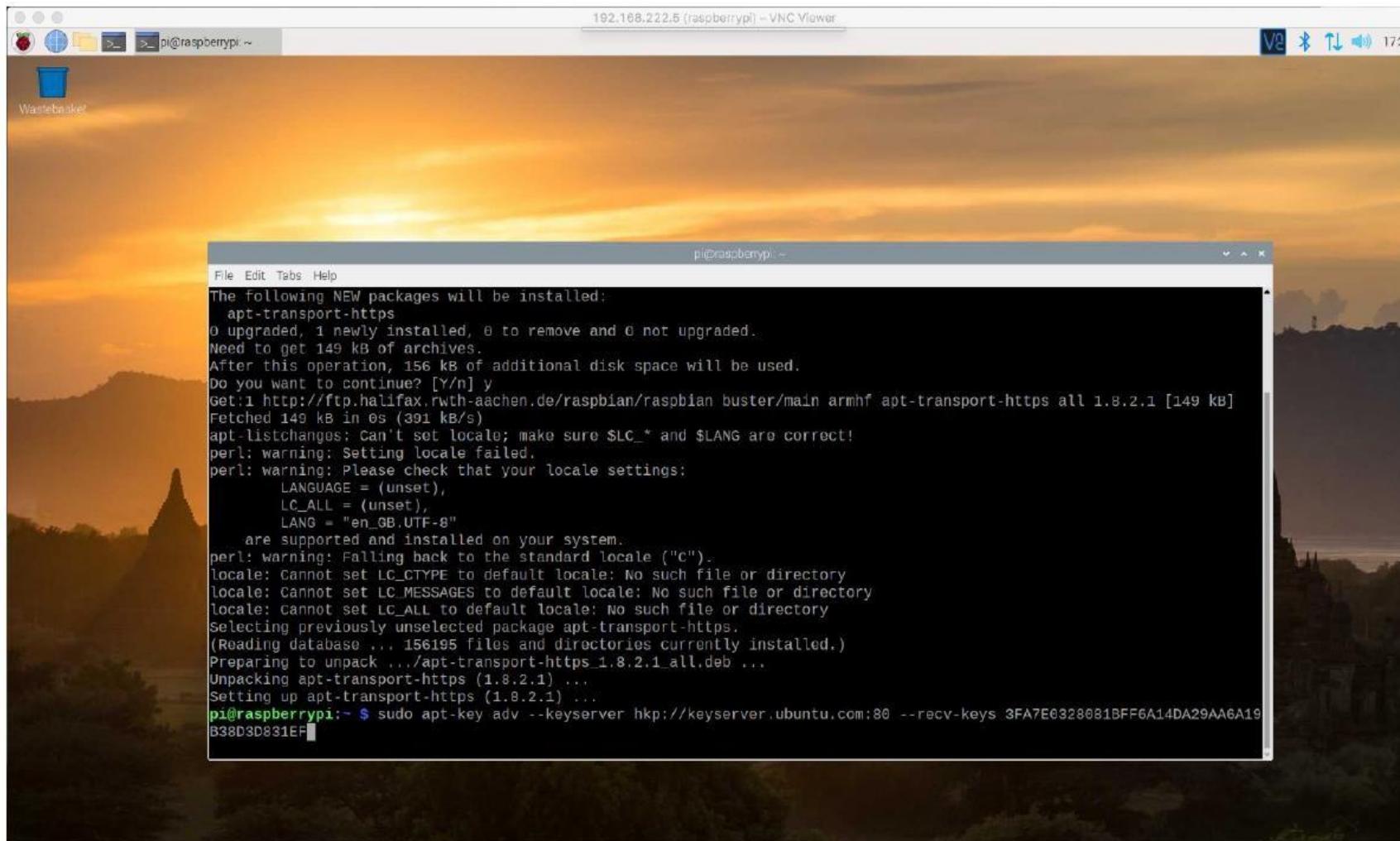
- First, open the Terminal by clicking the icon in the top left corner.



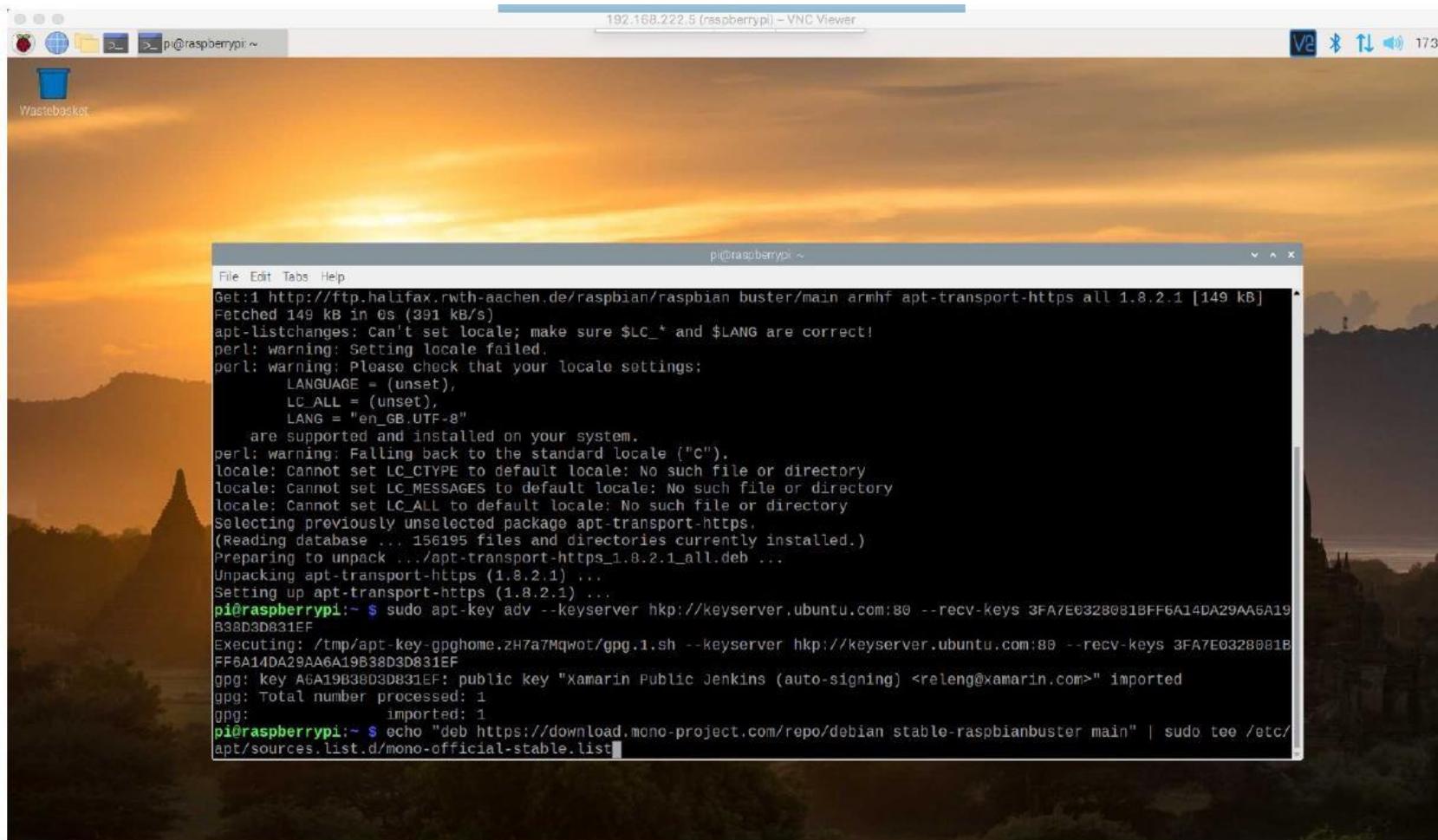
Command 1: "sudo apt install apt-transport-https dirmngr gnupg ca-certificates"



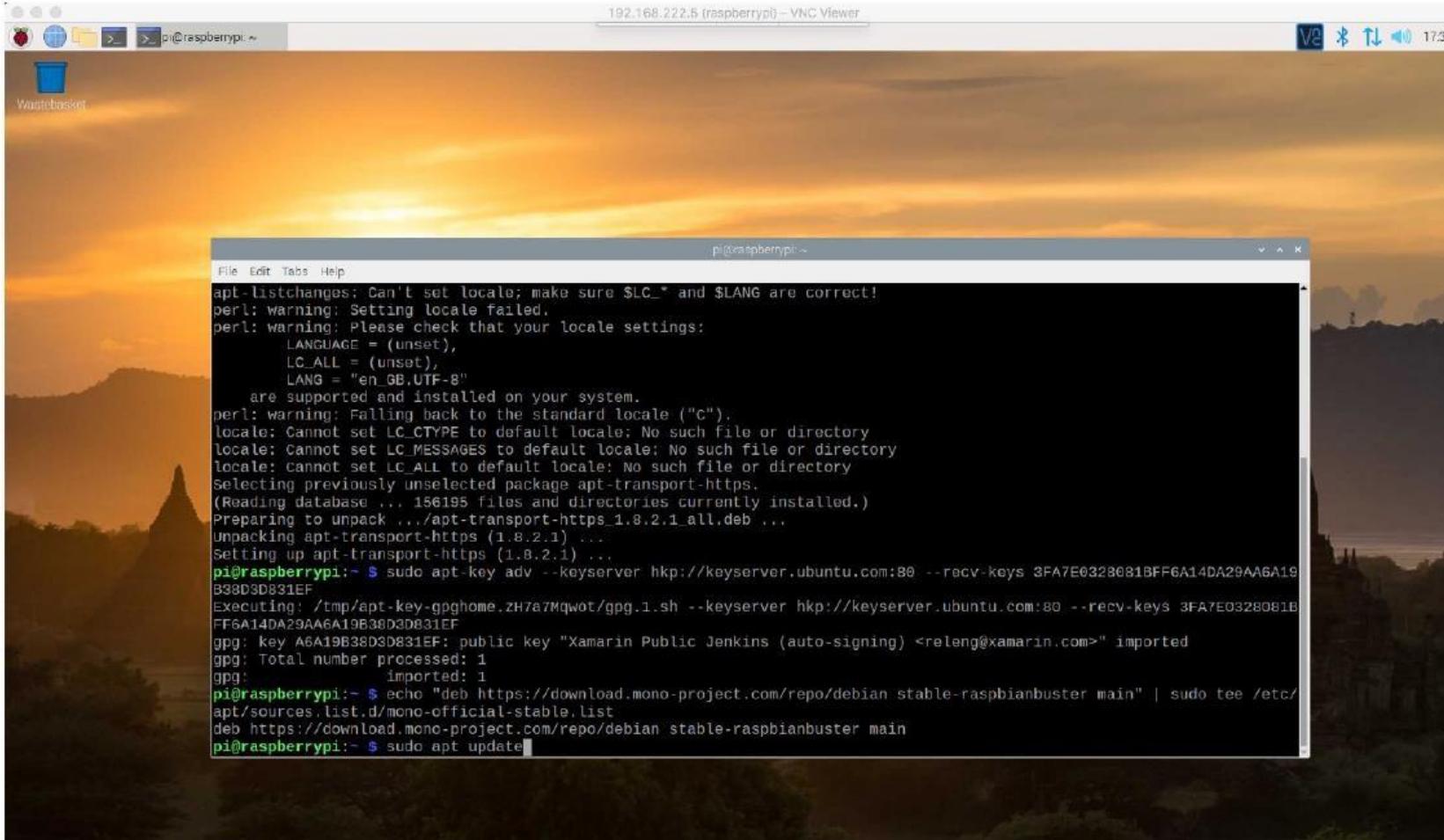
- Command 2:"`sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv-keys 3FA7E0328081BFF6A14DA29AA6A19B38D3D831EF`"



- Command 3: `echo "deb https://download.mono-project.com/repo/debian stable-raspbianbuster main" | sudo tee /etc/apt/sources.list.d/monoofficial-stable.list` **Enter both commands as one line!**



- Command 4: `sudo apt update`

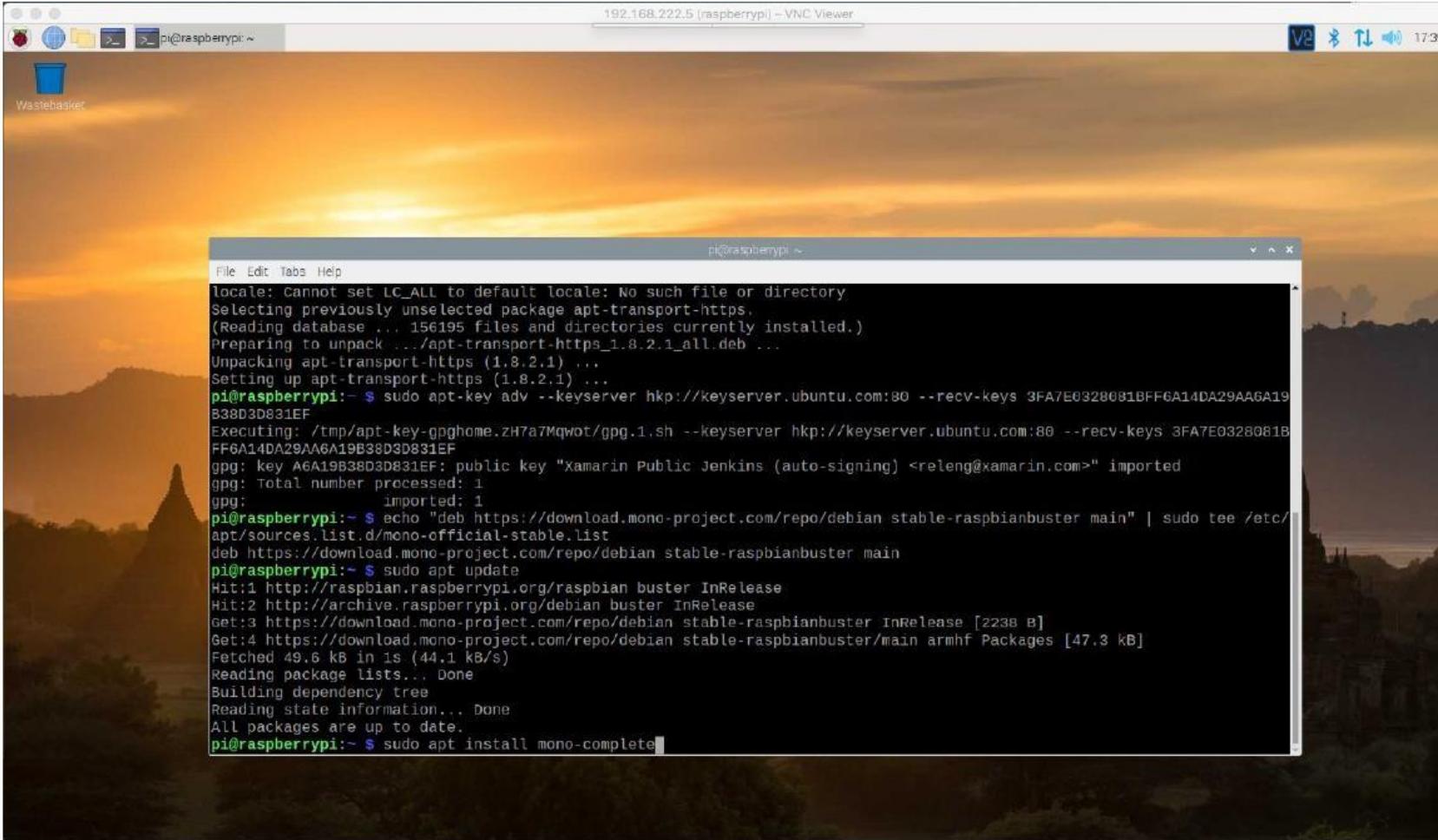


A screenshot of a VNC session on a Raspberry Pi. The desktop background is a sunset over water. A terminal window titled "pi@raspberrypi:~" is open, showing the output of the "apt update" command. The terminal shows several errors related to locale settings, followed by the successful import of a GPG key from a keyserver and the addition of a Mono Project repository to the sources list.

