

# RadioLink

## crossflight



### User Manual for Helicopter

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

CE FCC RoHS

Thank you for purchasing RadioLink flight controller crossflight.

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.

**This manual is based on the ARDUPILOT, with setting with RadioLink transmitter AT9S as example. More details about how to use flight controller please refer to: <http://ardupilot.org/copter/docs/initial-setup.html>**

# Contents

1. crossflight Introduction .....	3
1.1 Spare Parts .....	3
1.2 Connectors and Specifications .....	4
1.3 Advices .....	6
2. Mission Planner .....	6
2.1 Install Mission Planner .....	6
2.2 Mission Planner Introduction .....	7
3. Initial Setup .....	8
3.1 Download and Install Firmware .....	9
3.2 Accelerometer Calibration .....	12
3.3 Compass Calibration .....	14
3.4 Radio Calibration .....	18
3.5 Flight Modes Setting .....	22
3.6 Flight Modes Introduction .....	24
3.6.1 Stabilize Mode .....	24
3.6.2 Acro Mode (FPV) .....	24
3.6.3 Altitude Hold Mode .....	25
3.6.4 Auto Mode .....	26
3.6.5 PosHold Mode .....	28
3.6.6 RTL Mode .....	28
3.6.7 Simple and Super Simple Modes .....	30
3.6.8 More flight modes .....	33
4. F/S(failsafe) Setting .....	33
4.1 Radio Failsafe Setup .....	33
4.2 EKF FailSafe .....	38
5. Installation and setup of crossflight .....	38
5.1 Install crossflight on aircraft .....	38
5.2 Connect crossflight to Helicopter .....	40
5.3 Connect the Spare Parts .....	40
5.4 Level Calibration .....	41
5.5 Helicopter Setup .....	43
5.5.1 Heli Setup Interface Introduction .....	43

5.5.2 Select Swashplate Type .....	43
5.5.3 Swashplate Setting .....	45
5.5.4 Rotot Speed Control Setup .....	47
5.5.5 Internal RSC Governor .....	48
6. LED Indicator, Arming and Troubleshooting .....	50
6.1 LED Indicator .....	50
6.2 Arming and Disarming .....	50
6.3 Failure Messages .....	51
7. Helicopter Advanced Settings .....	54
7.1 Advanced parameters .....	54
7.2 Rate Yaw .....	55
7.3 PID Adjustment .....	55
7.3.1 Adjust FF (Feedforward Compensation) .....	56
7.3.2 Adjust D .....	57
7.3.3 Adjust P .....	57
7.3.4 Adjust I and IMAX .....	58
7.3.5 Hover Level Adjustment .....	59
8. GeoFence .....	59
9. Onboard OSD .....	62
9.1 Setting Introduction .....	62
9.2 Screen Introduction .....	63
10. Parameters Setting .....	64
10.1 Parameter Introduction .....	64
10.2 Parameter Modification .....	65
11. Download DataFlash Log .....	66

# 1. crossflight Introduction

## 1.1 Spare Parts



crossflight x1



Power Module  
(Support 2-12S)x1



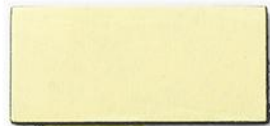
Buzzer x1



I2C Transfer  
Board x1



FC Status  
Indicate LED x1



Double-sided  
Adhesive Tape x1



Double-sided  
Adhesive Tape x1



Buzzer&Receiver  
Connect Cable x1



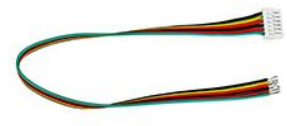
TELEM1&2 Ports  
Connect Cable x2



FC Status Indicate  
LED Cable x1



I2C Transfer Board  
Connect Cable x1



OSD Port  
Connect Cable x1



I2C Transfer Board  
Connect Cable x1



USB Type-C  
Cable x1

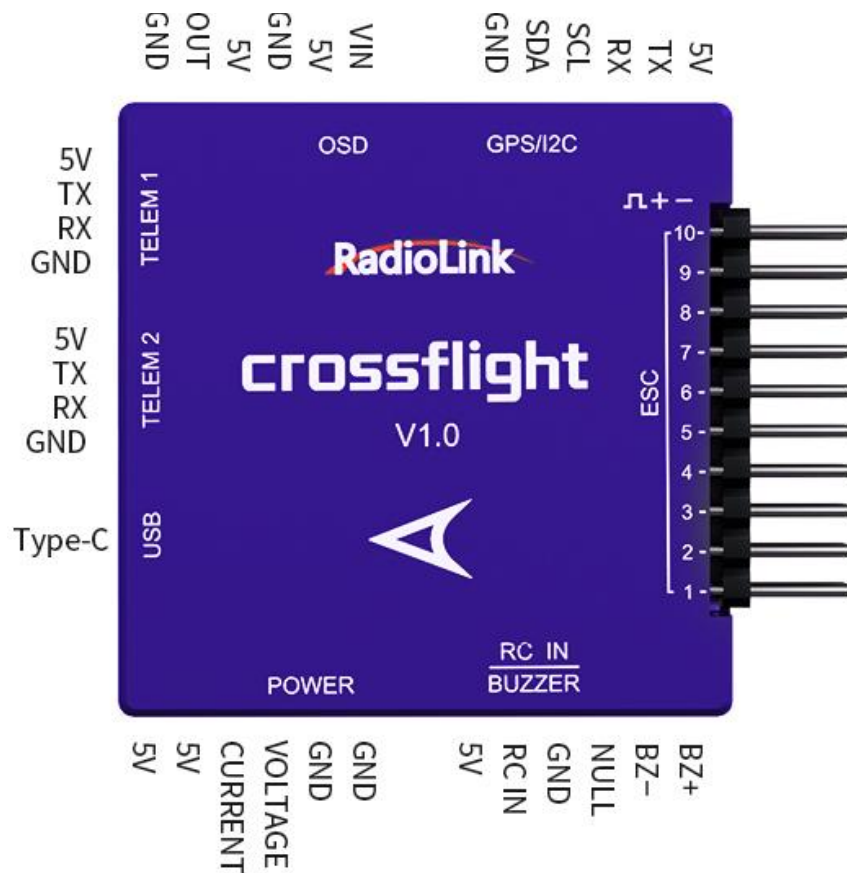
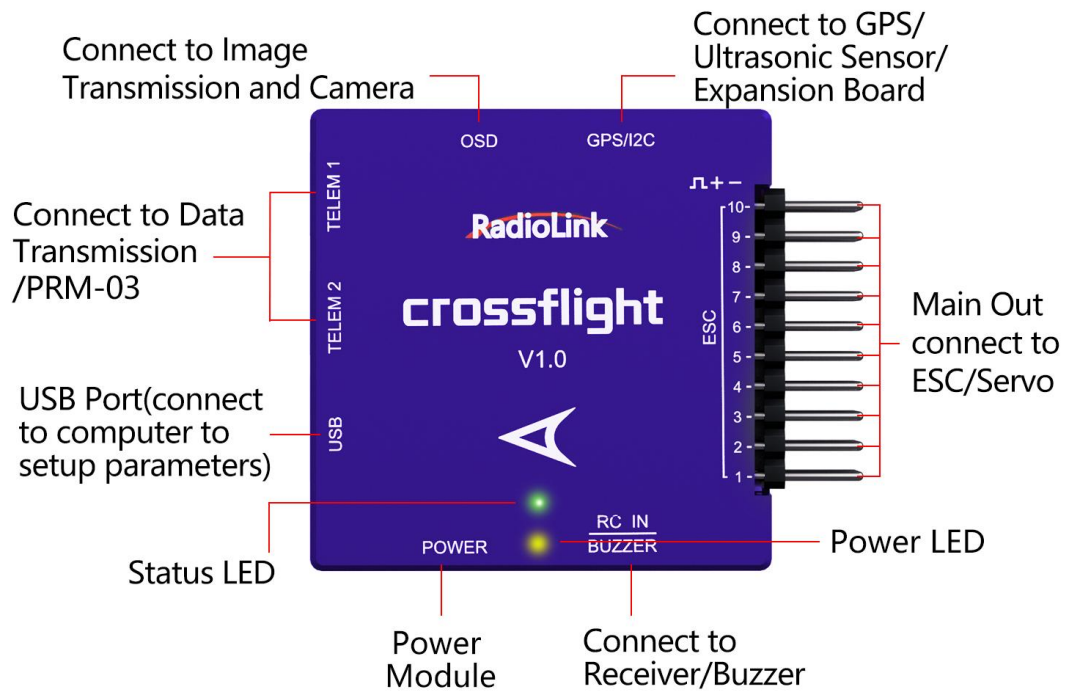


Quick Start  
Guide x1



Packing Box x1

## 1.2 Connectors and Specifications



Specifications		
Weight & Dimension	Dimension	39.7*39.7*12.1mm (1.56"*1.56"*0.48")
	Weight	16.5g (0.58oz), 54g (1.9oz when all the connect wires included)
Hardware	Processor	HC32F4A0PITB
Sensor	Gyro	ICM42670
	Compass	VCM5883L
	Barometer	LPS22HB
	FRAM	Without FRAM, use the internal flash to store parameters, 2617 waypoints for multi-copters, and 2623 waypoints for airplanes, cars, and boats.
	Buzzer	1
	Safety Switch	None
	Connector	JST GH 1.25 Connector
	PWM Output	10 PWM output
	Mavlink UART	2 (Without CTSRTS)
	USB Port	1 (Type-C)
	GPS UART / I2C Port	1
	RC In Signal Input	PPM/SBUS
	RSSI Output	Support
	OSD Module	OSD Module integrated
	ESC Protocol	PWM
	DShot Protocol	Do not support
	OneShot Protocol	Do not support
	RTK	Support
Power Module	Input Voltage	2-12S
	Input Current	90A
	Output Voltage	5.1V
	Output Current (BEC)	2.5A
	Input Current (connect to one ESC only)	20A
Adaptable Models	Airplane/3-8 Copters/Helicopter/Car/Boat/Submarine/Radartracker	

<b>Operating Parameters</b>	USB Voltage	5V±0.3V
	Servo Voltage	Not applicable
	Operating Temperature	-40~80℃

## 1.3 Advices

For the users who firstly use crossflight, we suggest that you use crossflight 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/crossflight\\_missionplanner](https://www.radiolink.com/crossflight_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.

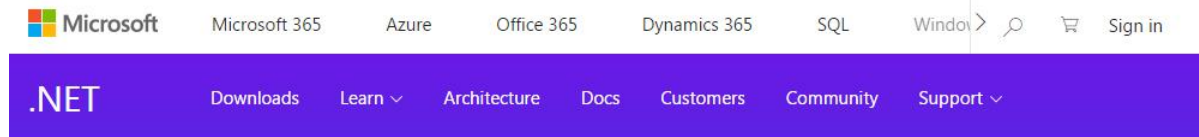
## 2. Mission Planner

### 2.1 Install Mission Planner

Net Framework 4.6.2 need to be installed first before Mission **Planner**; you can download form here:

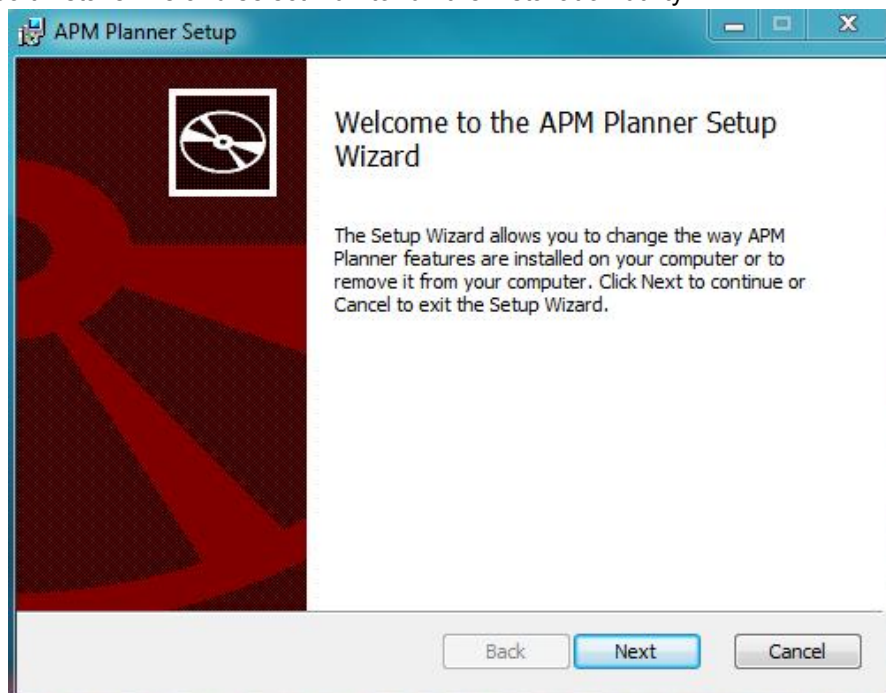
<https://www.microsoft.com/net/download/thank-you/net462>

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



Then download the Mission Planner from [https://www.radiolink.com/crossflight\\_missionplanner](https://www.radiolink.com/crossflight_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

