



## PIXHAWK



### User Manual

Compatible with Fixed-wing/Glider/Multirotor/Helicopter/Car/Boat/Robot

CE FCC RoHS

Thank you for purchasing RadioLink flight controller PIXHAWK.

To fully enjoy the benefits of this product and ensure safety, please read the manual carefully and set up the device as instructed steps.

If any problems found during the operation process, either way listed below can be used as online tech support.

1. Send mails to [after\\_service@radiolink.com.cn](mailto:after_service@radiolink.com.cn) and we will answer your question at the earliest.
2. Send message to us on our Facebook page or leave comments on our YouTube page
3. If the product is purchased from the local distributor, you can also ask them for support and repair as prefer.

All manuals and firmware are available on RadioLink official website [www.radiolink.com](http://www.radiolink.com) and more tutorials are uploaded. Or follow our Facebook and YouTube homepage to stay tuned with our latest news.



## SAFETY PRECAUTIONS

- Never operate models during adverse weather conditions. Poor visibility can cause disorientation and loss of control of pilots' model.
- Never use this product in a crowd or illegal areas.
- Always check all servos and their connections prior to each run.
- Always be sure about turning off the receiver before the transmitter.
- To ensure the best radio communication, please enjoy the flight/driving at the space without interference such as high voltage cable, communication base station or launching tower.

## WARNING

This product is not a toy and is **NOT** suitable for children under the age of 18. Adults should keep the product out of the reach of children and exercise caution when operating this product in the presence of children. Water or moisture may enter the transmitter inside through gaps in the antenna or joystick and cause model instability, even out of control. If running in the wet weather (such as game) is inevitable, always use plastic bags or waterproof cloth to cover the transmitter.

## FCC Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency

energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### Packing List

Package List	
PIXHAWK FC	1
Power Module	1
Safety Switch	1
Buzzer	1
TF Card(4G)	1
Double-sided Adhesive Tape	2
Cable	4
Instruction Manual	1

**This manual is based on the ARDUPILOT, with setting with RadioLink transmitter AT9S as example. More details about how to use flight controller PIXHAWK-series please refer to:**

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## 1. PIXHAWK Introduction

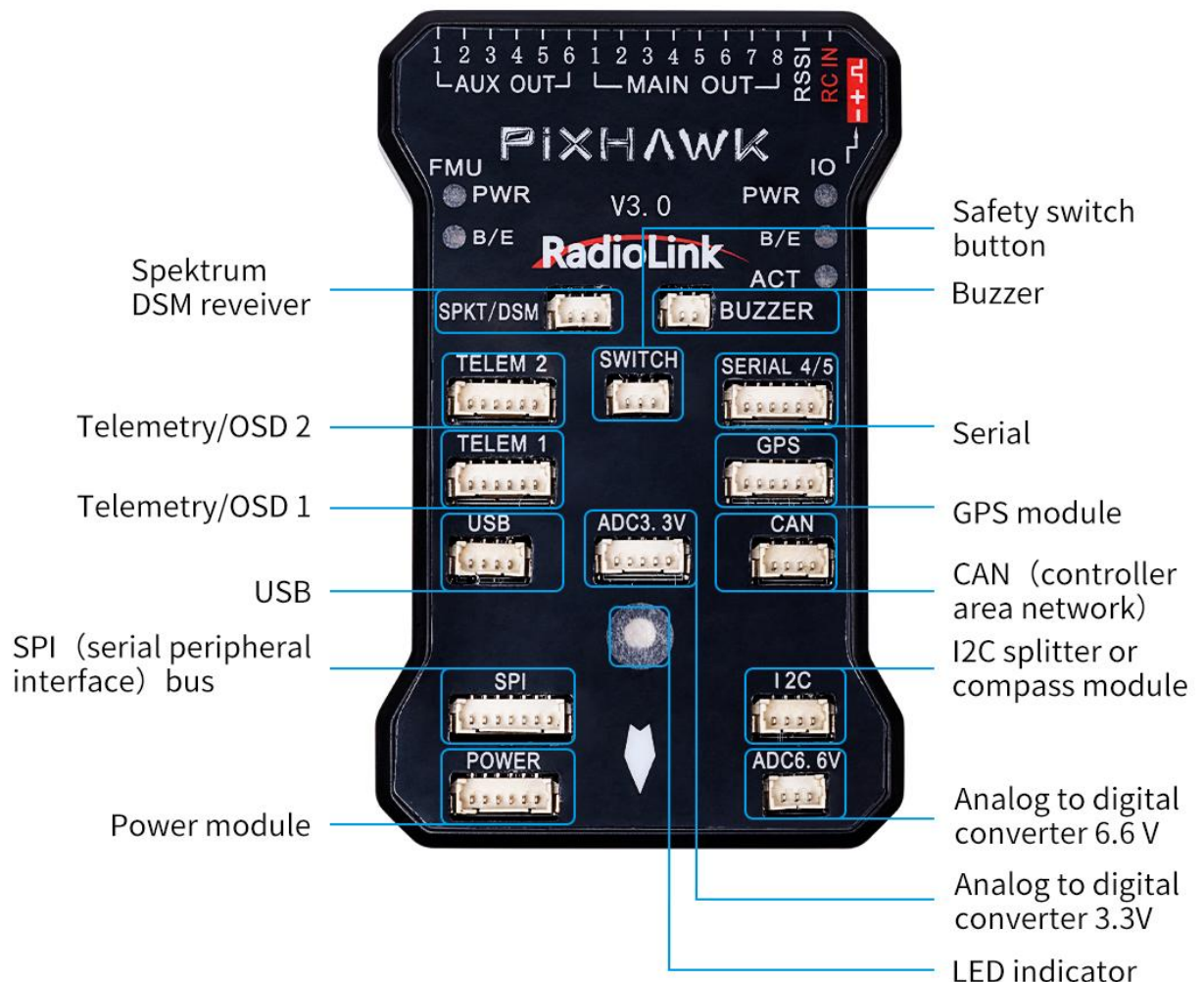
Redesigned the circuit after totally understanding the circuit design and program code of PIXHAWK, achieved less interference of inner components, less noise, more accurate compass and safety while flying, resolved the problem that Altitude Hold was not so much precision. Complete automatic, anti-static form SMT to welding achieved less interference of inner components.

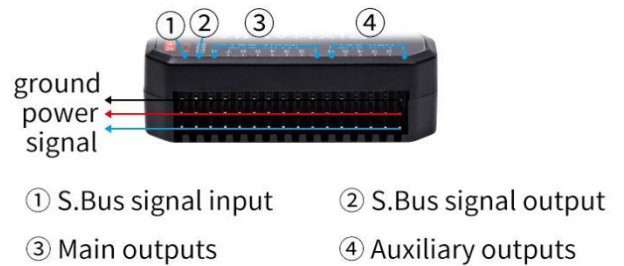
Full mechanical, anti-static fully automated welding from patch to backhand welding, to achieve reducing interference of geomagnetic sensors, which greatly improves the efficiency of production inspection.

All the chips such as processor, sensors and others are imported with whole package by primary agency. Dust-free and environmentally-friendly workshop ensures its durability.

**Note** PIXHAWK can flash firmwares and setup parameters with the official Mission Planner downloaded via <http://www.radiolink.com.cn/firmware/MissionPlanner/MissionPlanner-latest.msi> .

### 1.1 Connectors





### Parameters

<b>Weight &amp; Dimension</b>	Dimension	82.2*51.8*16.5mm
	Weight	38g (PIXHAWK only)
<b>Hardware Specification</b>	Main Processor	STM32F427VIT6
	Compressor	STM32F100C8T6
<b>Sensor</b>	Gyro	MPU6000
	E-compass	QMC5883L
	Barometer	MS5611
	Port	XH socket
	SPK/DSM	1
	Mavlink UART	2 (with CTSRTS)
	USB Port	2
	Buzzer	1
	Safety Switch	1
	ADC Port	3.3V *1 & 6.6V*1
<b>Sensor</b>	SERIAL4/5 Port	1
	GPS UART	1
	CAN Port	1
	SPI Port	1
	I2C	1
	RC In (TX Signal Supported)	SBUS/PPM
	RSSI Signal Strength Input	PWM ( 3.3V )
	PWM Output	8 OneShot PWM Output(Configurable)
	Aux Output	6 PWM output (Configurable)
	SD Port	1
<b>Power Module Specifications</b>	Input Voltage	2-12S (7.4V-44.4V )
	Input Current	90A

	Output Voltage	5.1V
	Output Current	2A
	Input Current(connect to one ESC only)	90A
<b>Adaptable Models</b>	Rotary/3-8 copter/Fixed Wing/VTOL/Car/Boat/Robot/Mower	
<b>Specifications</b>	USB Voltage	5V±0.3V
	Servo Voltage	Input Non Applicable
	Operating Temperature	-40~80°C

### Power Module

Input Voltage : 2-12S battery

Input Current(max.) : 90A

Output Voltage(max.) : 5.1V

Output Current(max.): 2A

### 1.2 Advices

For the users who firstly use PIXHAWK, we suggest that you use PIXHAWK following below steps:

1. You have to install the mission planner and driver from here and familiar with the menu.

Download the latest Mission Planner from here: [https://www.radiolink.com/pixhwak\\_missionplanner](https://www.radiolink.com/pixhwak_missionplanner)

Download the driver form here: <https://www.microsoft.com/net/download/dotnet-framework-runtime/net462>

2. To establish a connection, you must first choose the communication method/channel you want to use, and then set up the physical hardware and Windows device drivers. You can connect the PC and autopilot using USB cables, Telemetry Radios, Bluetooth, IP connections etc.

3. Download the update firmware by USB cable if you need.

4. Connect Mission Planner to AutoPilot, and then connect receiver to AutoPilot to finish the calibration of transmitter, Accelerometer and compass.

5. Setup RC transmitter flight mode.

6. Assemble aircraft and finish the pre-flight checklist.

7. PID usage.

8. Advanced configuration.

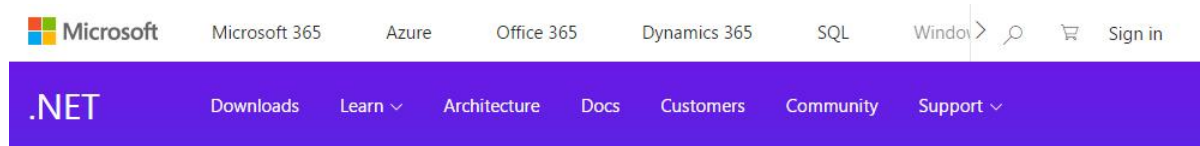
## 2. Mission Planner

### 2.1 Install Mission Planner

Net Framework 4.6.2 need to be installed first before Mission Planner, you can download form here:  
<https://www.microsoft.com/net/download/thank-you/net462>

**Note** The Net Framework 4.6.2 file will automatically download when website is clicked.





## Thanks for downloading .NET Framework 4.6.2

Problem downloading? [Try again.](#)



Then download the Mission Planner from [https://www.radiolink.com/pixhawk\\_missionplanner](https://www.radiolink.com/pixhawk_missionplanner)

Open the Microsoft installer file and select Run to run the installation utility.



### 2.2 Mission Planner Introduction

Once installation is complete, open Mission Planner by clicking on its system icon.

Once the installation of Mission Planner and driver is done, there will several pop-ups when you open the MP at the first time. The first pop-up clicks Yes and the others click NO.

There are six Menu Button in main menu.

**FLIGHTDATA:** flight attitude and data will show in real time on MP



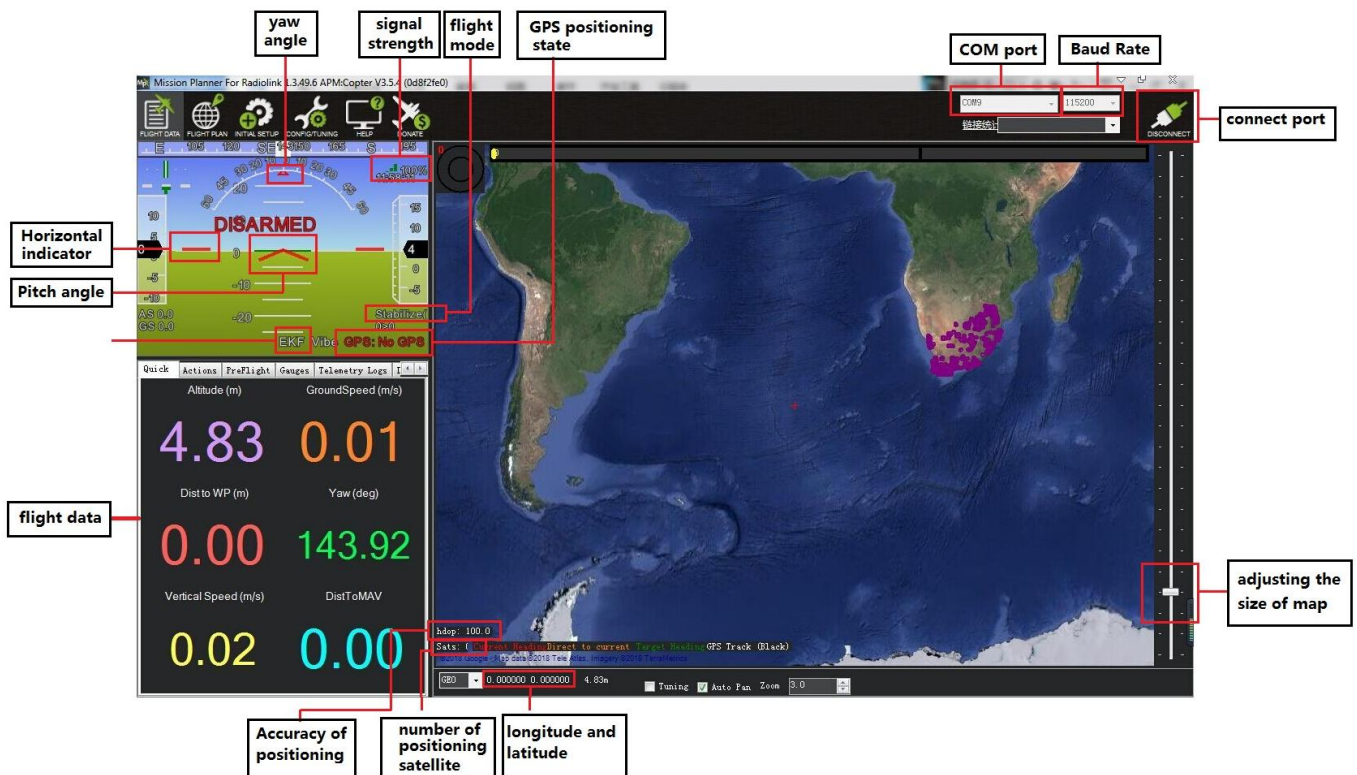
**FLIGHTPLAN:** planning the flight mission

**INITIAL SETUP:** for firmware installation and update, Mandatory Hardware and Optional Hardware setup

**CONFIG/TUNING:** including detailed PID setup and parameters change

**SIMULATION:** make PIXHAWK work as a simulator after upgrade a special simulation firmware

**HELP:** you can get help when you have questions about MP



### 3. Initial Setup

First, you have to upgrade the firmware you need when you the first time ready to use PIXHAWK.

Radiolink PIXHAWK is default with quadcopter firmware, you have to install the right firmware if you use the other frame drone.

#### 3.1 Download and Install Firmware

Please connect your PIXHAWK and computer via USB cable(other devices do not need to be connected).

Open the Mission Planner to loading the firmware you need to your PIXHAWK.

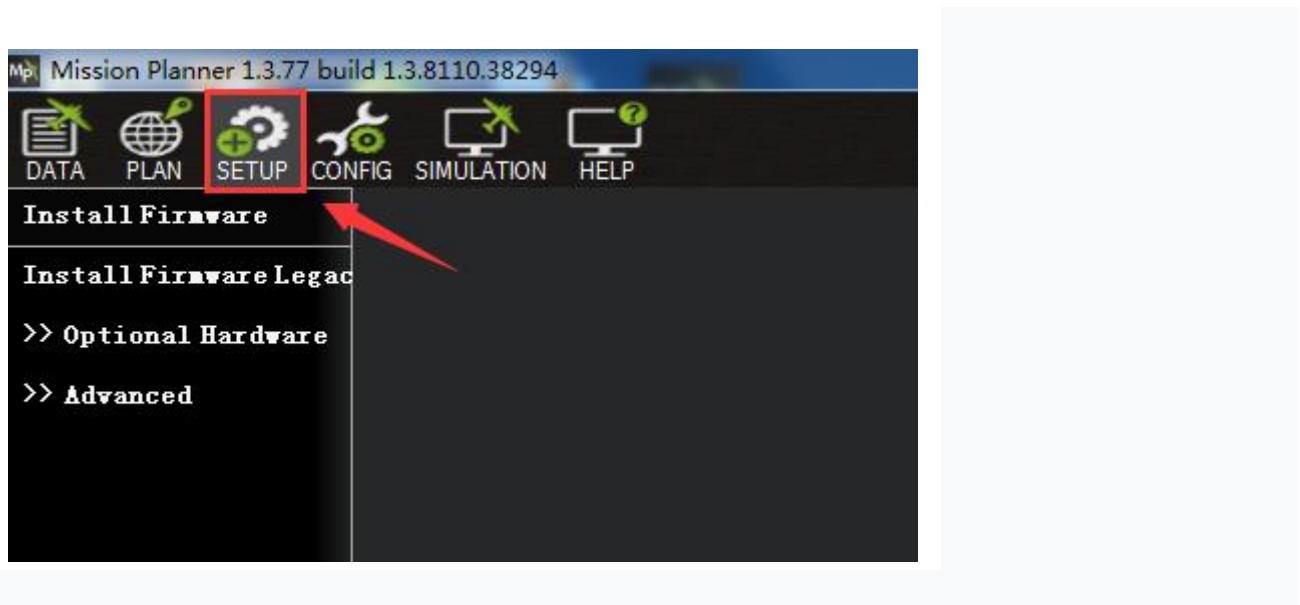
Make sure that the computer has recognized the COM port of the PIXHAWK before installing firmware. Then open Mission Planner (MP for short), and make sure that the port of the PIXHAWK can be recognized in the drop-down box at the top right of the MP interface.

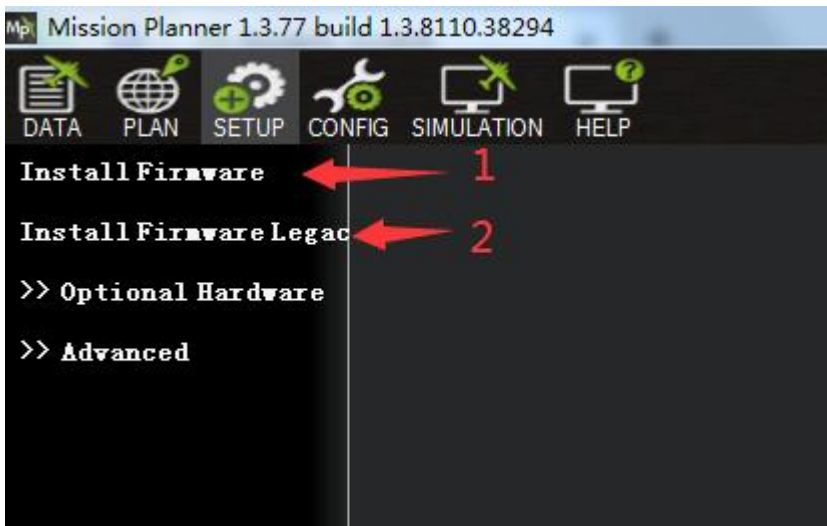
**Attention:**

- (1) Do not click CONNECT before you upload the new firmware, please click DISCONNECT if you have connected successful before. Upload new firmware will be not success if you have connected already.
- (2) Please do not upload new firmware by wireless data transmission because it has missed the reset signal.
- (3) If there's without firmware version number, it means failed upload new firmware. It may cause of network problem, please re-upgrade firmware until shows the version.