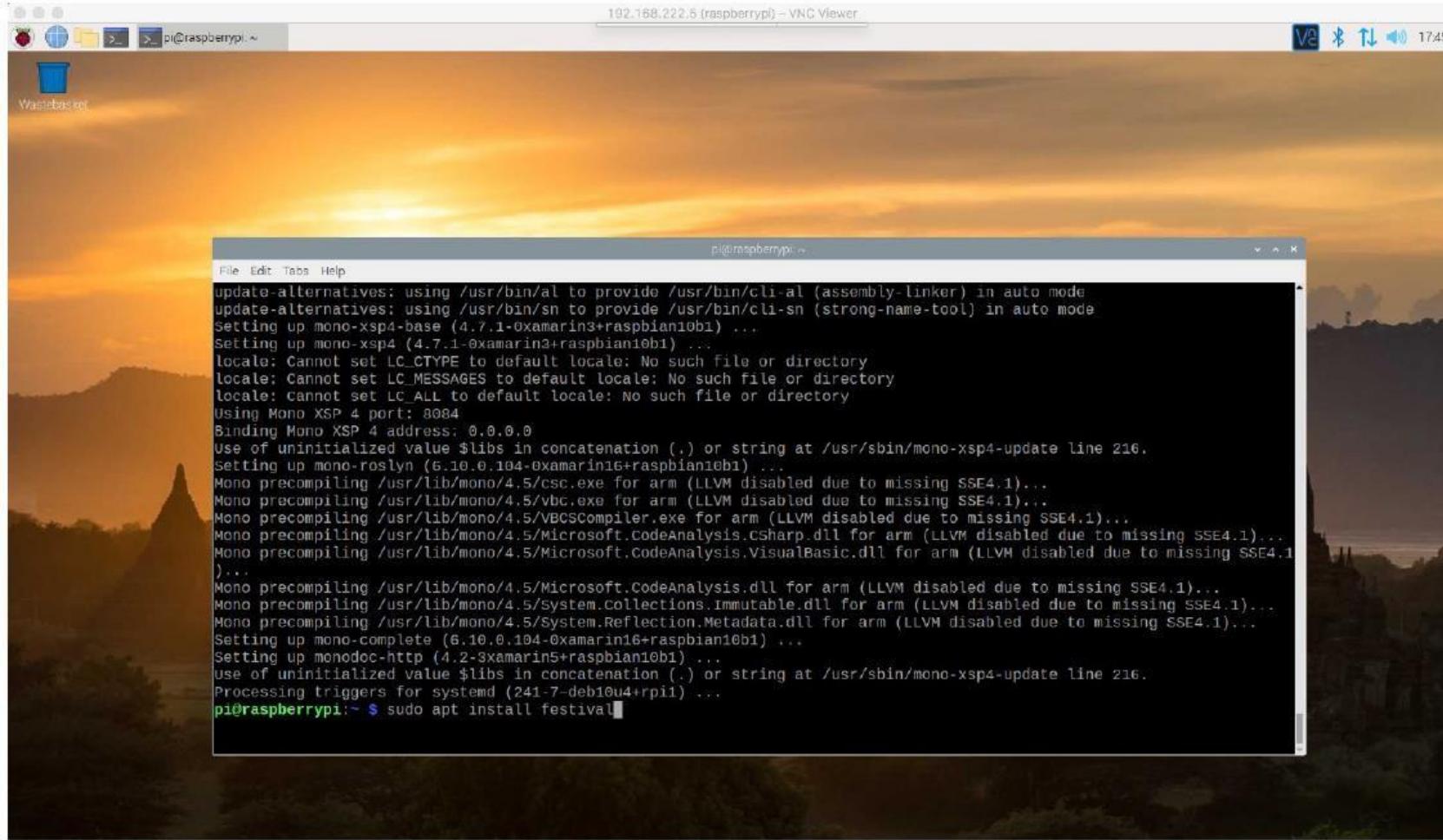
```
apt-listchanges: Can't set locale; make sure $LC_* and $LANG are correct!
perl: warning: Setting locale failed.
perl: warning: Please check that your locale settings:
    LANGUAGE = (unset),
    LC_ALL = (unset),
    LANG = "en_GB.UTF-8"
        are supported and installed on your system.
perl: warning: Falling back to the standard locale ("C").
locale: Cannot set LC_CTYPE to default locale: No such file or directory
locale: Cannot set LC_MESSAGES to default locale: No such file or directory
locale: cannot set LC_ALL to default locale: No such file or directory
Selecting previously unselected package apt-transport-https.
(Reading database ... 156195 files and directories currently installed.)
Preparing to unpack .../apt-transport-https_1.8.2.1_all.deb ...
Unpacking apt-transport-https (1.8.2.1) ...
Setting up apt-transport-https (1.8.2.1) ...
pi@raspberrypi:~ $ sudo apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv-keys 3FA7E0328081BFF6A14DA29AA6A19B38D3D831EF
Executing: /tmp/apt-key-gpghome.2H7a7Mqwo/gpg.i.sh --keyserver hkp://keyserver.ubuntu.com:80 --recv-keys 3FA7E0328081BFF6A14DA29AA6A19B38D3D831EF
gpg: key A6A19B38D3D831EF: public key "Xamarin Public Jenkins (auto-signing) <releng@xamarin.com>" imported
gpg: Total number processed: 1
gpg:               imported: 1
pi@raspberrypi:~ $ echo "deb https://download.mono-project.com/repo/debian stable-raspbianbuster main" | sudo tee /etc/apt/sources.list.d/mono-official-stable.list
deb https://download.mono-project.com/repo/debian stable-raspbianbuster main
pi@raspberrypi:~ $ sudo apt update
```

- After this, the terminal should tell you “all packages are up to date”. If this is not the case, please enter: “`sudo apt upgrade`”.

- Command 5: `sudo apt install mono-complete`
- Note: This step will download 300MB and take some minutes.

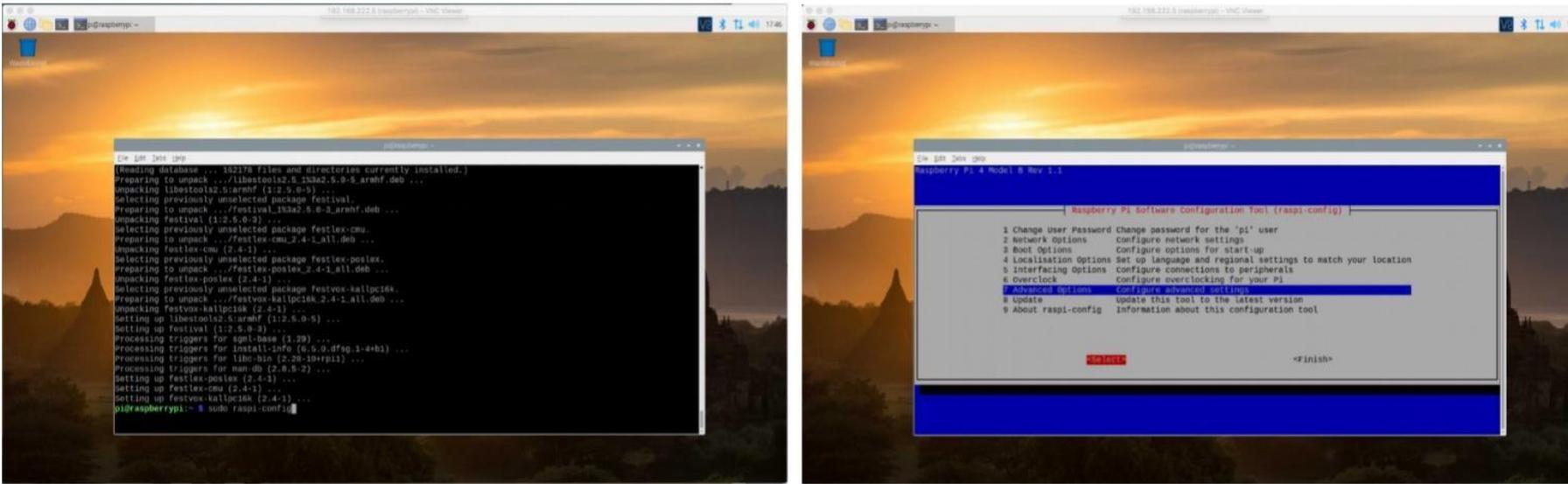


- When mono is finished, we need to install “Festival”. This is needed to give Mission Planner a voice.
- Command 6: `sudo apt install festival`

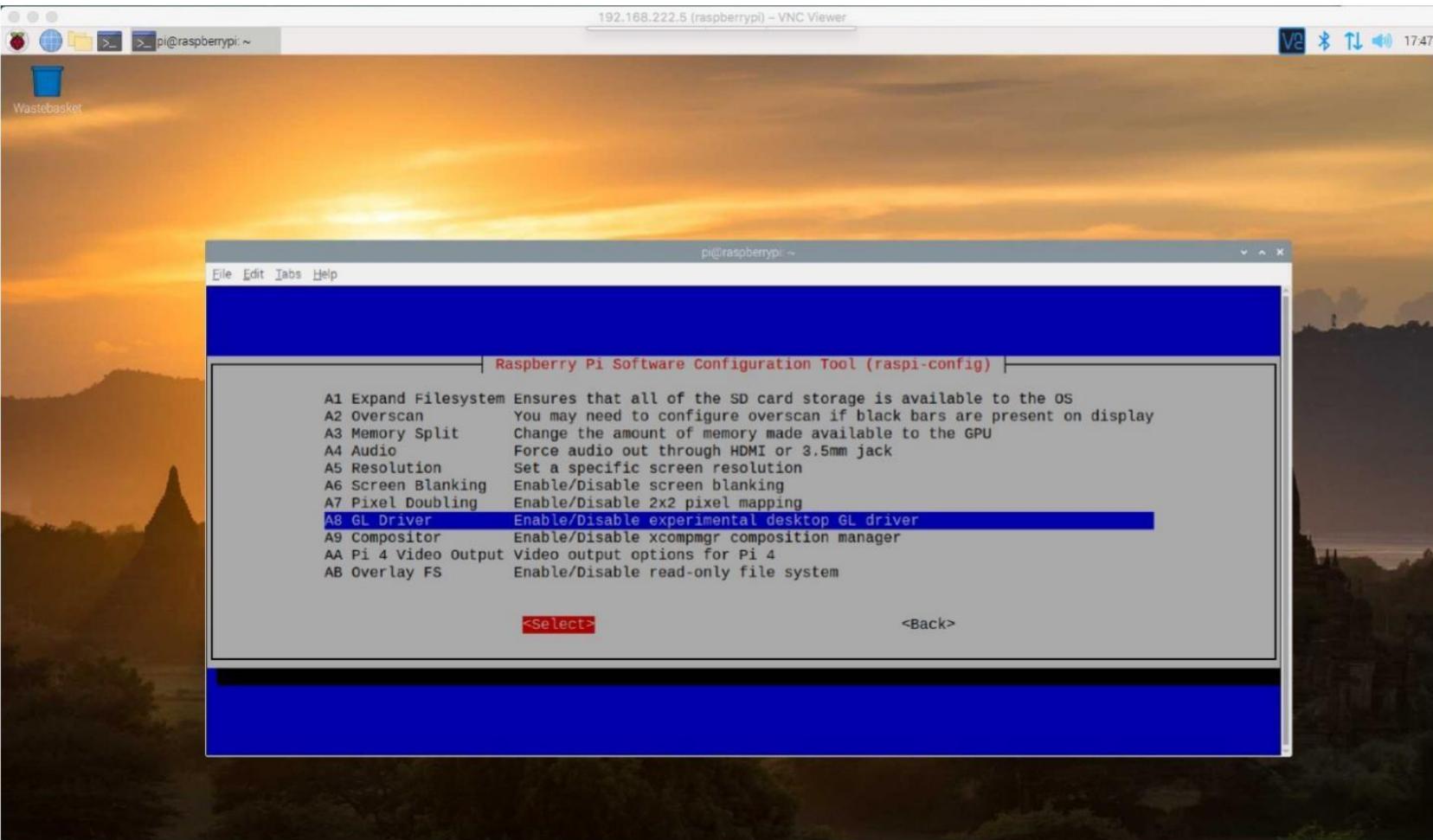


STEP 2: Deactivate OpenGL

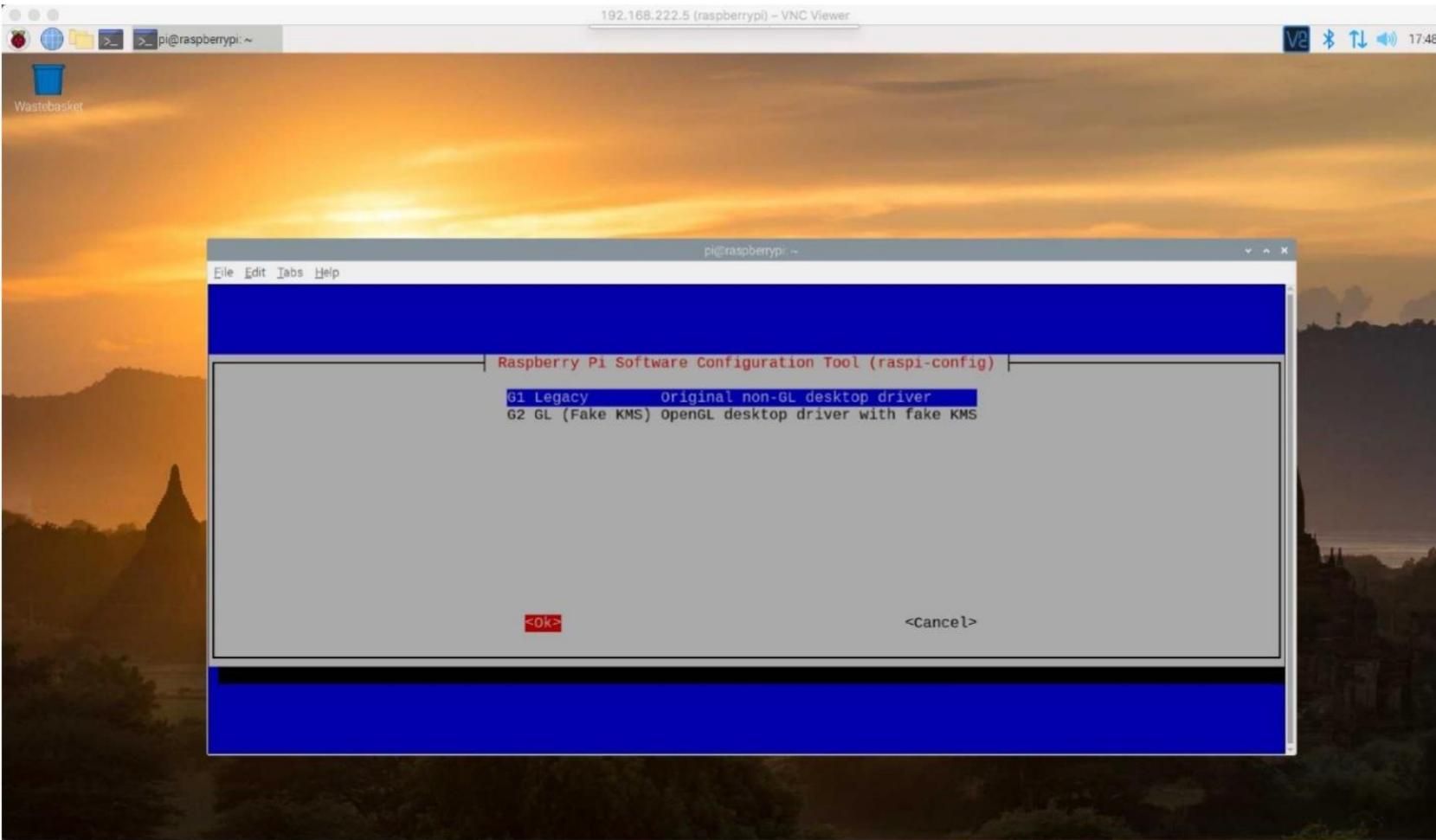
- Run command: `sudo raspi-config`
- Select “Advanced options”