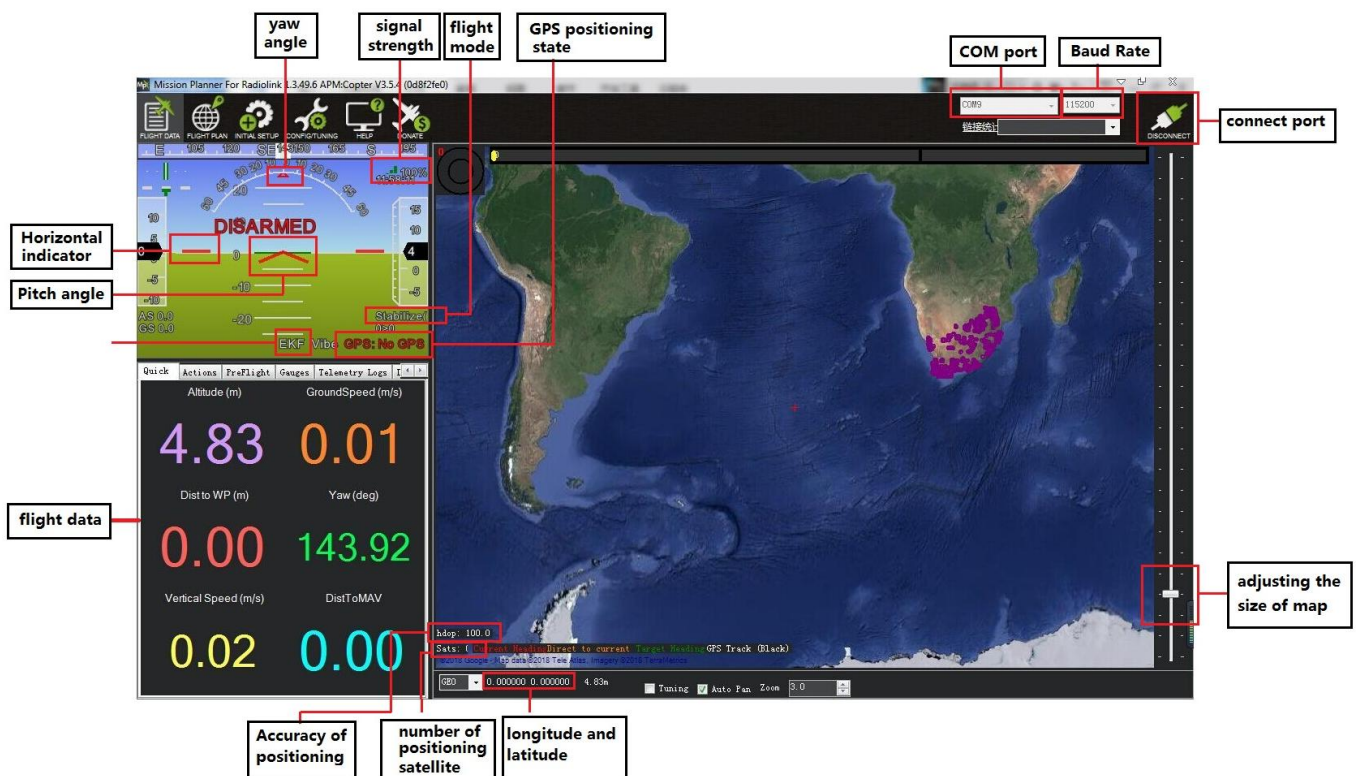
**FLIGHTPLAN:** planning the flight mission

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

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

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

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



### 3. Initial Setup

\* crossflight can set parameters by Radiolink Mission Planner, ArduPilot Mission Planner, and QGC Mission Planner.

\* crossflight can only upgrade the firmware by Radiolink Mission Planner, and can only upgrade the firmware from Radiolink. The default firmware of crossflight is for Multicopter.

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

Radiolink crossflight 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

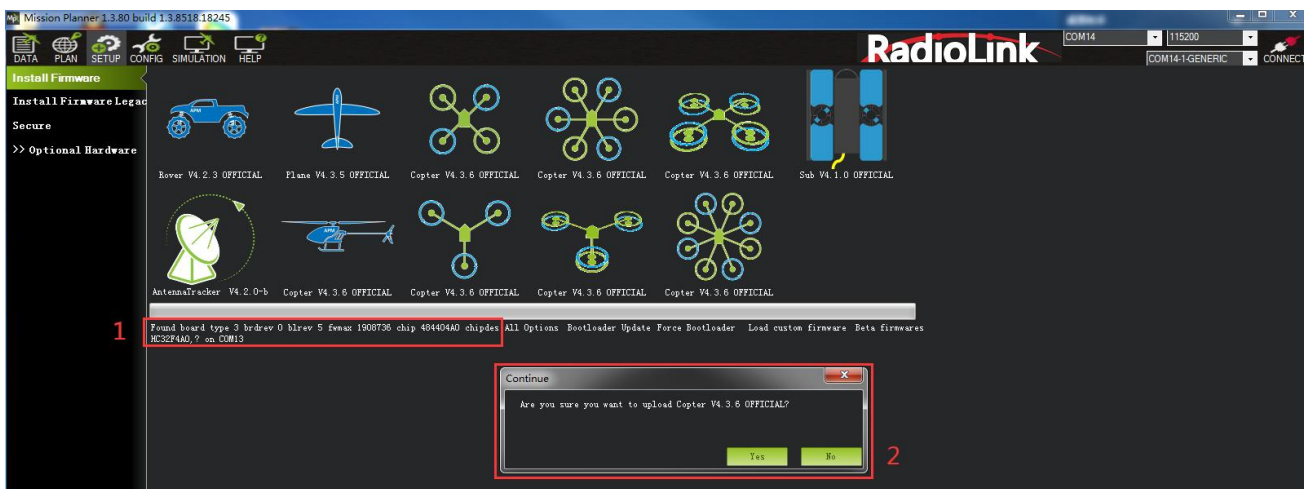
Please connect your crossflight and computer via USB cable. Open the Mission Planner to loading the firmware you need to your crossflight.

### Attention:

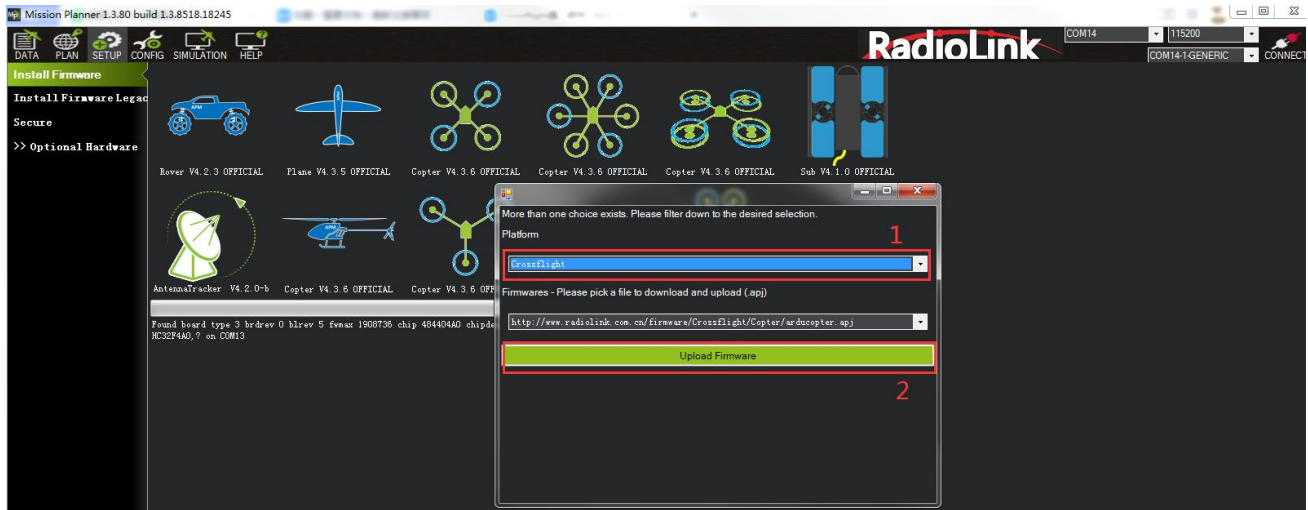
- (1) Do not click CONNECT before you upload the new firmware, please click DISCONNECT if you have connected successful before. Upload new firmware will be not success if you have connected already.
- (2) Please do not upload new firmware by wireless data transmission because it has missed the reset 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.

There are two ways to install firmware online.

1. Click Install Firmware", and connect the flight controller and the computer with a USB cable. When Mission Planner displays the following picture ①, click the firmware of the model you want, and the following picture ② will appear, click Yes to pop up the selection box shown in picture 2, select your flight controller, and click Upload Firmware to install the firmware. Follow the prompts to perform the firmware installation steps, and wait for the firmware to be installed.



picture ①



picture ②

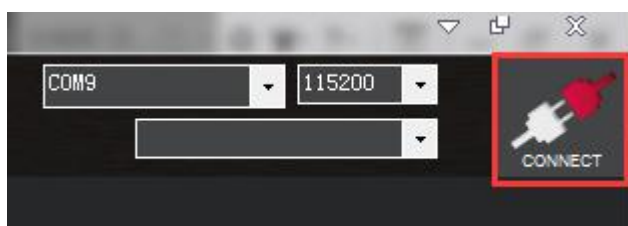
2. Click Install Firmware Legacy, the right side of the window will automatically download the latest firmware from the network and graphically display the firmware name and the aircraft mode corresponding to the firmware. You only need to click on the picture corresponding to your aircraft mode, Mission Planner will automatically download the firmware from the network.

In some situation, you it may prompt you to unplug the board, click OK and plug in the board. Please disconnect the USB cable, click OK and then reconnect USB cable immediately (Pay attention: crossflight will have failed to connect if there are more than one COM, please remove other equipment if disconnect).

Red status LED means the crossflight is loading the firmware.

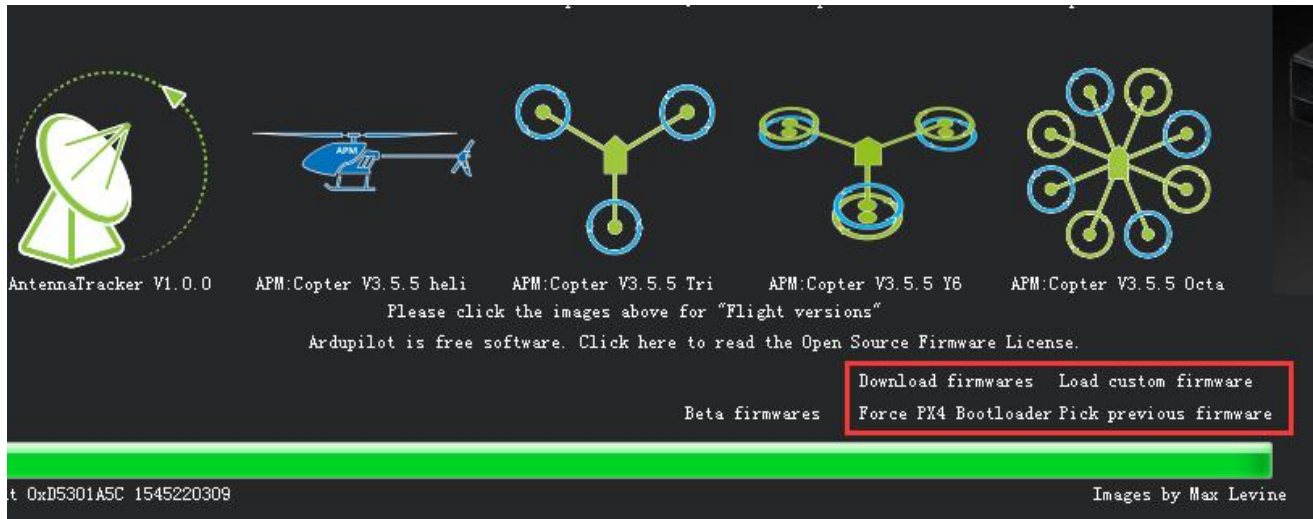
After upgrade firmware 3.1 or after version 3.1, there will be a pop-up warning motors will run at idle speed after disarmed.

Please click "CONNECT" to connect your crossflight and computer when firmware has installed successful. it turns to green means connect successful.