Click SETUP

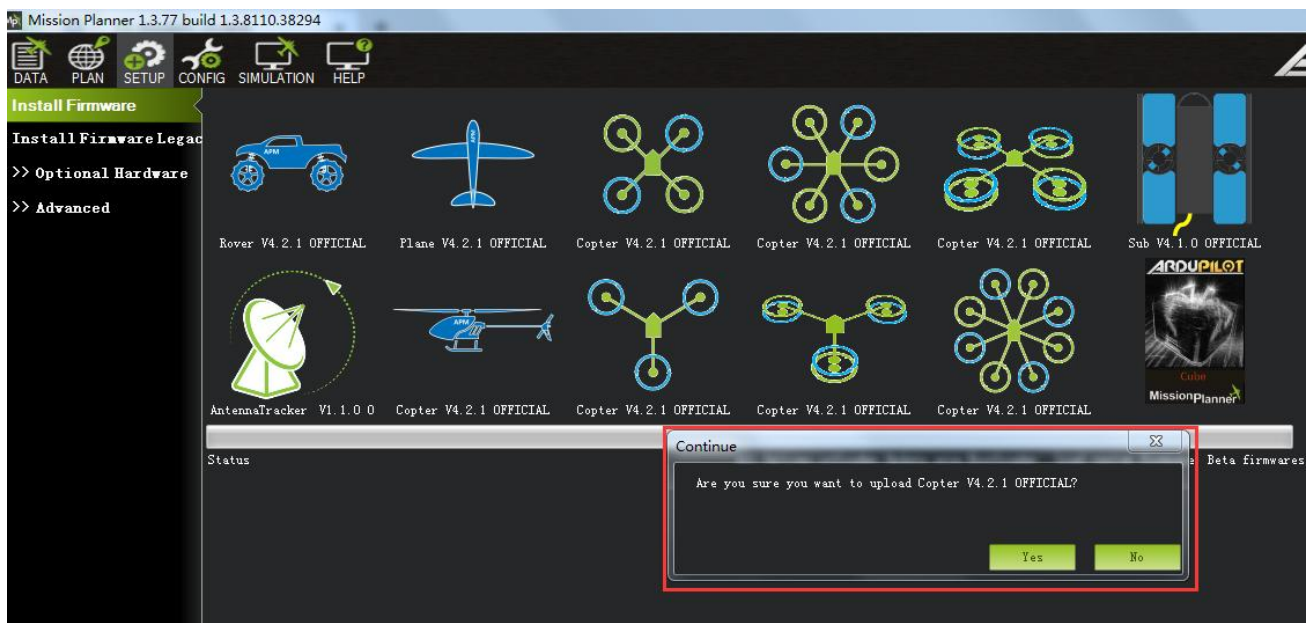




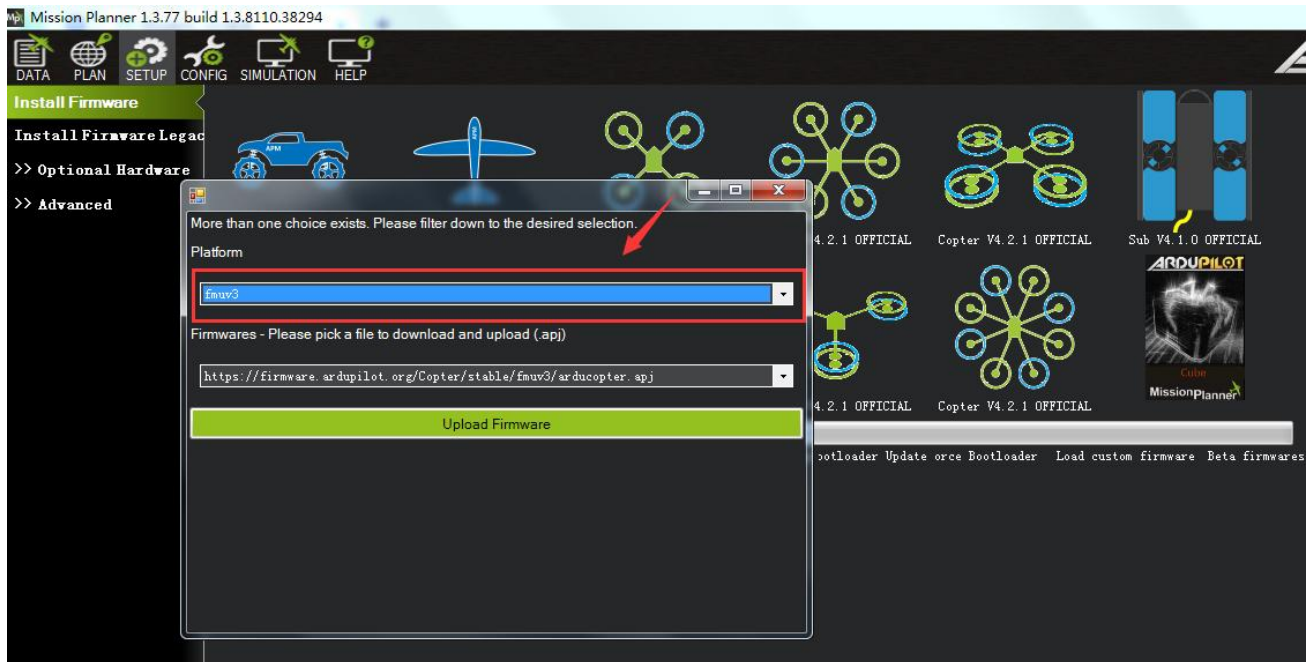
1. Install firmware: It is to flash the firmware online. Click the model icon in this interface, and MP will automatically download the firmware and upload it to the flight controller.
2. Install Firmware Legacy (traditional): It is to flash the custom firmware, you need to manually download the firmware from the official website, and then upload the firmware to the PIX flight control from this interface

Click "INSTALL FIRMWARE"

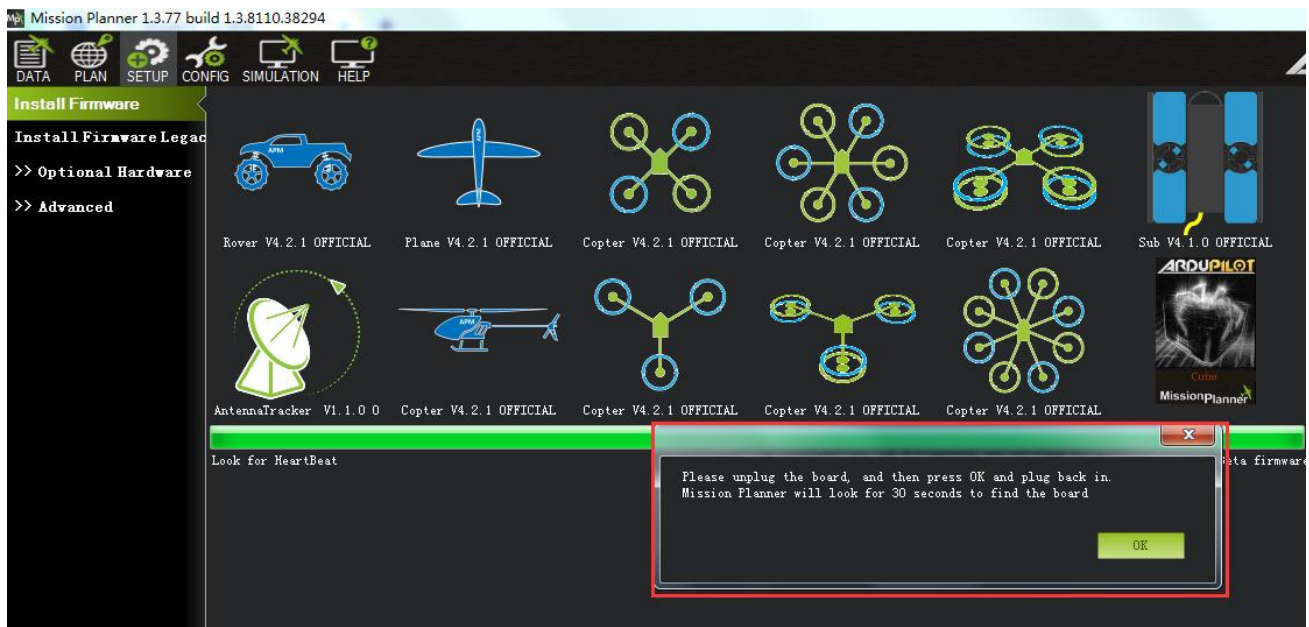
The right side of the window will automatically download the latest firmware from the network and graphically display the firmware name and the aircraft model corresponding to the firmware. You only need to click on the picture corresponding to your aircraft model, and the following prompt will pop up:



Click "Yes", and the following prompt will pop up:

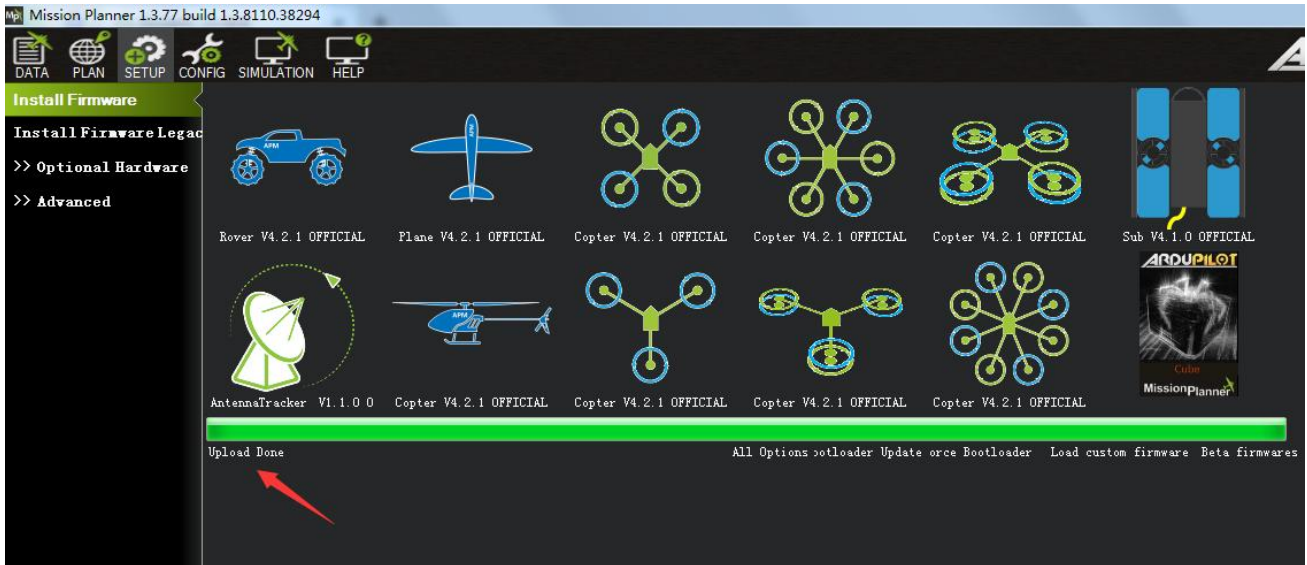


Select the model according to the version type of PIXHAWK. If there is a "V3.0" mark on the PIXHAWK board, select fmuv3, otherwise select fmuv2. Then click "Upload Firmware", then MP will automatically download the corresponding firmware from the server. (Because the server is abroad, the download speed may be a little slow, please be patient.)



If the above prompt appears, unplug the USB cable, click OK and then re-plug USB cable immediately. Then it will automatically complete a series of actions such as connecting to PIX - writing program - verifying program - disconnecting connection, without manual intervention at all.



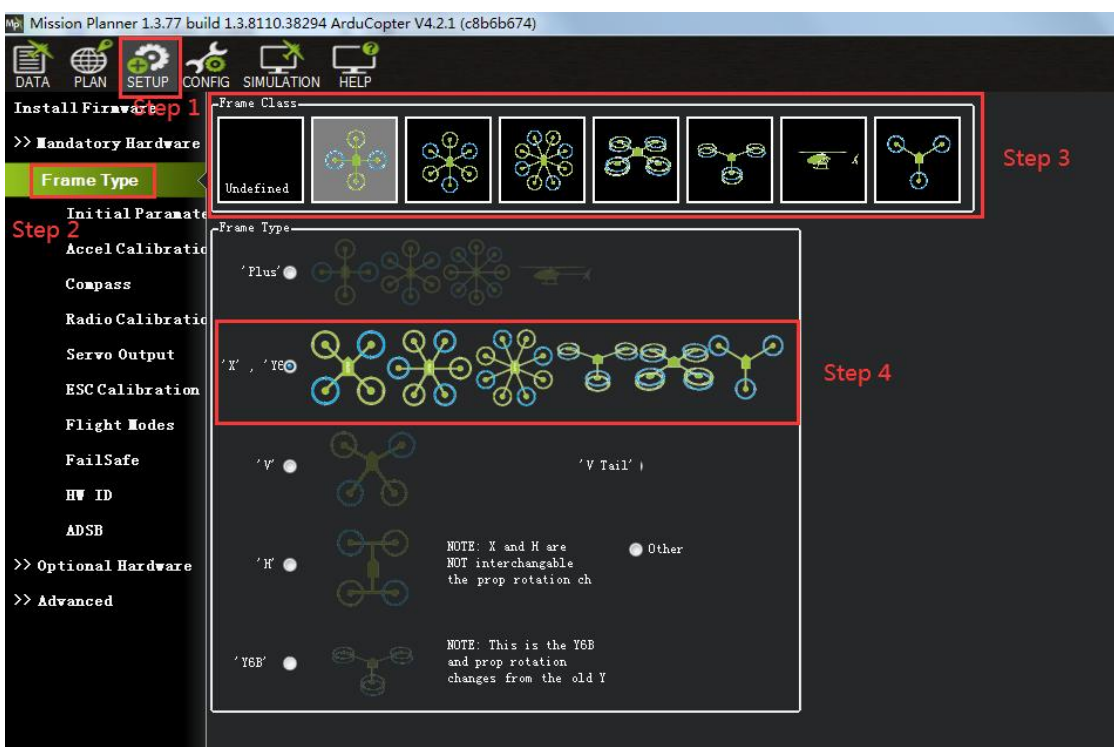


When the above window appears, the prompt “Upload Done” means the firmware installation is successful. After the firmware is installed successfully, you can click the “CONNECT” button in the upper right corner to connect to the PIXHAWK and view the real-time data of the PIXHAWK.

### 3.2 Frame Type

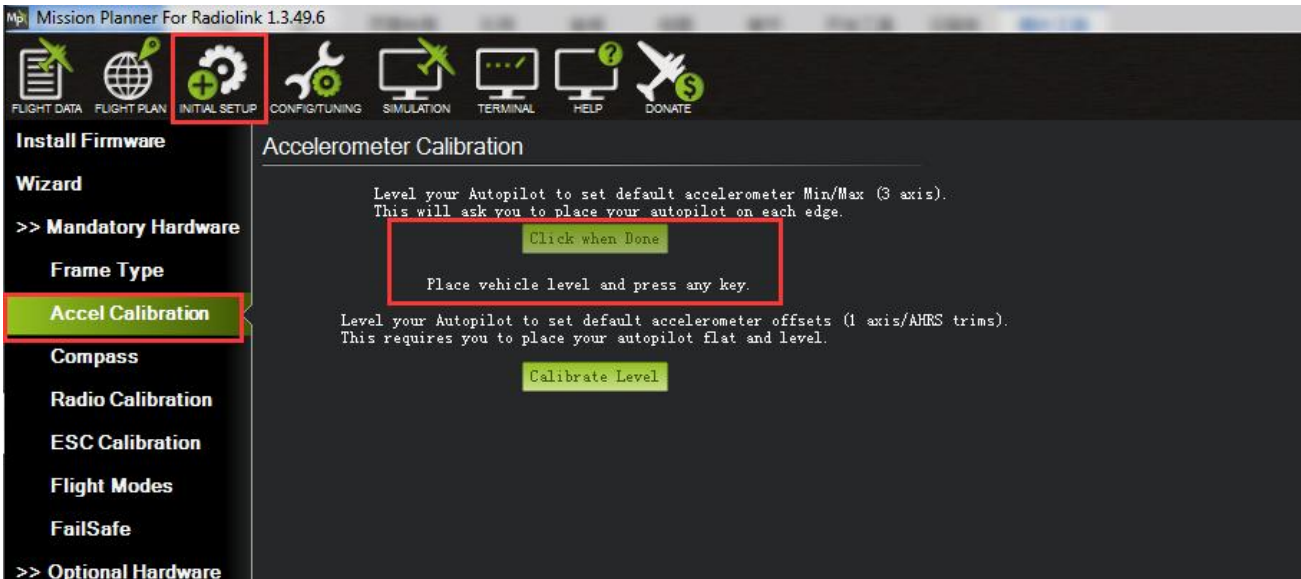
Please setup as below:

1. SETUP
2. Mandatory Hardware ->Frame Type
3. Choose Quad or Hexa or other frame types as you need



### 3.3 Accelerometer Calibration

Make sure the PIXHAWK is keeping horizontal when do the accel calibration.



1. Place vehicle level and press any key to save setting.

Direction points straight ahead  
Keep PIXHAWK horizontal



2. Place vehicle on its LEFT side and press any key to save setting.



Direction points to left  
Keep PIXHAWK perpendicular to the horizontal plane

3. Place vehicle on its RIGHT side and press any key to save setting.

Direction points to right  
Keep PIXHAWK perpendicular to the horizontal plane



4. Place vehicle DOWN and press any key to save setting.



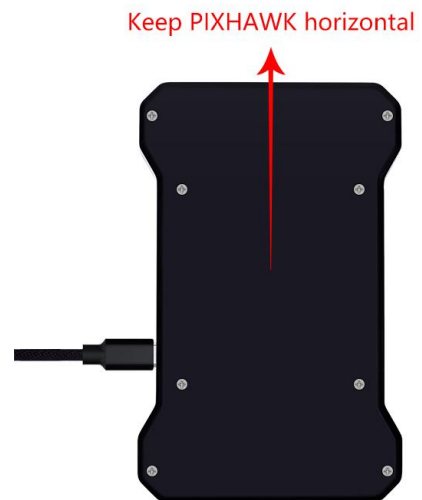
Direction downwards  
Keep PIXHAWK perpendicular to the horizontal plane

5. Place vehicle UP and press any key to save setting.



Direction upwards  
Keep PIXHAWK perpendicular to the horizontal plane

6. Place vehicle on its BACK and press any key to save setting.



Keep PIXHAWK horizontal

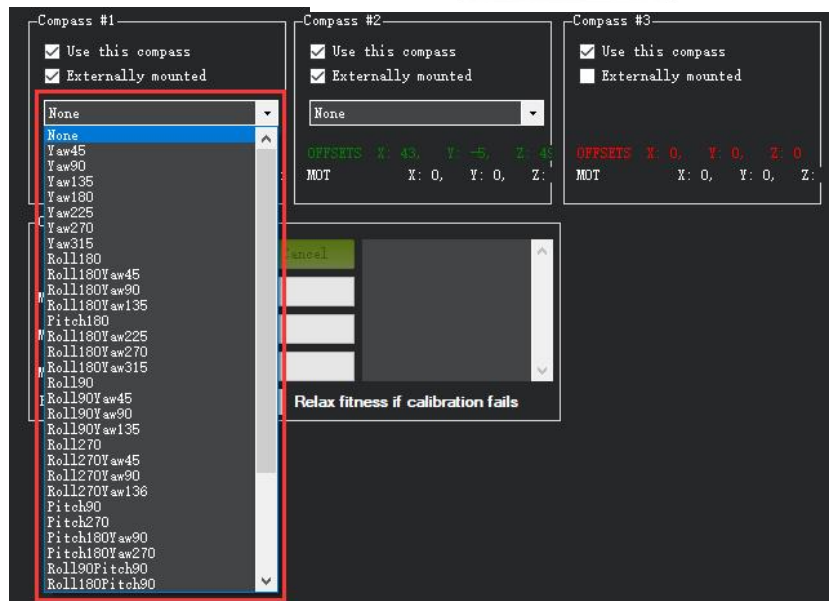
### 3.4 Compass Calibration

There are two situations about compass calibration:

1. Without GPS, use internal compass
2. With GPS, use external and internal compass.

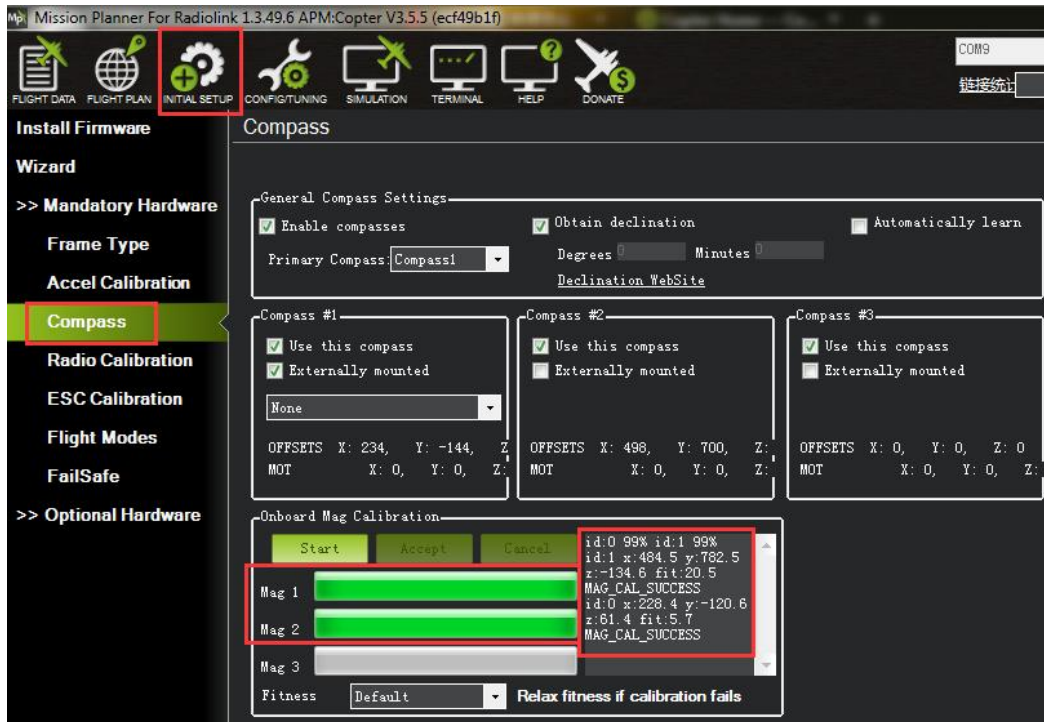
Calibrate interface will shows as picture below when use with GPS.