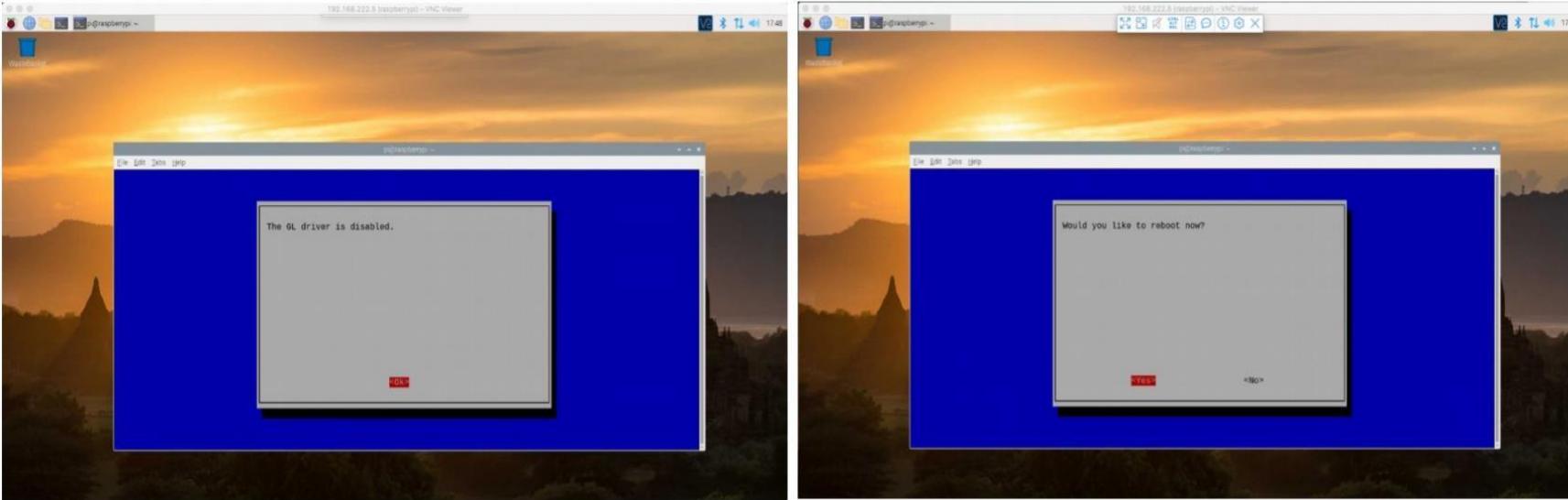
- Select “GL Driver”



- Choose “G1 Legacy”



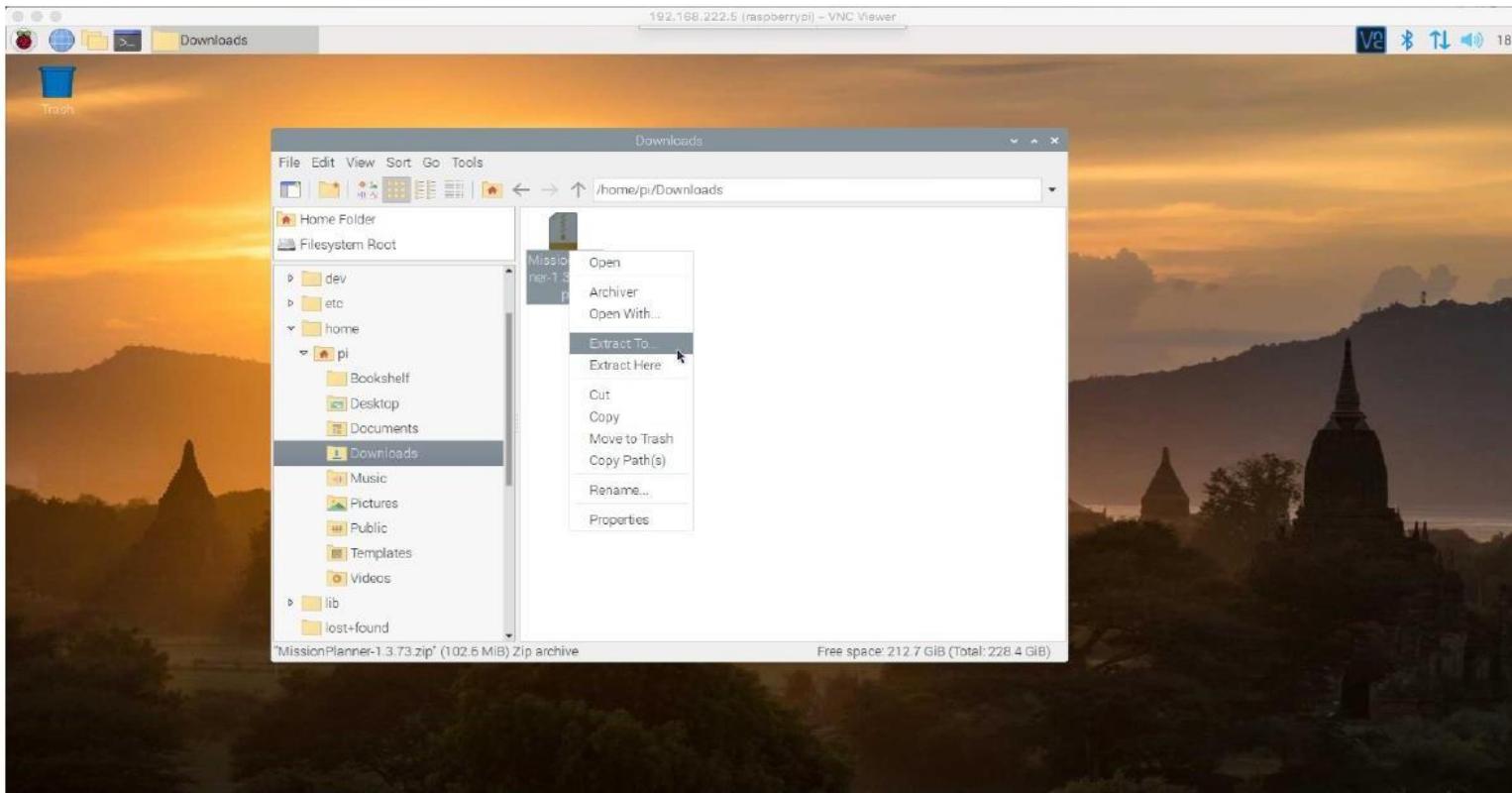
- It should say “GL driver is disabled”. Click “OK”
- Select the “Finish” option and select “Reboot” to reboot the system and apply changes.



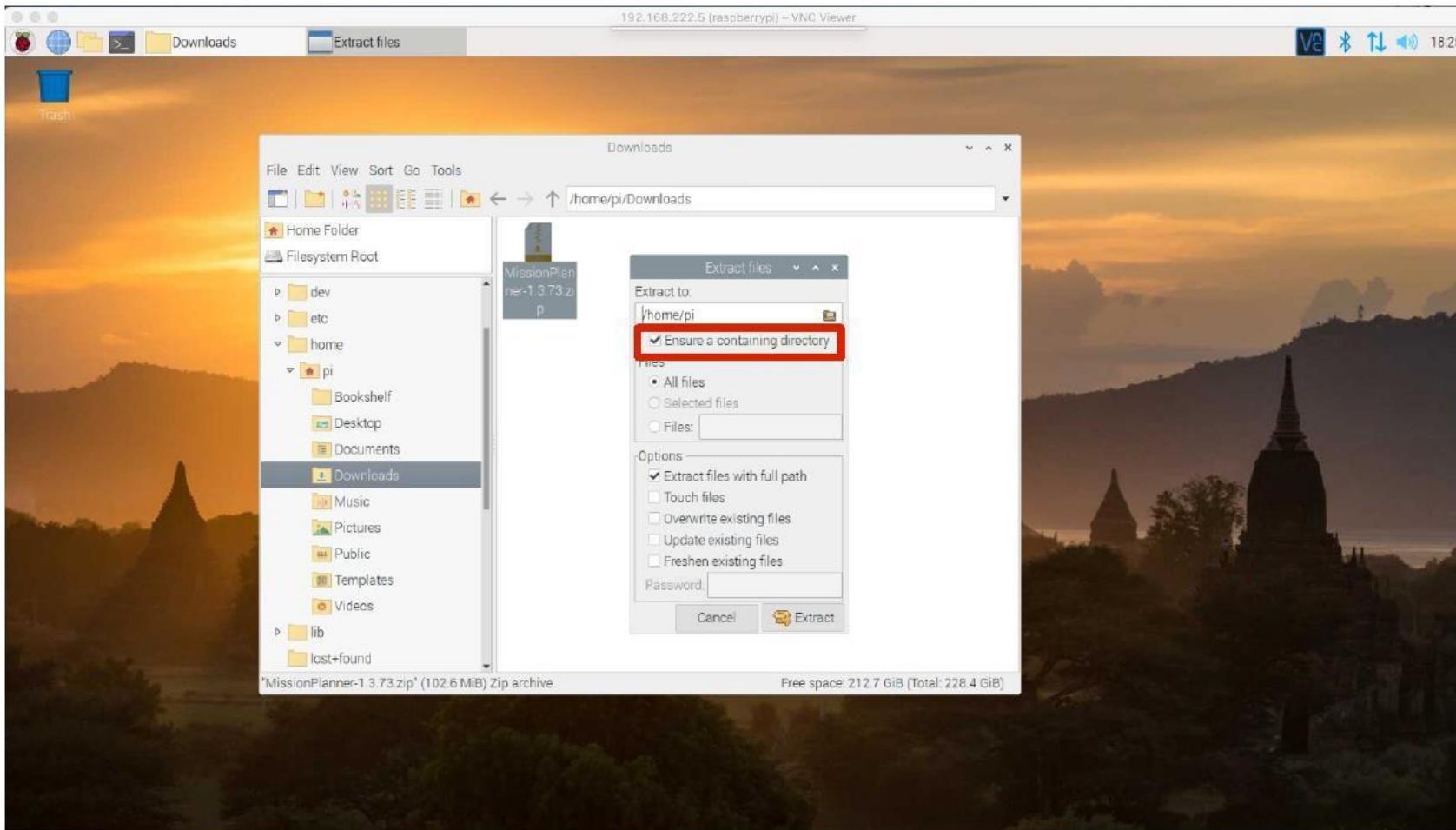
STEP 3: Download Mission planner

Download MissionPlanner.zip using the below steps:

- Open Chromium web browser.
- Go to <https://firmware.ardupilot.org/Tools/MissionPlanner/>
- Download the latest version of Mission Planner. (1.3.74)
- Note: download the .zip file.
- Also, on the top left, you'll find your File Manager. Go to “home/pi/Downloads”.
- Right-click on the file → extract to.

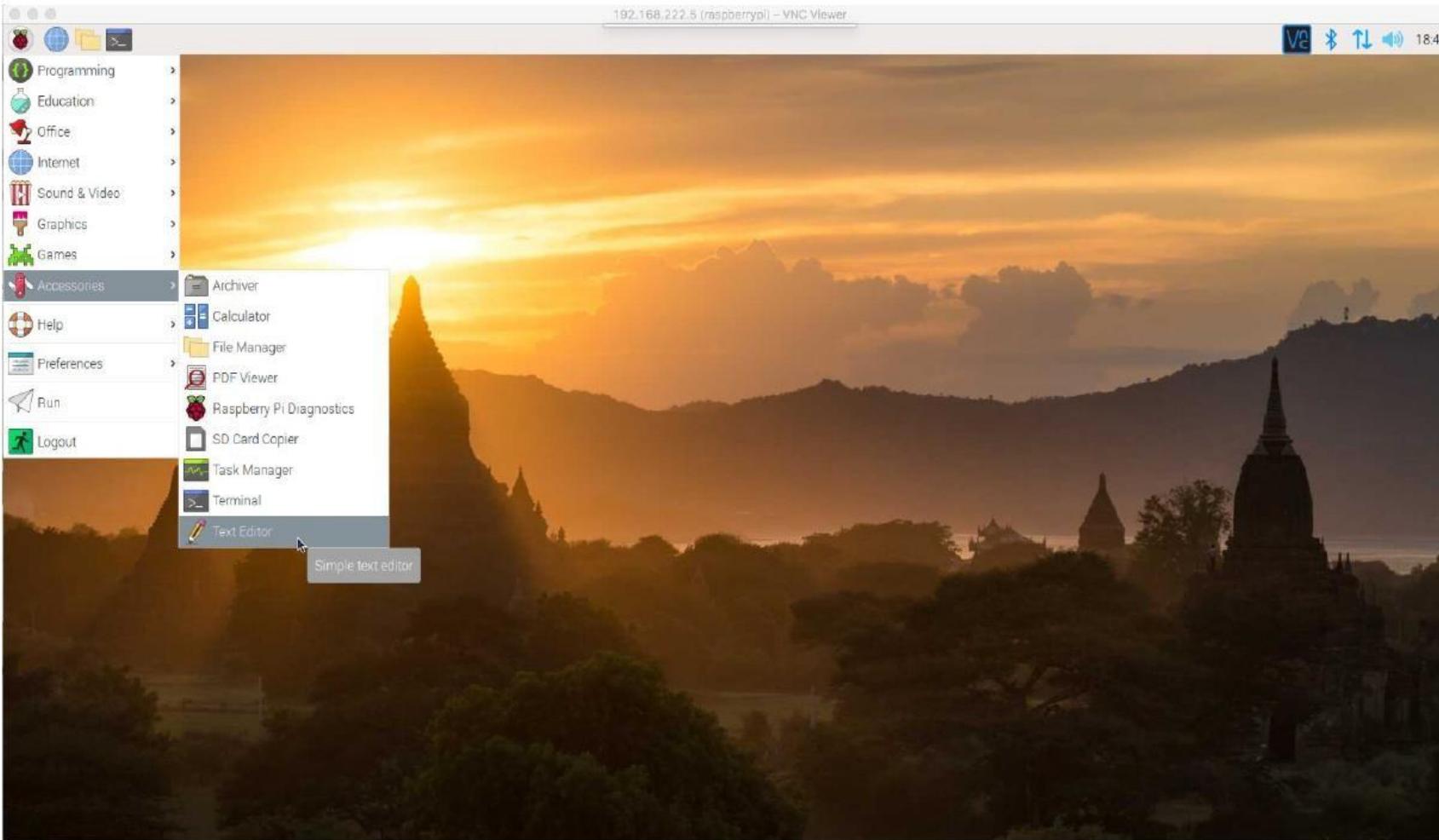


- Extract it at any desire location. However, you'll need to enter the path later to create a desktop icon for easy access.
- I extracted it straight to “home/pi/” where it will create its own directory (be sure to tick “ensure a containing directory”)



Follow these steps to create a desktop icon:

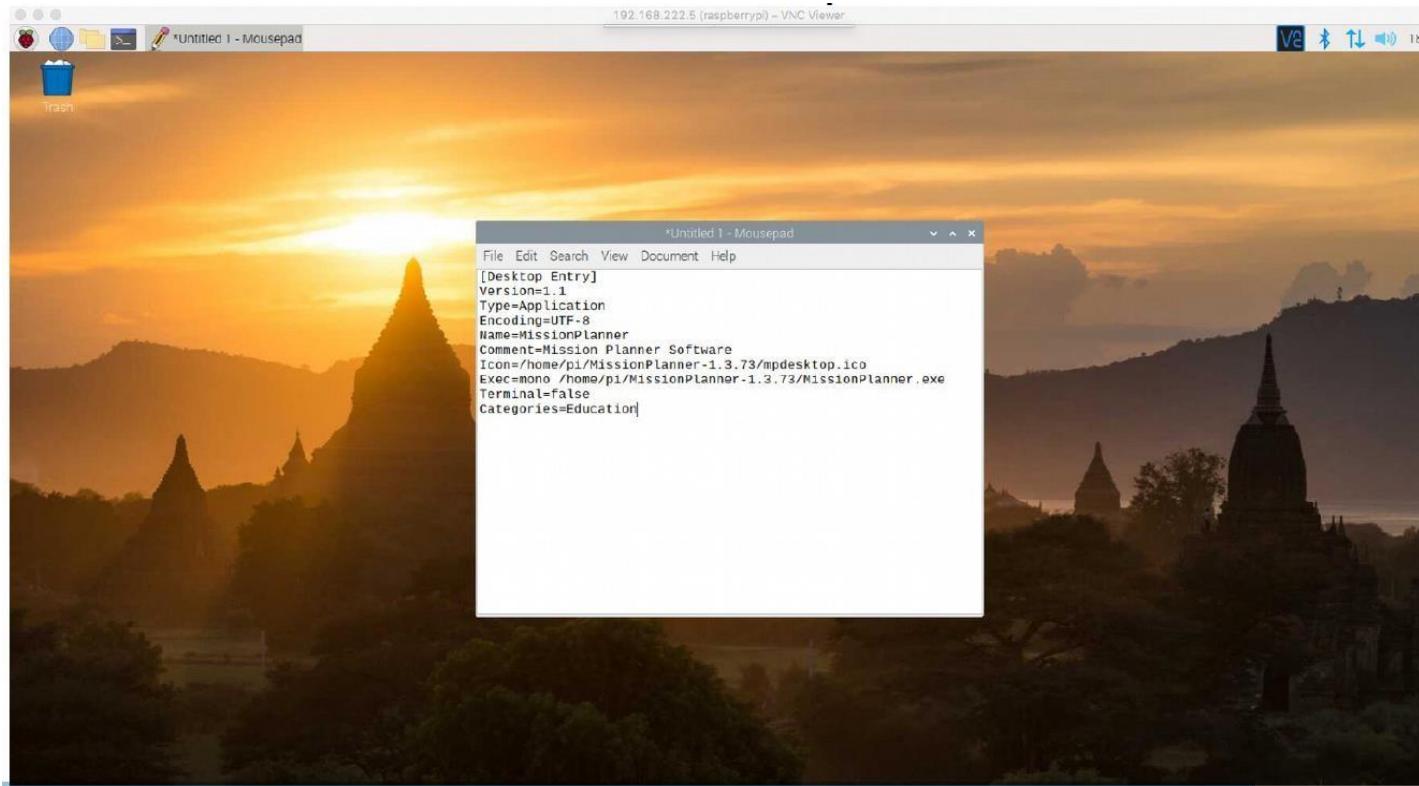
- Have a look under the Raspberry for Text Editor.



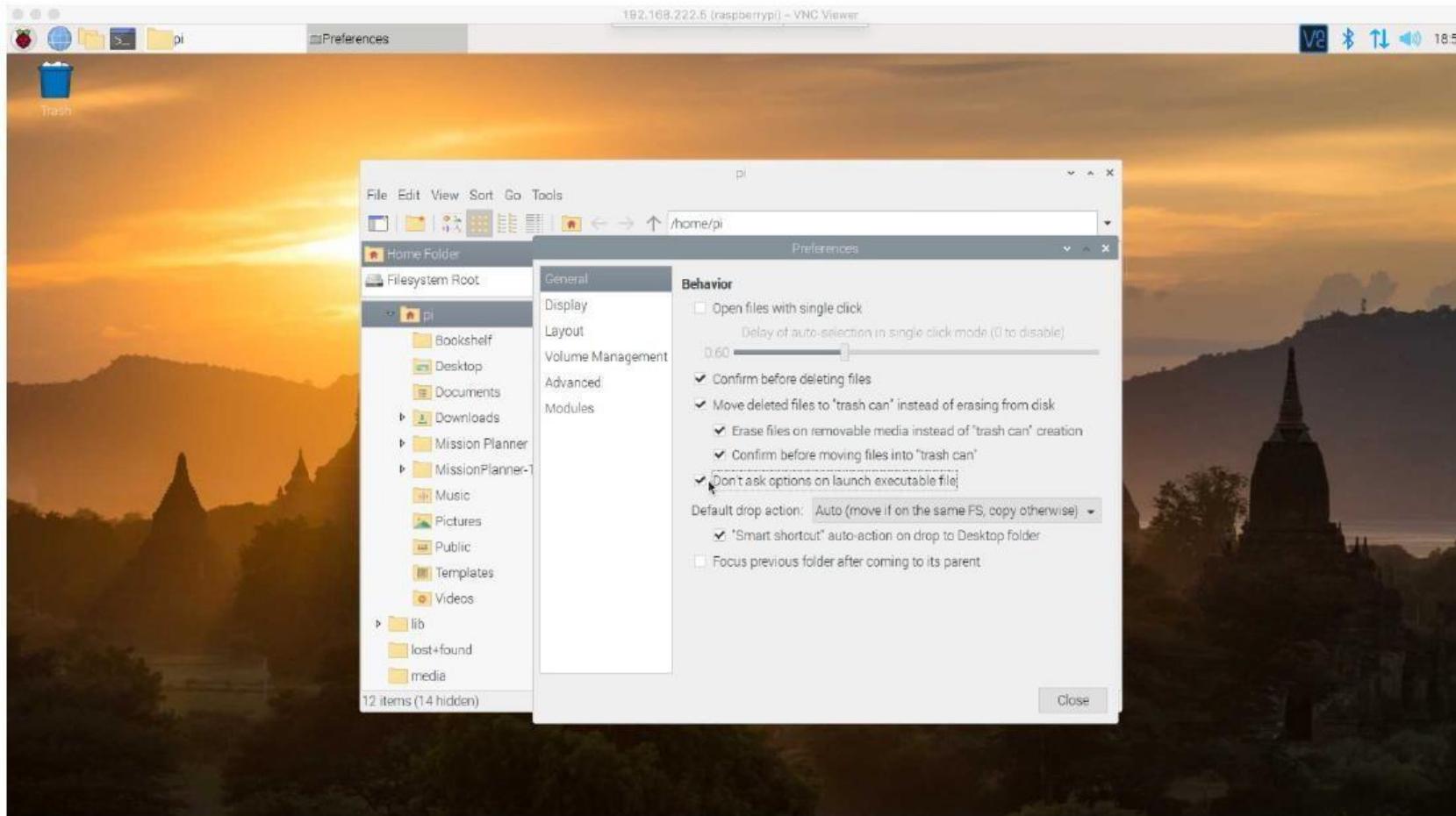
- We will copy the following lines into the Text editor and save that as “MissionPlanner.desktop” straight on our desktop. (Note: Change the path for the Icon and the Exec to the path of extraction. However,

=mono” is required) [Desktop Entry]

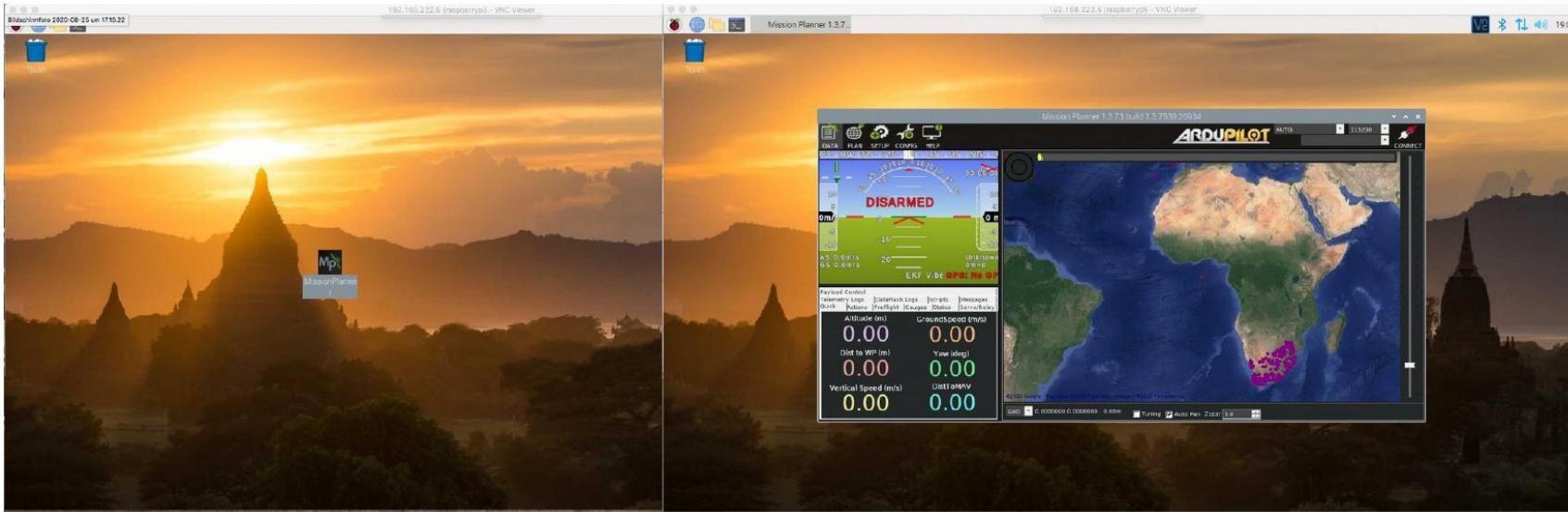
```
Version=1.1
Type=Application
Encoding=UTF-8
Name=MissionPlanner
Comment=Mission Planner Software
Icon=/home/pi/MissionPlanner-1.3.74/mpdesktop.ico
Exec=mono /home/pi/MissionPlanner-1.3.74/MissionPlanner.exe
Terminal=false
Categories=Education
```



- When you click on your new desktop icon, your Pi will prompt you with some rather annoying choices. We will now remove them.
- Inside your “File Manager” top menu → edit → preferences → general.
- Toggle the box “don't ask options on launch executable files”.



- The Download and install process is now completed.



Calibration of drone using mission planner on Raspberry pi OS

STEP 1: Getting started.

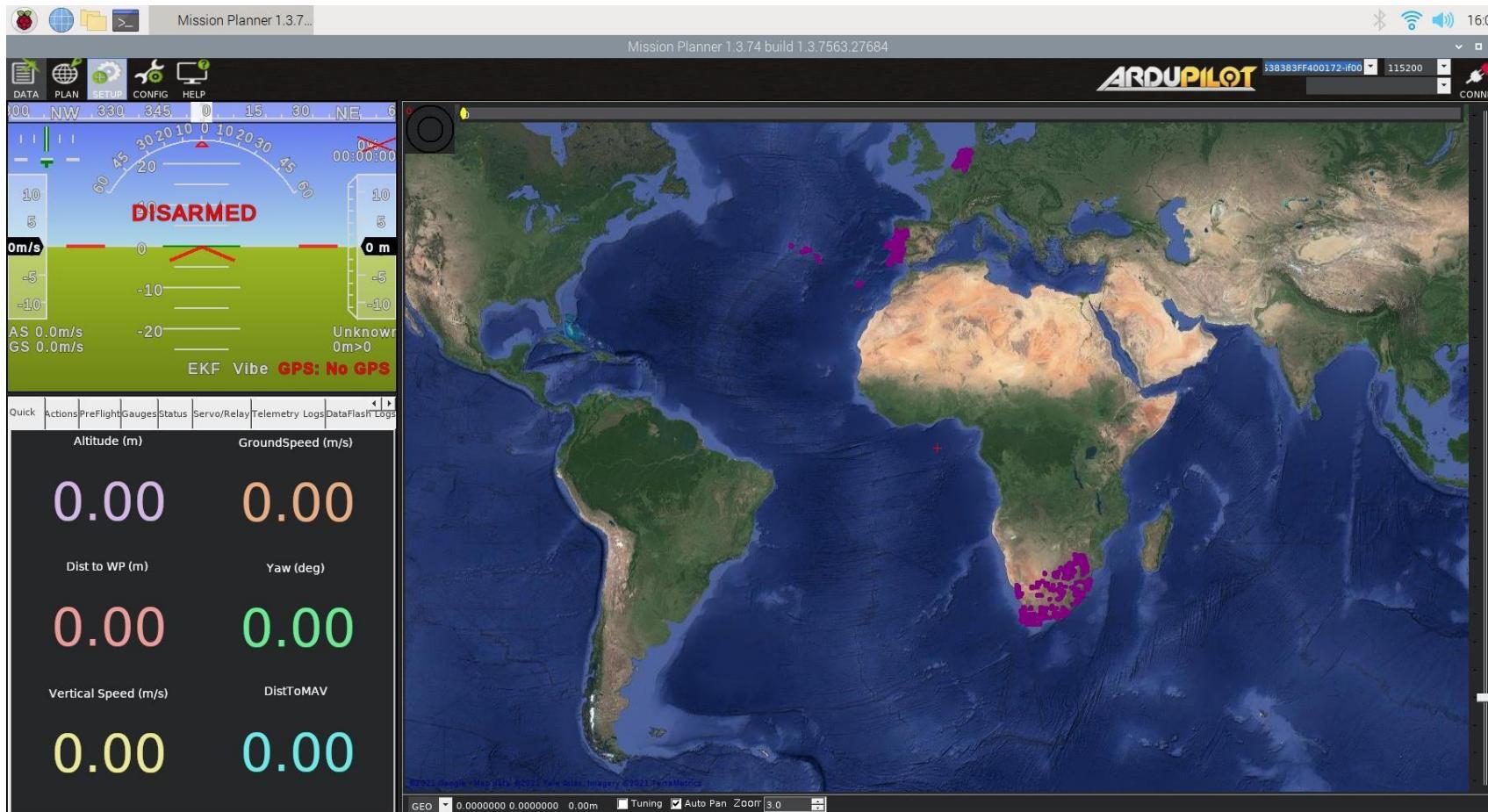
- Connect the Raspberry pi board to APM 2.8 using a Type-B USB cable.
- Open mission planner using the desktop icon created in the previous section.