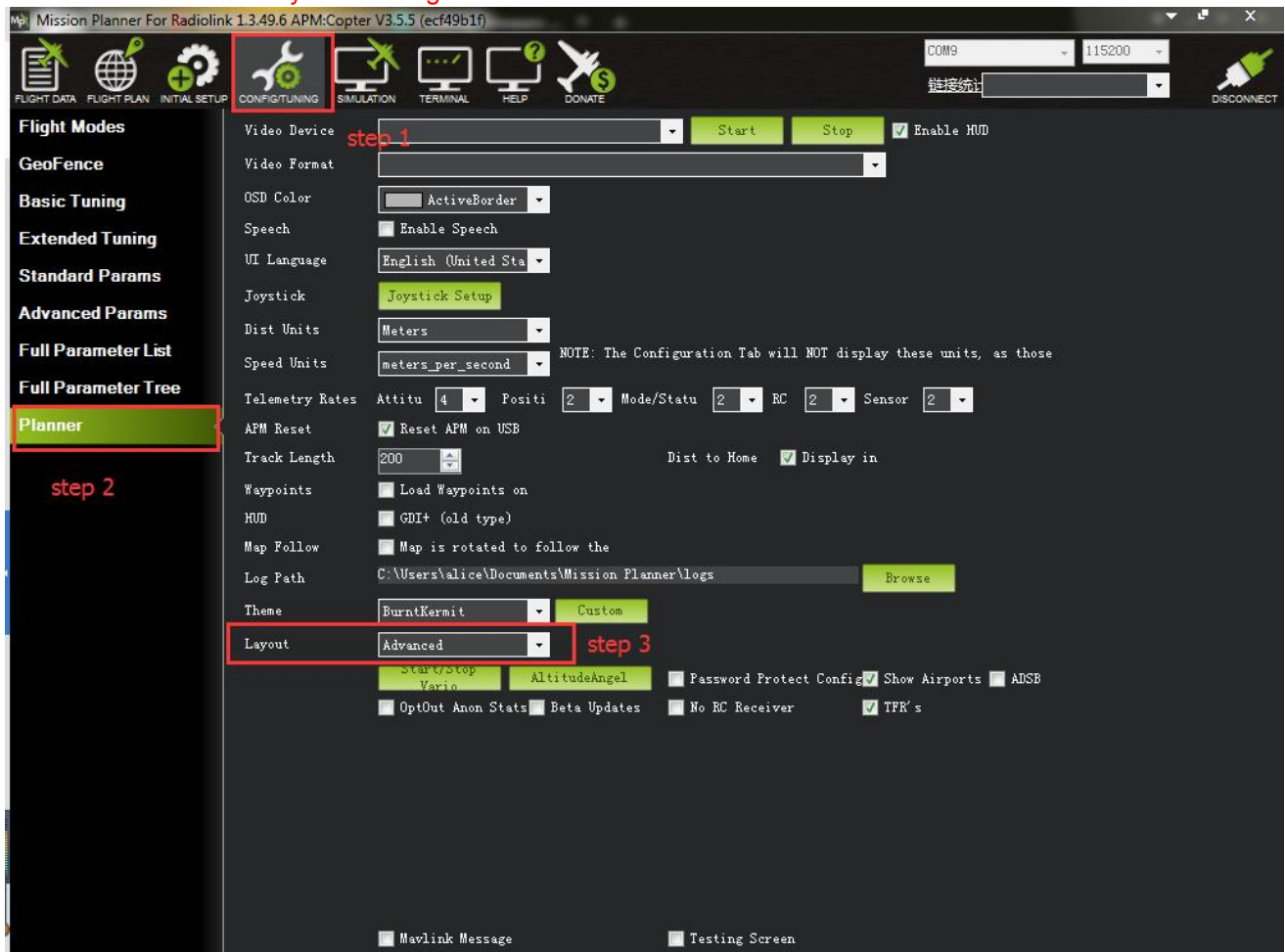
### Pay attention:

- (1) It needs to take a long time to read the parameters.
- (2) Clicking on the options in the red box below is invalid.



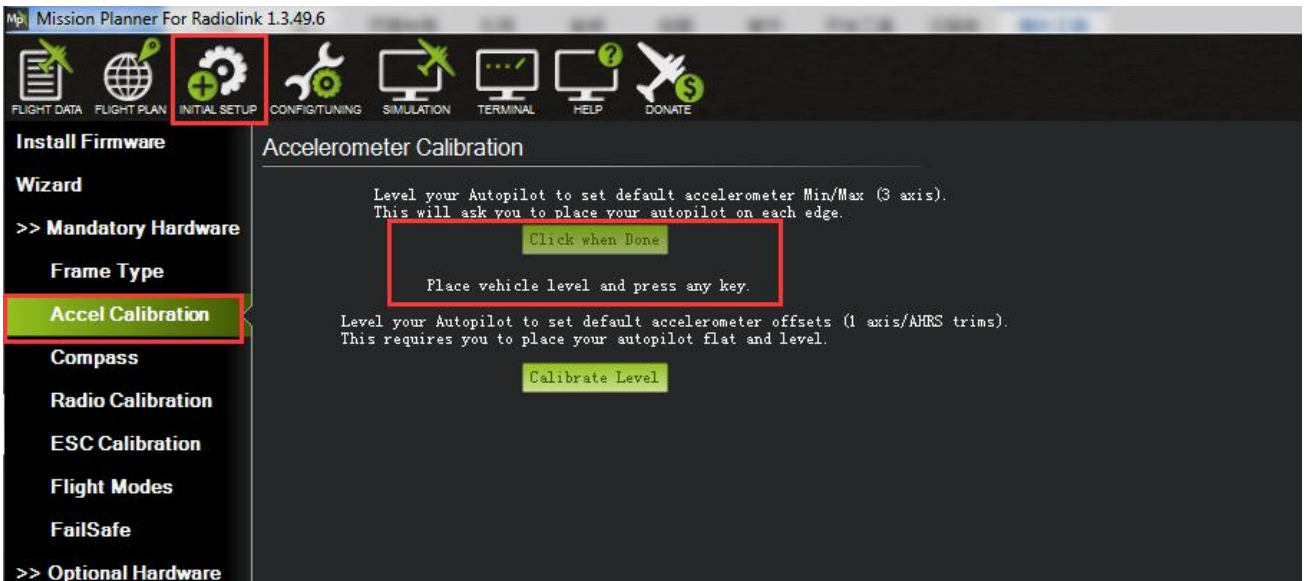
(3) There's no Full Parameter List in INITIAL SETUP.

Please set Layout from "Basic" to "Advanced" in CONFIG/TUNING menu if any of the three questions as below encountered when you installing the Mission Planner.



## 3.2 Accelerometer Calibration

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



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



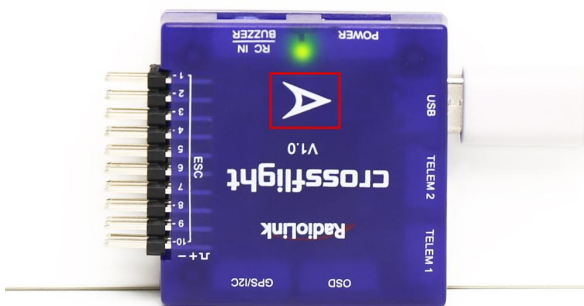
2. Place vehicle on its LEFT side and press any key to save setting.

The arrow turns to the left 90 degree



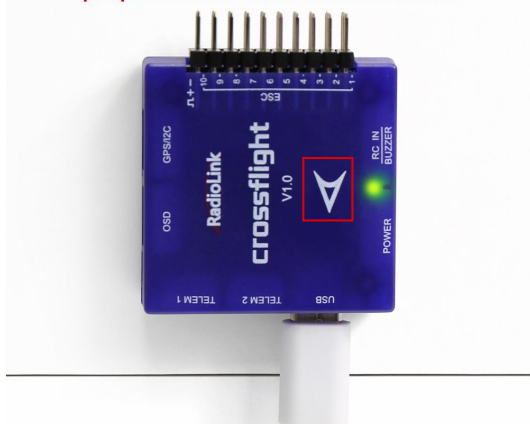
3. Place vehicle on its RIGHT side and press any key to save setting.

The arrow turns to the right 90 degree



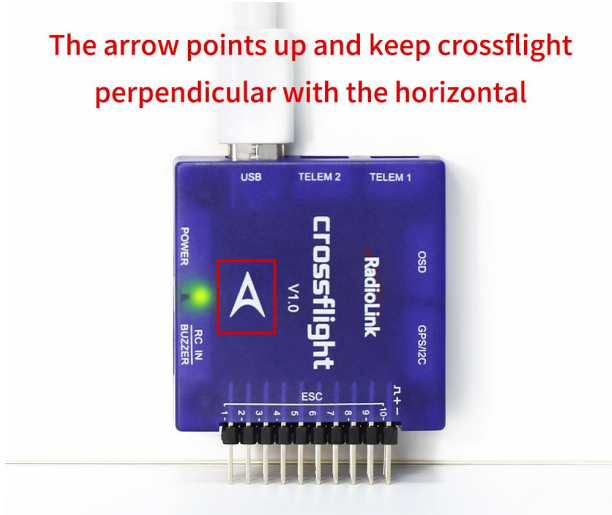
4. Place vehicle DOWN and press any key to save setting.

The arrow points down and keep crossflight perpendicular with the horizontal



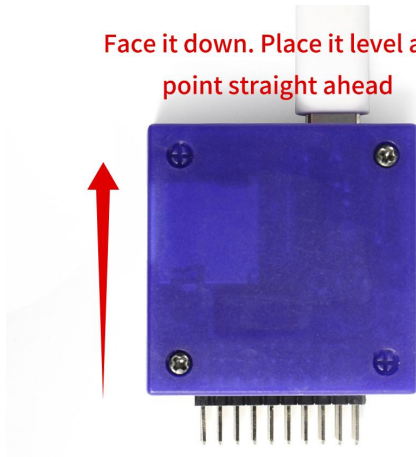
5. Place vehicle UP and press any key to save setting.

The arrow points up and keep crossflight  
perpendicular with the horizontal



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

Face it down. Place it level and  
point straight ahead



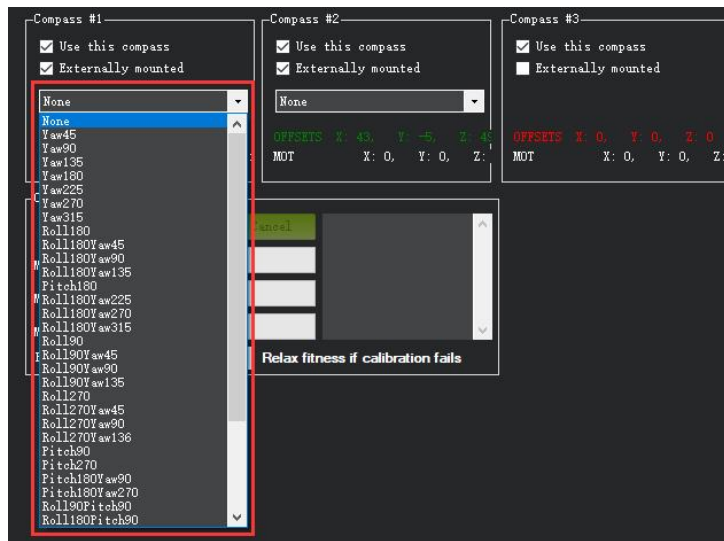
### 3.3 Compass Calibration

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.

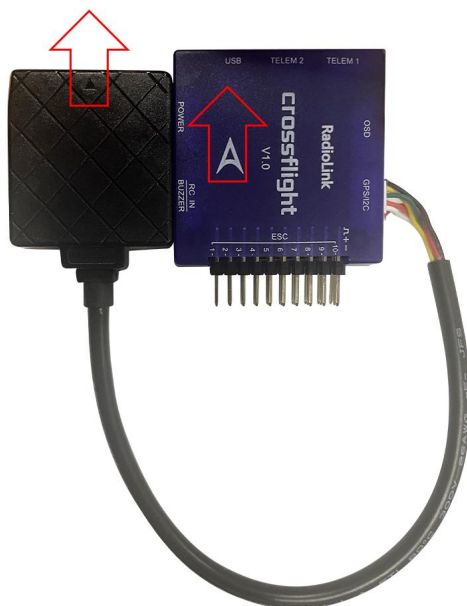
If the GPS mounted with the same direction with flight controller, then it need not to setup the direction of GPS in MP but if you mounted the GPS with the different direction of crossflight, you have to setup in the MP.



### Compass calibrate

Please use Mission Planner

Arrows shows the front, point to the same direction as the flight controller.  
Keep the same direction with flight controller.

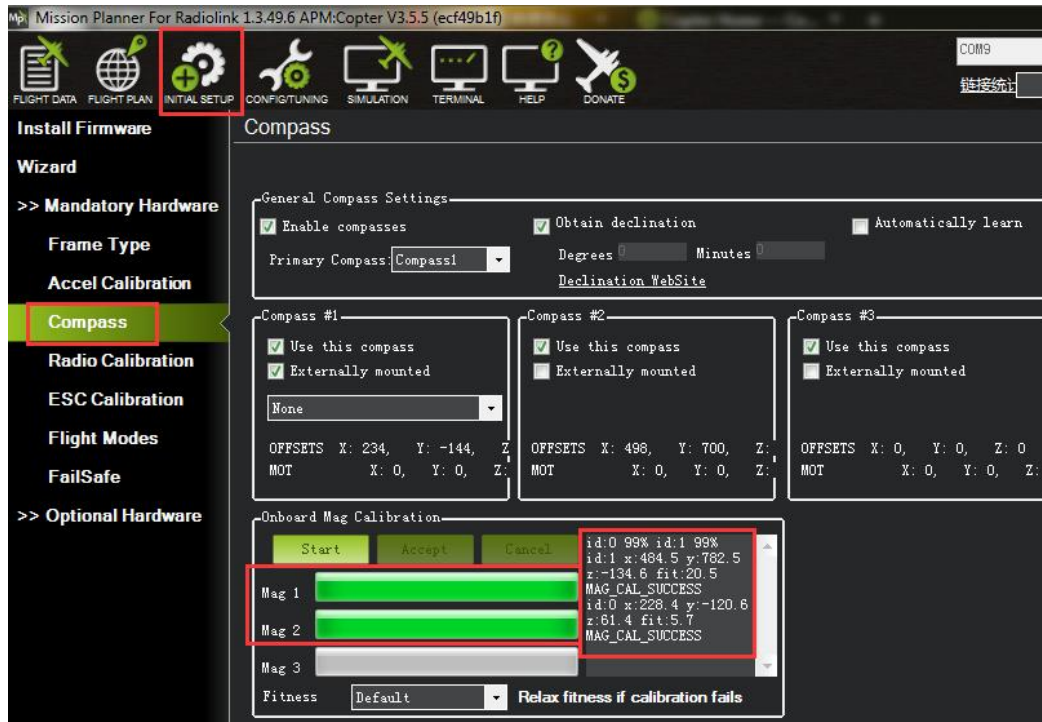


### Positioning Indicate

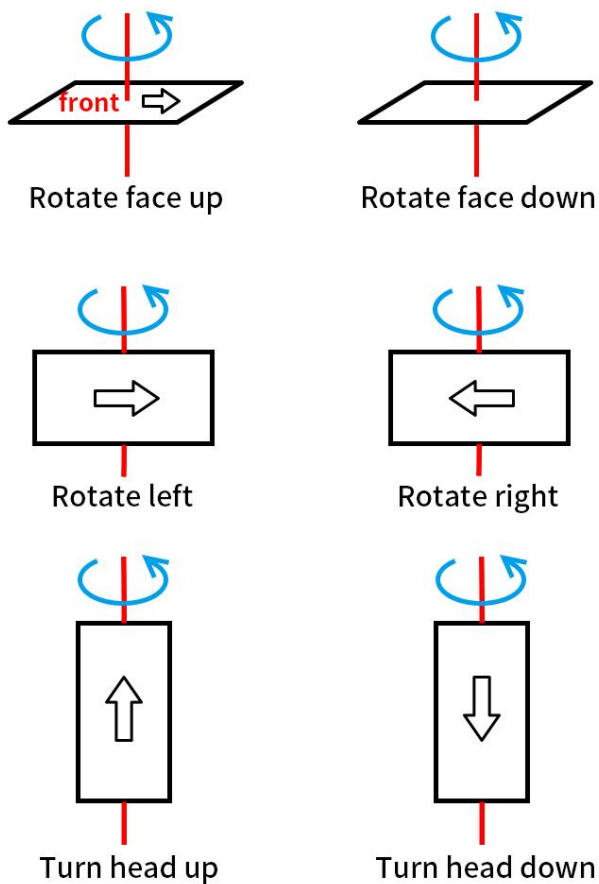
Humanized positioning green LED indicate.