If the GPS mounted with the same direction with flight controller, then it need not to setup the direction of GPS in MP but if you mounted the GPS with the different direction of PIXHAWK, you have to setup





in the MP.



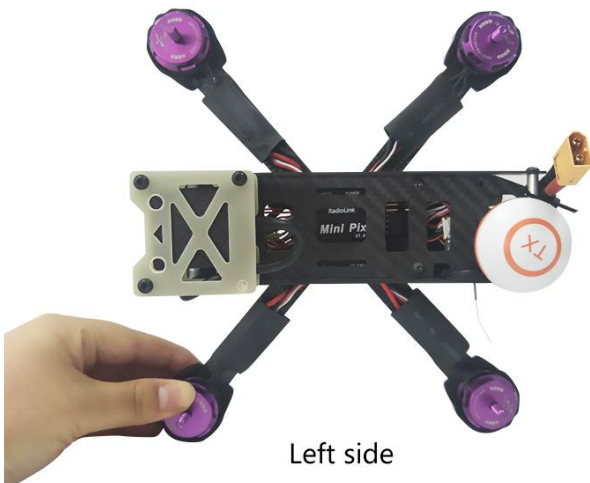
Please fixed PIXHAWK and TS100, then click “Start” and turn PIXHAWK and TS100 till the progress bar of Mag 1 and 2 to the end and comes out the MAG\_CAL\_SUCCESS marked words.

Calibrate the compass as these steps below:

Hold the vehicle in the air and rotate it slowly so that each side (front, back, left, right, top and bottom) points down towards the earth for a few seconds in turn.



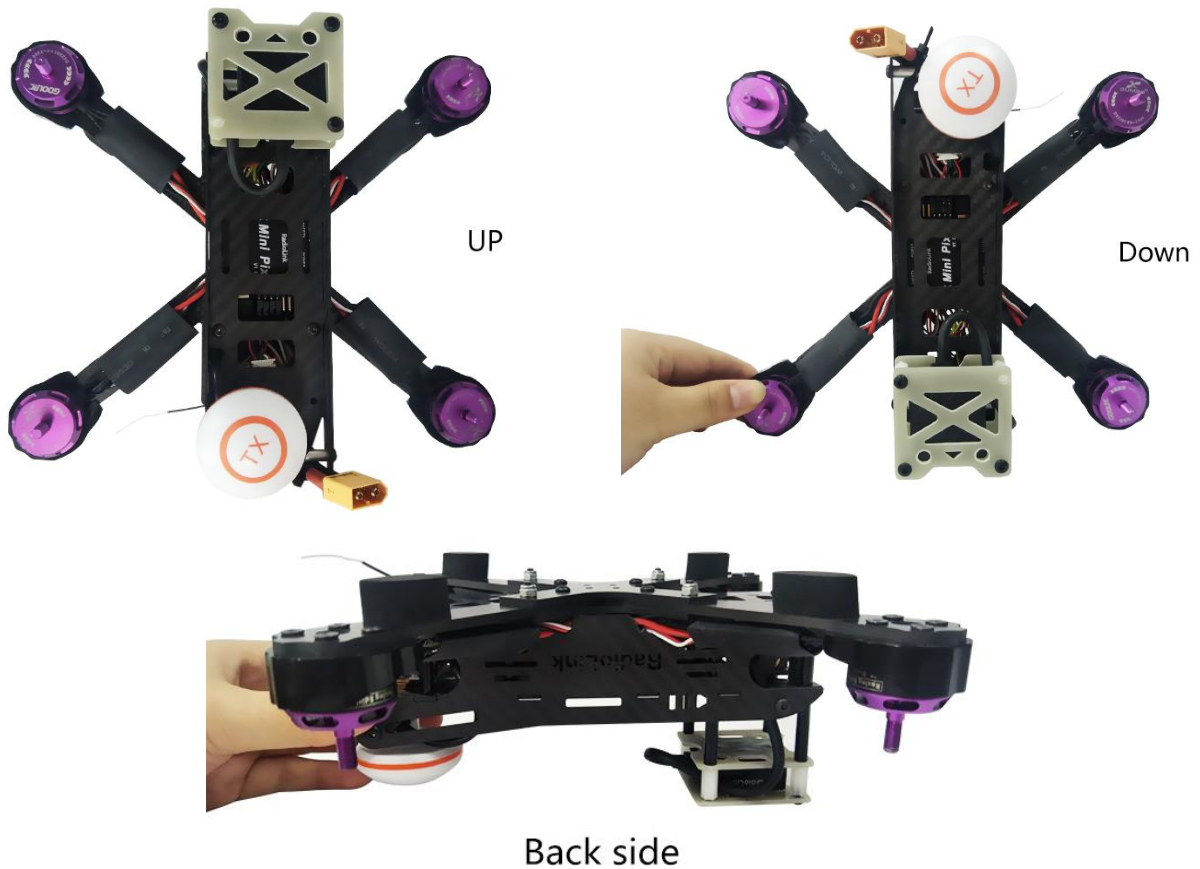
Level



Left side

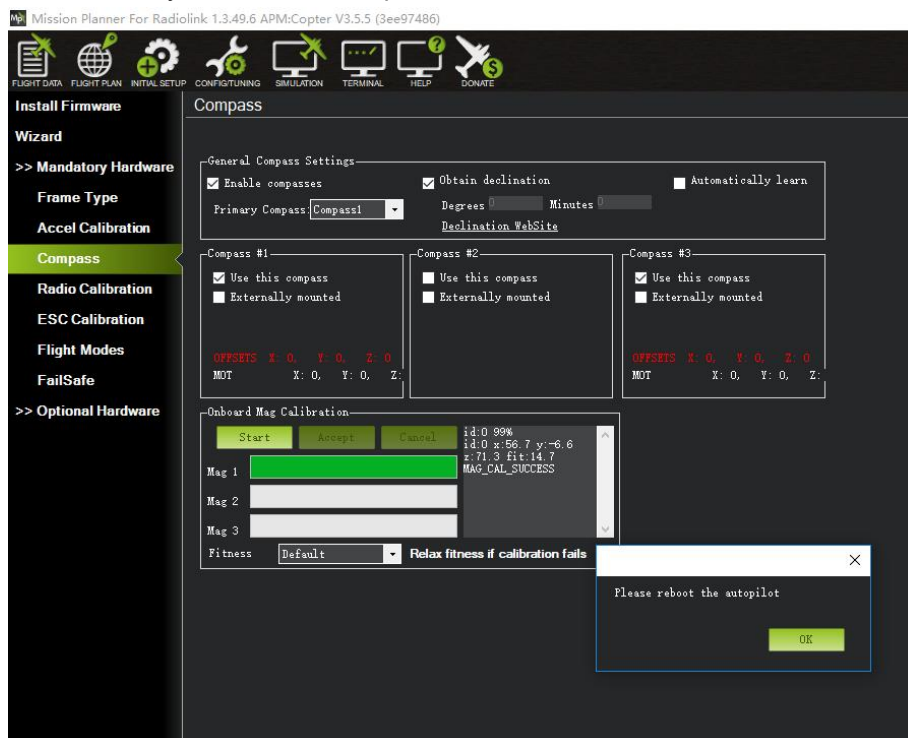


Right side



The mission planner will keep recording the data that collected by the compass sensor and the progress bar and the percentage will keep change when you calibrate the compass, if the percentage have not changed, please check if the compass is connect success.

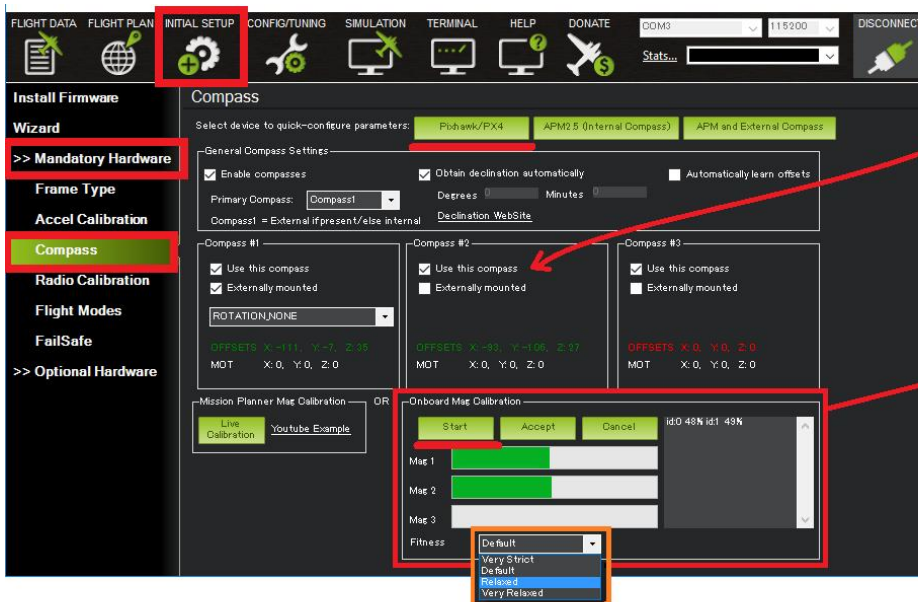
The mission planner will remind you when the compass has calibrated success.



Click OK and then reconnect PIXHAWK to computer, compass calibrate success after restart the PIXHAWK.

**Attention:**

When the progress bar moves to 100 and then restart from 0, it may be because of the wrong calibrate action or interference. You can have a try to calibrate again till compass calibrate success, or setup the Fitness is Relaxed and recalibrate.



Disable internal compass if "inconsistent compasses" pre-arm appears too often and you are sure external compass orientation is OK

Onboard calibration produces better results

If calibration fails "Relax" Fitness

### 3.5 Radio Calibration

This article shows how to perform radio control calibration using *Mission Planner*.

RC transmitters are used to control vehicle movement and orientation. Copter and Plane minimally control throttle, pitch, roll and yaw, while on Rover we just control throttle and roll. Each of these control signals are mapped to transmitter stick/switch(s) and in turn to autopilot channels from the connected receiver.

Calibrating each of the transmitter controls/channels is a straightforward process - simply move each of the enabled sticks/switches through their full range and record the maximum and minimum positions.

There are two main transmitter configurations:

**Mode 1:** left stick controls pitch and yaw, the right stick will control throttle and roll.

**Mode 2:** left stick controls throttle and yaw; the right stick will control pitch and roll.

Copter default channel mappings are:

Channel 1: Roll

Channel 2: Pitch

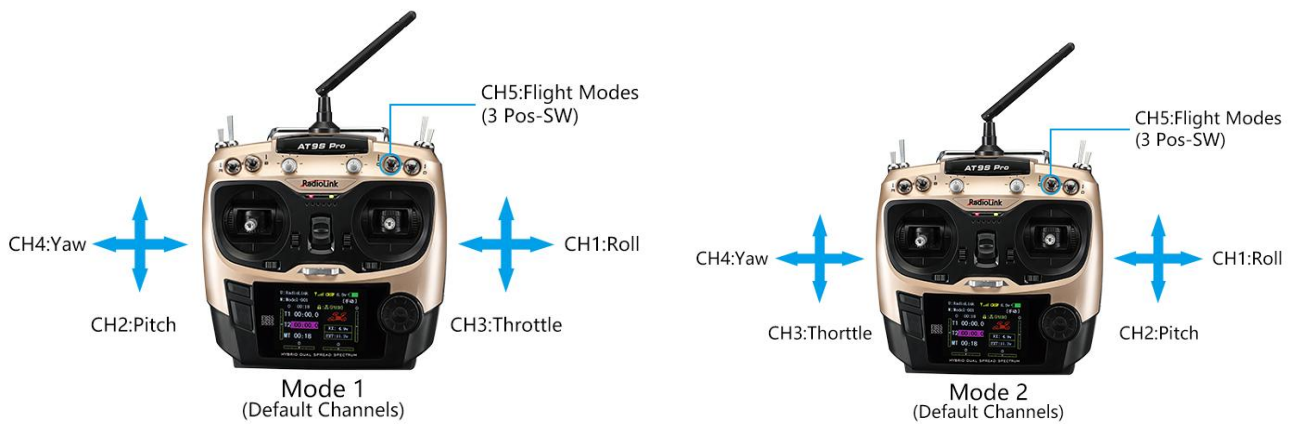
Channel 3: Throttle

Channel 4: Yaw

Channel 5: Flight modes

Channel 6: (Optional) In flight tuning or camera mount (mapped to transmitter tuning knob)

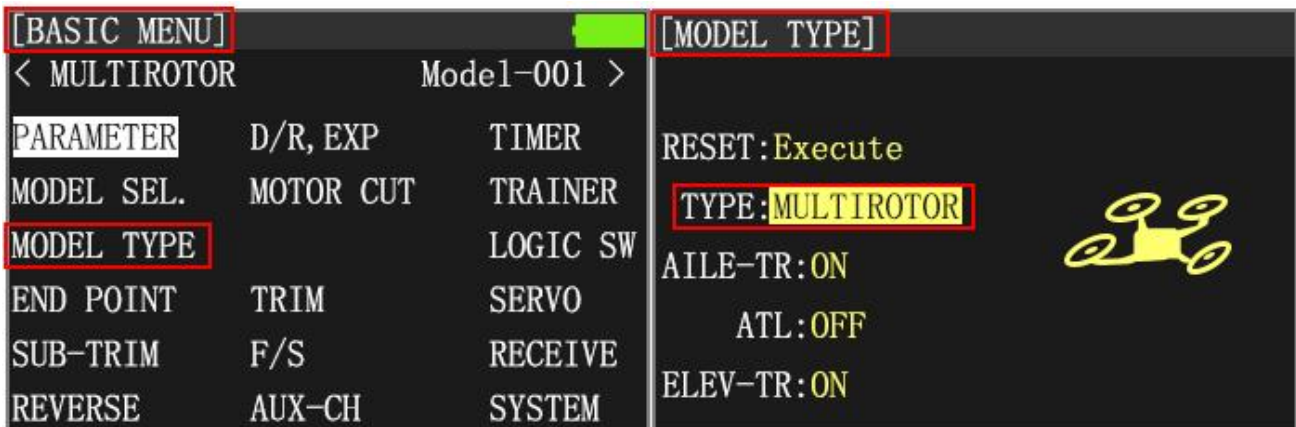
Unused channels can be mapped to control additional peripherals.



For safety, you should disconnect the battery and/or remove propellers before performing radio calibration. Bind your transmitter and receiver before calibrate radio, connect PIXHAWK to computer via USB cable and then turn on transmitter. The RC receiver ask to connect to the RC port of PIXHAWK.

The transmitter will make AT9S as an example in this manual.

1. Press Mode button about one second to into BASIC MENU, and then turn the dial to set MODE TYPE as MULTIROTOR (press Push button 1 second—press Push button again when the display pop-ups “Are you sure?”— you will find out DDD sounds come out with “Please wait...”), the mode type MULTIROTOR have setup success after the DDD sounds have finished.



3. Setup CH3: THRO REV in REVERSE menu (setting steps: Press Mode button about one second to into BASIC MENU, and then turn the dial to choose REVERSE, press Push button to into the REVERSE menu, turn the dial to setup 3: THRO REV, press End to back to Basic menu.



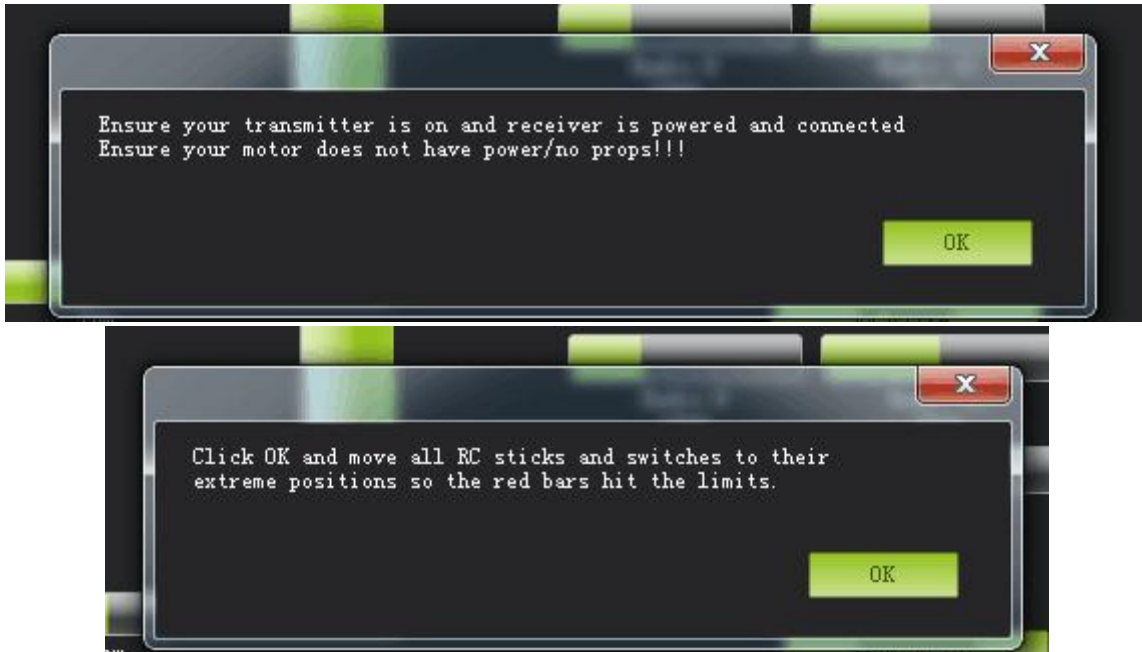


Radio Calibration Steps:

1. Open Mission Planner
2. Choose the right COM and Baud rate
3. Click the CONNECT
4. Choose INITIAL SETUP—Mandatory Hardware—Radio Calibration
5. Click “Calibrate Radio”



There are two tool pop-ups after you click “OK”, one for make sure both your transmitter and receiver are powered on and connected, and the motor of your drone does not have power and without propellers.



And then click “OK” and move all RC sticks and switches to their extreme positions so the red bars hit the limits.

If the red bars have not any change when you move the sticks, please check the receiver have connect success or not, make sure the receiver (maybe R9DS) is output SBUS signal (the blue LED of R9DS means work as SBUS signal). You can check if every corresponding red bar for every channel is work as below:

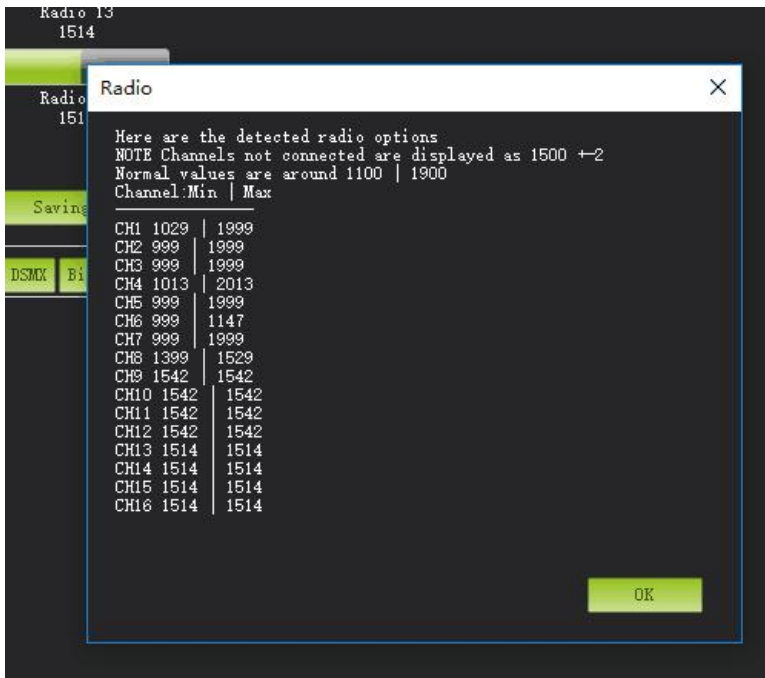
CH1: low position = roll (towards the left), up position= roll (towards the right).

CH2: low position =pitch(forward), up position =pitch(backwards).

CH3: low position =reduced speed, up position =speed up.

CH4: low position = yaw (towards the left), up position = yaw (towards the right).





Click OK to save the radio calibration data.

### 3.6 Flight Modes

PIXHAWK has 20 flight built-in flight modes, 10 of which are regularly used. There are modes to support different levels/types of flight stabilization, a sophisticated autopilot, a follow-me system etc. Flight modes are controlled through the radio (via a transmitter switch), via mission commands, or using commands from a ground station (GCS) or companion computer. You can setup six flight modes once and max setup eight modes combine with AUX-CH (CH7 and CH8).