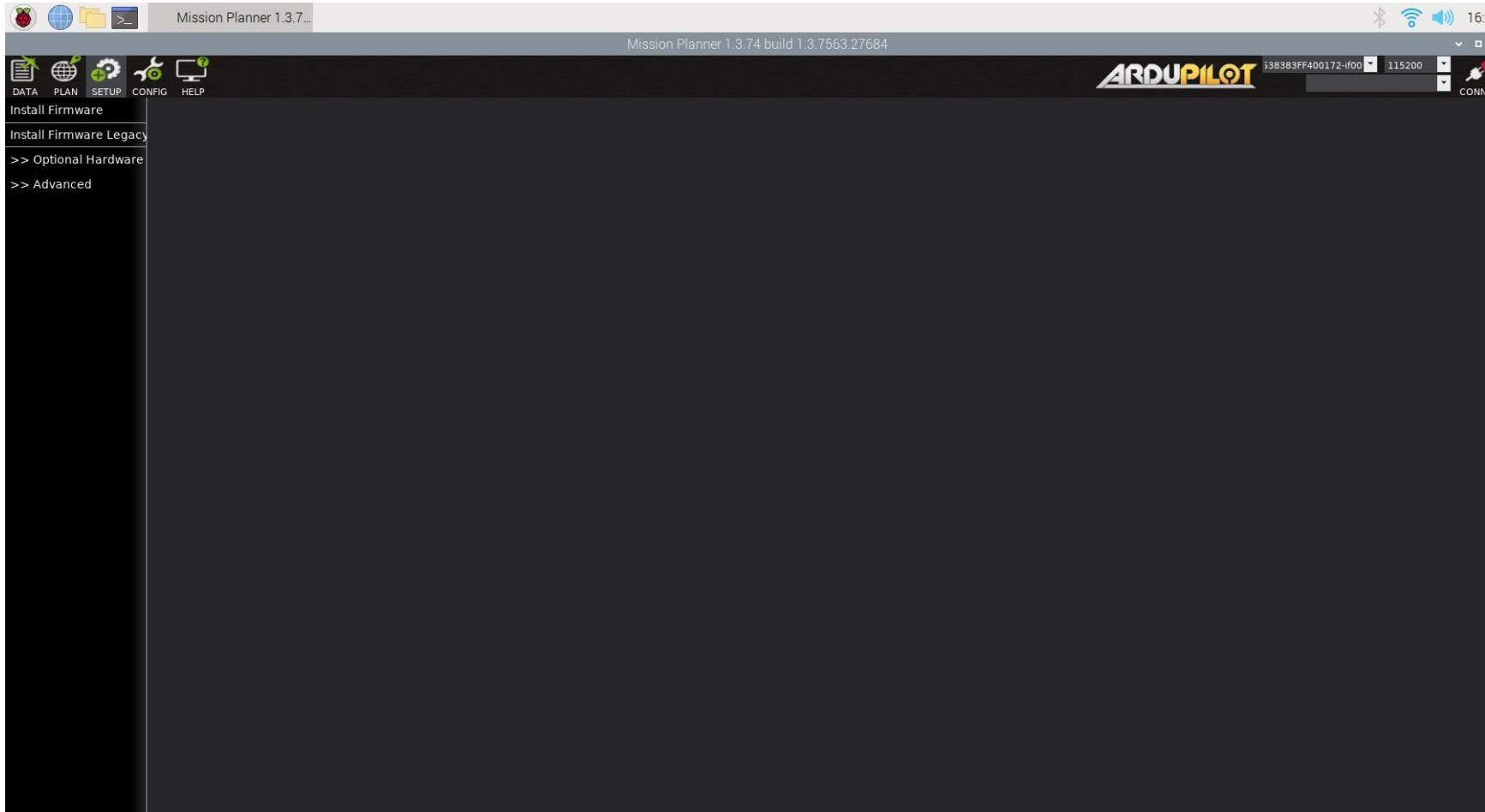
- Select “/dev/serial/by-id/usb-Arduino_ww....” port from the dropdown menu in the top right corner.



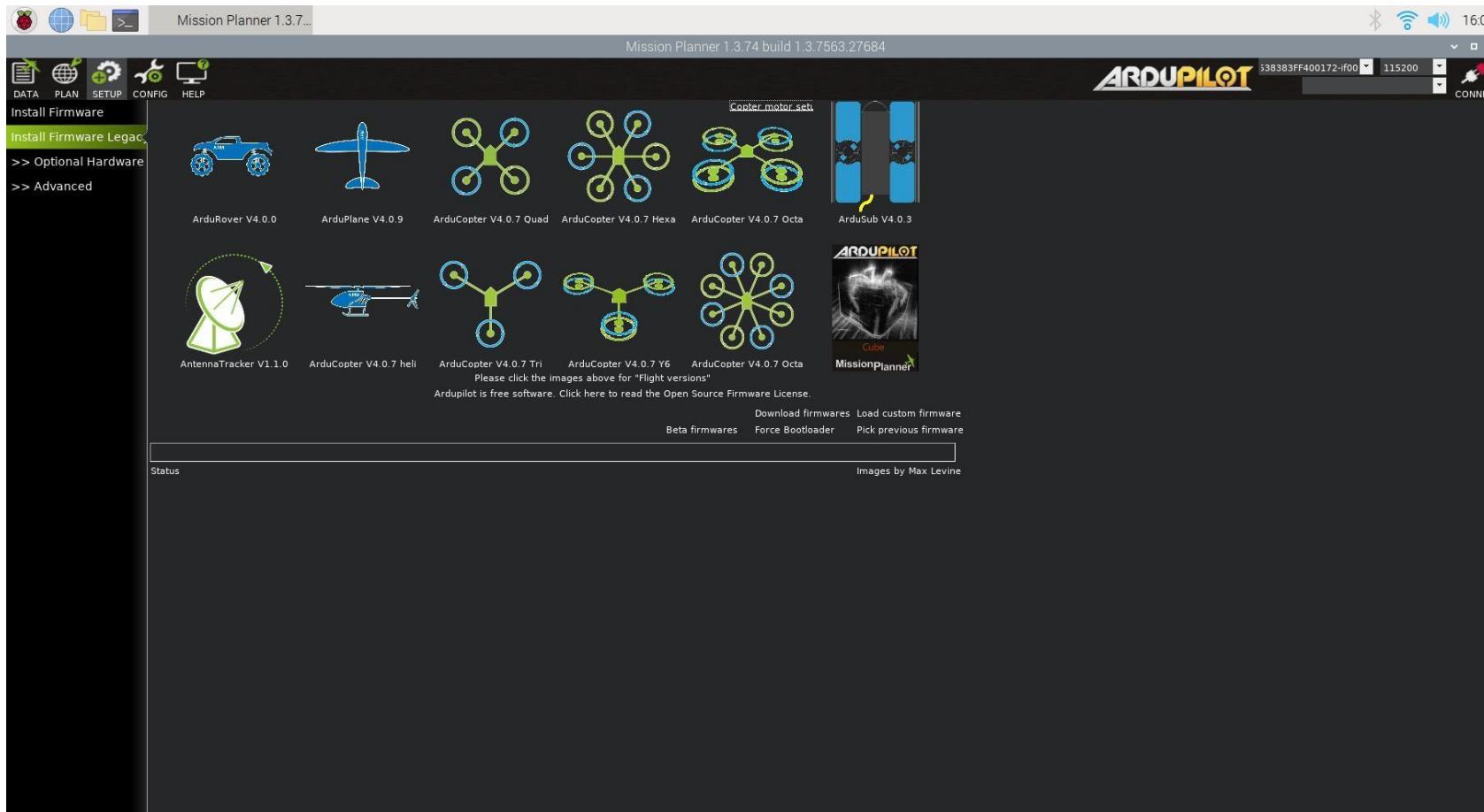
- Open the “Setup” menu from the top left corner, select “Firmware legacy”.



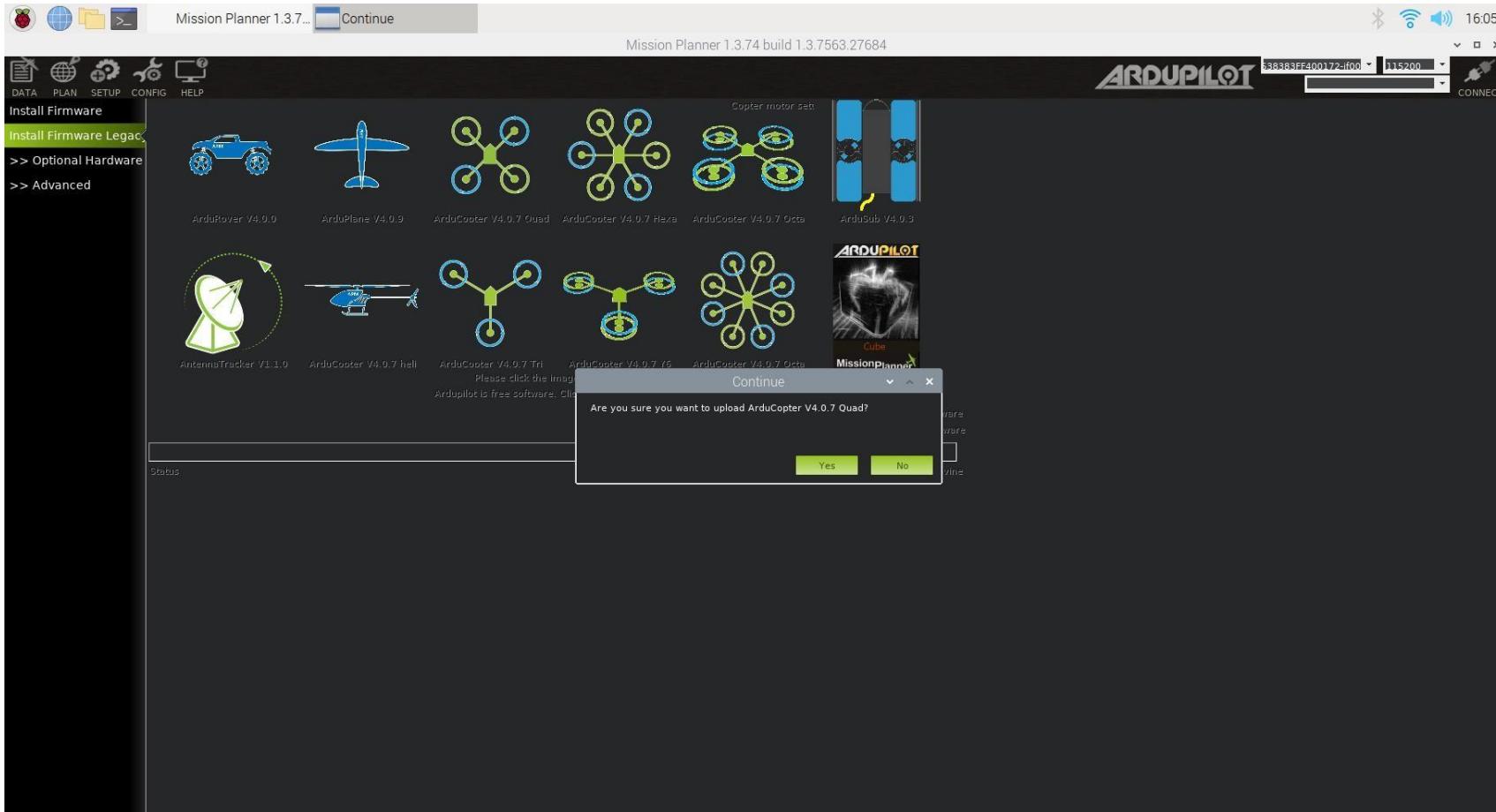
- Select “Firmware Legacy”.



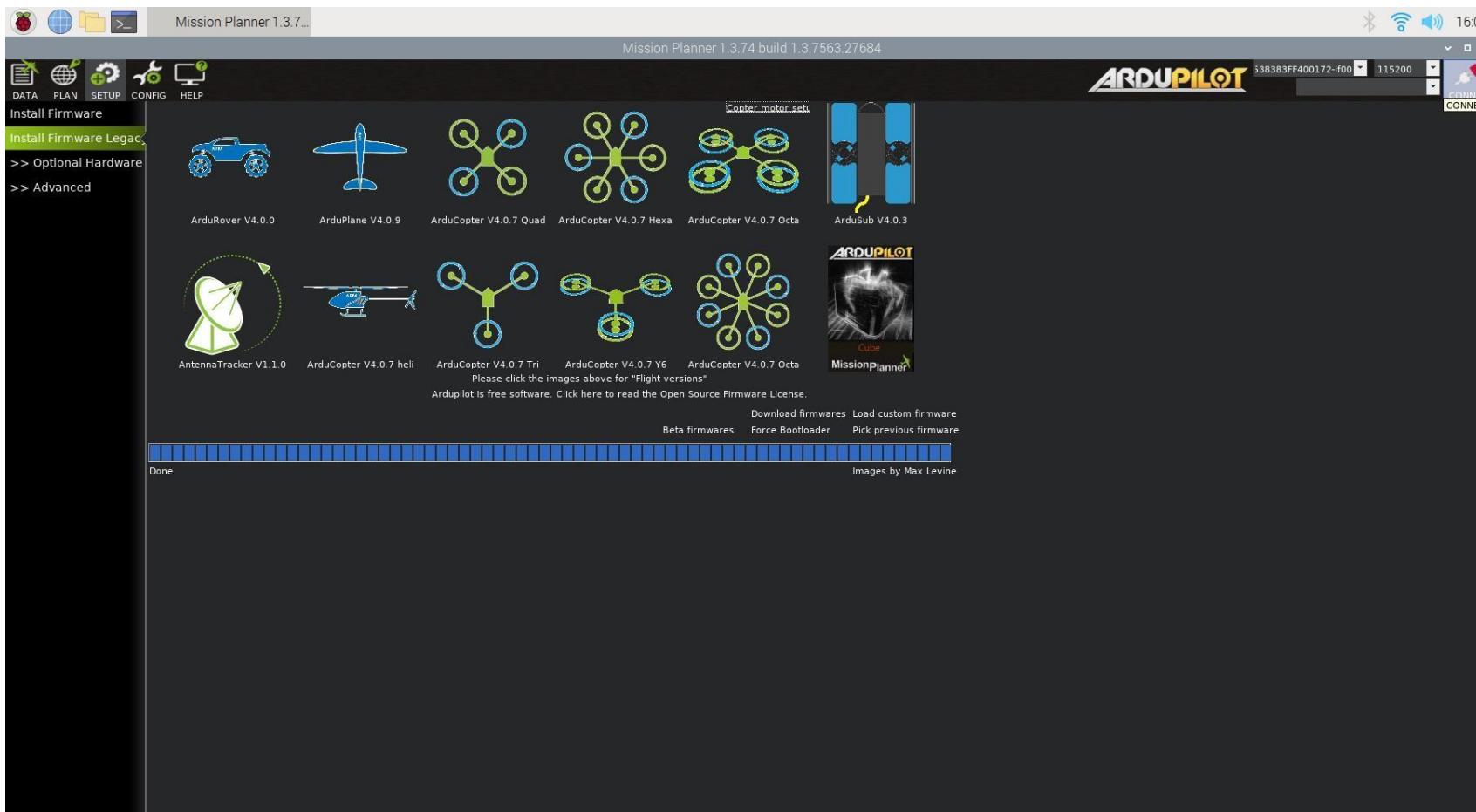
- Select the appropriate icon that matches your frame (i.e., Quad)



- Answer Yes when it asks you “Are you sure?”.