The green LED will flicker when TS100 have positioning.



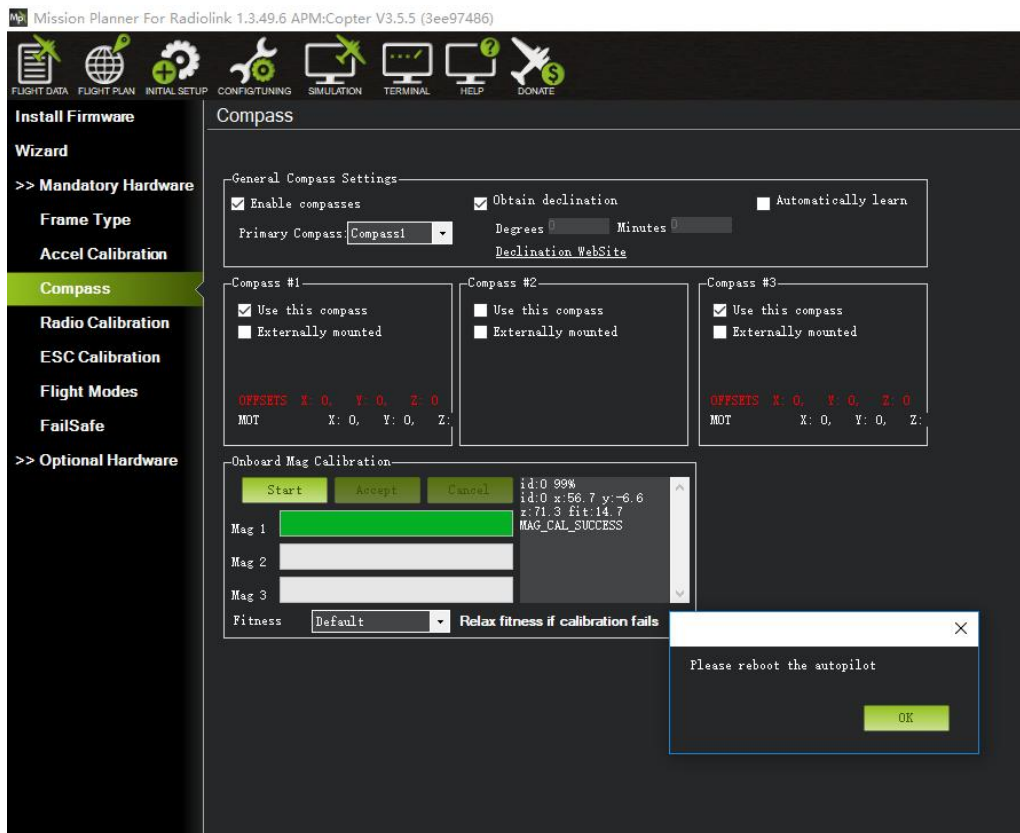


Please fixed crossflight and TS100, then click “Start” and turn crossflight and TS100 till the progress bar of Mag 1 and 2 to the end and comes out the MAG\_CAL\_SUCCESS marked words.  
Calibrate the compass as these steps below:



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.

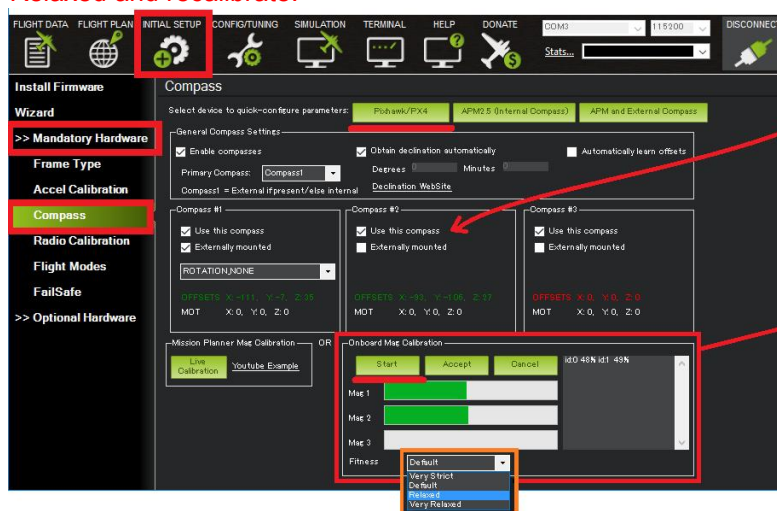
The mission planner will remind you when the compass has calibrated success.



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

**Attention:**

When the progress bar moves to 100 and then restart from 0, it may 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

## 3.4 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

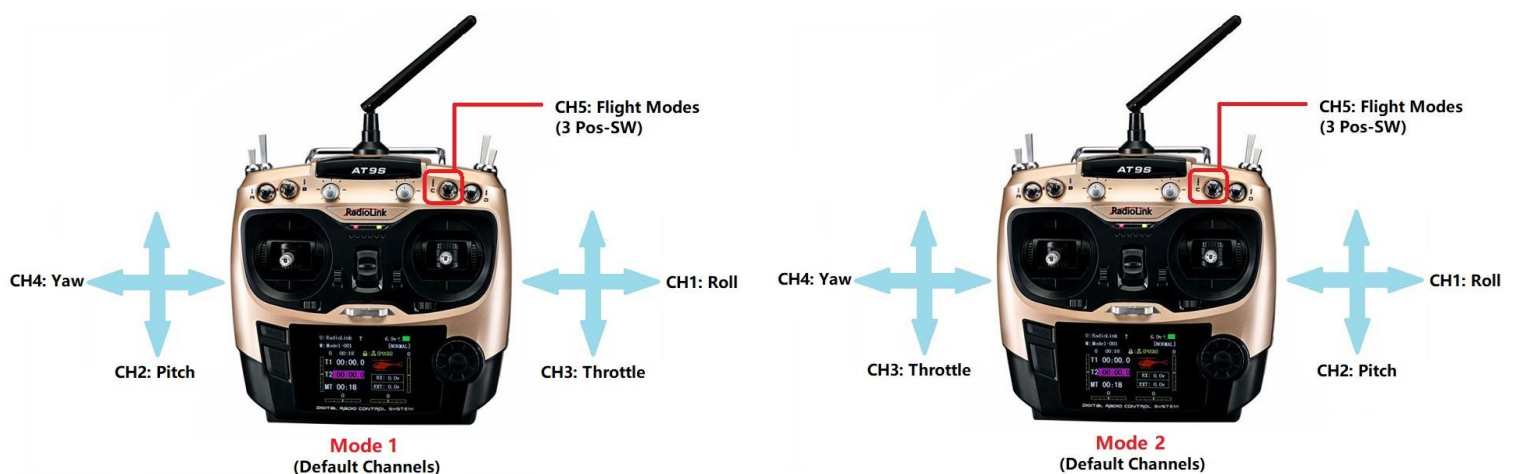
Channel 3: Throttle

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.

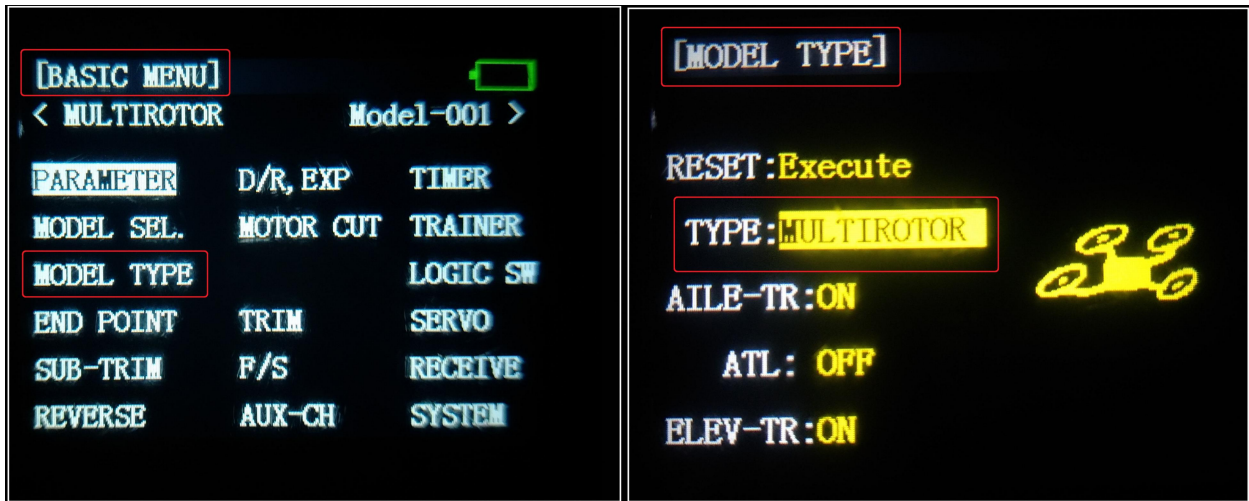


For safety, you should disconnect the battery and/or remove propellers before performing radio calibration.

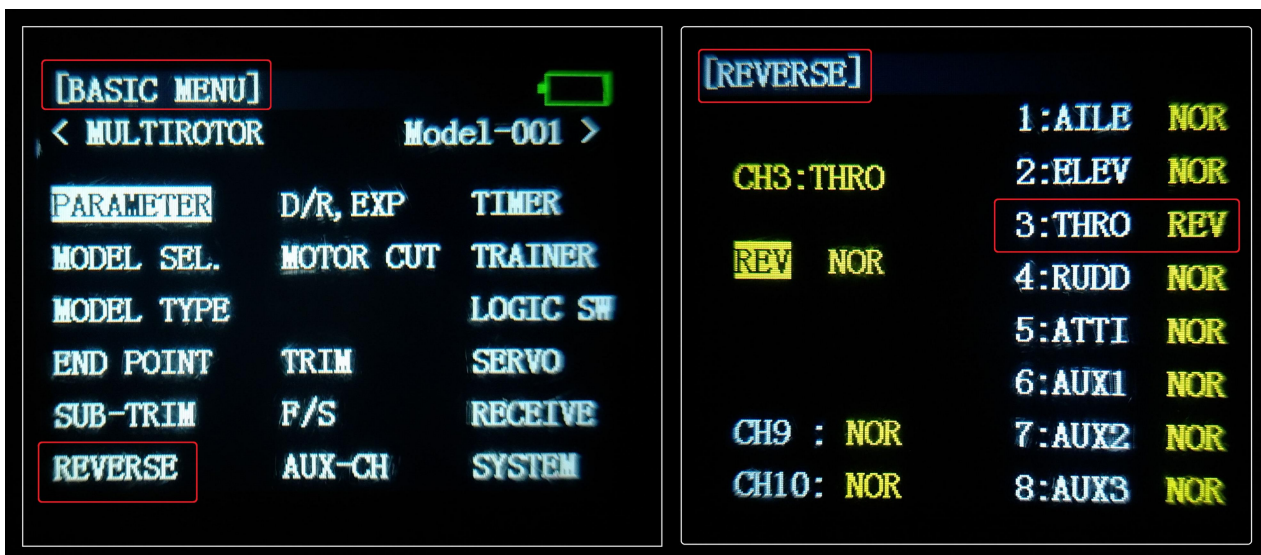
Bind your transmitter and receiver before calibrate radio, connect crossflight to computer via USB cable and then turn on transmitter. The RC receiver ask to connect to the RC port of crossflight.

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.