#### Flight modes setting steps:

1. Connect PIXHAWK and receiver (connect the RC port of PIXHAWK, and make sure receiver work as SBUS signal).
2. Make sure transmitter bind to receiver success.
3. Make sure PIXHAWK connect to Mission Planner success and click INITIAL SETUP—Mandatory Hardware—Flight modes, you can setup the flight modes you want in this menu.

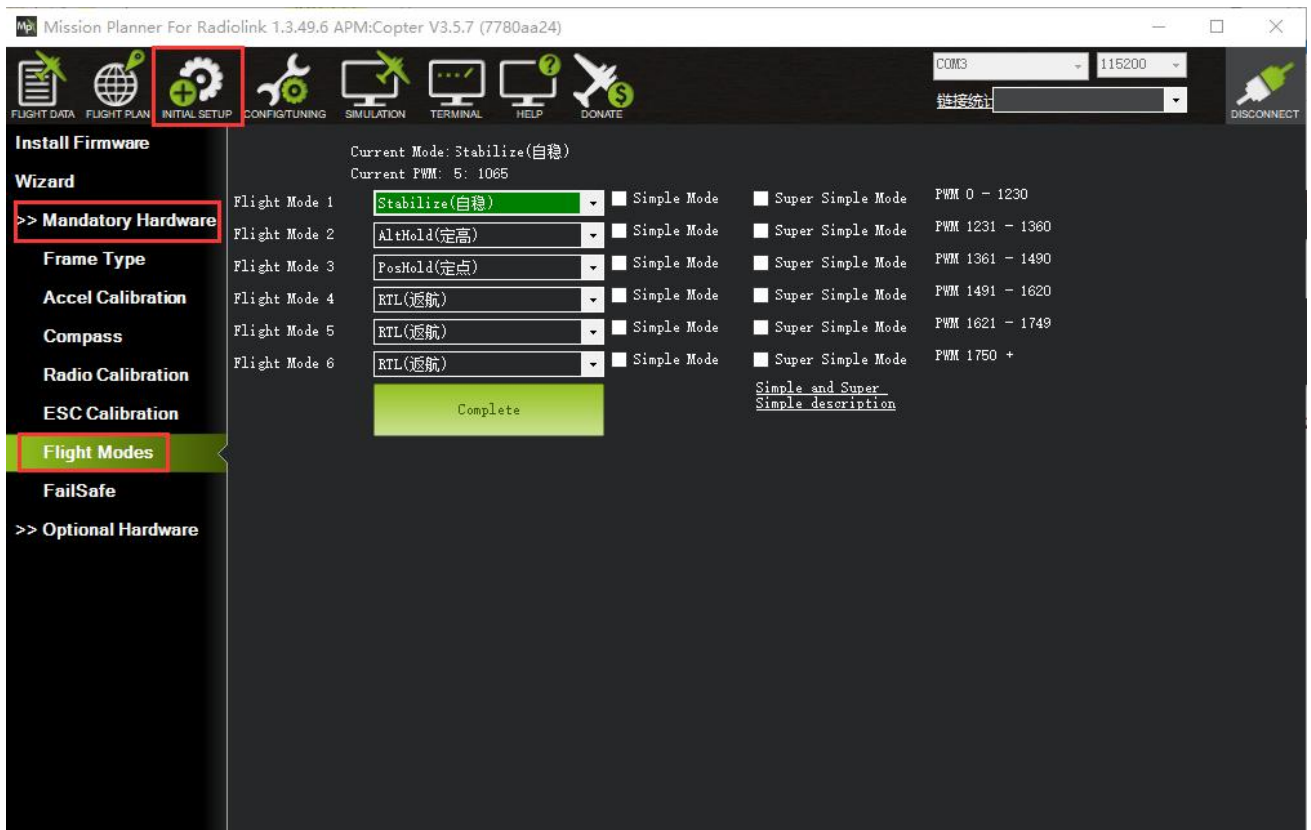
In flight modes menu, it's very clear that the flight modes, the PWM numerical interval of six flight modes you have set and choose Simple Mode/Super Simple Mode or not.

Most of the RC fans setup the Flight Mode 1 is Stabilize, the other five flight mode will be setup according to users' flight habit.

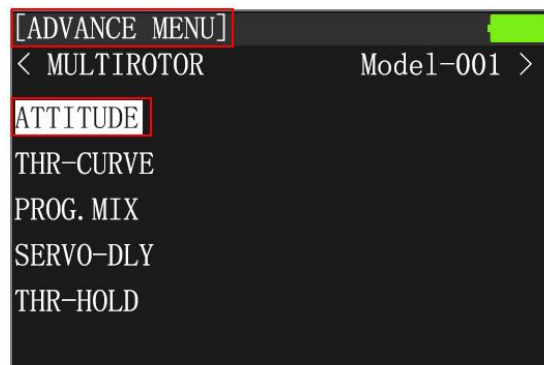
First, you have to setup flight mode in transmitter. The setting steps as below:



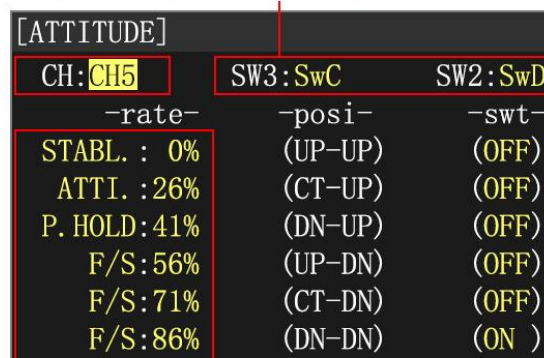
1. Power on and turn on your transmitter.



2. Press Mode button twice to into ADVANCE MENU, press Push button into ATTITUDE setting menu, CH5 is default to the attitude control channel and please choose a 3 Posi-SW and a 2 Posi-SW to control the attitude.



the attitude chabbel is default CH5, you can setup a 3-posi SW and a 2-posi SW to control it if you ready to setup 6 flight modes

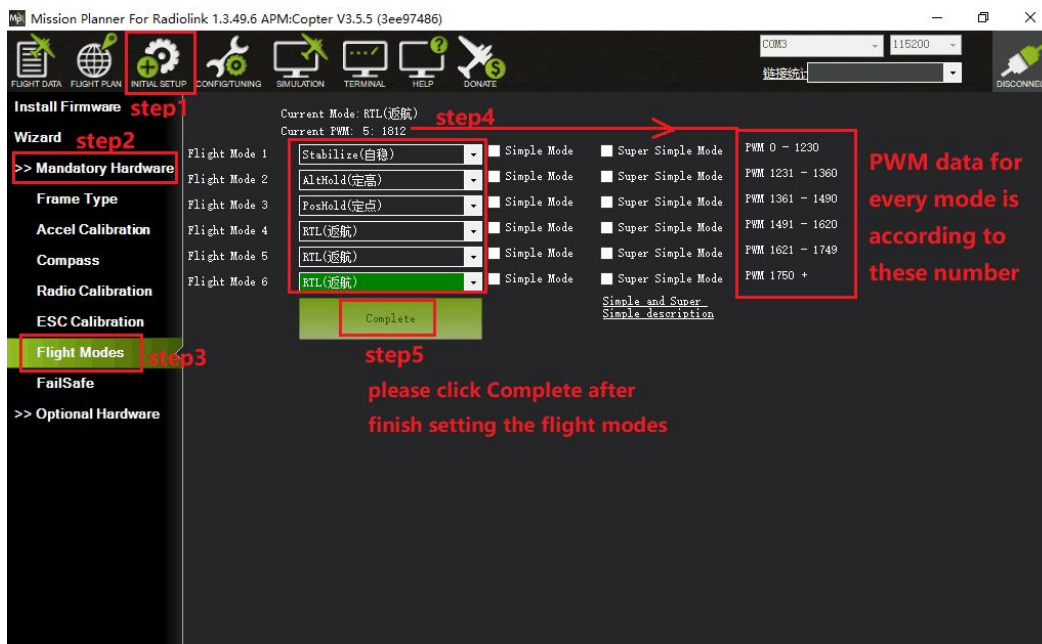


setup same fligt modess as the setting you have set in MP

3 . Setup Flight Mode 1 is Stabilize both in Mission Planner and transmitter.

Make sure the -swt- is ON (by press the 3 Posi-SW or 2 Posi-SW to make it ON or OFF) and then you can setup the PWM data.

Setup the PWM value according to the default numerical interval (change the value by turn the dial, press the Push button when you choose the right value.



### 3.6.1 Stabilize Mode

Stabilize mode allows you to fly your vehicle manually, but self-levels the roll and pitch axis.

If you're learning to fly, try Alt Hold or Loiter instead of Stabilize. You'll have fewer crashes if you don't need to concentrate on too many controls at once.

- (1) Pilot's roll and pitch input control the lean angle of the copter. When the pilot releases the roll and pitch sticks the vehicle automatically levels itself.
- (2) Pilot will need to regularly input roll and pitch commands to keep the vehicle in place as it is pushed around by the wind.
- (3) Pilot's yaw input controls the rate of change of the heading. When the pilot releases the yaw stick the vehicle will maintain its current heading.
- (4) Pilot's throttle input controls the average motor speed meaning that constant adjustment of the throttle is required to maintain altitude. If the pilot puts the throttle completely down the motors will go to their minimum rate (MOT\_SPIN\_ARMED) and if the vehicle is flying it will lose attitude control and tumble.

(5) The throttle sent to the motors is automatically adjusted based on the tilt angle of the vehicle (i.e. increased as the vehicle tilts over more) to reduce the compensation the pilot must do as the vehicle's attitude changes.

Always switch into a manual mode such as stabilize if the autopilot fails to control the vehicle. Maintaining control of your copter is your responsibility.

### 3.6.2 Acro Mode (FPV)

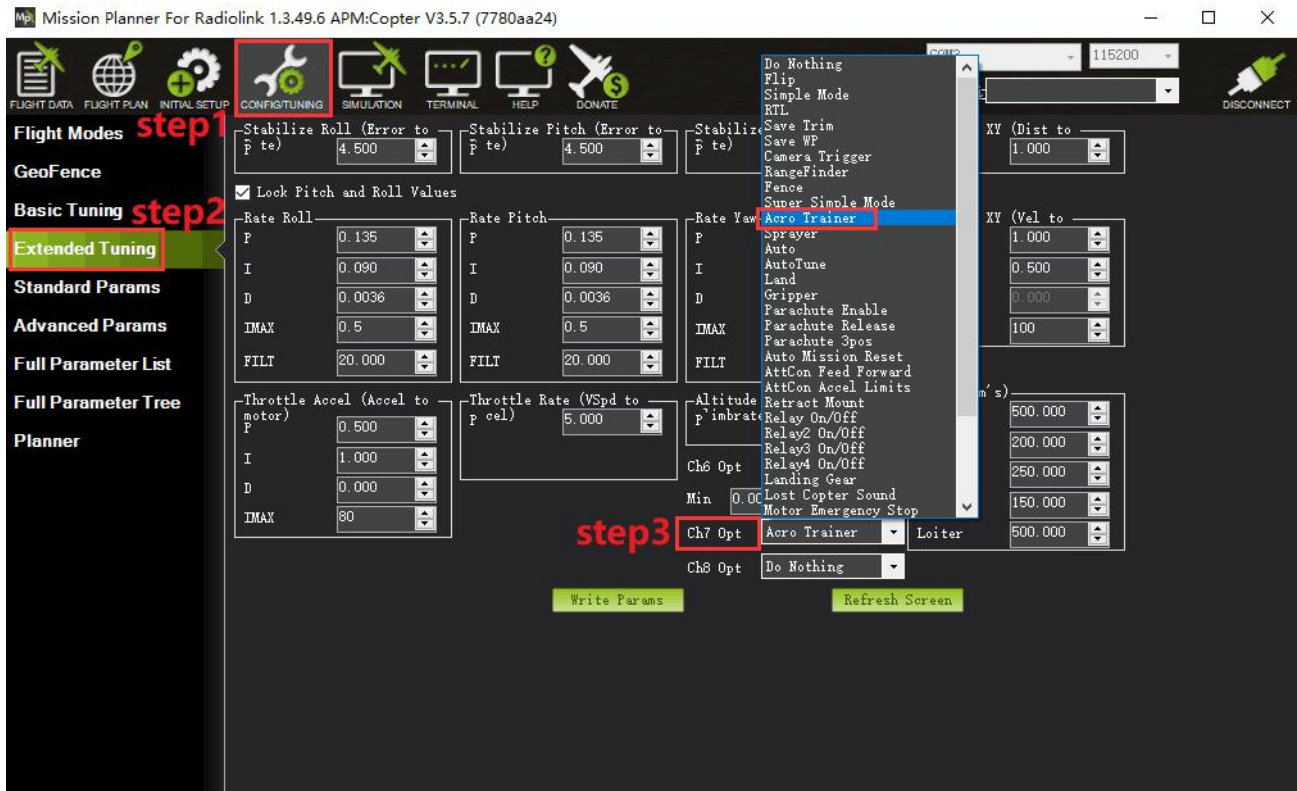
Acro mode (Rate mode) uses the RC sticks to control the angular velocity of the copter. Release the sticks and the vehicle will maintain its current attitude and will not return to level. Acro mode is useful for aerobatics such as flips or rolls, or FPV when smooth and fast control is desired.

#### ACRO mode trainer

##### ACRO\_TRAINER setting

- 0 is disabled. This means the pilot operates in full Rate control with no automatic leveling nor angle-limiting performed by the autopilot.
- 1 is automatic leveling. The vehicle will automatically return to the level when the pilot releases the sticks. The aggressiveness with which it returns to level can be controlled with the ACRO\_BAL\_ROLL and ACRO\_BAL\_PITCH parameters. The default of 1.0 will cause it to return to level at up to 30deg/sec. Higher values will make it return more quickly.
- 2 is Default to automatic leveling and lean angle limited. Includes the automatic leveling as option #1 but in addition the vehicle will not lean more than 45 degrees (this angle can be configured with the ANGLE\_MAX parameter).

The trainer can be enabled/disabled using the Ch7/Ch8 switches. With a 3 position switch the off position (i.e. PWM < 1200) will disable the trainer, middle position will enable option #1 (automatic leveling) and the top position (i.e. PWM > 1800) will enable option #2 (leveling and lean angle limited). With a 2-position switch only options #0 (disabled) and option #2 (leveling & limited) are possible.



## Parameters Setting

**ACRO\_RP\_P** controls the rotation rate for the roll and pitch axis. The default, 4.5, will command a 200deg/sec rotation rate. Higher values lead to higher rotation rates, lower to slower rotation rates. **ACRO\_YAW\_P** controls the rotation rate for the yaw axis. The default, 4.5, like roll and pitch, will command a 200deg/sec rotation rate.

**ACRO\_RP\_EXPO** Acro roll/pitch Expo to allow faster rotation when stick at edges

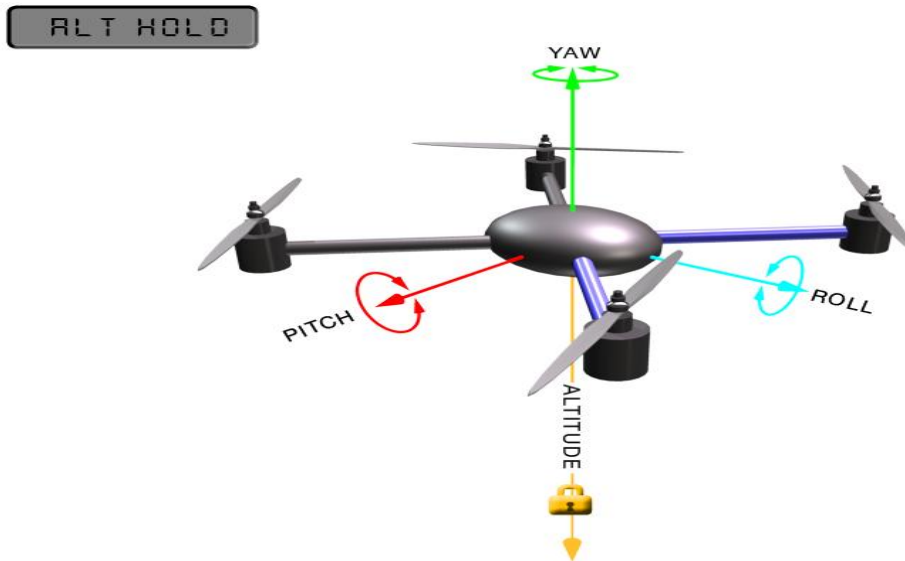
**ACRO\_Y\_EXPO** Acro yaw expo to allow faster rotation when stick at edges

**ACRO\_EXPO** is an amount of Exponential to apply to the pilots stick inputs that only applies to ACRO mode. By default, ACRO mode is much more responsive, even in the center-sticks positions, than the other modes, so this parameter allows the pilot to fine-tune stick response in the control to match what they feel when they are in other modes such as Stabilize, AltHold, PosHold, etc. The default value of 0 applies 30% expo to Roll and Pitch demands from the pilot.

### 3.6.3 Altitude Hold Mode

In altitude hold mode, Copter maintains a consistent altitude while allowing roll, pitch, and yaw to be controlled normally. This page contains important information about using and tuning AltHold.

Automatic altitude hold is a feature of many other flight modes (Loiter, Sport, etc.) so the information here pertains to those modes as well.



**Note:** The flight controller uses a barometer which measures air pressure as the primary means for determining altitude (“Pressure Altitude”) and if the air pressure is changing in your flight area due to extreme weather, the copter will follow the air pressure change rather than actual altitude. When fitted and enabled, a downward facing rangefinder such as LiDAR or SONAR will automatically provide even more accurate altitude maintenance, up to the limit of the sensor.

### How to control

The pilot can control the climb or descent rate of the vehicle with the throttle stick. If the throttle stick is in the middle (40% ~ 60%) the vehicle will maintain the current altitude. Outside of the mid-throttle dead zone (i.e. below 40% or above 60%) the vehicle will descend or climb depending upon the deflection of the stick. When the stick is completely down the copter will descend at 2.5m/s and if at the very top it will climb by 2.5m/s. These speeds can be adjusted with the PILOT\_VELZ\_MAX parameter.

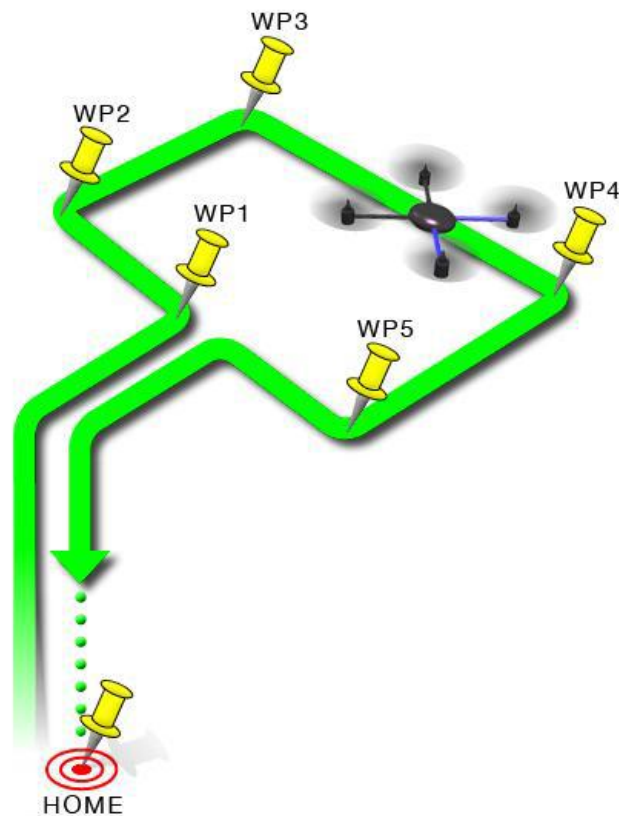
The size of the deadband can be adjusted with the THR\_DZ parameter (AC3.2 and higher only). This param's value should be between “0” and “400” with “0” meaning no deadband. “100” would produce a deadband 10% above and below mid throttle (i.e., deadband extends from 40% to 60% throttle stick position).

AC3.1 and later allow arming and disarming in altitude hold mode. When disarming, the copter may need to rest in the landing position for a few seconds to allow the “landing checker” to verify that the copter has landed before you are able to disarm.

### 3.6.4 Auto Mode

In Auto mode the copter will follow a pre-programmed mission script stored in the autopilot which is made up of navigation commands (i.e., way points) and “do” commands (i.e., commands that do not affect the location of the copter including triggering a camera shutter).

AUTO



AUTO mode incorporates the altitude control from AltHold mode and position control from Loiter mode and should not be attempted before these modes are flying well. All the same requirements apply including ensuring that vibration levels and compass interference levels are acceptable and that the GPS is functioning well including returning an HDOP of under 2.0.

AUTO should be set-up as one of the Flight Modes on the flight mode switch.

Make sure that the GPS is positioning first:

- The LED of PIXHAWK is green.
- The LED of GPS and compass module is blinking.

If starting the mission while the copter is on the ground the pilot should ensure the throttle is down, then switch to the Auto flight mode, then raise the throttle. The moment that the throttle is raised above zero, the copter will begin the mission.