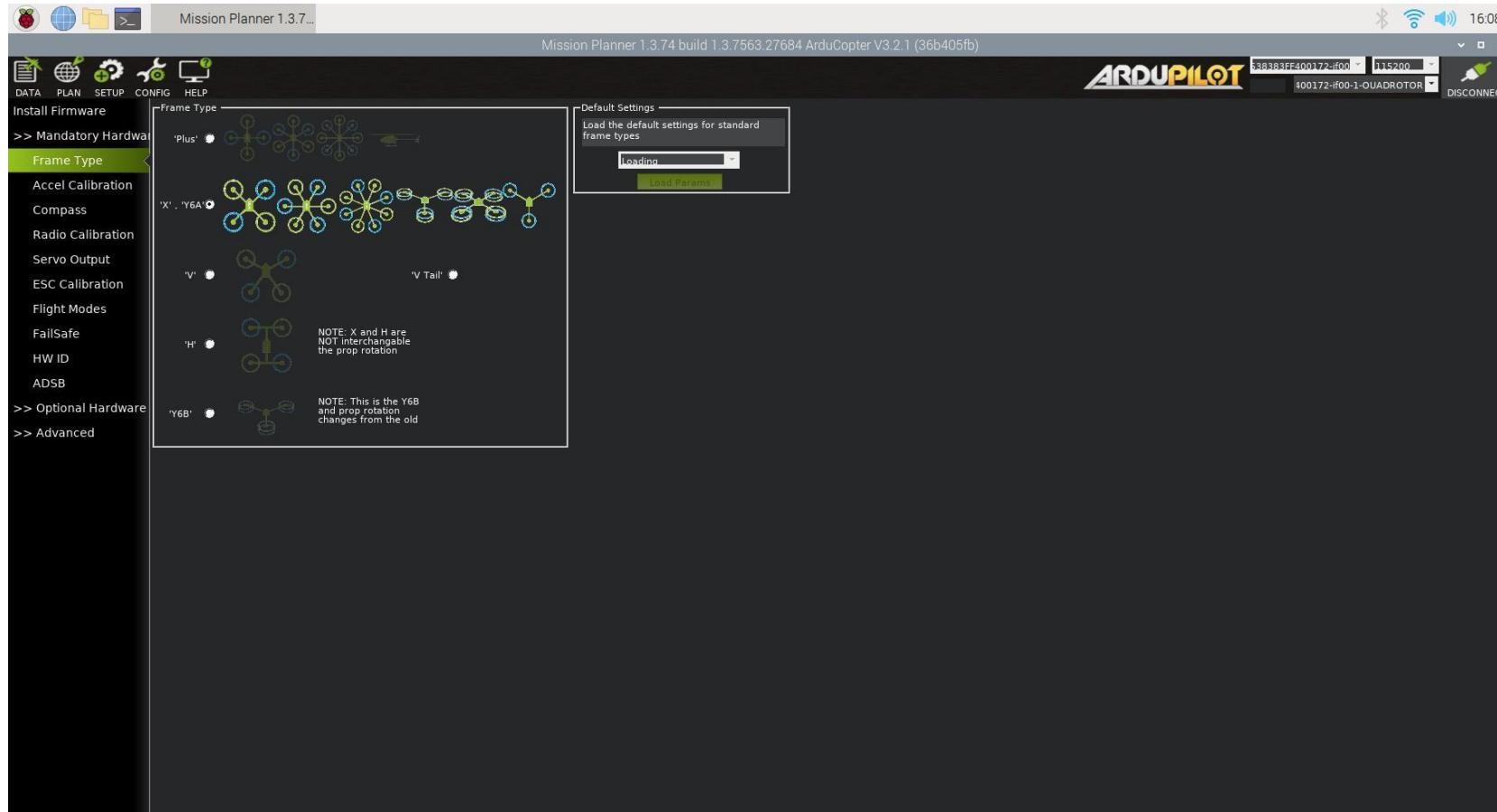


- If all goes well you will see some status appear on the bottom right including the words, “erase...”, “program...”, “verify...” and “Upload Done”. The firmware has been successfully uploaded to the board.
- It usually takes a few seconds for the bootloader to exit and enter the main code after programming or a power-up.
- Press CONNECT.



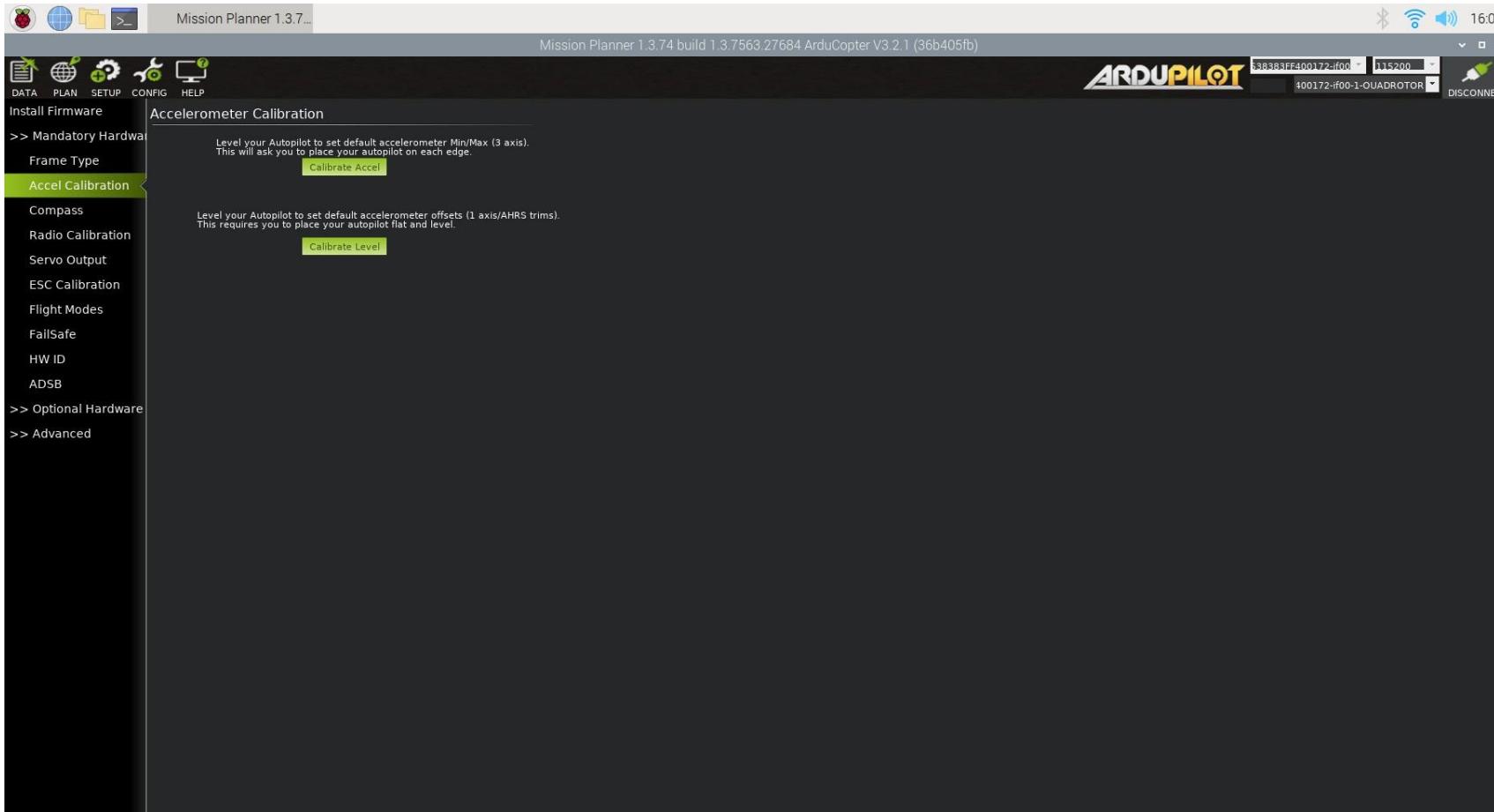
STEP 2: Selecting FrameType

- Under **Setup | Mandatory Hardware**.
- Select **Frame type** from the left-side menu and then choose “ ‘X’ . ‘Y6A’ ”.

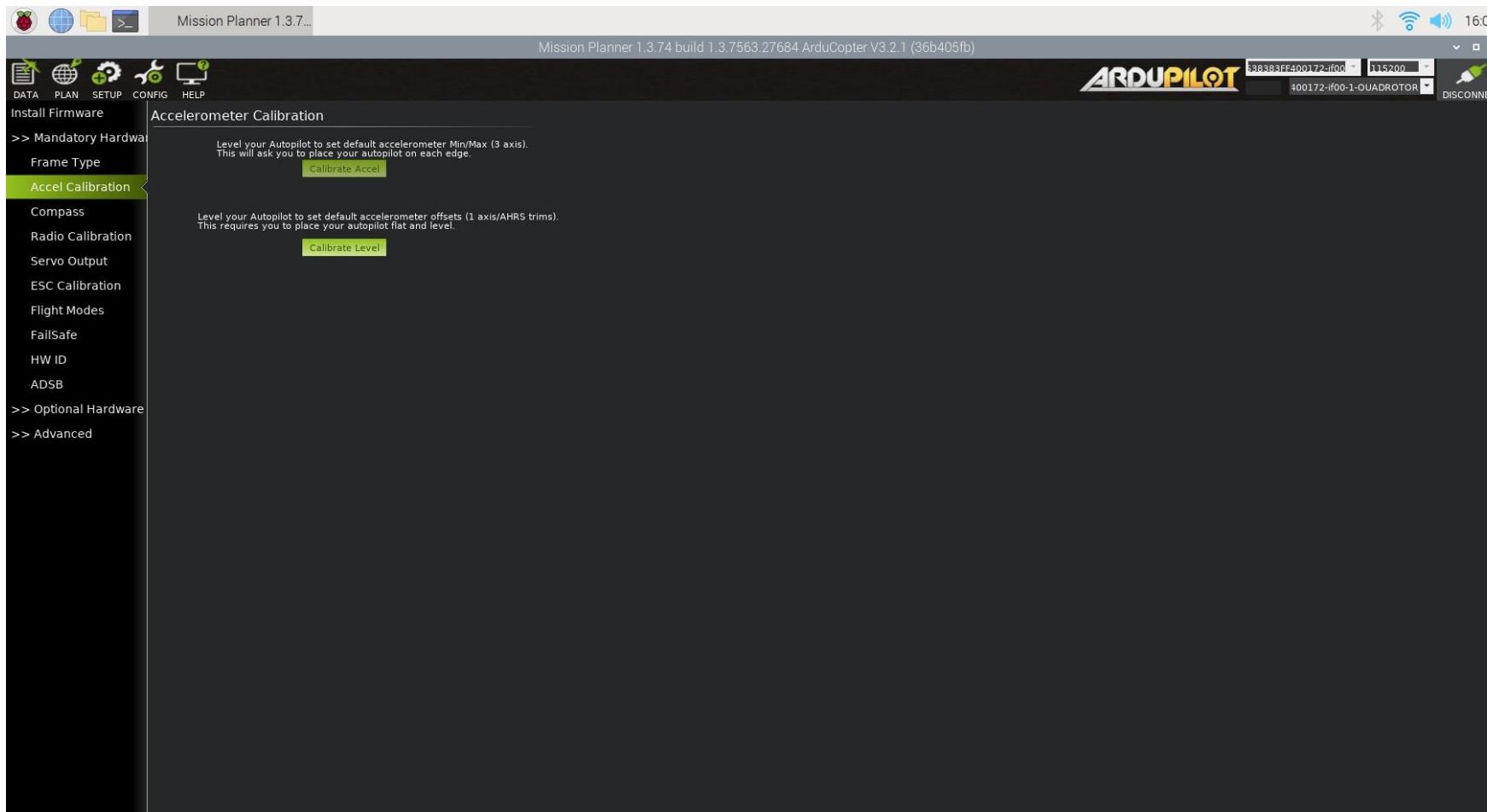


STEP 3: Calibration of Accelerometer

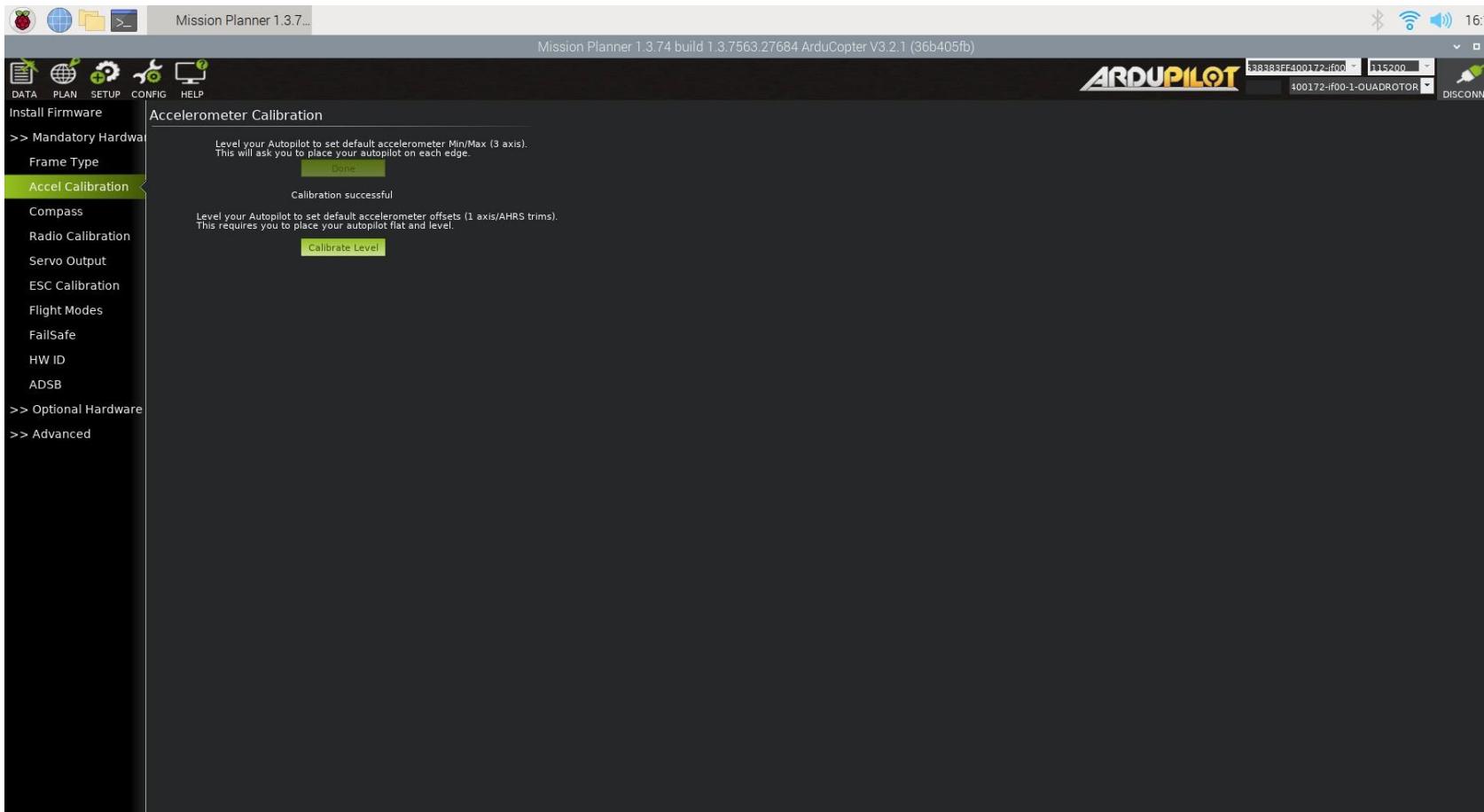
- Under **Setup | Mandatory Hardware**.
- Select **Accel Calibration** from the left-side menu.



- Click **Calibrate Accel** to start the calibration.