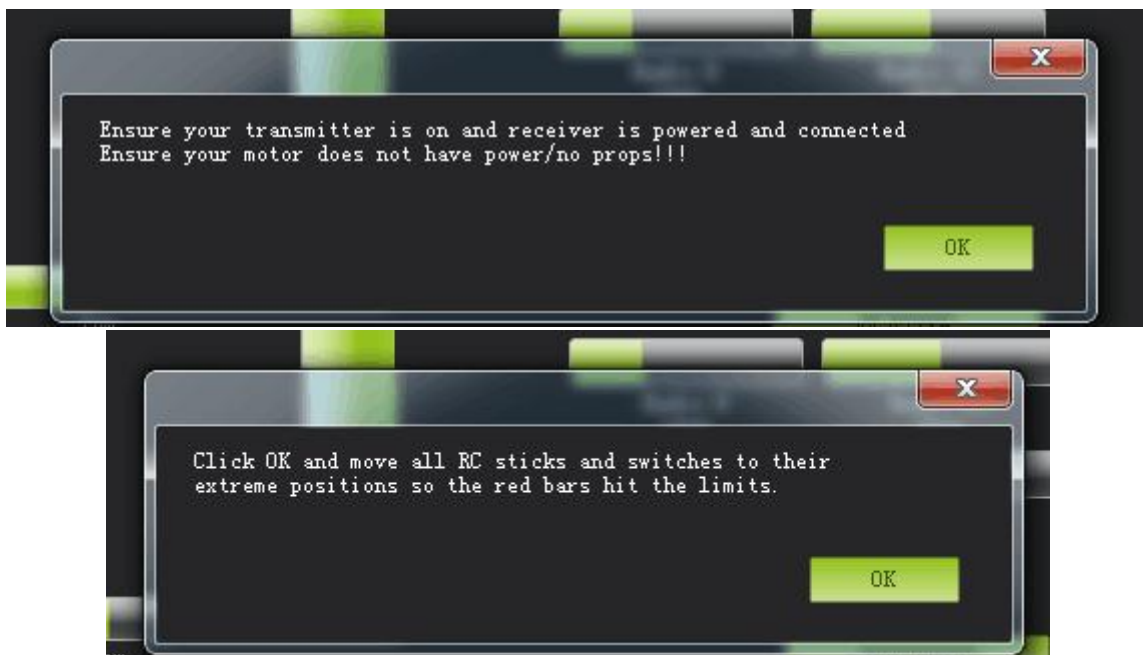


Radio Calibration Steps:

1. Open Mission Planner
2. Choose the right COM and Baud rate
3. Click the CONNECT
4. Choose INITAIL 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.

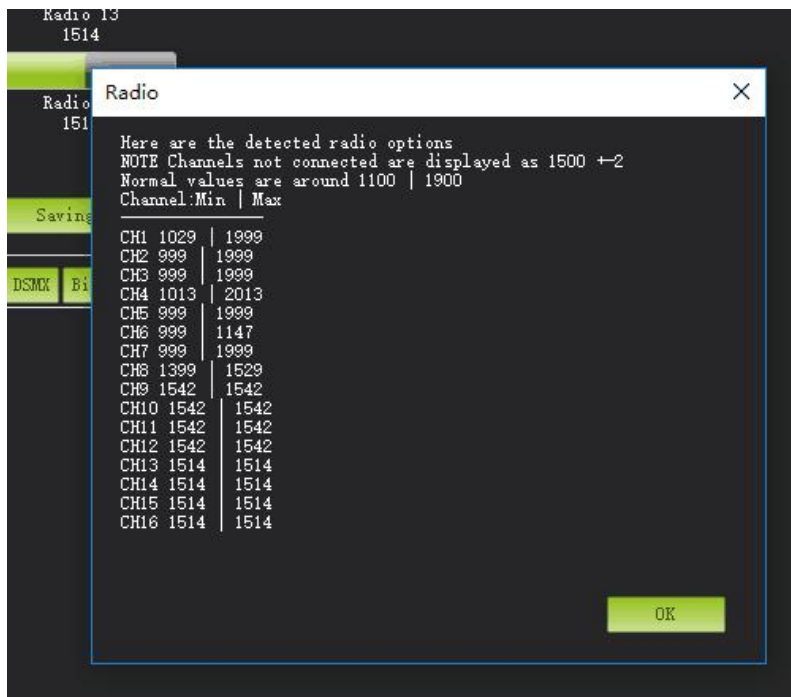
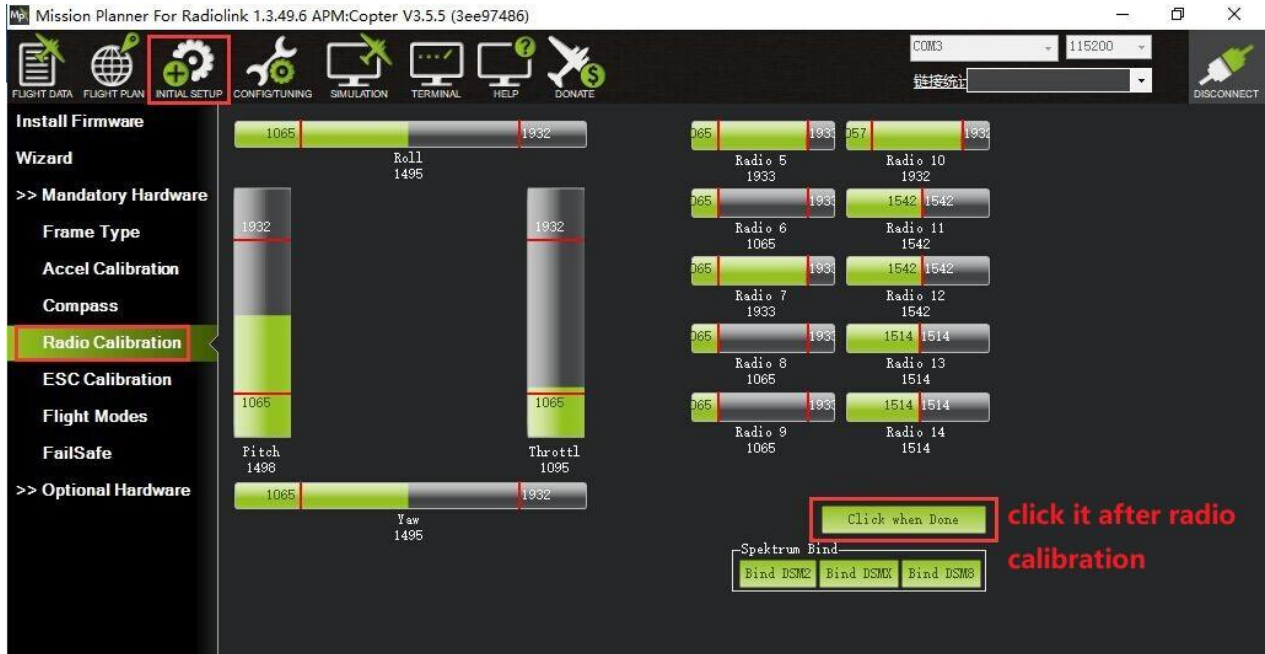
If the red bars have not any change when you move the sticks, please check the receiver have connect success or not, make sure the receiver (maybe R9DS) is output SBUS signal (the blue LED of R9DS means work as SBUS signal). You can check if every corresponding red bar for every channel is work as below:

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.

## 3.5 Flight Modes Setting

crossflight 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:

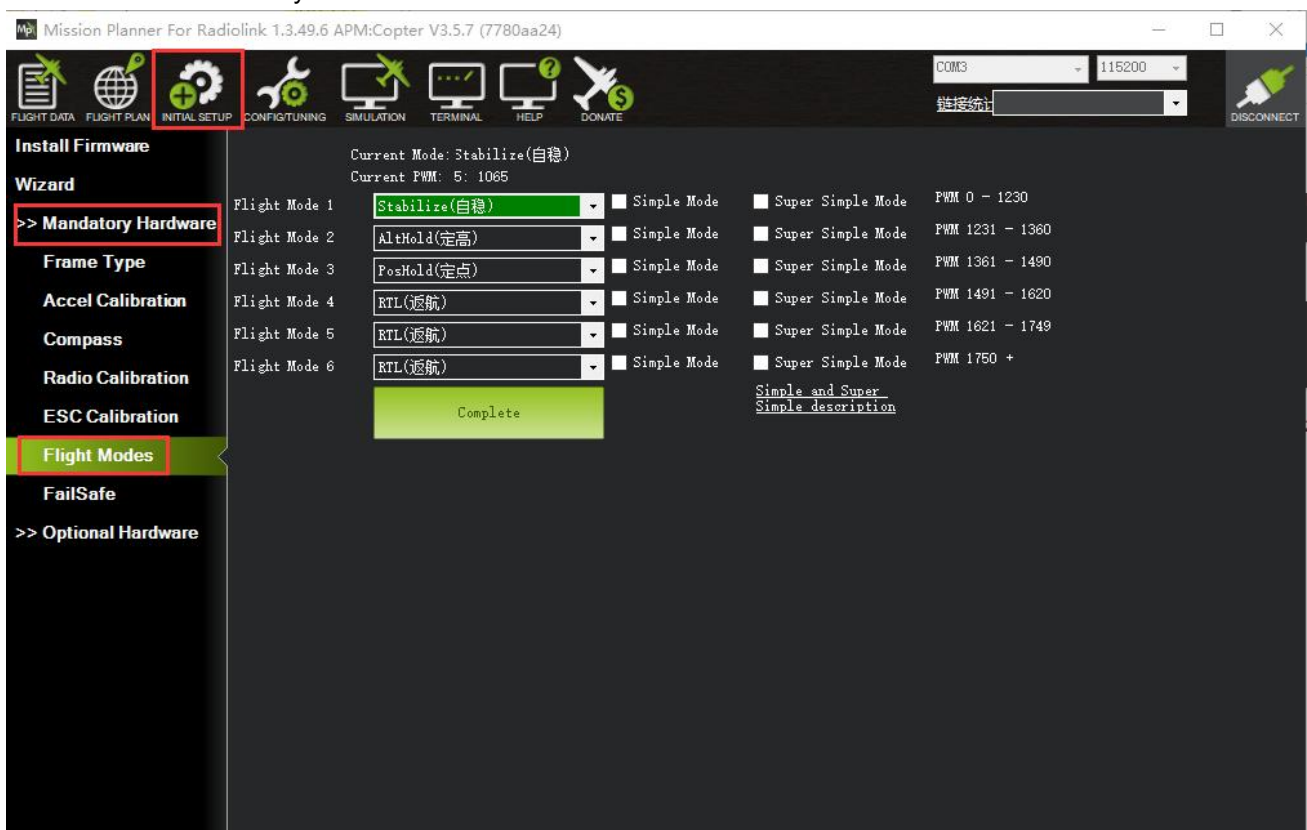
1. Connect crossflight and receiver (connect the RC port of crossflight, and make sure receiver work as SBUS signal).
2. Make sure transmitter bind to receiver success.
3. Make sure crossflight connect to Mission Planner success and click INITIAL SETUP—Mandatory Hardware—Flight modes, you can setup the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

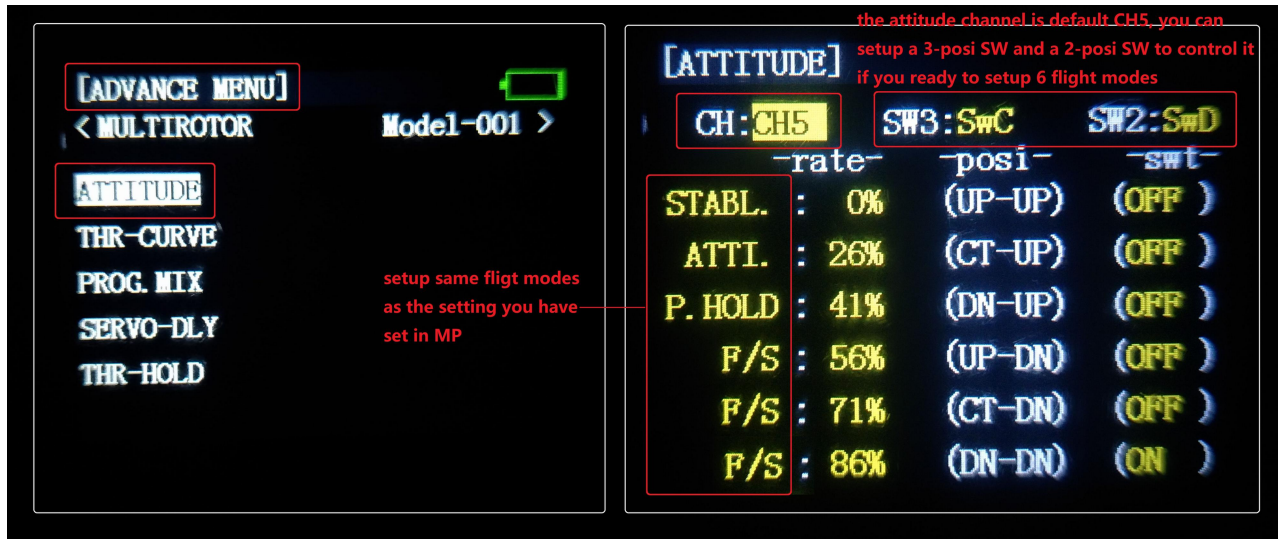
Most of the RC fans setup the Flight Mode 1 is Stabilize, the other five flight mode will be setup according to users' flight habit.