If starting the mission from the air the mission will begin from the first command the moment that the flight mode switch is moved to Auto. If the first command in the mission is a take-off command but the vehicle is already above the take-off command's altitude the take-off command will be considered completed and the vehicle will move onto the next waypoint.

At any time, the pilot can retake control from the autopilot by returning the flight mode switch to another flight mode such as Stabilize or Loiter. If the pilot then switches to AUTO again, the mission will restart from the first command.

During the mission the pilot's roll, pitch and throttle inputs are ignored but the yaw can be overridden with the yaw stick. This allows the pilot to for example aim the nose of the copter (which might have a hard-mounted



camera on it) as the copter flies the mission. The autopilot will attempt to retake yaw control as the vehicle passes the next waypoint.

### Ending a mission

Missions should normally have an RTL as their final command to ensure the copter will return after the mission completes. Alternatively, the final command could be a LAND with a different location. Without a final RTL or LAND command the copter will simply stop at the final waypoint and the pilot will need to retake control with the transmitter.

Remember that when using RTL, the copter will return to the “home” position which is the location where the copter was armed.

As the copter touches down at the end of the mission the pilot should move the throttle to zero at which point the autopilot will disarm the motors if it also believes that it has landed.

### 3.6.5 PosHold Mode

The PosHold flight mode (previously known as “Hybrid”) is a new mode for AC3.2. It is similar to Loiter in that the vehicle maintains a constant location, heading, and altitude but is generally more popular because the pilot stick inputs directly control the vehicle’s lean angle providing a more “natural” feel.

When switched on, PosHold mode will automatically attempts to maintain the current location, heading and altitude. Good GPS position, low magnetic interference on the compass and low vibrations are all important in achieving good loiter performance.

#### How to control

The pilot can control the copter’s location horizontally and vertically with the control sticks.

Horizontal location can be adjusted with the Roll and Pitch control sticks with the default maximum lean angle being 45 degrees (angle can be adjusted with the ANGLE\_MAX parameter). When the pilot releases the sticks, the copter will lean back to bring the vehicle to a stop.

Altitude can be controlled with the Throttle control stick just as in AltHold mode

The heading can be set with the Yaw control stick

You may arm in PosHold mode but only once the GPS has 3D lock and the HDOP has dropped to 2.0 or lower.

The HDOP value can be made clearly visible through the mission planner’s Quick screen by double clicking and then selecting “gpshdop” from the large grid of checkboxes.

The maximum brake-angle can be set with the PHLD\_BRAKE\_ANGLE parameter (i.e. 3000 = the vehicle will lean back up to 30degrees).

The speed the vehicle rotates back to the maximum angle can be set with the PHLD\_BRAKE\_RATE parameter (i.e., 8 = rotates back at 8 degrees per second)).

### 3.6.6 RTL Mode

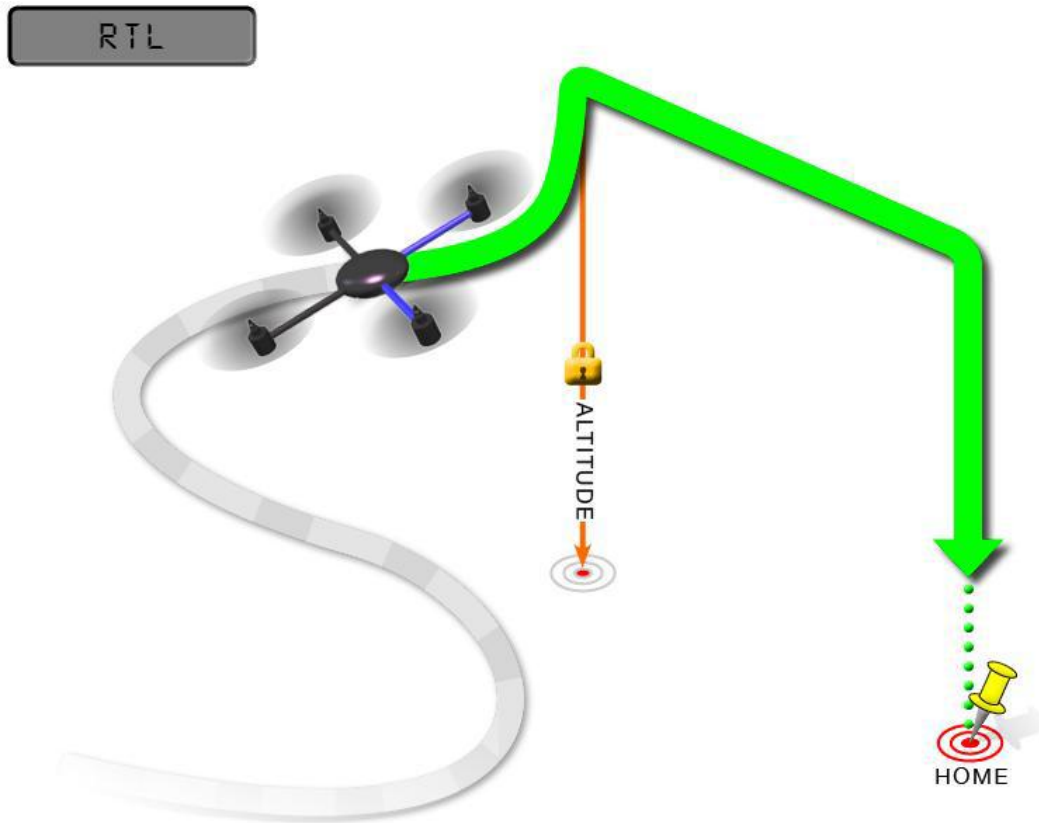
This very simple flight mode simply stops the vehicle as soon as possible using the Loiter controller. Once invoked, this mode does not accept any input from the pilot. This mode requires GPS.

RTL mode (Return to Launch mode) navigates Copter from its current position to hover above the home



position. The behavior of RTL mode can be controlled by several adjustable parameters.

When RTL mode is selected, the copter will return to the home location. The copter will first rise to RTL\_ALT before returning home or maintain the current altitude if the current altitude is higher than RTL\_ALT. The default value for RTL\_ALT is 15m.



RTL is a GPS-dependent move, so it is essential that GPS lock is acquired before attempting to use this mode. Before arming, ensure that the APM's blue LED is solid and not blinking. For a GPS without compass, the LED will be solid blue when GPS lock is acquired. For the GPS+Compass module, the LED will be blinking blue when GPS is locked.

RTL will command the copter to return to the home position, meaning that it will return to the location where it was armed. Therefore, the home position is always supposed to be your copter's actual GPS takeoff location, unobstructed and away from people. For Copter if you get GPS lock and then ARM your copter, the home position is the location the copter was in when it was armed. This means if you execute an RTL in Copter, it will return to the location where it was armed.

In RTL mode the flight controller uses a barometer which measures air pressure as the primary means for determining altitude ("Pressure Altitude") and if the air pressure is changing in your flight area, the copter will follow the air pressure change rather than actual altitude (unless you are within 20 feet of the ground and have SONAR installed and enabled).

#### Options (User Adjustable Parameters)

1. RTL\_ALT: The minimum altitude the copter will move to before returning to launch.  
(1) Set to zero to return at the current altitude.

- (2) The return altitude can be set from 1 to 8000 centimeters.
  - (3) The default return altitude Default is 15 meters (1500)
2. RTL\_ALT\_FINAL: The altitude the copter will move to at the final stage of “Returning to Launch” or after completing a Mission.

- (1) Set to zero to automatically land the copter.
  - (2) The final return altitude may be adjusted from 0 to 1000 centimeters.
3. RTL\_LOIT\_TIME: Time in milliseconds to hover/pause above the “Home” position before beginning final descent.

The “Loiter” time may be adjusted from 0 to 60,000 milliseconds.

4. WP\_YAW\_BEHAVIOR: Sets how the autopilot controls the “Yaw” during Missions and RTL.
- (1) 0 = Never change Yaw.
  - (2) 1 = Face Next Waypoint including facing home during RTL.
  - (3) 2 = Face Next Waypoint except for RTL (i.e., during RTL vehicle will remain pointed at its last heading)

5. LAND\_SPEED: The descent speed for the final stage of landing in centimeters per second.  
The landing speed is adjustable from 20 to 200 centimeters per second.

6. RTL\_CLIMB\_MIN: The vehicle will climb at least these many meters at the first stage of the RTL. By default, this value is zero. (only Copter-3.3 and above)

7. RTL\_SPEED: The horizontal speed (in cm/s) at which the vehicle will return to home. By default, this value is zero meaning it will use WPNAV\_SPEED. (only Copter-3.4 and higher)

8. RTL\_CONE\_SLOPE: Defines the slope of an inverted cone above home which is used to limit the amount the vehicle climbs when RTL-ing from close to home. Low values lead to a wide cone meaning the vehicle will climb less, High values will lead to the vehicle climbing more. (supported in Copter-3.4 and higher)

#### Notes

1. Other navigation settings also have an influence over RTL mode:
  - (1) WPNAV\_ACCEL
  - (2) WPNAV\_SPEED\_DN
  - (3) WPNAV\_SPEED\_UP
2. To use RTL, GPS lock needs to be achieved (Blue GPS LED and Blue APM LED on solid not blinking) before arming and takeoff to establish the home or launch position.
3. Landing and re-arming the copter will reset home, which is a great feature for flying at airfields.
4. If you get lock for the first time while flying, your home will be set at the location of lock.
5. If you set the RTL\_ALT to a number at other than 0 it will go to and maintain that altitude while returning.
6. RTL uses WPNAV\_SPEED to determine how fast it travels.
7. Once the copter arrives at the home location the copter will pause for RTL\_LOIT\_TIME milliseconds, timeout (AUTO\_LAND), then land.

### 3.6.7 Simple and Super Simple Modes

“Simple” and “Super Simple” modes allow the pilot to control the movement of the copter from the pilot’s point of view regardless of which way the copter is facing. This is useful for new pilots who have not mastered adjusting their roll and pitch inputs depending upon which way the vehicle is facing and for cases when the copter is far enough away that its heading is not apparent.

- (1) “Simple” and “Super Simple” modes can be used in combination with nearly all flight modes except the Acro and Drift (in these flight modes the setting is ignored).

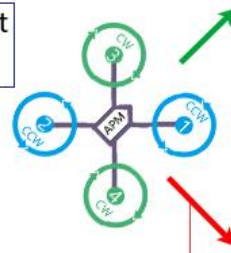
- (2) Simple Mode allows you to control the copter relative to the copters heading at takeoff and relies only on a good compass heading.
- (3) Super Simple Mode allows you to control the copter relative to its direction from home (i.e. where it was armed) but requires a good GPS position.
- (4) Either mode can be assigned to a particular flight mode switch position or can be enabled/disabled from the Ch7/Ch8 switches.

**Normal Mode**

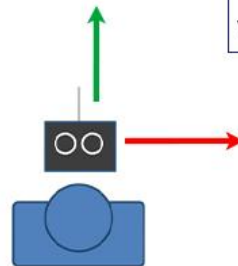
Without Simple or Super Simple enabled, the pilot's transmitter stick inputs are applied in the orientation of the copter. For example, in the diagram above when the pilot applies roll input right (red) the vehicle rolls to its right.

With the copter is facing in the same direction as the pilot, it is relatively easy to control the vehicle but when the vehicle is facing towards the pilot an inexperienced pilot will feel that the controls are all reversed. I.e., if the pilot inputs right roll, the vehicle will move to the left from the pilot's point of view.

Normal controls apply pilot input from the vehicle's perspective



Pilots roll command causes the vehicle to roll to it's right.

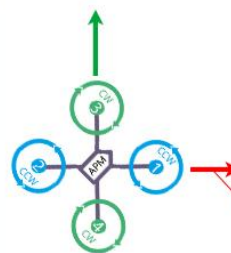
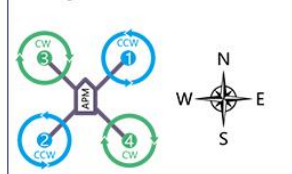


**Simple Modes**

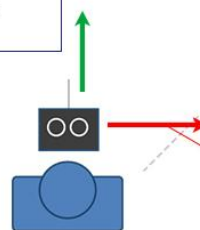
Similar to the "care free" mode on other systems, this mode allows you to fly your copter as though it were pointed in the direction it was pointed when it was armed regardless of its current heading orientation. So, if you hold the pitch stick forward the copter will fly away from you, pull the pitch stick back and it will come back towards home. You can even apply yaw to spin the copter in any direction but the movement of the copter's position relative to the stick inputs will behave exactly as it did at takeoff.

Generally, when arming you should stand behind the vehicle with its nose

Simple mode:controls are applied based on vehicle's heading when armed. In this example copter was facing North when armed



Pilots roll command causes the vehicle to move to the right from the pilot's point of view regardless of the vehicle's heading.



Keep the vehicle generally forward of it's starting position to keep the controls from feeling backwards

pointing directly away from you. While flying you should try to keep the vehicle flying in front of its starting position because if it flies behind you all the controls will feel reversed.

As mentioned above simple mode is also very useful in emergency situations where the copter is far enough away that it is very difficult to determine its heading.

### Super Simple Modes

Super Simple mode is the same as simple mode except that it uses the vehicle's position relative to home instead of the vehicle's initial heading when it was armed. This means that no matter where the vehicle is, pulling the pitch back will cause it to return towards home regardless of the vehicle's actual heading.

The advantage over simple mode is that the controls are applied from the pilot's point of view even when the copter flies behind the pilot/home location.

If the pilot holds full right roll the vehicle will fly a circle clockwise

around the pilot (although the circle's radius may tend to grow slightly with each orbit due to "lag").

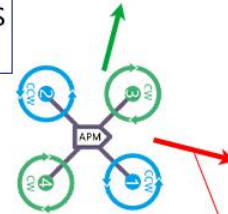
The disadvantage is that mode require a GPS lock because so you should ensure you have GPS lock before take-off.

The orientation is not updated when the vehicle is within 10m of home meaning close fly-bys of the home location should be avoided.

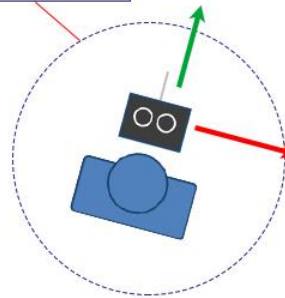
To ensure the controls are correct right at take-off, as with simple mode, you should arm with the pilot standing behind the vehicle and with both pilot and vehicle pointing in the same direction.

Super Simple mode: controls are applied based on the vehicle's GPS position relative to home.

Pilot vs vehicle control angles are not updated within 10m of home



Pilots roll command causes the vehicle to move to the right from the pilot's point of view regardless of the vehicle's heading and even if the vehicle moves behind the pilot.



### 3.6.8 More flight modes

**Guided Mode:** Guided mode is a capability of Copter to dynamically guide the copter to a target location wirelessly using a telemetry radio module and ground station application. This page provides instructions for using guided mode.

**Loiter Mode:** Loiter Mode automatically attempts to maintain the current location, heading and altitude. The pilot may fly the copter in Loiter mode as if it were in a more manual flight mode but when the sticks are released, the vehicle will slow to a stop and hold position.

**Circle Mode:** Circle will orbit a point located CIRCLE\_RADIUS centimeters in front of the vehicle with the nose of the vehicle pointed at the center.

**Drift Mode:** This page provides tips for flying in Drift Mode and methods for tuning your copter to fly optimally in Drift Mode.

**Sport Mode:** Sport Mode is also known as “rate controlled stabilize” plus Altitude Hold.

**Flip Mode:** Vehicle will flip on its roll or pitch axis depending upon the pilot’s roll and pitch stick position. Vehicle will rise for 1 second and then rapidly flip. The vehicle will not flip again until the switch is brought low and back to high. Give yourself at least 10m of altitude before trying flip for the first time!

**AutoTune:** AutoTune attempts to automatically tune the Stabilize P, Rate P and D, and maximum rotational accelerations to provide the highest response without significant overshoot. Copter needs to be “basically” flyable in AltHold mode before attempting to use AutoTune as the feature needs to be able to “twitch” the copter in the roll and pitch axis.

**Land Mode:** LAND Mode attempts to bring the copter straight down

**Break Mode:** This very simple flight mode simply stops the vehicle as soon as possible using the Loiter controller. Once invoked, this mode does not accept any input from the pilot. This mode requires GPS.

**Throw Mode:** This slightly dangerous flight mode allows the pilot to throw the vehicle into the air (or drop the vehicle) in order to start the motors. Once in the air, this mode does not accept any input from the pilot. This mode requires GPS.

**Avoid\_ADSB:** for ADS-B based avoidance of manned aircraft. Should not be set-up as a pilot selectable flight mode.

**Guided\_NoGPS:** which is meant for developer use only.

The details introduction about flight modes can check on website here:

<http://ardupilot.org/copter/docs/flight-modes.html>

<http://www.ncnynl.com/archives/201608/417.html>

## 4. F/S(failsafe) Setting

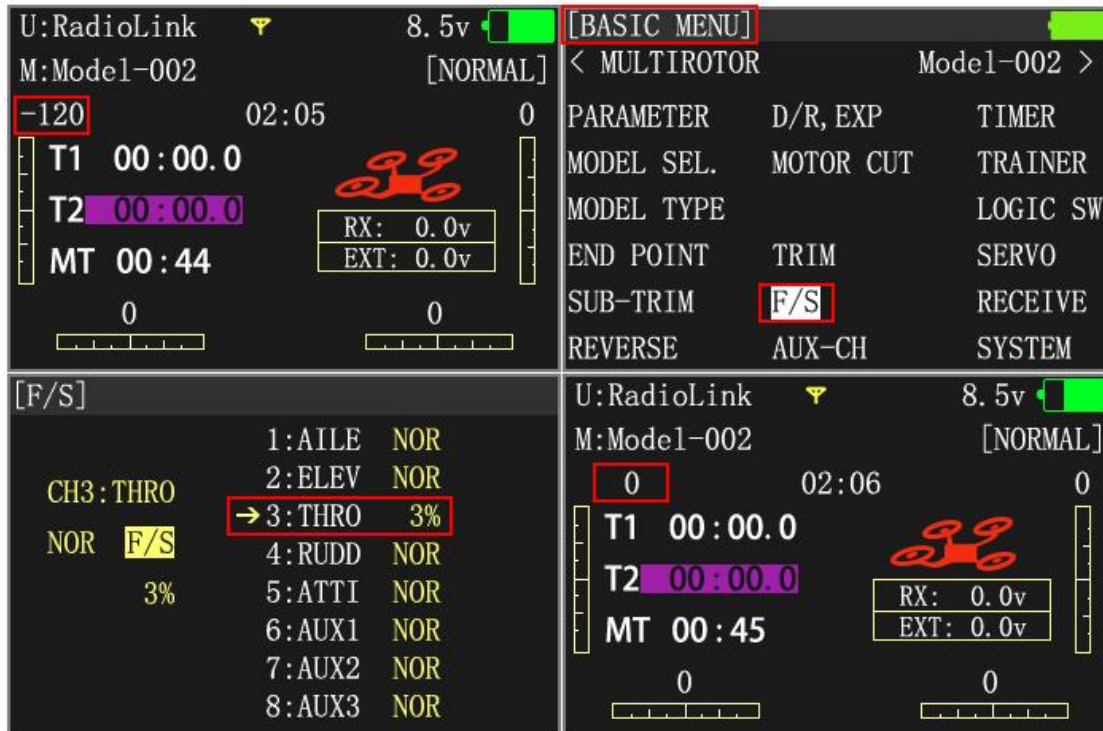
### 4.1 Radio Failsafe Setup

PIXHAWK supports Return-To-Launch in cases where contact between the Pilot’s RC transmitter and the flight controller’s receiver is lost. This page explains this failsafe’s setup and testing. Note the “Radio failsafe” was previously called “Throttle failsafe” because of the way in which some receivers use the throttle channel to signal the loss of contact.

Make sure transmitter and receiver connect success and work with SBUS signal.

### F/S setting steps:

Setup in transmitter: setup the throttle trim to -120 by trim switch and then press Mode button one second into BASIC MENU, choose and into F/S menu, put the throttle stick to the bottom to setup 3: THRO 3%. Please setup the throttle trim back to 0 after setup the THRO 3% success.



### Receiver and flight controller PIXHAWK setup:

By default, a newly purchased receiver will be set-up to simply hold all channels at their last known position when the receiver and transmitter lose contact. This is not good because the flight controller has no way to know that the Pilot has lost control of the vehicle. Instead, the receiver must be set-up to signal to the flight controller it has lost contact and there are two ways that it can do this (the method depends upon the receiver): "Low-Throttle" method - the receiver pulls the throttle channel (normally channel 3) to a value below the bottom of its normal range (normally below 975).

With the LiPo battery disconnected:

1. Connect your flight controller to the mission planner and select Initial Setup >> Mandatory Hardware >> Failsafe.
2. Set the Failsafe Options to one of the three options:
  - (1) "Enabled always RTL" to force the vehicle to always RTL even if flying a mission in AUTO mode.
  - (2) "Enabled Continue with Mission in AUTO" to allow the vehicle to continue with missions even if it takes the vehicle outside of RC range (not recommended). In all other cases the vehicle will RTL.
  - (3) "Enable always LAND" to force the vehicle to Land immediately if it loses RC contact.