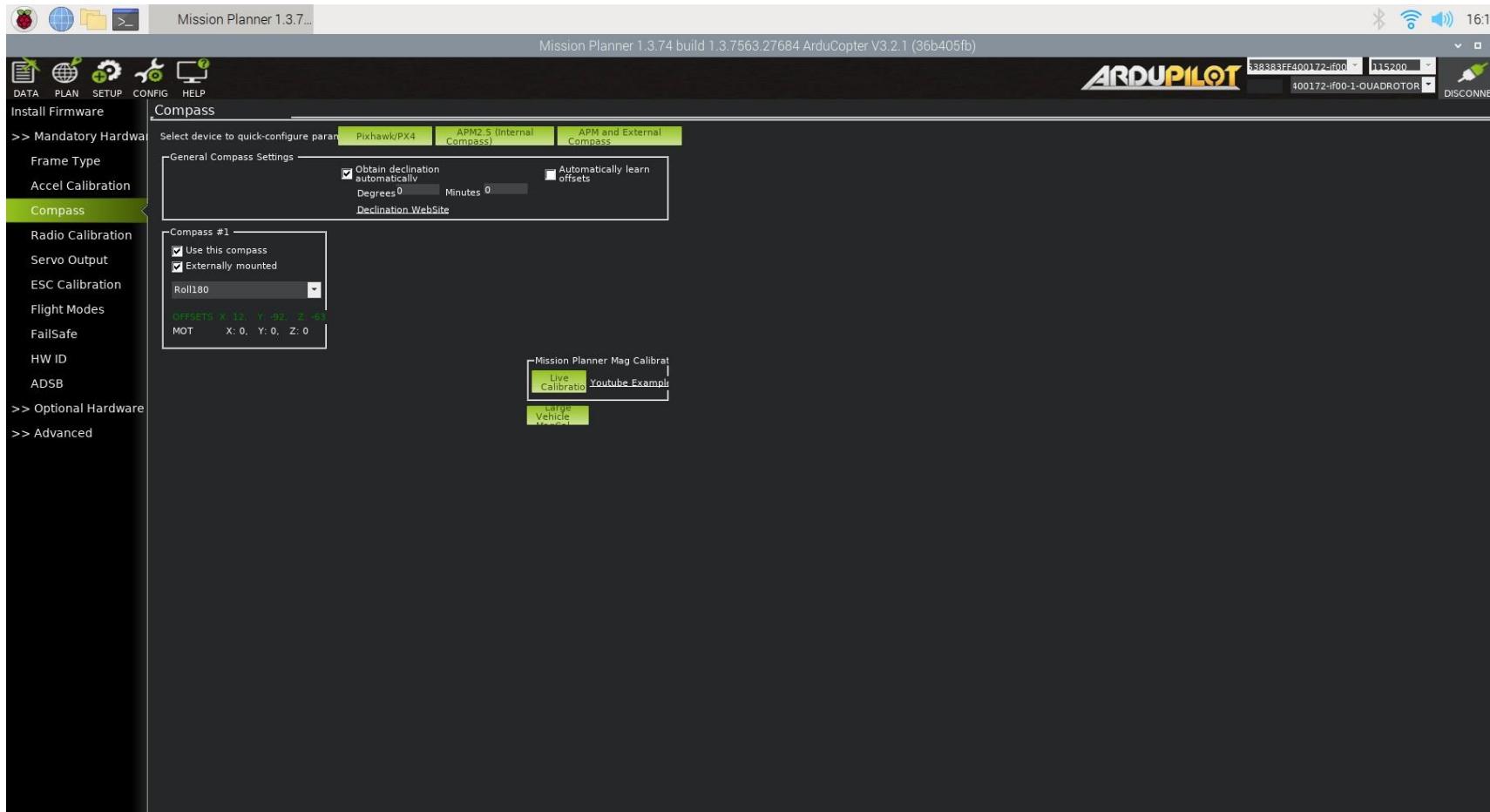


- Mission Planner will prompt you to place the vehicle in each calibration position.
- Press any key to indicate that the autopilot is in position and then proceed to the next orientation.
- The calibration positions are level, on the right side, left side, nose down, nose up, and on its back.
- Proceed through the required positions, using the Click when Done button after each position is reached.
- When you have completed the calibration process, Mission Planner will display “Calibration Successful!”

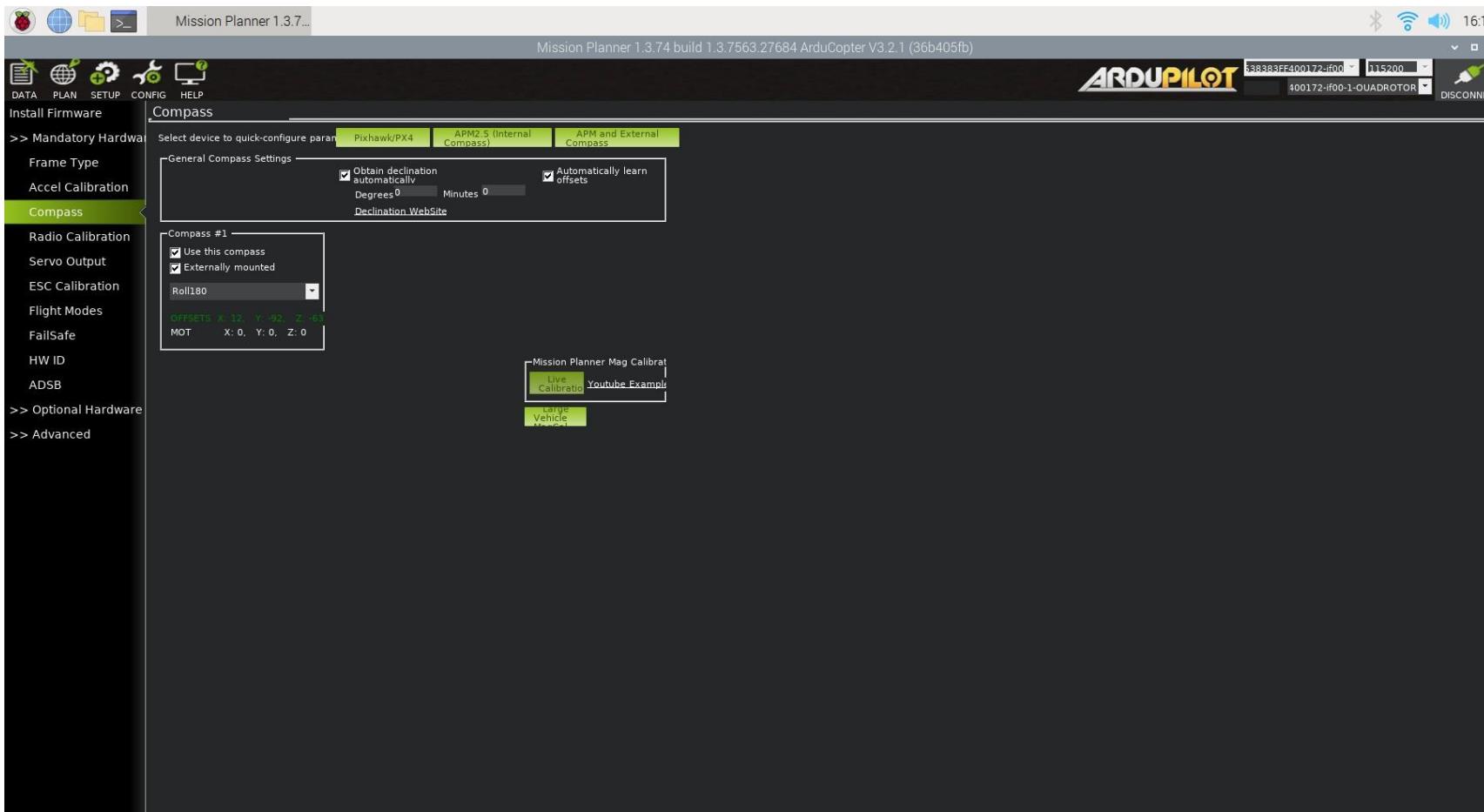


STEP 4: Calibration of Compass

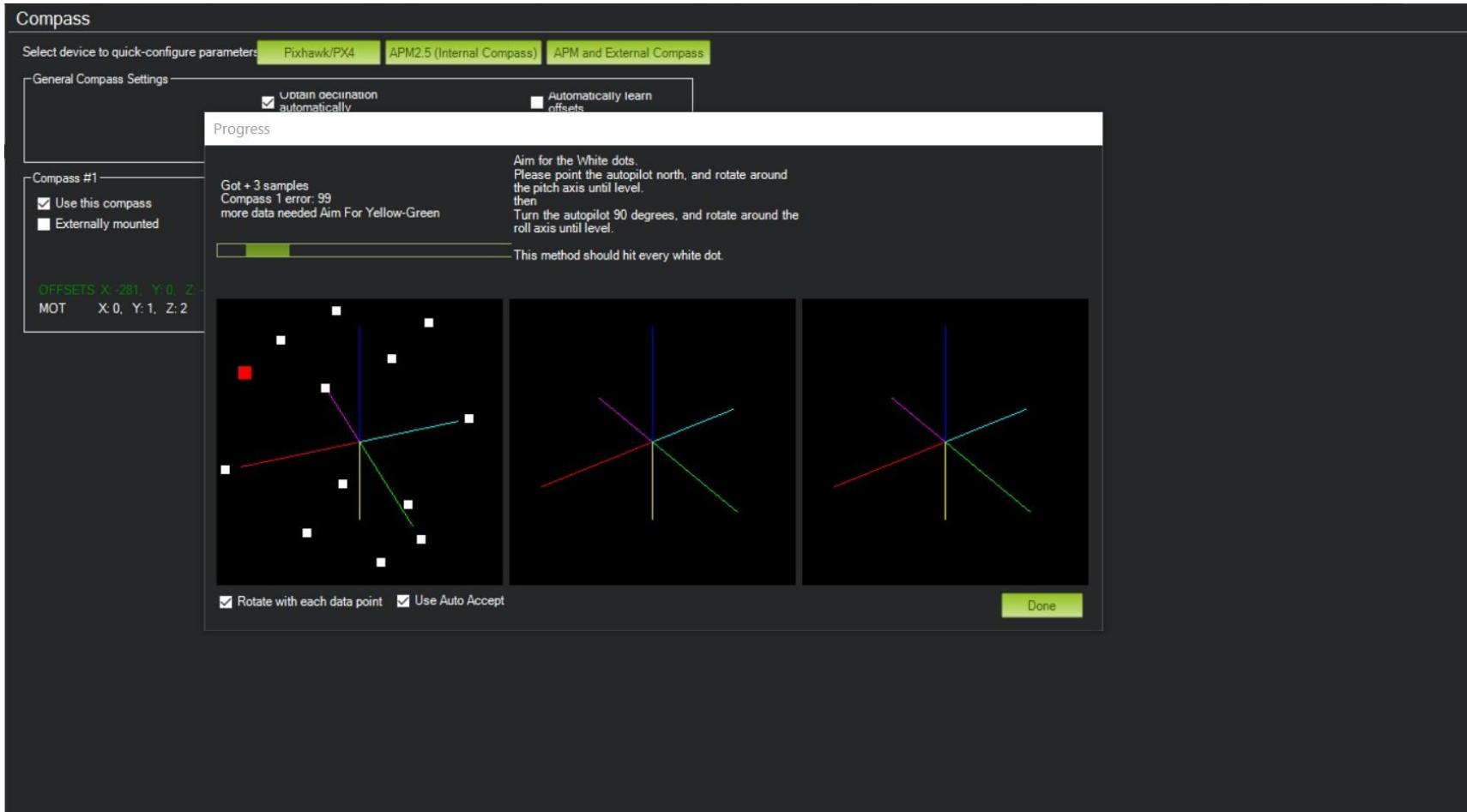
- Under **SETUP | Mandatory Hardware** select **Compass**.



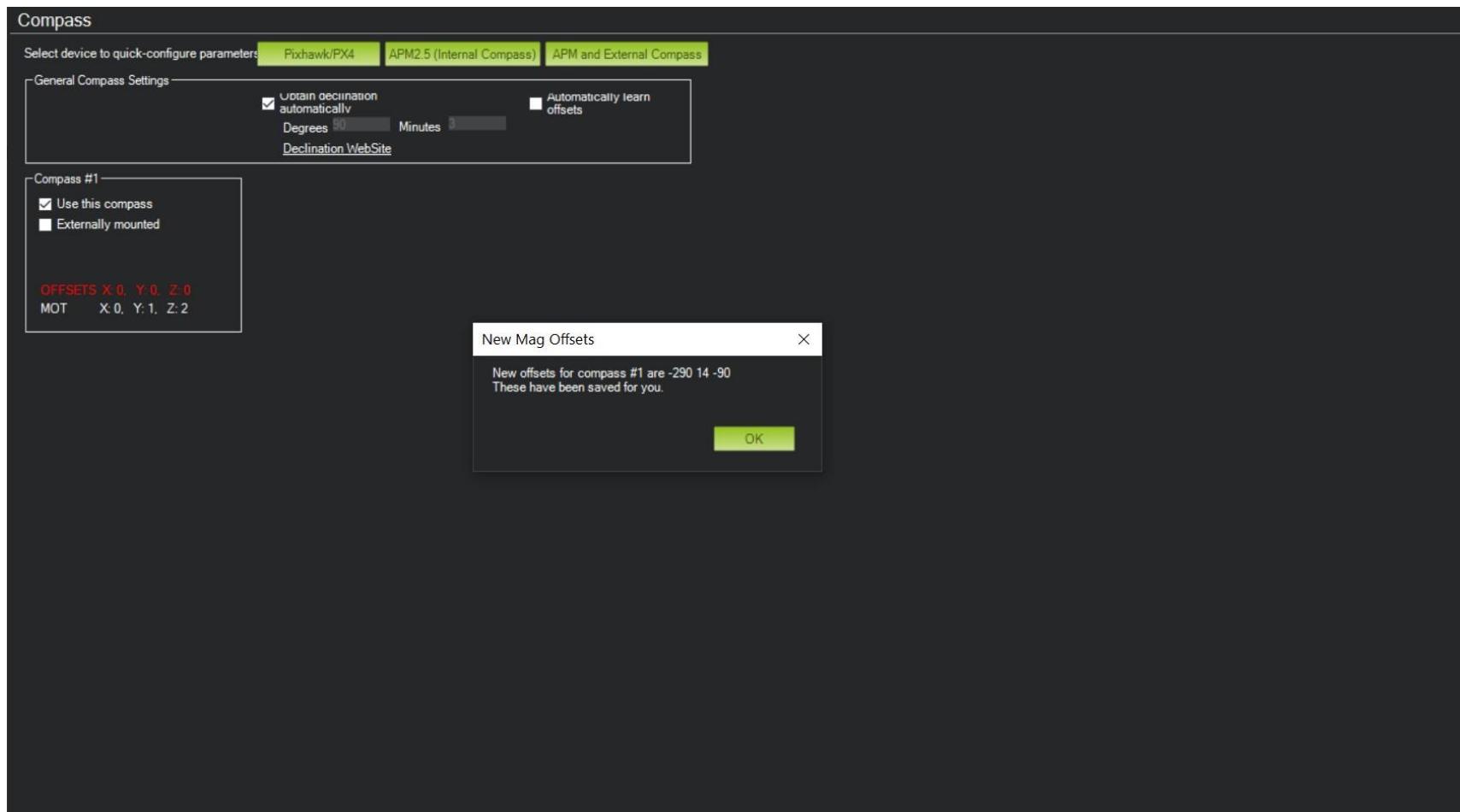
- Click on “Live Calibration”.