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

1. Power on and turn on your transmitter.



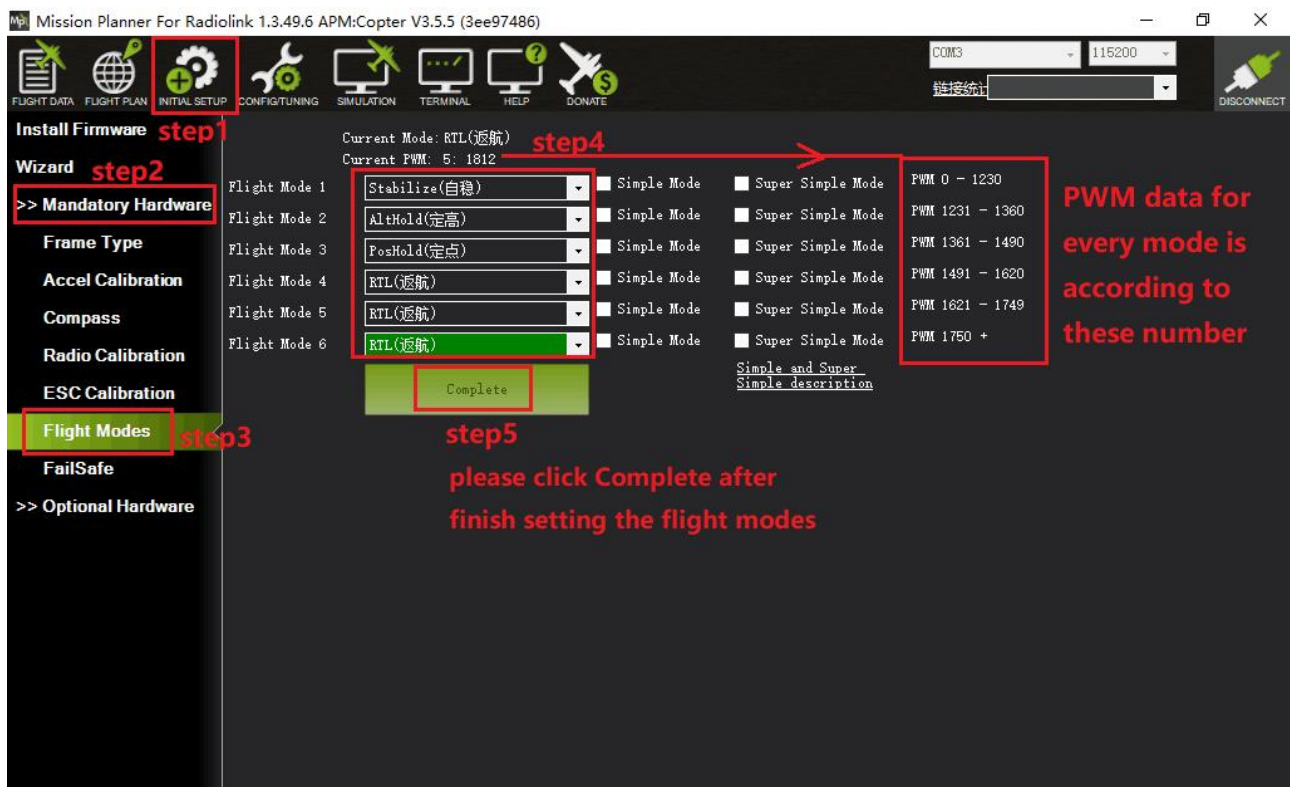
2. Press Mode button twice to into ADVANCE MENU, press Push button into ATTITUDE setting menu, CH5 is default to the attitude control channel and please choose a 3 Posi-SW and a 2 Posi-SW to control the attitude.



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 Flight Modes Introduction

### 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)

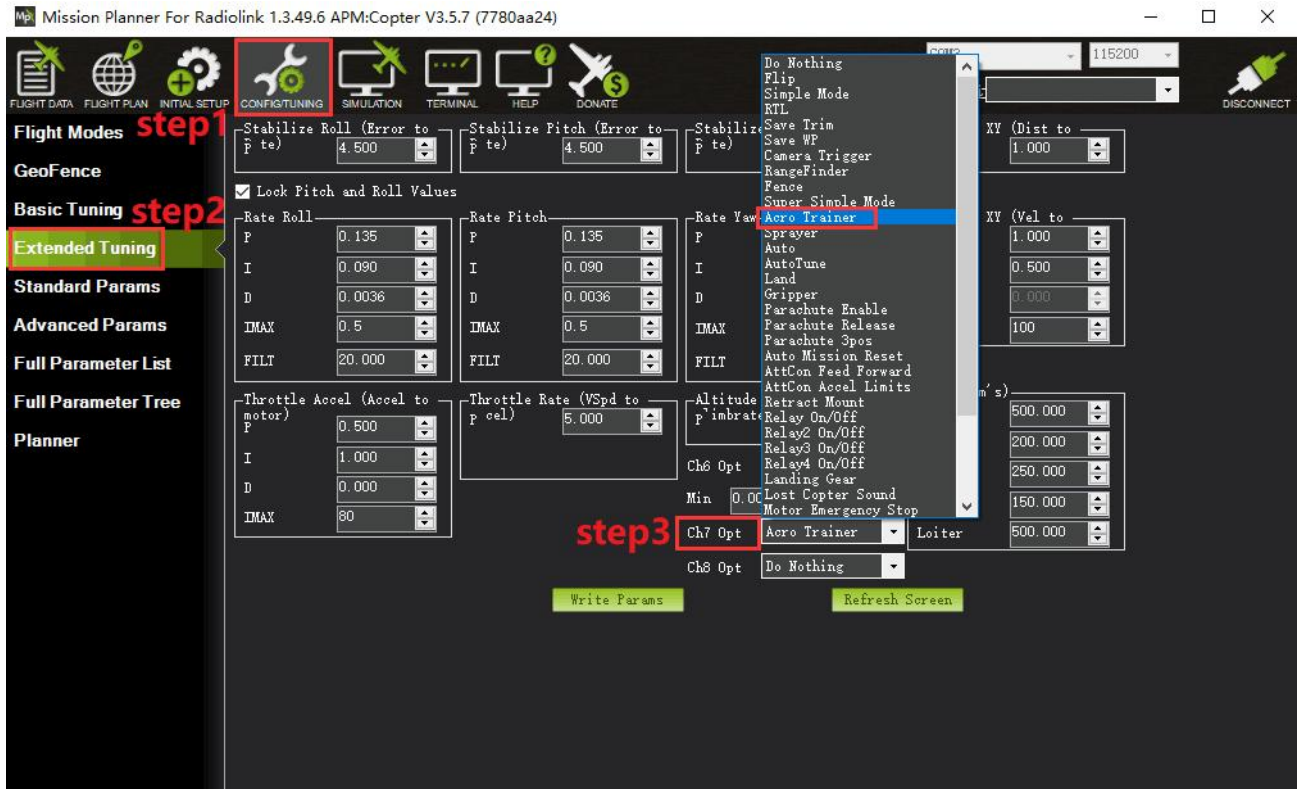
Acro mode (Rate mode) uses the RC sticks to control the angular velocity of the copter. Release the sticks and the vehicle will maintain its current attitude and will not return to level. Acro mode is useful for aerobatics such as flips or rolls, or FPV when smooth and fast control is desired.

#### 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

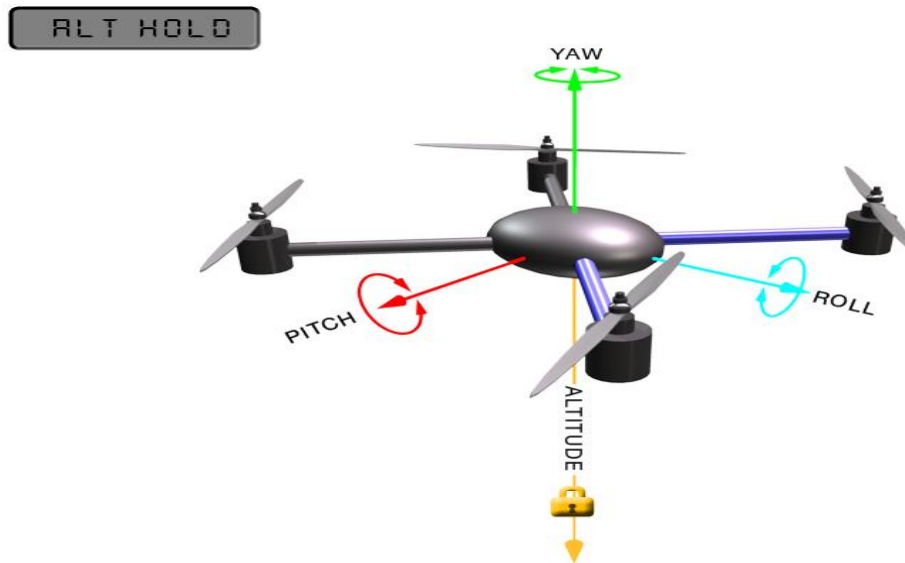
**ACRO\_Y\_EXPO** Acro yaw expo to allow faster rotation when stick at edges

**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.

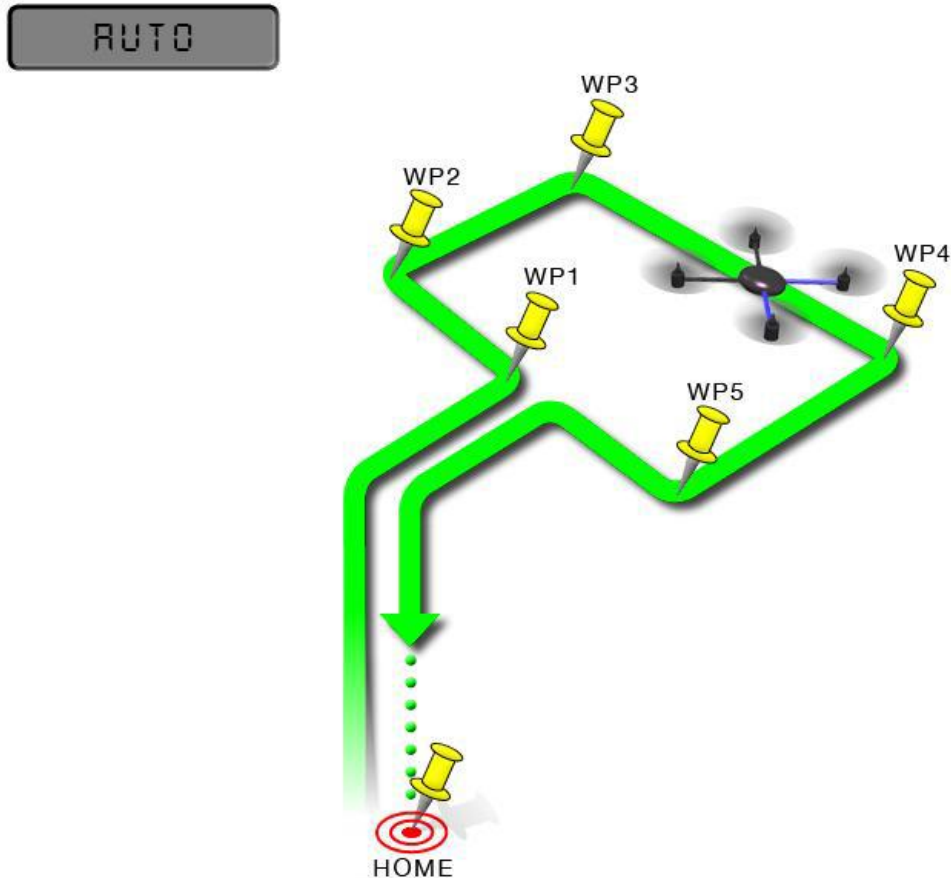
These speeds can be adjusted with the PILOT\_VELZ\_MAX parameter.

The size of the deadband can be adjusted with the THR\_DZ parameter (AC3.2 and higher only). This parameter'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). crossflight multi-rotor firmware can store up to 2617 waypoints, commands and events at one time.



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 crossflight 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).

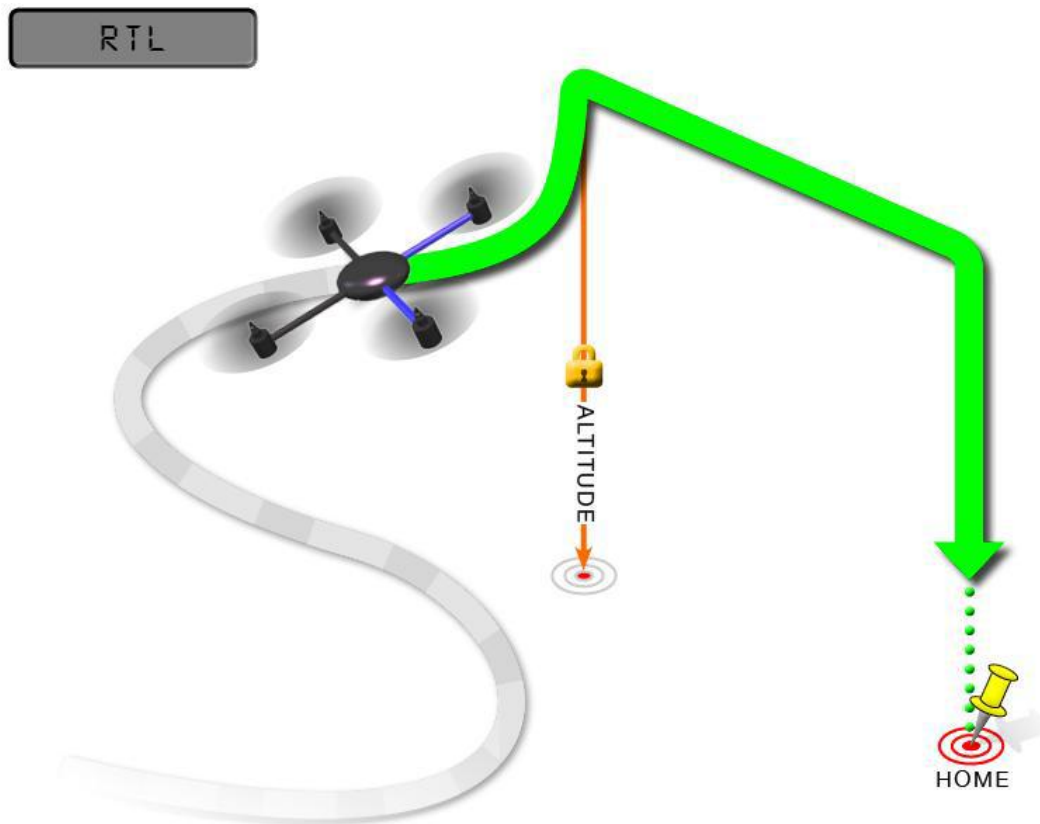
The speed the vehicle rotates back to the maximum angle can be set with the PHLD\_BRAKE\_RATE parameter (i.e. 8 = rotates back at 8 degrees per second)).