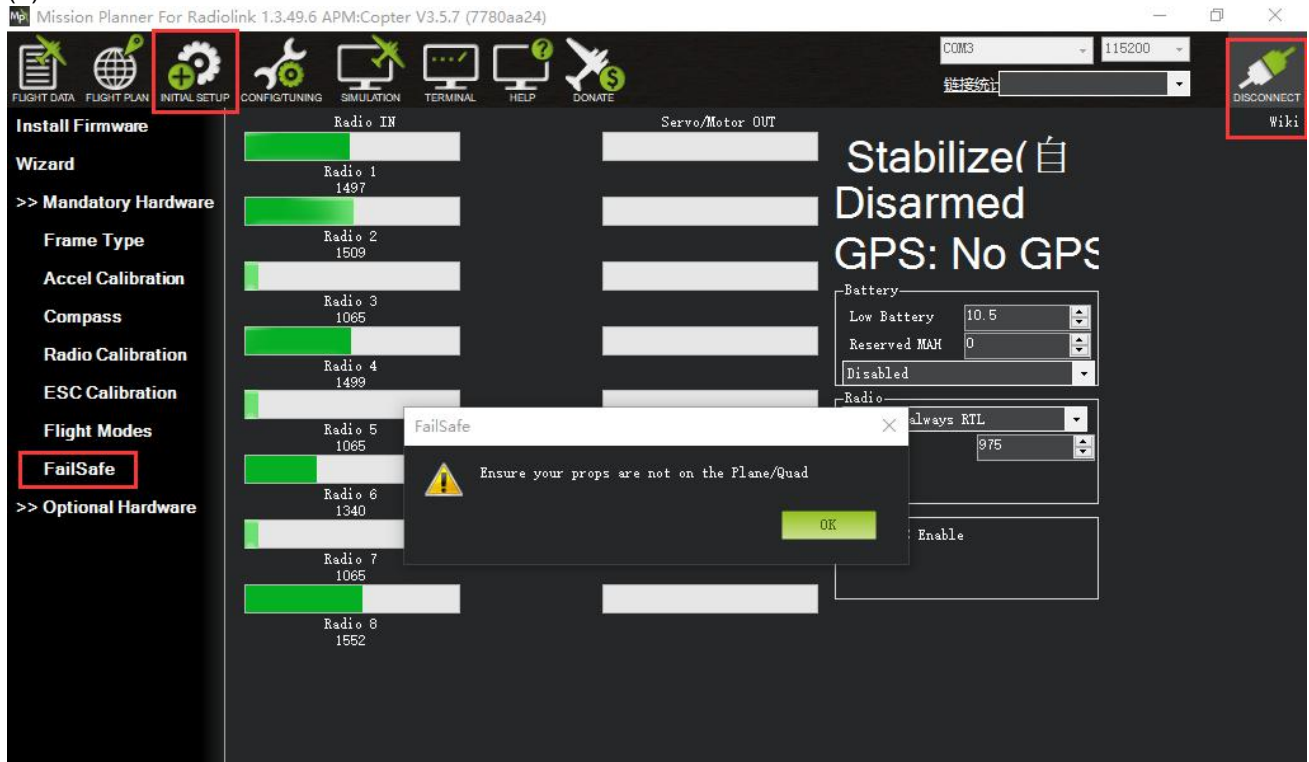
Set the "FS PWM" value to be:

- (1) at least 10 PWM higher than your Channel 3's PWM value when the throttle stick is fully down and the transmitter is off.
- (2) at least 10 lower than your channel 3's PWM value when the throttle stick is fully down and the transmitter

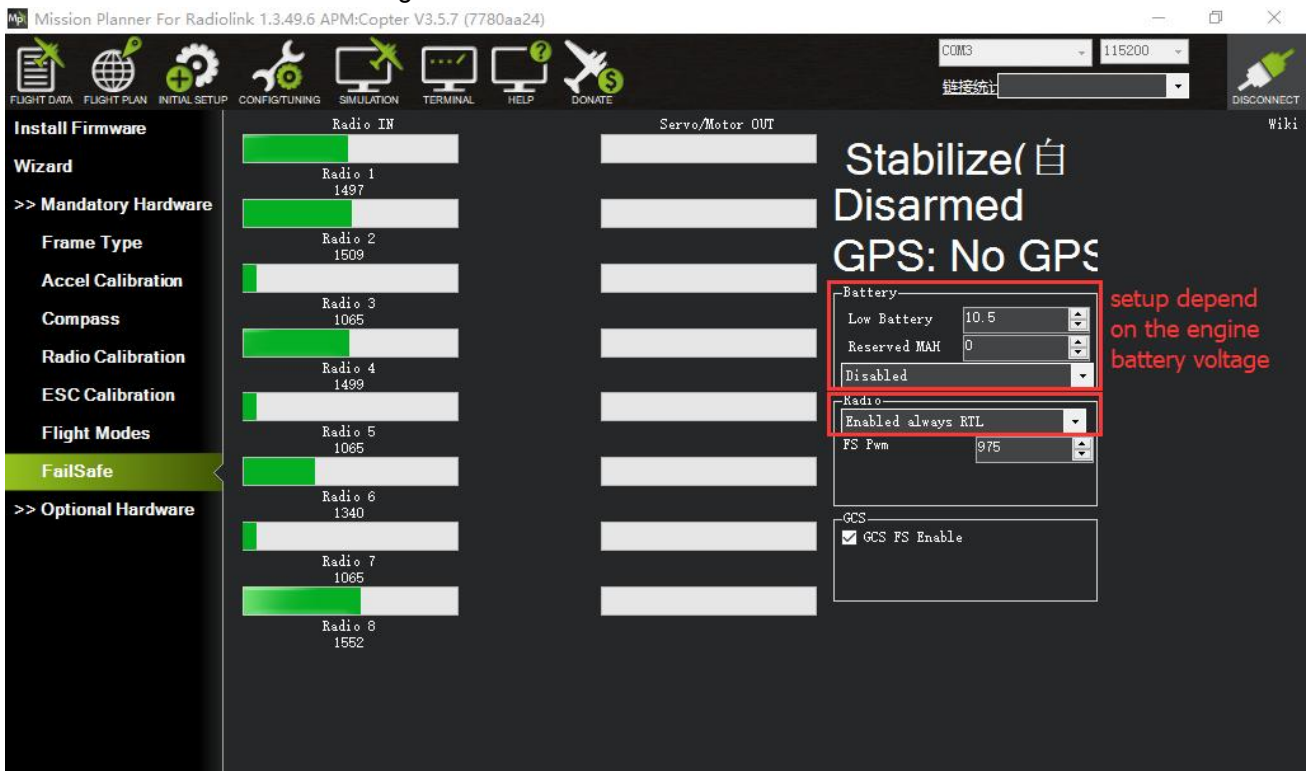


is on.

(3) above 910.

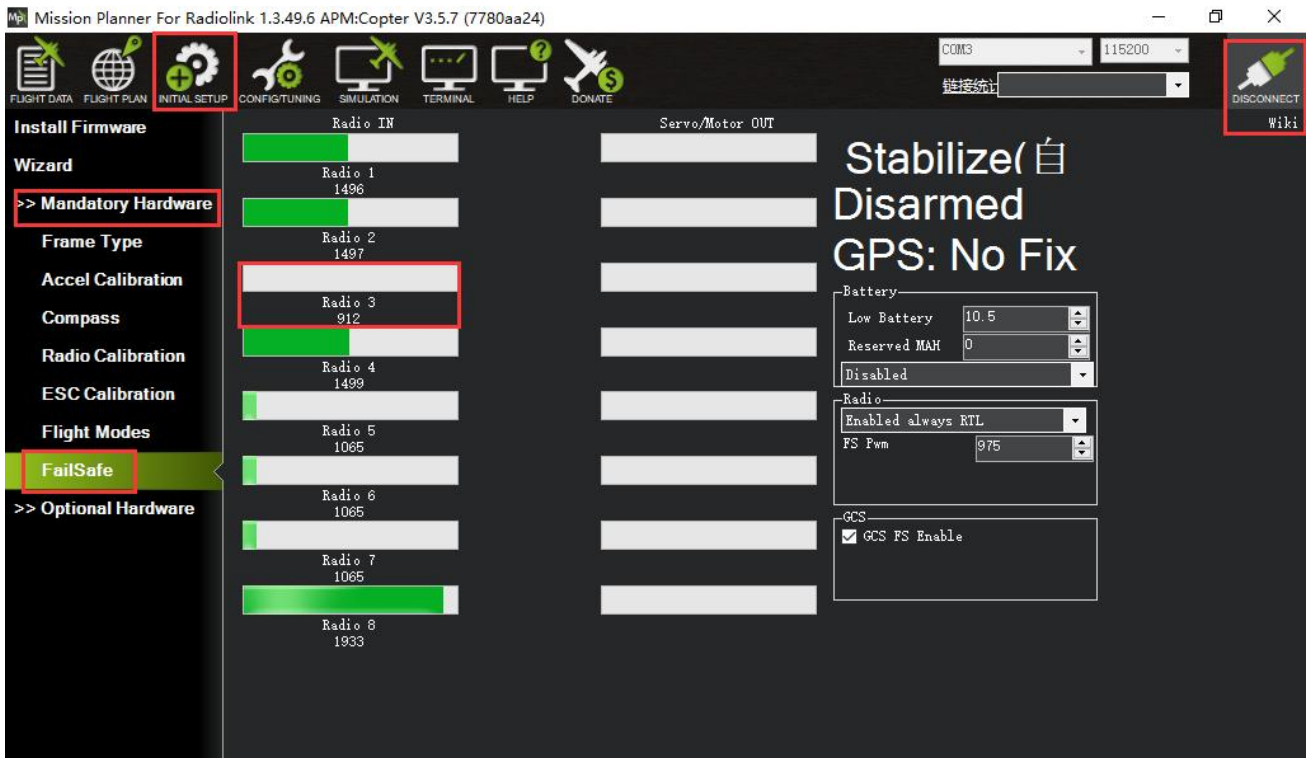


Click OK to into the failsafe setting menu.



You can turn off transmitter to check if the Failsafe function setup success(the PWM of CH3 is smaller than 975)





If enabled and set-up correctly the radio Failsafe will trigger if:

- (1) The pilot turns off the RC transmitter.
- (2) The vehicle travels outside of RC range.
- (3) The receiver loses power (unlikely).
- (4) The wires connecting the receiver to the flight controller are broken (unlikely).

When a radio Failsafe is triggered one of the following will happen:

- (1) Nothing if the vehicle is already disarmed.
- (2) Motors will be immediately disarmed if the vehicle is landed OR in stabilize or acro mode and the pilot's throttle is at zero.
- (3) Return-to-Launch (RTL) if the vehicle has a GPS lock and is more than 2 meters from the home position.
- (4) LAND if the vehicle has:

no GPS lock OR

is within 2 meters of home OR

the FS\_THR\_ENABLE parameter is set to "Enabled Always Land"

If the Failsafe clears (i.e., transmitter and receiver regain contact) the copter will remain in its current flight mode. It will **not** automatically return to the flight mode that was active before the Failsafe was triggered.

This means that if, for example, the vehicle was in Loiter when the Failsafe occurred and the flight mode was automatically changed to RTL, even after the transmitter and receiver regained contact, the vehicle would remain in RTL. If the pilot wished to re-take control in Loiter, he/she would need to change your flight mode switch to another position and then back to Loiter.

Copter also supports Battery, Ground Station and EKF/DCM failsafes.

You can check your Failsafe by performing the following tests with the PIXHAWK connected to the Mission Planner either via a USB cable or telemetry link. You can complete these tests without plugging in your LiPo battery but if you do connect a battery, you should first remove the propellers.

Test #1: if using the "Low-Throttle" method, ensure the throttle channel drops with loss of radio contact  
Ensure your RC transmitter is on and connected with the throttle all the way down and flight mode set to Stabilize

The throttle (channel 3) PWM value should be approximately as in first illustration below. Its value may be higher or lower but it should definitely be at least 10 higher than the value held in the FS PWM field  
Turn the transmitter off and the throttle PWM value should drop to be at least 10 below the FS PWM field value (as in the second illustration below) below

Test #2: ensuring motors disarm if in stabilize or acro with throttle at zero

Switch to stabilize mode, arm your motors but keep your throttle at zero. Turn off your transmitter. The motors should disarm immediately (red led will start flashing, DISARMED will be displayed in the Mission Planner's Flight Data screen).

Test #3: ensuring flight mode changes to RTL or LAND when throttle is above zero

Switch to stabilize mode, arm your motors and raise your throttle to the midpoint. Turn off your transmitter. The Flight Mode should switch to RTL if you have a GPS lock or LAND if you do not have a GPS lock (the flight mode and GPS lock status are visible in the Mission Planner's flight data screen).

Test #4: retaking control after the failsafe has cleared

continuing on from test #3, turn your transmitter back on

while the flight mode is still in RTL or LAND and armed, change the flight mode switch to another position and then back to stabilize mode. Ensure that the flight mode displayed on the Failsafe page is updating appropriately.

Test #5 (optional): removing power from the receiver

Switch to stabilize mode, arm your motors and keep your throttle above zero.

Carefully disconnect the power wires connecting the receiver to the APM

The Flight Mode should switch to RTL or LAND as described in Test #3

Warning: unplug the APM so that it is powered down before reattaching the receiver's power

## 4.2 EKF FailSafe

FS\_EKF\_ACTION

Note: This parameter is for advanced users

Controls the action that will be taken when an EKF failsafe is invoked

## Values

Value	Meaning
1	Land
2	AltHold
3	Land even in Stabilize

It defaults the value 1, that is the drone will land if lose signal, but you can change the setting from value 1 to value 2, which means the drone will AltHold if lose signal.

FS\_EKF\_THRESH

Note: This parameter is for advanced users

Allows setting the maximum acceptable compass and velocity variance

## Values

0.6:Strict,0.8:Default,1.0:Relaxed

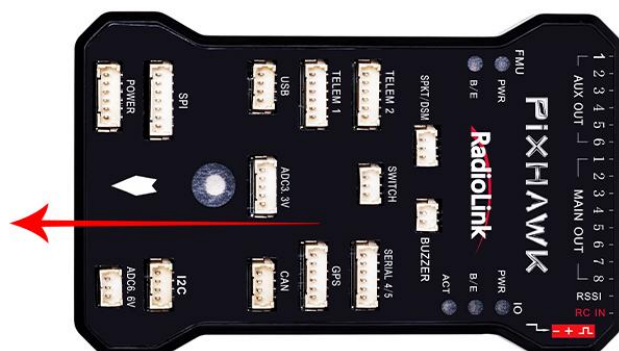
## 5. Optional hardware setup

Prepare a drone first, a X frame quadcopter as a sample, please mount a PIXHAWK as below steps after you have assembled the drone.

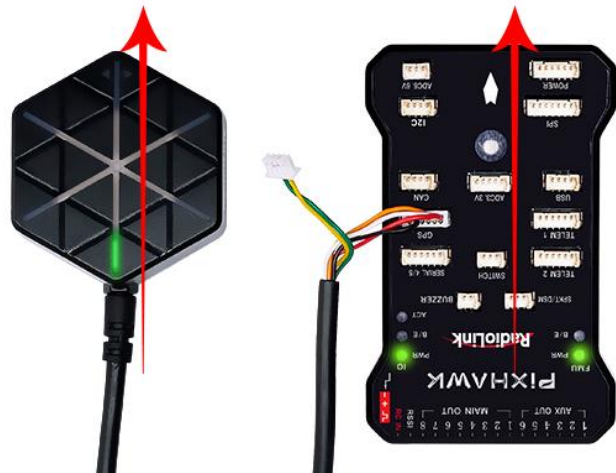
1. mount a PIXHAWK on the center position of the drone, and make sure that the PIXHAWK is horizontal on the drone.
2. connect the Mission Planner after download the firmware, calibrate and setup parameters as the steps above.
3. press the safety switch and have a try to disarmed, mount on the propellers if the drone can disarm success, then you can go to flight.

### 5.1 Install PIXHAWK on aircraft

Mount the PIXHAWK at the barycenter of the drone, Make sure the arrow of the PIXHAWK is point to the front.



Keep the GPS with the same direction of PIXHAWK .if you need to use PIXHAWK with GPS.



If the installation can't be done with the default direction, parameters need to be setup according to the installation direction.

### AHRS\_ORIENTATION

AHRS_ORIENTATION	0	0:None 1:Yaw45 2:Yaw90 3:Yaw135 4:Yaw180 5:Yaw225 6:Yaw270 7:Yaw315 8:Roll90 9:Roll180 10:Yaw45 10:Roll180 10:Yaw90 11:Roll180 10:Yaw135 12:Pitch180 13:Roll180 10:Yaw225 14:Roll180 10:Yaw270 15:Roll180 10:Yaw315 15:Roll180 17:Roll90 10:Yaw45 18:Roll90 10:Yaw90 19:Roll90 10:Yaw135 20:Roll270 21:Roll270 10:Yaw45 22:Roll270 10:Yaw90 23:Roll270 10:Yaw135 24:Pitch90 25:Pitch270 26:Pitch180 10:Yaw90 27:Pitch180 10:Yaw270 28:Roll90 Pitch90 29:Roll100 Pitch90 30:Roll270 Pitch90 31:Roll90 Pitch180 32:Roll270 Pitch180 33:Roll90 Pitch270 34:Roll180 Pitch270 35:Roll270 Pitch270 36:Roll90 Pitch180 10:Yaw90 37:Roll90 10:Yaw270	Overall board orientation relative to the standard orientation for the board type. This rotates the IMU and compass readings to allow the board to be mounted in your vehicle at any 90 or 45 degree angle. This option takes effect on next boot. After changing you will need to re-level your vehicle.
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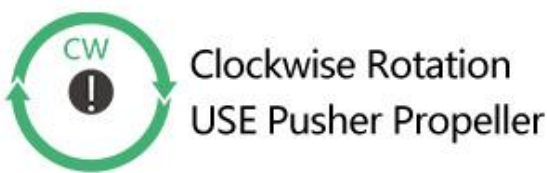
Set the rotation direction and degree and the corresponding values basing on the variation of the flight controller and the aircraft vehicle and input to save. Restart and test if the movements of the flight controller are correct at the homepage of Mission Planner.