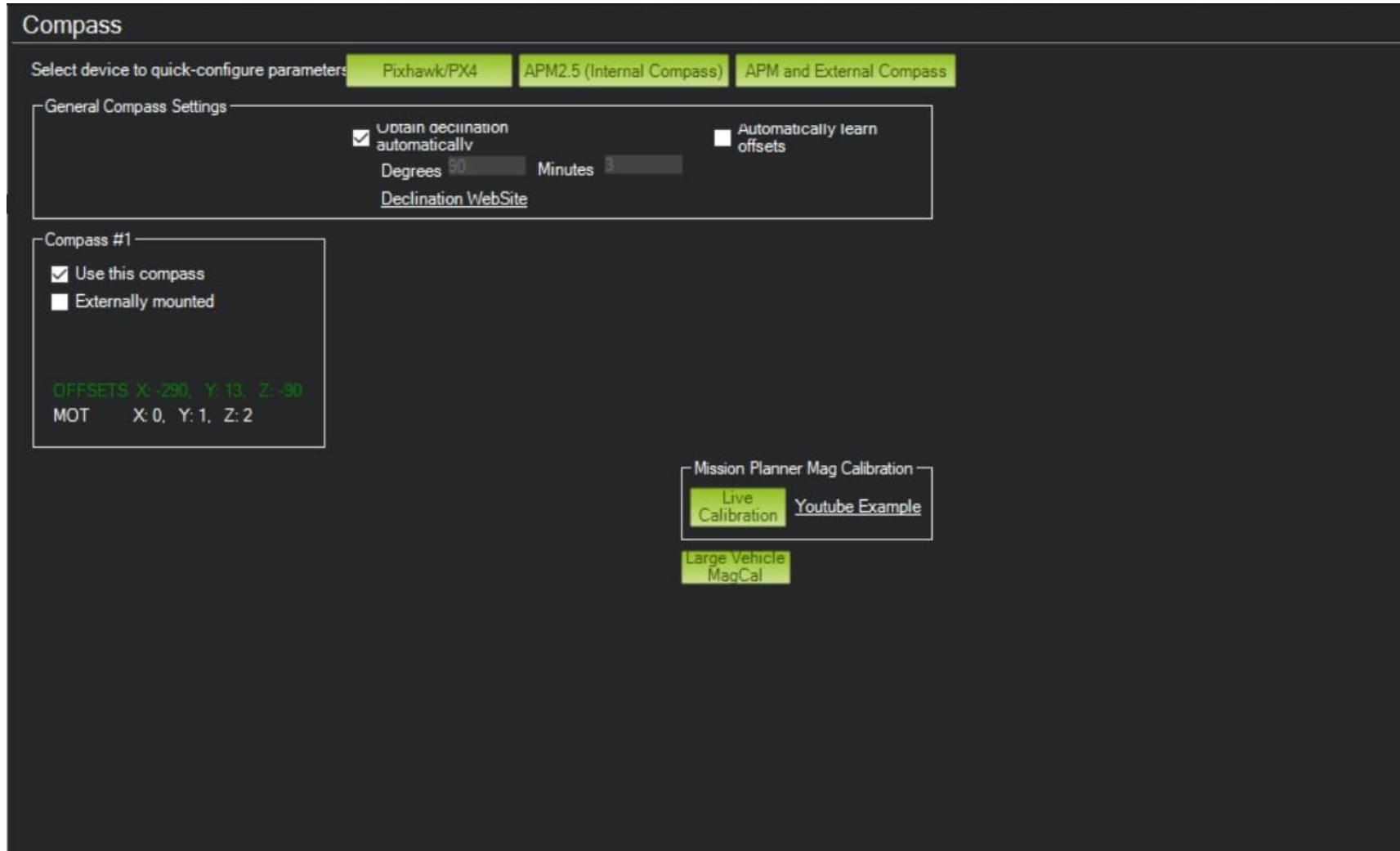
- Rotate the Controller in all directions and make sure all the white spots are interconnected.



- Compass offsets will be recorded. Press **OK** to save the calibrated offsets.



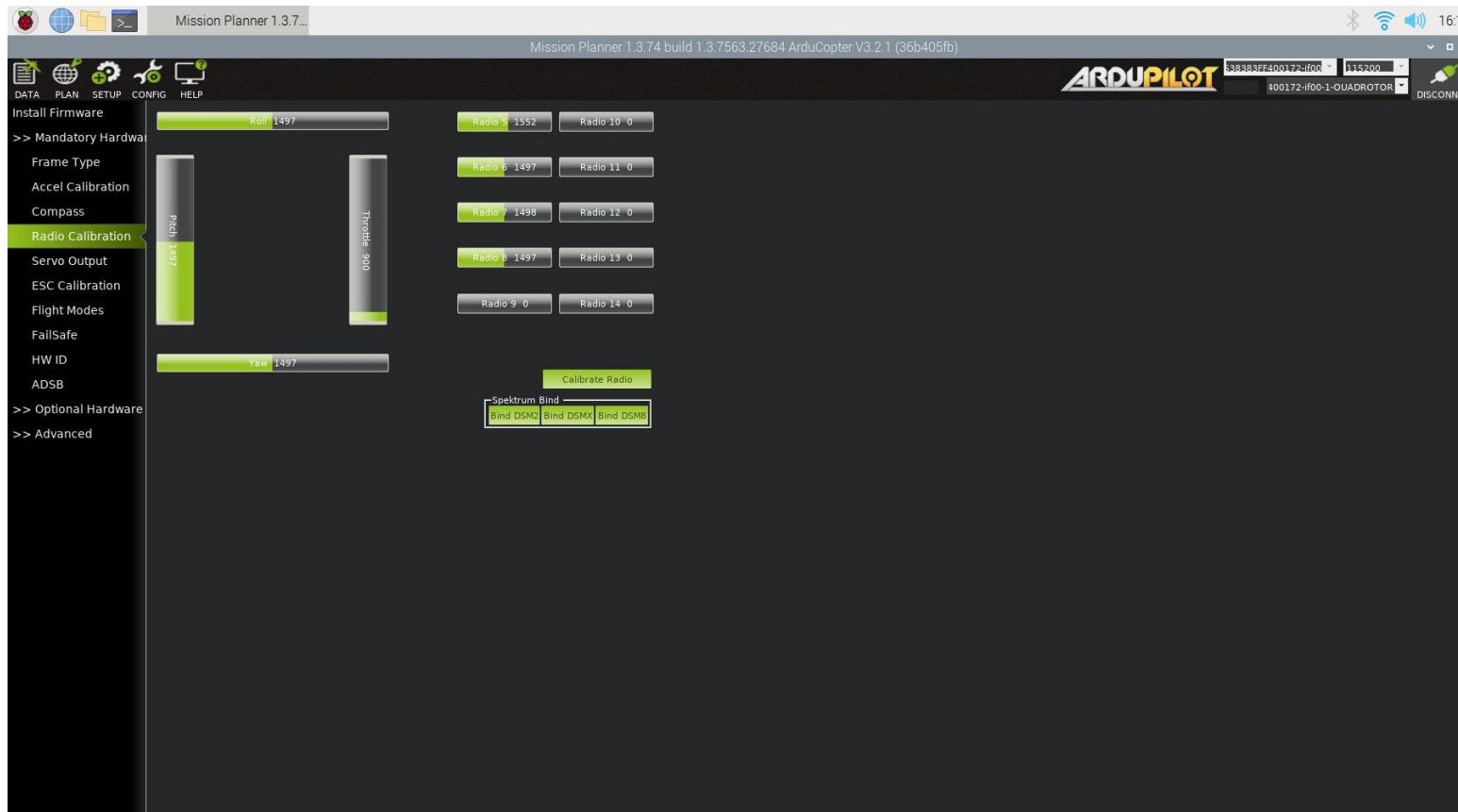
- After clicking on OK, the following screen appears showing the calibrated offset in green color.



STEP 5: Calibration of Radio

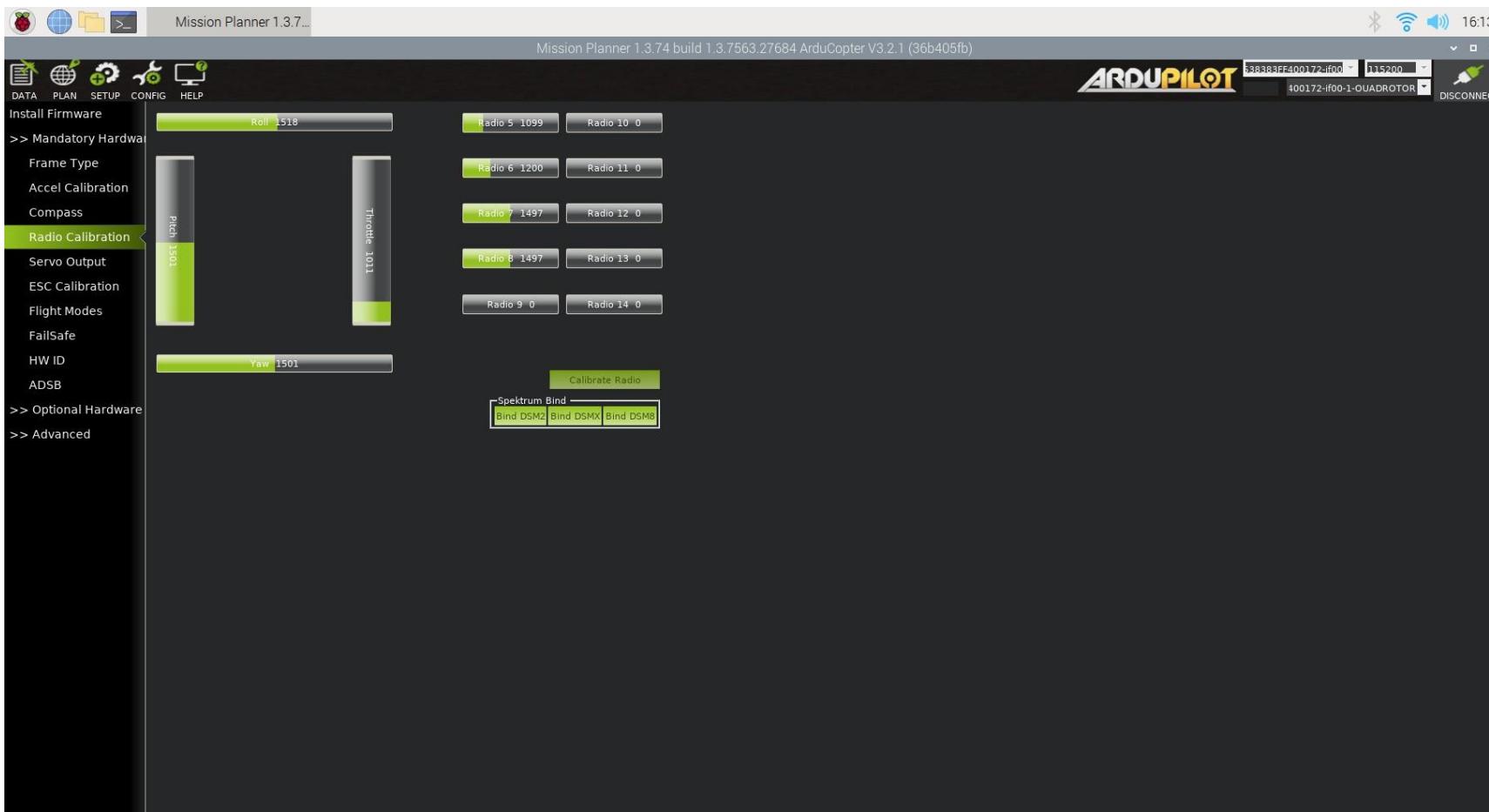
- Ensure the battery is disconnected (this is important because it is possible to accidentally arm the vehicle during the RC calibration process)
- Ensure the RC receiver is connected to the autopilot.
- Turn on your RC transmitter and if it has “trim tabs” ensure they are in the middle.
- Connect the autopilot to the PC using a USB cable.
- On the Mission Planner press the “Connect” button and open Mission Planner’s **SETUP | Mandatory Hardware | Radio Calibration** screen.

- Some green bars should appear showing the ArduPilot is receiving input from the Transmitter/Receiver.



- If no bars appear check the receiver's LED:
 - No lights may indicate that it is incorrectly wired to the autopilot. Look for connectors that may have been inserted upside down.
 - A Red or flashing LED may indicate that your RC transmitter/receiver needs to be bound. See the manual that came with your RC equipment for instructions.

- Click on “Radio Calibration”

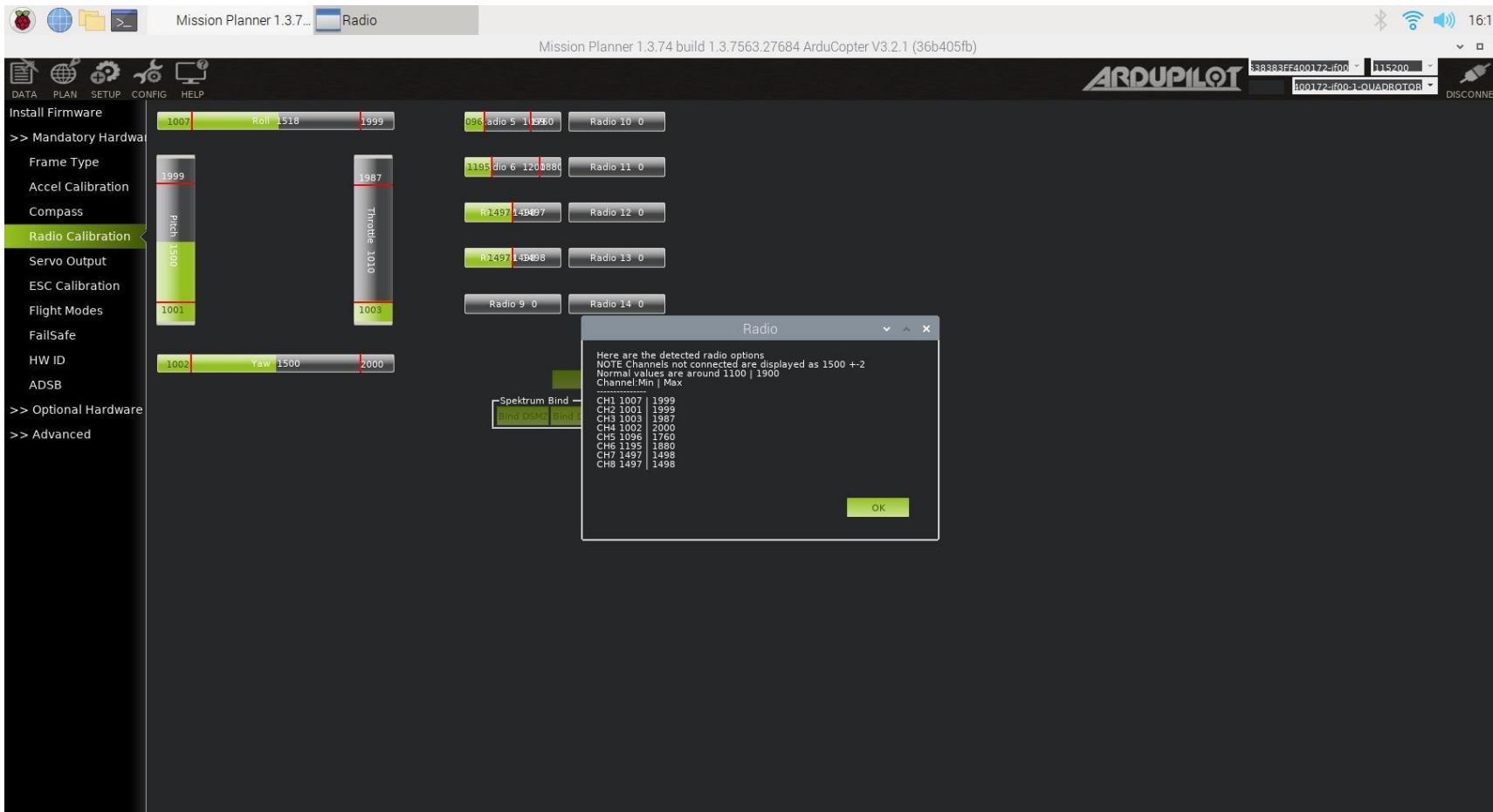


- Press “OK”, when prompted to check the radio control equipment, is on, the battery is not connected, and propellers are not attached.

- Move the transmitter's control sticks, knobs and switches to their limits. Red lines will appear across the calibration bars to show minimum and maximum values seen so far. Select **Click when Done**.



- A window will appear with the prompt, “Ensure all your sticks are centered and the throttle is down and click ok to continue”. Move the throttle to zero and press “OK”.
- Mission Planner will show a summary of the calibration data. Normal values are around 1100 for minimums and 1900 for maximums.



STEP6: Calibration of ESC (Electronic speedcontroller)

- Connect the ESC to be calibrated to the channel-3 of the receiver.
- Power ON the transmitter.
- Make the Throttle knob to its max position.



- Provide the power supply to the controller by connecting the battery.

- Now, Bring the Throttle knob position from max to min, you will **hear 2 beeps sound** which indicates the ESC under calibration is now calibrated.



- Repeat these steps for other ESCs.