## 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).

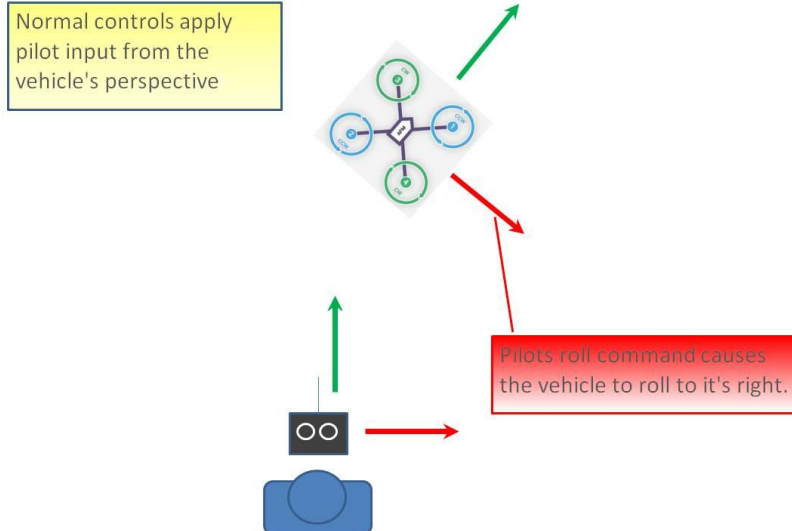
(2) Simple Mode allows you to control the copter relative to the copters heading at takeoff and relies only on a good compass heading.

(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.

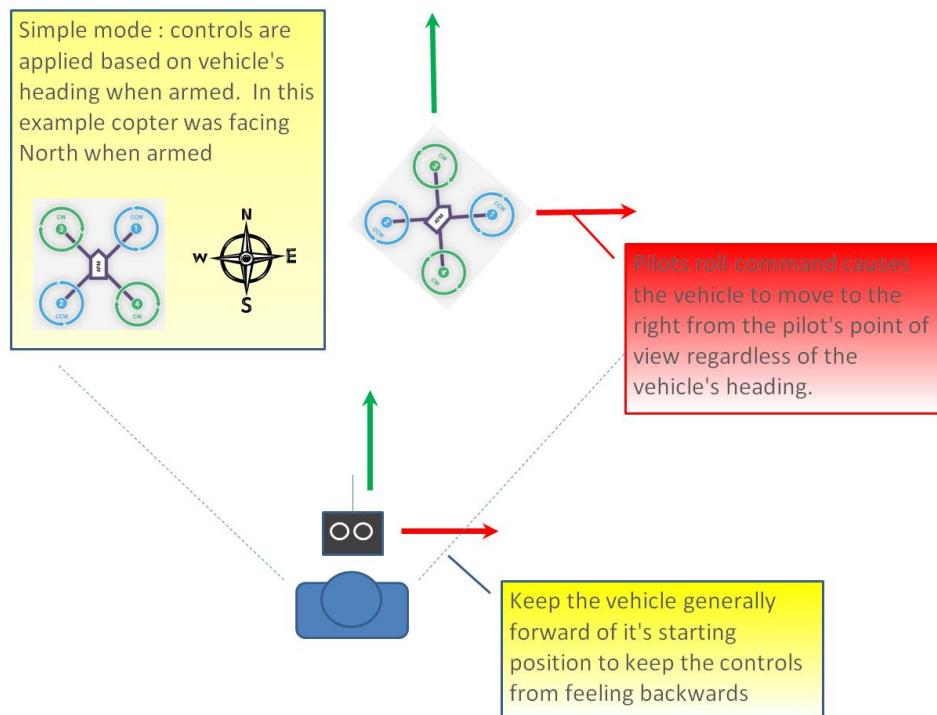
### Normal Mode



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.

### Simple Modes

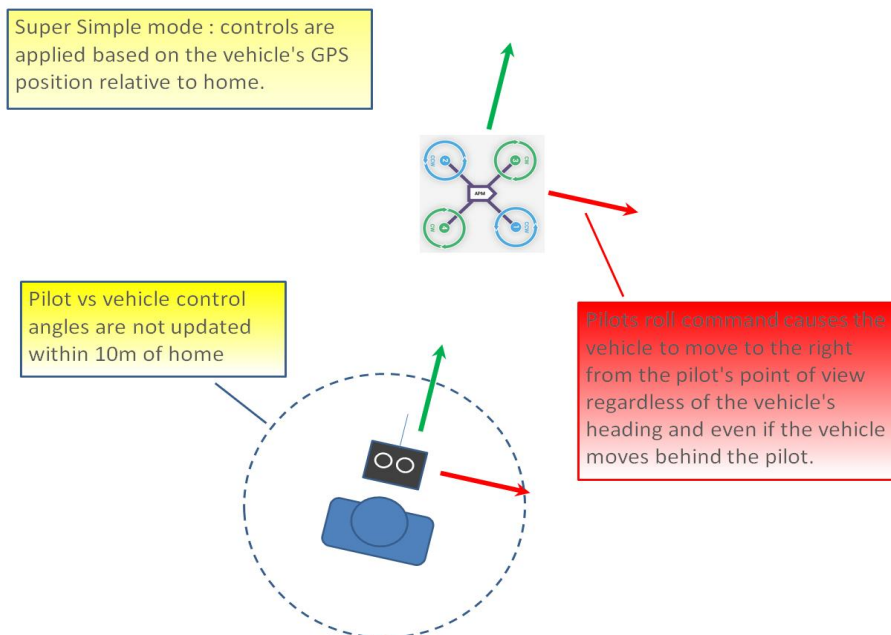


Similar to the “care free” mode on other systems, this mode allows you to fly your copter as though it were pointed in the direction it was pointed when it was armed regardless of its current heading orientation. So, if you hold the pitch stick forward the copter will fly away from you, pull the pitch 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 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.

### 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

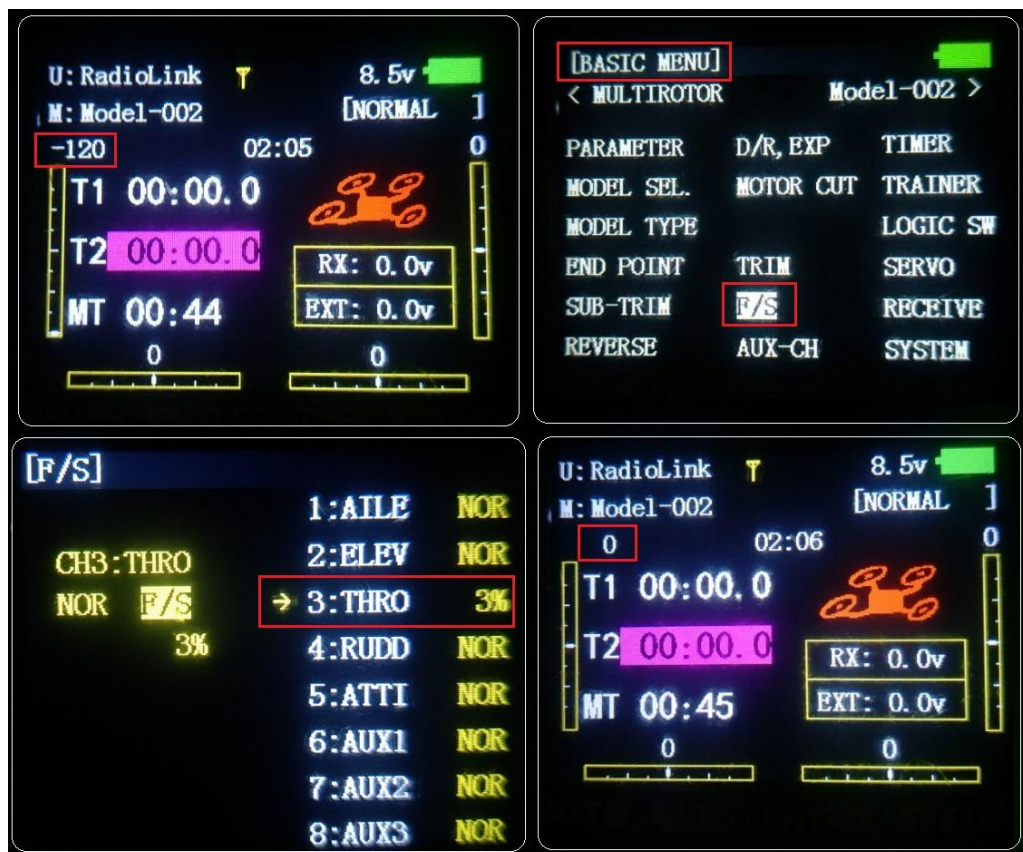
crossflight supports Return-To-Launch in cases where contact between the Pilot’s RC transmitter and the flight controller’s receiver is lost. This page explains this failsafe’s setup and testing. Note the “Radio failsafe” was previously called “Throttle failsafe” because of the way in which some receivers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

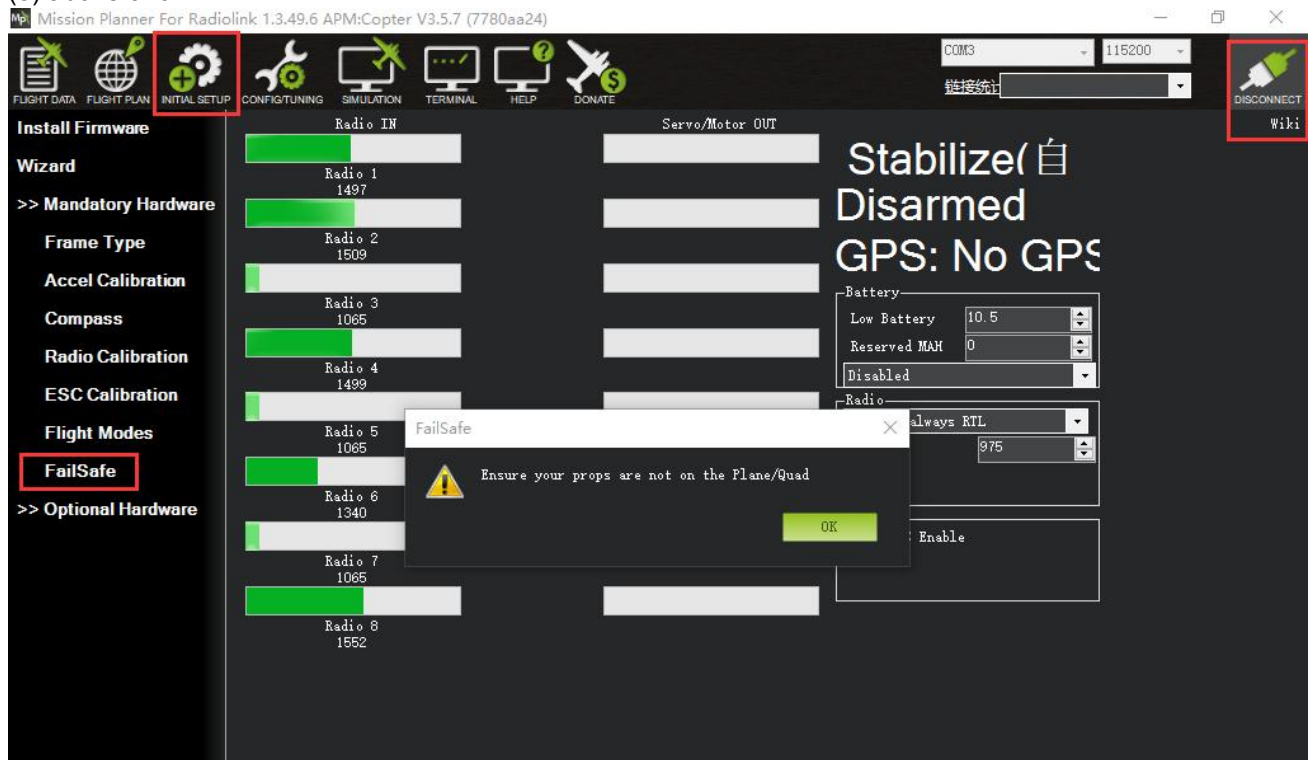
1. Connect your flight controller to the mission planner and select Initial Setup >> Mandatory Hardware >> Failsafe.