## 5.2 Connect PIXHAWK to the aircraft

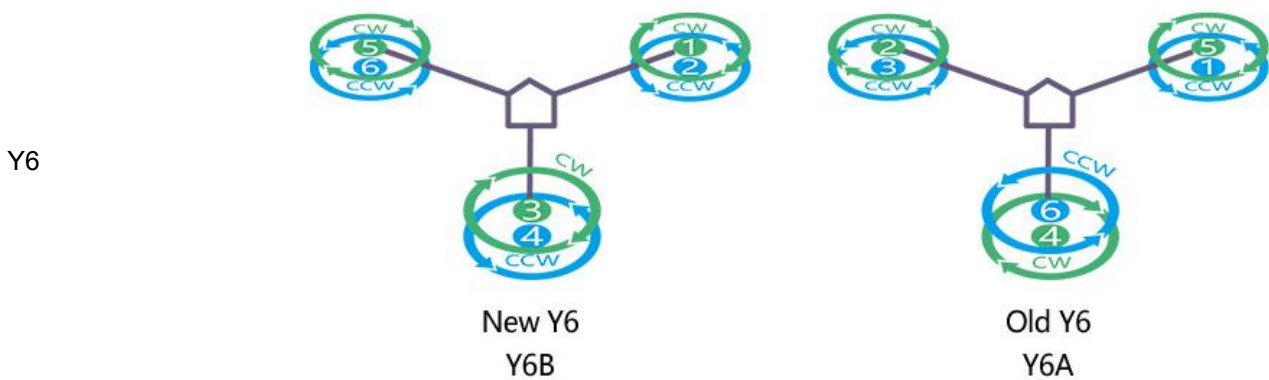
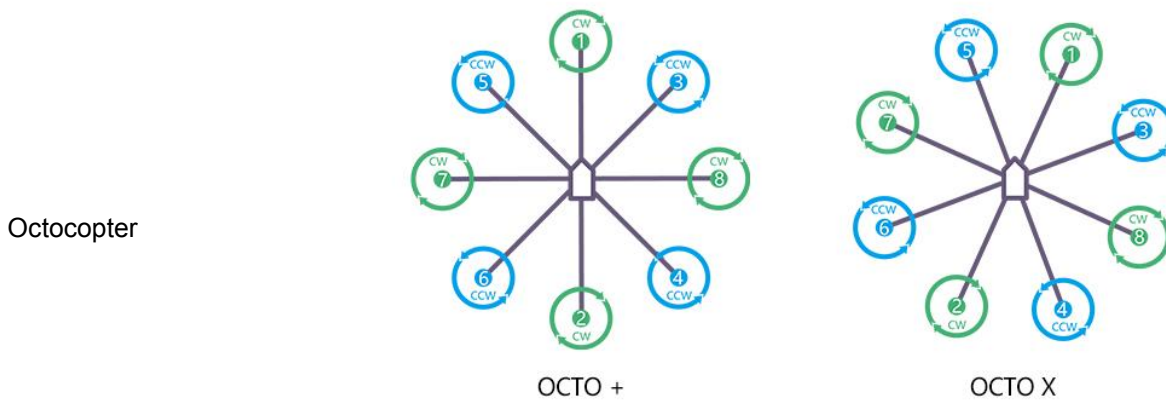
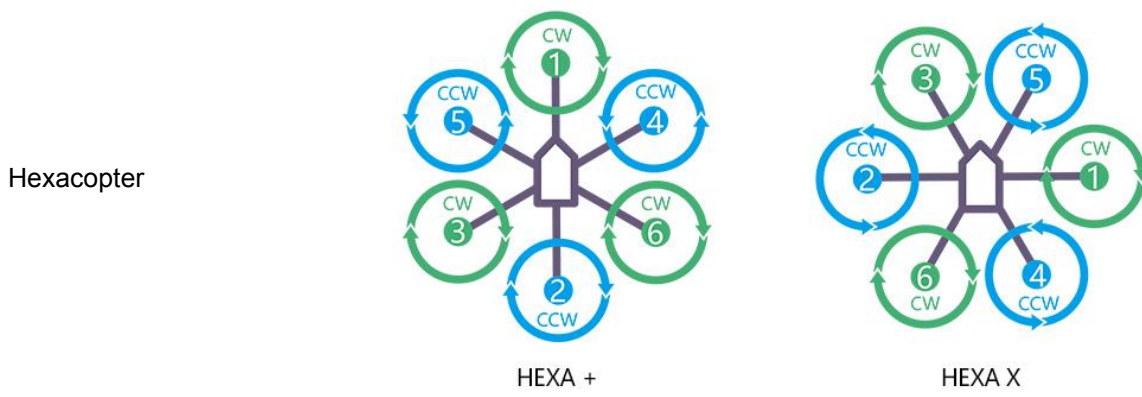
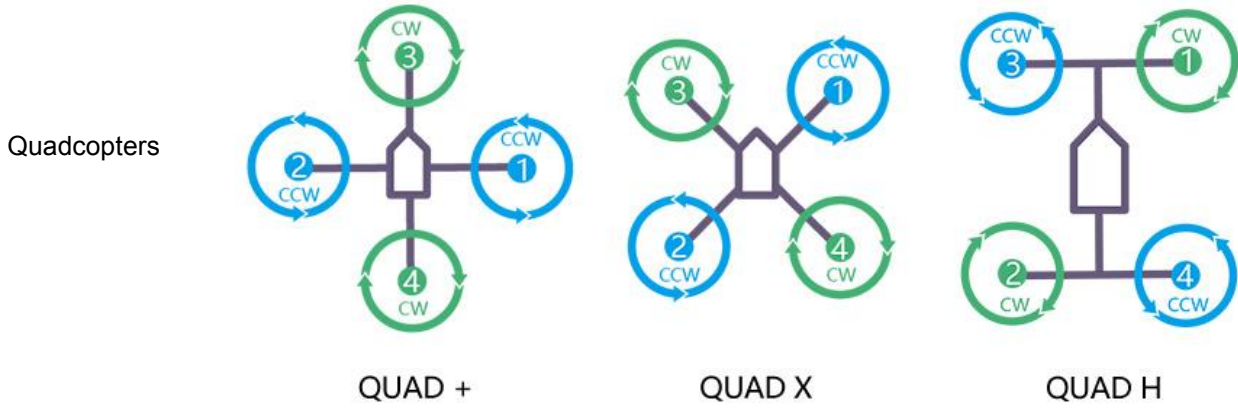
### 5.2.1 Motor order rotation select

Green means CW

Blue means CCW

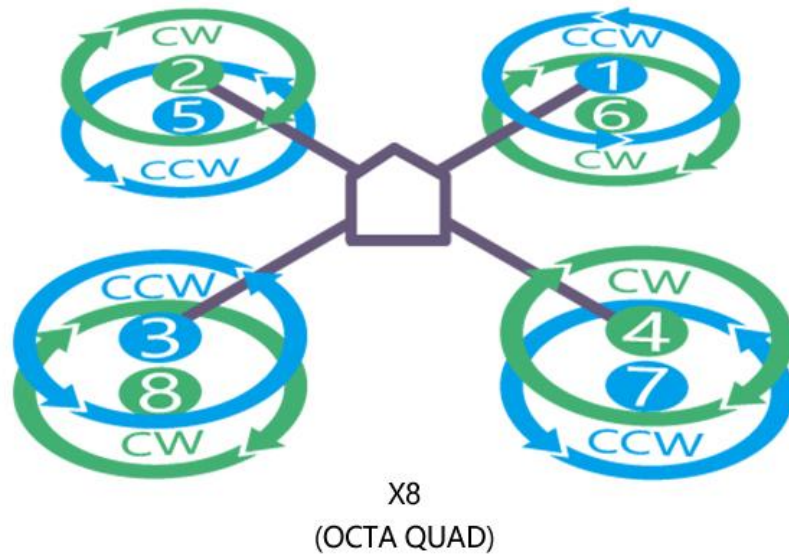


Legend for motor-order diagrams

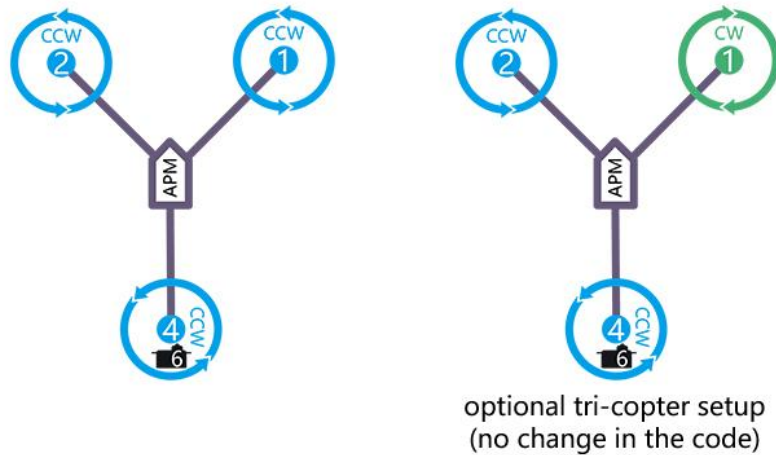




X8



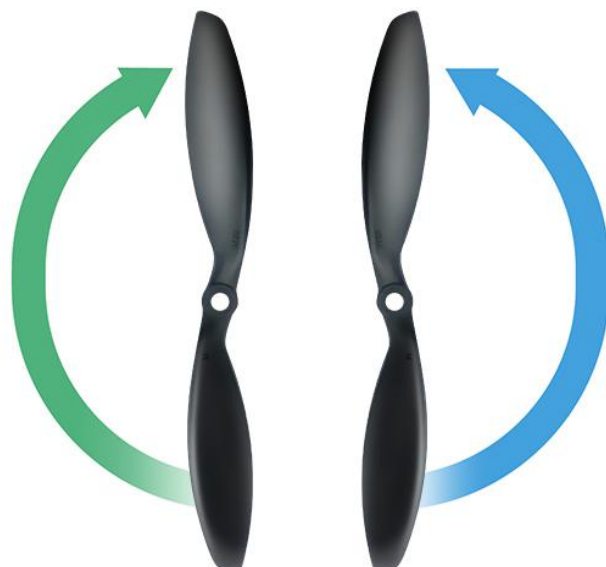
Tricopter



**Note** Since there's no voltage output from the flight controller, an extra BEC module needs to be connected to power supply servo for this model frame

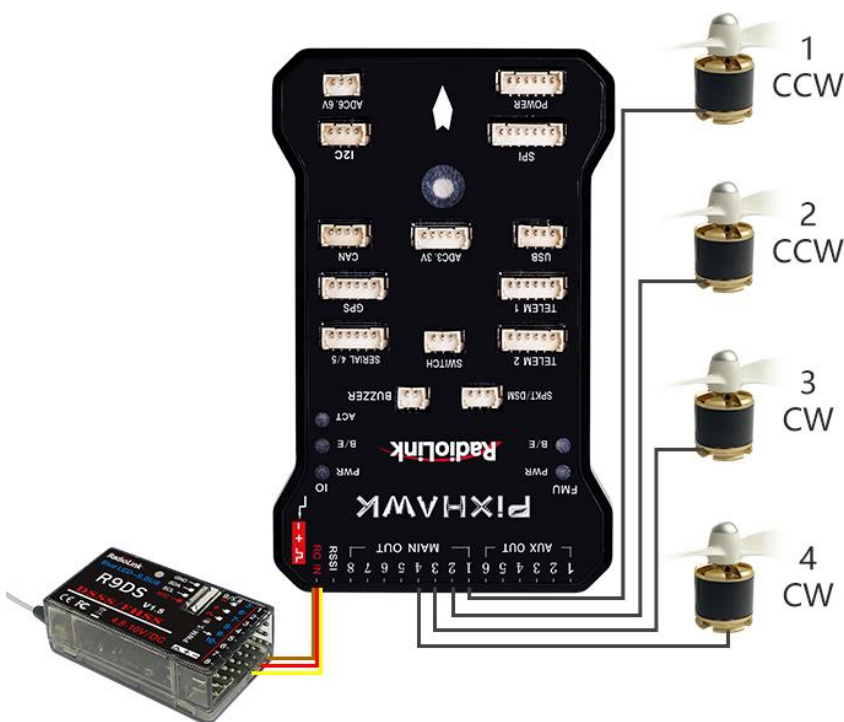
### 5.2.2 How to recognizing clockwise and counterclockwise propellers

The diagrams above show two types of propellers: clockwise (called pushers) and



counterclockwise (called pullers). Pusher propellers are often marked with a P. However not all propellers are marked and both types are often available in either rotational direction. Therefore, it is most reliable to recognize the correct propeller type by its shape as shown below. Note that the propellers below have the edge with the shallow consistent curve at the leading edge in direction of rotation and the more radical scalloped (and usually thinner edge) as the trailing edge. You can use these features to recognize propellers of the correct direction of rotation.

### 5.2.3 Connect the Spare Parts



**Buzzer:** a 2-pin DF13 connector to the BUZZER port

**Safety switch:** a 3-pin DF13 connector to the SWITCH port.

**Power Module:** a 6-pin DF13 connector to the POWER port

**GPS and compass:** a 6-pin DF13 connector to the GPS port (e.g., TS100) or a 4-pin DF13 connector to the I2C port (Make sure that GPS keeps the same direction as PIXHAWK).

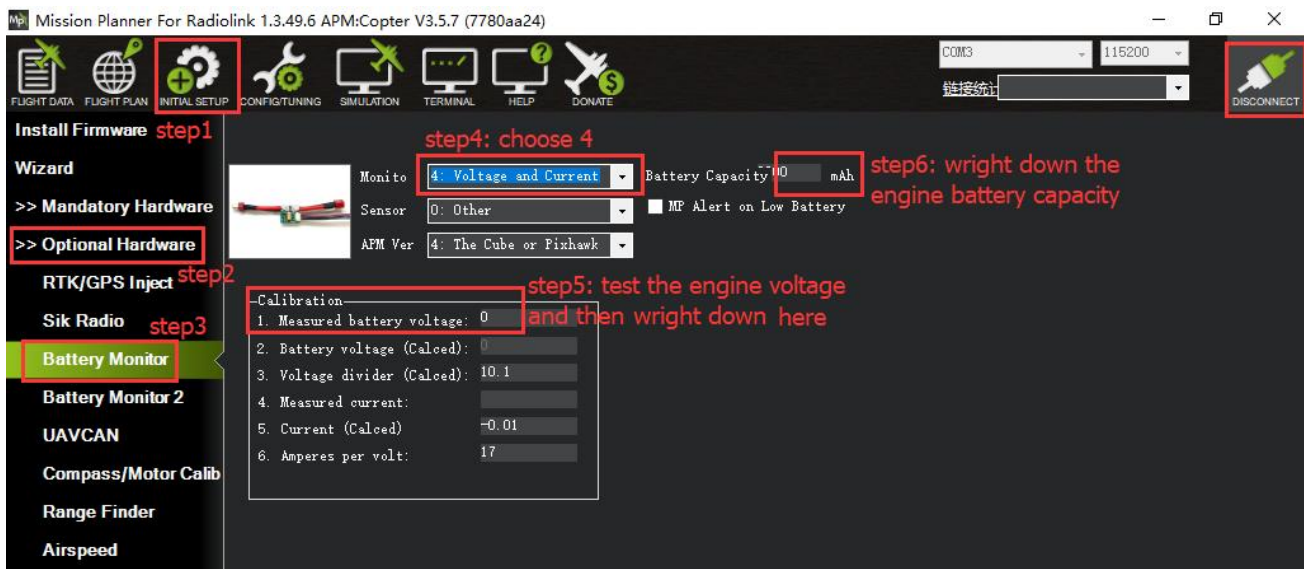
### 5.2.4 Battery Monitors Setup

The battery monitor module provides a stable 5.37V and 2.25Amp power supply which reduces the chances of a brown-out.

Allows monitoring of the battery's voltage and current and triggering a return-to-launch when the voltage becomes low or the total power consumed during the flight approaches the battery's capacity.

Allows the autopilot firmware to more accurately compensate for the interference on the compass from other components.

The 6-pin cable plugs into the 6-pin connector on both the Power Module and PIXHAWK.



## Mission Planner Setup

Battery measurement is primarily set up in the *Mission Planner*'s **INITIAL SETUP -- Optional Hardware -- Battery Monitor** screen.

Enter the properties your module can measure, the type of module, the type of flight controller, and the battery capacity:

**Monitor:** Voltage and Current or Battery Volts

**Sensor:** Supported power module, or "Other"

**APM ver:** Flight controller (e.g. Pixhawk )

**Battery Capacity:** Battery capacity in mAh

The bottom section of the *Battery Monitor* screen allows you to calibrate the voltage/current measurement in order to verify that the measured voltage of the battery is correct. You can also set the **Sensor** selection list to **Other** and use the calibration process to configure an "unknown" power module.

To calibrate the voltage reading:

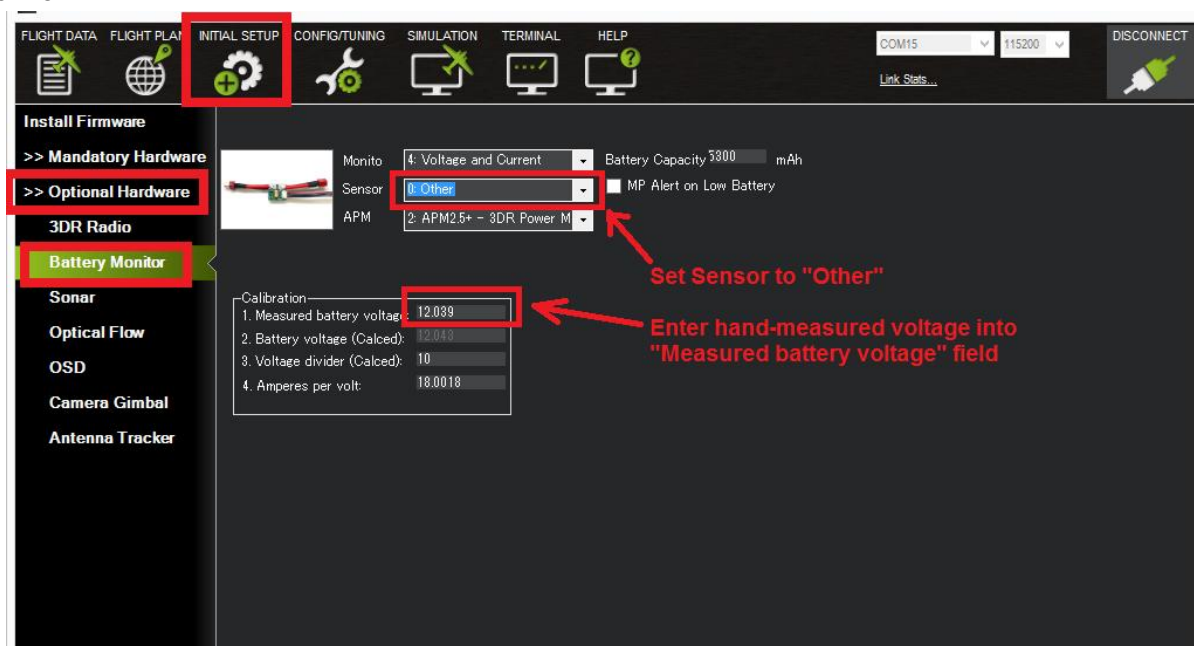
1. Check the voltage of your LiPo battery with a hand-held volt meter or a power analyzer
2. Connect your PIXHAWK to your computer and plug in the LiPo battery
3. Check the voltage through the *Mission Planner*'s **INITIAL SETUP | Optional Hardware | Battery Monitor** screen or on the Flight Data screen's HUD or *Status* tab.



If you find the voltage is not correct (i.e., if off from the hand-held volt meter's reading by more than perhaps 0.2V) you can correct the APM/PX4's reading by doing the following:









1. On Mission Planner's INITIAL SETUP | Optional Hardware | Battery Monitor screen set the "Sensor" to "Other".
2. Enter the voltage according to the hand-held volt meter in the "Measured Battery Voltage" field.
3. Press tab or click out of the field and the "Voltage Divider (Calced)" value will update and the "Battery voltage (Calced)" should now equal the measured voltage.

Using the power analyzer, you can also measure the current and compare to results displayed in the Mission Planner.






### 5.3 LED Indicator, Arming and Troubleshooting

#### 5.3.1 LED Indicator

	<u>Blue and red flashing:</u> Initializing
	<u>Yellow flashing twice:</u> Error, Arming rejected
	<u>Blue flashing:</u> System locked and GPS is searching signals. Please note that no matter which mode (Auto/Loiter/RTL) is, GPS needs to be locked.
	<u>Green flashing:</u> System and GPS locked and ready to be armed. Please note that there would be two fast d sounds to notify from locked to unlocked status.
	<u>Green always on + a long D sound:</u> Armed and ready to take off
	<u>Yellow flashing:</u> Transmitter failsafe activated
	<u>Yellow flashing+repeated fast D sounds:</u> Battery failsafe activated
	<u>Yellow/Blue flashing+High/High/Low sounds:</u> GPS data error or GPS failsafe activated

#### Safety button indicator

	<u>Continous flashing quickly:</u> System auto checking
	<u>Flashing intervally:</u> System is ready. Press the button to activate the system
	<u>Always on:</u> Ready to be armed.

#### 5.3.2 Arming and Disarming

Arming the motors causes ArduPilot to apply power to your motors, which will cause them to start spinning. Before arming the motors, make sure all people, objects, and any body parts (e.g., hands) are clear of the propellers. Then do the following:

You can only arm or disarm in Stabilize, ACRO, AltHold, Loiter, and PosHold modes. You cannot arm your copter in AUTO mode.

1. Turn on your transmitter.
2. Plug in your LiPo battery. The red and blue lights should flash for a few seconds as the gyros are calibrated (do not move the copter)
3. The pre-arm checks will run automatically and if any problems are found a PIXHAWK will double blink the red arming light, on a Pixhawk the RGB led will blink yellow.
4. Check that your flight mode switch is set to Stabilize, ACRO, AltHold.
5. Press the safety button until the light goes solid.
6. If you are planning on using the autopilot (i.e. Loiter, RTL, Drift, Auto or Guided modes) you should wait for 30 seconds after the GPS has gotten 3d lock. This will give the GPS position time to settle. On a PIXHAWK the RGB LED will blink green.



7. Arm the motors by holding the throttle down, and rudder right for 5 seconds. It takes approximately 5 seconds the first time the copter is armed as it re-initializes the gyros and barometer. Do not hold the rudder right for too long (>15 seconds) or you will begin the AutoTrim feature.

8. Once armed, the red arming light should go always-on and the propellers will begin to spin.

9. Raise the throttle to take-off.

If you leave the throttle at minimum for 15 seconds while in any of the above modes the motors will automatically disarm.

It means the drone have failed to disarmed when you heard a long sound like D~~~~.

You can connect the PIXHAWK to computer and check the reason.

RC failures (i.e., transmitter/receiver failures):

**RC not calibrated:** the radio calibration has not been performed. RC3\_MIN and RC3\_MAX must have been changed from their default values (1100 and 1900), and for channels 1 to 4, MIN value must be 1300 or less, and MAX value 1700 or more.

Barometer failures:

**Baro not healthy:** the barometer sensor is reporting that it is unhealthy which is normally a sign of a hardware failure.

**Alt disparity:** the barometer altitude disagrees with the inertial navigation (i.e., Baro + Accelerometer) altitude estimate by more than 2 meters. This message is normally short-lived and can occur when the flight controller is first plugged in or if it receives a hard jolt (i.e., dropped suddenly). If it does not clear the accelerometers may need to be calibrated or there may be a barometer hardware issue.

Compass failures:

**Compass not healthy:** the compass sensor is reporting that it is unhealthy which is a sign of a hardware failure.

**Compass not calibrated :** the compass(es) has not been calibrated. the COMPASS\_OFS\_X, Y, Z parameters are zero or the number or type of compasses connected has been changed since the last compass calibration was performed.

**Compass offsets too high:** the primary compass's offsets length (i.e.  $\sqrt{x^2+y^2+z^2}$ ) are larger than 500. This can be caused by metal objects being placed too close to the compass. If only an internal compass is being used (not recommended), it may simply be the metal in the board that is causing the large offsets and this may not actually be a problem in which case you may wish to disable the compass check.

**Check mag field:** the sensed magnetic field in the area is 35% higher or lower than the expected value. The expected length is 530 so it's > 874 or < 185. Magnetic field strength varies around the world but these wide limits mean it's more likely the compass calibration has not calculated good offsets and should be repeated.

**Compasses inconsistent:** the internal and external compasses are pointing in different directions (off by >45 degrees). This is normally caused by the external compasses orientation (i.e. COMPASS\_ORIENT parameter) being set incorrectly.

GPS related failures:

**GPS Glitch :** the GPS is glitching and the vehicle is in a flight mode that requires GPS (i.e. Loiter, PosHold, etc) and/or the circular fence is enabled.

**Need 3D Fix :** the GPS does not have a 3D fix and the vehicle is in a flight mode that requires the GPS and/or the circular fence is enabled.

**Bad Velocity:** the vehicle's velocity (according to inertial navigation system) is above 50cm/s. Issues that could lead to this include the vehicle actually moving or being dropped, bad accelerometer calibration, GPS updating at below the expected 5hz.

**High GPS HDOP :** the GPS's HDOP value (a measure of the position accuracy) is above 2.0 and the vehicle is in a flight mode that requires GPS and/or the circular fence is enabled. This may be resolved by simply waiting a few minutes, moving to a location with a better view of the sky or checking sources of GPS interference (i.e. FPV equipment) are moved further from the GPS. Alternatively, the check can be relaxed by increasing the GPS\_HDOP\_GOOD parameter to 2.2 or 2.5. Worst case the pilot may disable the fence and take-off in a mode that does not require the GPS (i.e. Stabilize, AltHold) and switch into Loiter after arming but this is not recommended.

Note: the GPS HDOP can be readily viewed through the Mission Planner's Quick tab as shown below.

INS checks (i.e. Accelerometer and Gyro checks):

**INS not calibrated:** some or all of the accelerometer's offsets are zero. The accelerometers need to be calibrated.

**Accels not healthy:** one of the accelerometers is reporting it is not healthy which could be a hardware issue. This can also occur immediately after a firmware update before the board has been restarted.

**Accels inconsistent:** the accelerometers are reporting accelerations which are different by at least 1m/s/s. The accelerometers need to be re-calibrated or there is a hardware issue.

**Gyros not healthy:** one of the gyroscopes is reporting it is unhealthy which is likely a hardware issue. This can also occur immediately after a firmware update before the board has been restarted.

**Gyro cal failed:** the gyro calibration failed to capture offsets. This is most often caused by the vehicle being moved during the gyro calibration (when red and blue lights are flashing) in which case unplugging the battery and plugging it in again while being careful not to jostle the vehicle will likely resolve the issue. Sensors hardware failures (i.e. spikes) can also cause this failure.

**Gyros inconsistent:** two gyroscopes are reporting vehicle rotation rates that differ by more than 20deg/sec. This is likely a hardware failure or caused by a bad gyro calibration.

Board Voltage checks:

**Check Board Voltage:** the board's internal voltage is below 4.3 Volts or above 5.8 Volts.

If powered through a USB cable (i.e. while on the bench) this can be caused by the desktop computer being unable to provide sufficient current to the flight controller - try replacing the USB cable.

If powered from a battery this is a serious problem and the power system (i.e. Power Module, battery, etc) should be carefully checked before flying.

Parameter checks:

**Ch7&Ch8 Opt cannot be same:** Auxiliary Function Switches are set to the same option which is not permitted because it could lead to confusion.

**Check FS\_THR\_VALUE:** the radio failsafe pwm value has been set too close to the throttle channels (i.e. ch3) minimum.

**Check ANGLE\_MAX:** the ANGLE\_MAX parameter which controls the vehicle's maximum lean angle has been set below 10 degrees (i.e. 1000) or above 80 degrees (i.e. 8000).

**ACRO\_BAL\_ROLL/PITCH:** the ACRO\_BAL\_ROLL parameter is higher than the Stabilize Roll P and/or ACRO\_BAL\_PITCH parameter is higher than the Stabilize Pitch P value. This could lead to the pilot being

unable to control the lean angle in ACRO mode because the Acro Trainer stabilization would overpower the pilot's input.

#### Disabling the pre-arm safety check

If you are confident that the pre-arm check failure is not a real problem you can disable the checks by:

Connecting your Flight Controller to the Mission Planner

Go to Mission Planner's Config/Tuning >> Standard Params screen

set the Arming Check drop-down to "Disabled" or one of the "Skip" options which more effectively skips the item causing the failure.

Push the "Write Params" button

Ideally however you should determine the cause of the pre-arm failure and if it can be resolved, return the Arming Check parameter back to "Enabled".

#### **Disarming the motors:**

Disarming the motors will cause the motors to stop spinning. To disarm the motors, do the following:

1. Check that your flight mode switch is set to Stabilize, ACRO, AltHold.
2. Hold throttle at minimum and rudder to the left for 2 seconds till the propeller stop to spin.
3. On the PIXHAWK the RGB LED will start flashing green.
4. Press the safety button until the led begins flashing
5. Disconnect the LiPo battery.
6. Turn off your transmitter.

It needs GPS if flight with Loiter, or PosHold mode.

Please make sure that the propellers stop to spin and then arm or it will cause the drone roll over.

#### **Turn of the function that spin when armed (without speed when motors are armed and throttle is at zero)**

If you connect the battery and armed, the motors begin to have speed even though the throttle is at zero from the version 3.1 firmware. It reminds you that PIXHAWK is in service and please take care of the safety.

This function is very importance for the safety but if you do not want use this function, you can turn off it.

How to turn off this function:

Setup the number of Spin when Armed from 0.100 to 0.000 as the picture below.



## 5.4 ESC Calibration

ESC calibration will vary based on what brand of ESC you are using, so always refer to the documentation for the brand of ESC you are using for specific information (such as tones). “All at once” calibration works well for most ESCs, so it is good idea to attempt it first and if that fails try the “Manual ESC-by-ESC” method.

If using BLHeli and/or DShot ESC’s, please refer to DShot and BLHeli ESC Support for setup.

Some ESCs like the DJI Opto ESCs do not require and do not support calibration, so skip this page completely

Some brands of ESC do not allow calibration and will not arm unless you adjust your radio’s throttle end-points so that the minimum throttle is around 1000 PWM and maximum is around 2000. Note that if you change the end-points on your TX you must re-do the Radio Calibration. Alternatively with Copter-3.4 (and higher) you may manually set the MOT\_PWM\_MIN to 1000 and MOT\_PWM\_MAX to 2000.

If using OneShot ESCs set the MOT\_PWM\_TYPE to 1 (for regular OneShot) or 2 (for OneShot125). Note only supported in Copter-3.4 (and higher).

Begin this procedure only after you have completed the radio control calibration and Connect ESCs and motors part of the Assembly Instructions. Next follow these steps:

Before calibrating ESCs, please ensure that your copter has NO PROPS on it and that the PIXHAWK is NOT CONNECTED to your computer via USB and the LiPo battery is disconnected.

ESC calibration steps:

1. Turn on your transmitter and put the throttle stick at maximum.
2. Connect the Lipo battery. The autopilot’s red, blue and yellow LEDs will light up in a cyclical pattern. This means the it’s ready to go into ESC calibration mode the next time you plug it in.
3. With the transmitter throttle stick still high, disconnect and reconnect the battery.
4. For PX4 or Pixhawk, press and hold the safety button until it displays solid red.
5. The autopilot is now in ESC calibration mode. (On an APM you may notice the red and blue LEDs blinking alternatively on and off like a police car).

6. Wait for your ESCs to emit the musical tone, the regular number of beeps indicating your battery's cell count (i.e. 3 for 3S, 4 for 4S) and then an additional two beeps to indicate that the maximum throttle has been captured.
7. Pull the transmitter's throttle stick down to its minimum position.
8. The ESCs should then emit a long tone indicating that the minimum throttle has been captured and the calibration is complete.
9. If the long tone indicating successful calibration was heard, the ESCs are "live" now and if you raise the throttle a bit they should spin. Test that the motors spin by raising the throttle a bit and then lowering it again.
10. Set the throttle to minimum and disconnect the battery to exit ESC-calibration mode.

## 6. AutoTune

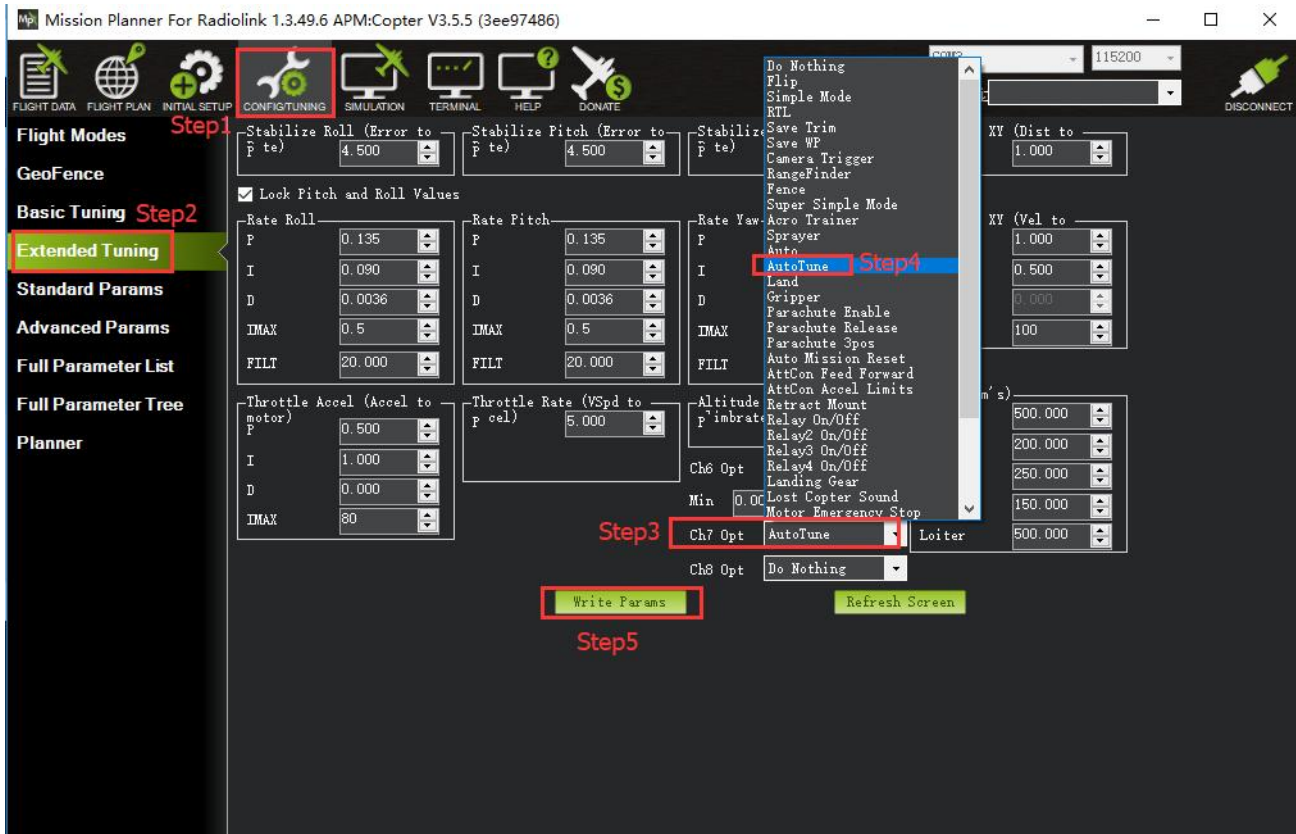
AutoTune attempts to automatically tune the Stabilize P, Rate P and D, and maximum rotational accelerations to provide the highest response without significant overshoot. Copter needs to be "basically" flyable in AltHold mode before attempting to use AutoTune as the feature needs to be able to "twitch" the copter in the roll and pitch axis.

Position Hold during AutoTune is available in Copter 3.5 (and higher).

### Setup before flying

1. Set up one flight mode switch position to be AltHold.
2. Set an Auxiliary Function Switch to Autotune to allow you to turn the auto tuning on/off with the a switch.
3. Remove the camera gimbal or any other parts of the frame that could wobble in flight
4. Select which combination of axis (roll, pitch, yaw) you wish to tune using the AUTOTUNE\_AXES parameter
5. Set the autotune's aggressiveness using the AUTOTUNE\_AGGR parameter (0.1=agressive, 0.075=medium, 0.050=weak), normally start with the default 0.1.
6. For large copters (with props at least 13inch or 33cm diameter) set the Rate Roll and Pitch filters to 10hz (in Copter-3.3 these are RATE\_RLL\_FILT\_HZ and RATE\_PIT\_FILT\_HZ, in Copter-3.4 they are ATC\_RAT\_RLL\_FILT, ATC\_RAT\_PIT\_FILT)
7. It is recommended to enable battery voltage scaling of PID gains





### How to invoke AutoTune

1. Wait for a calm day and go to a large open area.
  2. Ensure the ch7 or ch8 switch is in the LOW position.
  3. Take off and put the copter into AltHold mode at a comfortable altitude.
  4. Face the vehicle so that it will twitch at 90degrees from the direction the wind is blowing (i.e. if tuning Roll first, point the vehicle into the wind)
  5. Set the ch7/ch8 switch to the HIGH position to engage auto tuning:
    - (1) You will see it twitch about 20 degrees left and right for a few minutes, then it will repeat forward and back.
    - (2) Use the roll and pitch stick at any time to reposition the copter if it drifts away (it will use the original PID gains during repositioning and between tests). When you release the sticks, it will continue auto tuning where it left off.
    - (3) Move the ch7/ch8 switch into the LOW position at any time to abandon the autotuning and return to the origin PIDs.
    - (4) Make sure that you do not have any trim set on your transmitter or the autotune may not get the signal that the sticks are centered.
  6. When the tune completes the copter will change back to the original PID gains.
  7. Put the ch7/ch8 switch into the LOW position then back to the HIGH position to test the tuned PID gains.
  8. Put the ch7/ch8 switch into the LOW position to fly using the original PID gains.
  9. If you are happy with the autotuned PID gains, leave the ch7/ch8 switch in the HIGH position, land and disarm to save the PIDs permanently.
- If you DO NOT like the new PIDS, switch ch7/ch8 LOW to return to the original PIDs. The gains will not be saved when you disarm.

If you find after performing an AutoTune that the vehicle feels overly twitchy when flying Stabilize, AltHold or PosHold (but ok in more autonomous modes like Loiter, RTL, Auto) try reducing the RC\_FEEL parameter to 0.25. This smooths out the pilot's input. Alternatively try reducing the AUTOTUNE\_AGGR parameter (it should always be in the range 0.05 to 0.10) and try again.

If the vehicle feels sloppy after the AutoTune, try increasing the AUTOTUNE\_AGGR parameter as high as 0.10 and attempt the autotune again.

**All of the parameters of PIXHAWK can setup in Mission Planner, please do not change the parameters during the flight.**

Mission Planner For Radiolink 1.3.49.6 APM:Copter V3.5.7 (7780aa24)

Command	Value	Units	Options	Desc
ACCEL_Z_D	0		0.000 0.400	Throttle acceleration controller D gain. Compensates for short-term change in desired vertical acceleration vs actual acceleration
ACCEL_Z_FF	0			
ACCEL_Z_FILT	20	Hz	1.000 100.000	Filter applied to acceleration to reduce noise. Lower values reduce noise but add delay.
ACCEL_Z_I	1		0.000 3.000	Throttle acceleration controller I gain. Corrects long-term difference in desired vertical acceleration and actual acceleration
ACCEL_Z_IMAX	800	d%	0 1000	Throttle acceleration controller I gain maximum. Constrains the maximum pwm that the I term will generate
ACCEL_Z_P	0.5		0.100 1.500	Throttle acceleration controller P gain. Converts the difference between desired vertical acceleration and actual acceleration into a motor output
ACRO_BAL_PITCH	1		0 3	rate at which pitch angle returns to level in acro mode. A higher value causes the vehicle to return to level faster.
ACRO_BAL_ROLL	1		0 3	rate at which roll angle returns to level in acro mode. A higher value causes the vehicle to return to level faster.
ACRO_RP_EXPO	0.3		-0.5 1.00:Disabled 0.1:Very Low 0.2:Low 0.3:Medium 0.4:High 0.5:Very High	Acro roll/pitch Expo to allow faster rotation when stick at edges
ACRO_RP_P	4.5		1 10	Converts pilot roll and pitch into a desired rate of rotation in ACRO and SPORT mode. Higher values mean faster rate of rotation.
ACRO_THR_MID	0		0 1	Acro Throttle Mid
ACRO_TRAINER	2		0:Disabled 1:Leveling 2:Leveling and Limited	Type of trainer used in acro mode
ACRO_Y_EXPO	0		-0.5 1.00:Disabled 0.1:Very Low 0.2:Low 0.3:Medium 0.4:High 0.5:Very High	Acro yaw expo to allow faster rotation when stick at edges

**Function button for Full Parameter List/Tree introduction:**

**Load from file:** load the files with the parameters have setup already.

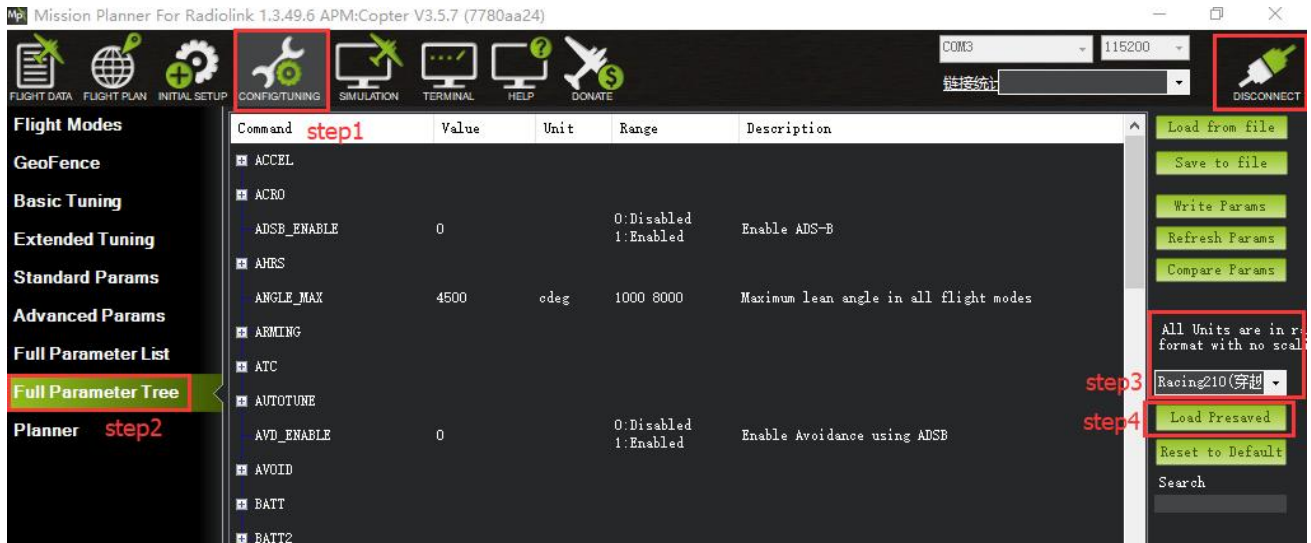
Save to file: save the file with the parameters to your computer.

Write Params: write the parameters that have modified to PIXHAWK.

Refresh Params: exhibit the newest parameters which have modified no the Mission Planner.

Compare Params: compare the current and the previous parameters.

Load Presaved: load the parameters that Radiolink upgrade the files which design for 210-250 frame racing drone to PIXHAWK.



Reset to default: reset all the parameters to default files. Please recalibrate and re-setup all the parameters after reset.

Search: write down the name of parameters you want to setup, much same as the keyboard shortcuts function.

## 7. Download DataFlash Log

There are two ways to record your flight data. With some exceptions, the two methods record very similar data but in different ways:

Dataflash logs use the PIXHAWK onboard dataflash memory, which you can download after the flight. On Plane and Rover dataflash logs are created soon after start-up. On Copter they are created after you first arm the copter.

Telemetry logs (also known as “tlogs”) are recorded by the *Mission Planner* (or other ground station) when you connect ArduPilot to your computer via a telemetry link.

If you are not yet familiar with the basics of these log files, first review the introductory pages to understand where these logs are stored and how you can download and view the information held within them.



More details about how to use PIXHAWK, APM, please check on this website:  
<http://ardupilot.org/copter/docs/common-mission-planning.html>