2. Set the Failsafe Options to one of the three options:

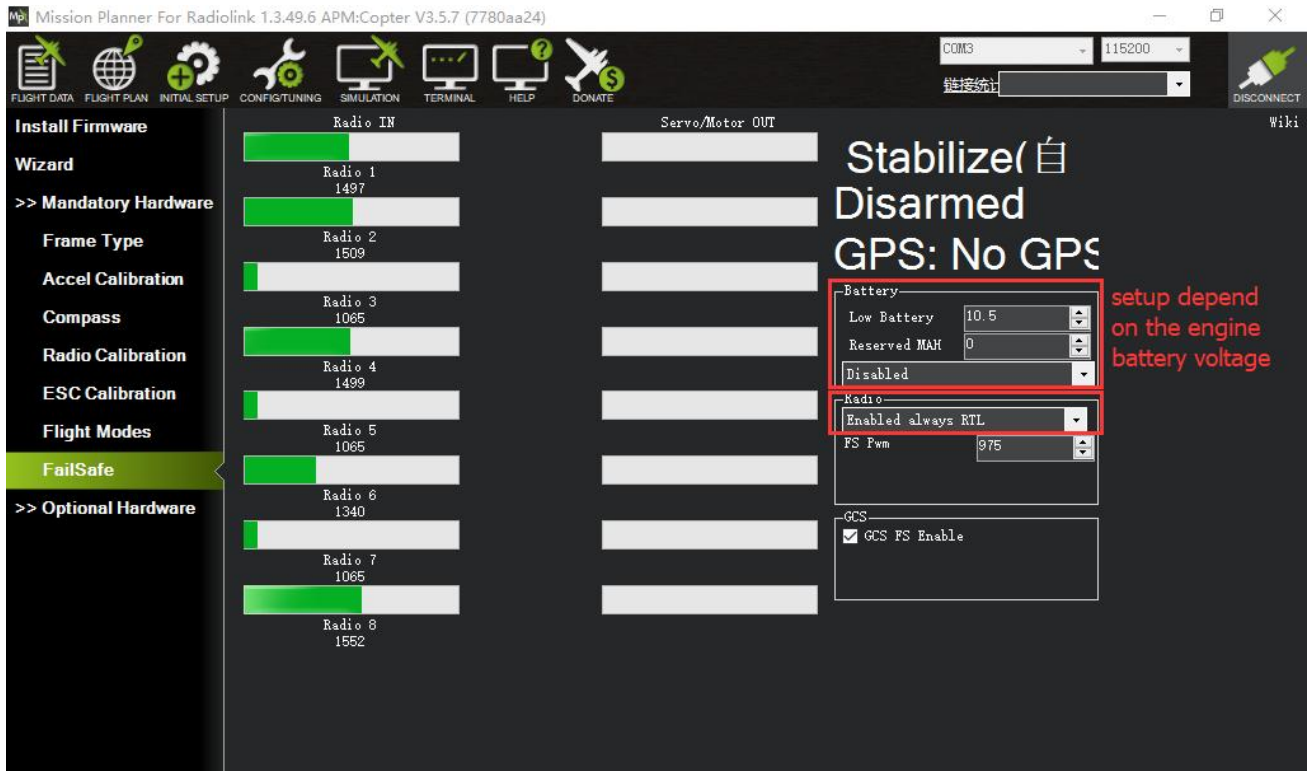
- (1) “Enabled always RTL” to force the vehicle to always RTL even if flying a mission in AUTO mode.
- (2) “Enabled Continue with Mission in AUTO” to allow the vehicle to continue with missions even if it takes the vehicle outside of RC range (not recommended). In all other cases the vehicle will RTL.
- (3) “Enable always LAND” to force the vehicle to Land immediately if it loses RC contact.

Set the “FS PWM” value to be:

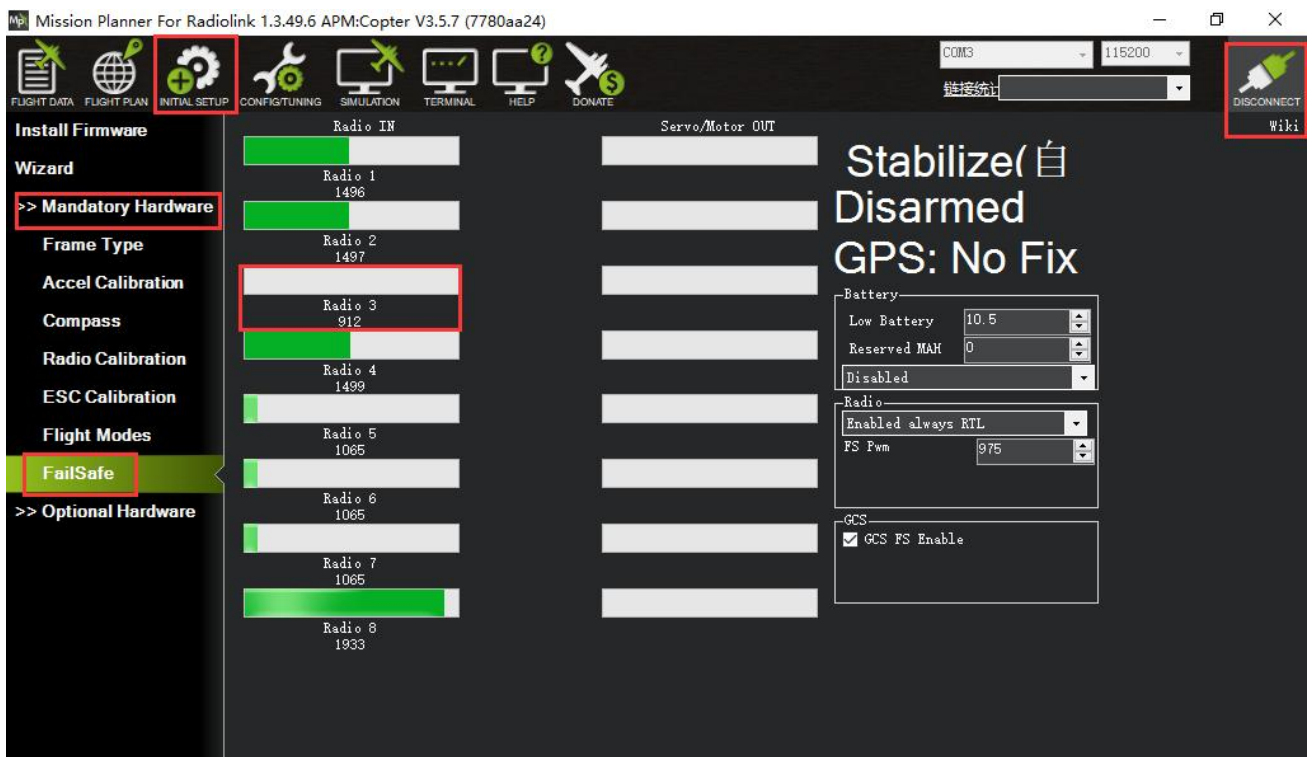
- (1) at least 10 PWM higher than your Channel 3’s PWM value when the throttle stick is fully down and the transmitter is off.
- (2) at least 10 lower than your channel 3’s PWM value when the throttle stick is fully down and the transmitter is on.
- (3) above 910.



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 crossflight 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. Installation and setup of crossflight

### 5.1 Install crossflight on aircraft

Mount the crossflight at the barycenter of the drone, make sure the arrow of the crossflight is point to the front.



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

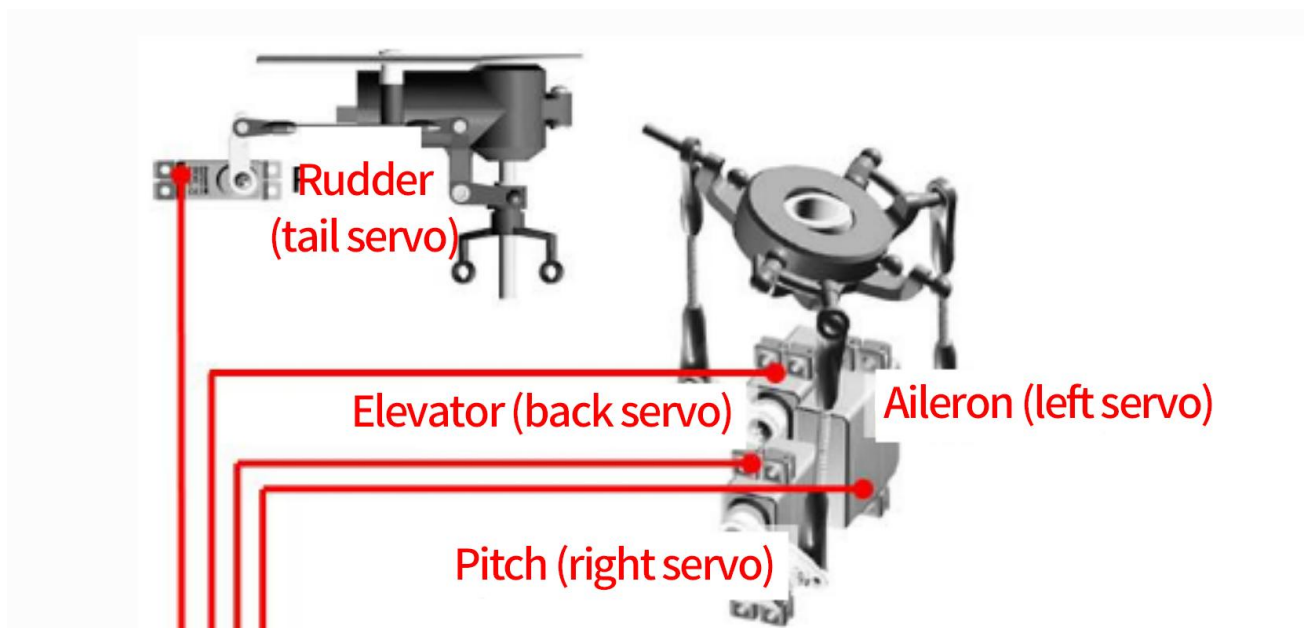
If the installation can't be done with the default direction, parameters need to be setup according to the installation direction.

## AHRS\_ORIENTATION

AHRS_ORIENTATION	0 None 1 Yaw 45 2 Yaw 90 3 Yaw 135 4 Yaw 180 5 Yaw 225 6 Yaw 270 7 Pitch 5 8 Roll 10 9 Roll 20 10 Yaw 5 10 Roll 00 Yaw 60 11 Roll 180 Yaw 135 12 Roll 180 13 Roll 180 Yaw 225 14 Roll 180 Yaw 270 15 Roll 180 Yaw 315 16 Roll 90 17 Roll 00 Yaw 45 18 Roll 00 Yaw 90 19 Roll 90 Yaw 135 20 Roll 270 21 Roll 270 Yaw 45 22 Roll 270 Yaw 90 23 Roll 270 Yaw 135 24 Roll 90 25 Pitch 270 26 Pitch 60 Yaw 60 27 Pitch 60 Yaw 270 28 Roll 90 Pitch 90 29 Roll 180 Pitch 90 30 Roll 270 Pitch 90 31 Roll 90 Pitch 180 32 Roll 270 Pitch 180 33 Roll 90 Pitch 270 34 Roll 180 Pitch 270 35 Roll 270 Pitch 270 36 Roll 90 Pitch 180 Yaw 90 37 Roll 90 Yaw 270	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.
------------------	---	---

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 crossflight to Helicopter



### Crossflight connection instructions:

Crossflight ESC1 -- aileron, left servo

Crossflight ESC2 -- pitch, right servo

Crossflight ESC3 -- elevator, back servo

Crossflight ESC4 -- rudder, tail servo,

Crossflight ESC6 -- ESC

**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

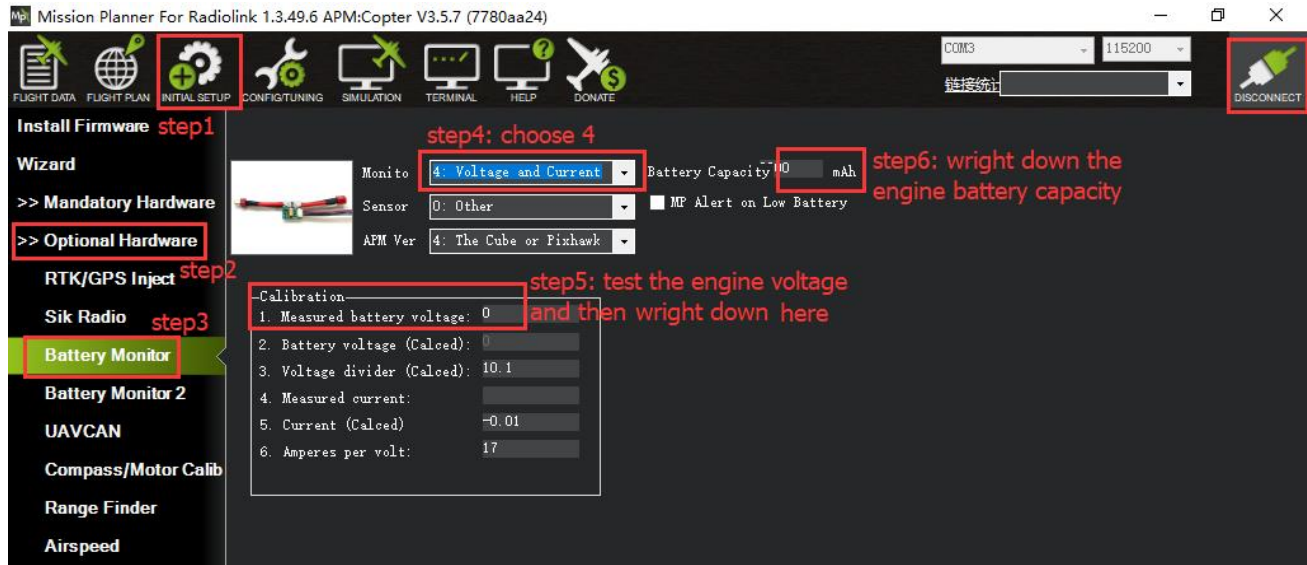
## 5.3 Connect the Spare Parts

**Receiver module and buzzer:** connect to the flight control RC IN/BUZZER port with the provided 5pin GH plug-in cable.

**Power Module:** use a 6-pin GH wire to connect the power module to the POWER port of the crossflight.

**GPS and compass:** use a 6-pin GH wire to connect the GPS (TS100 for example) to the GPS/I2C port of the crossflight, please make sure that GPS keeps the same direction as crossflight.

## Battery Monitors Setup



Set battery monitor on

Monitors: 4: Battery & Voltage

Sensor: 0: Other

APM version: 4: The Cube or Pixhawk

Turn off battery monitor settings

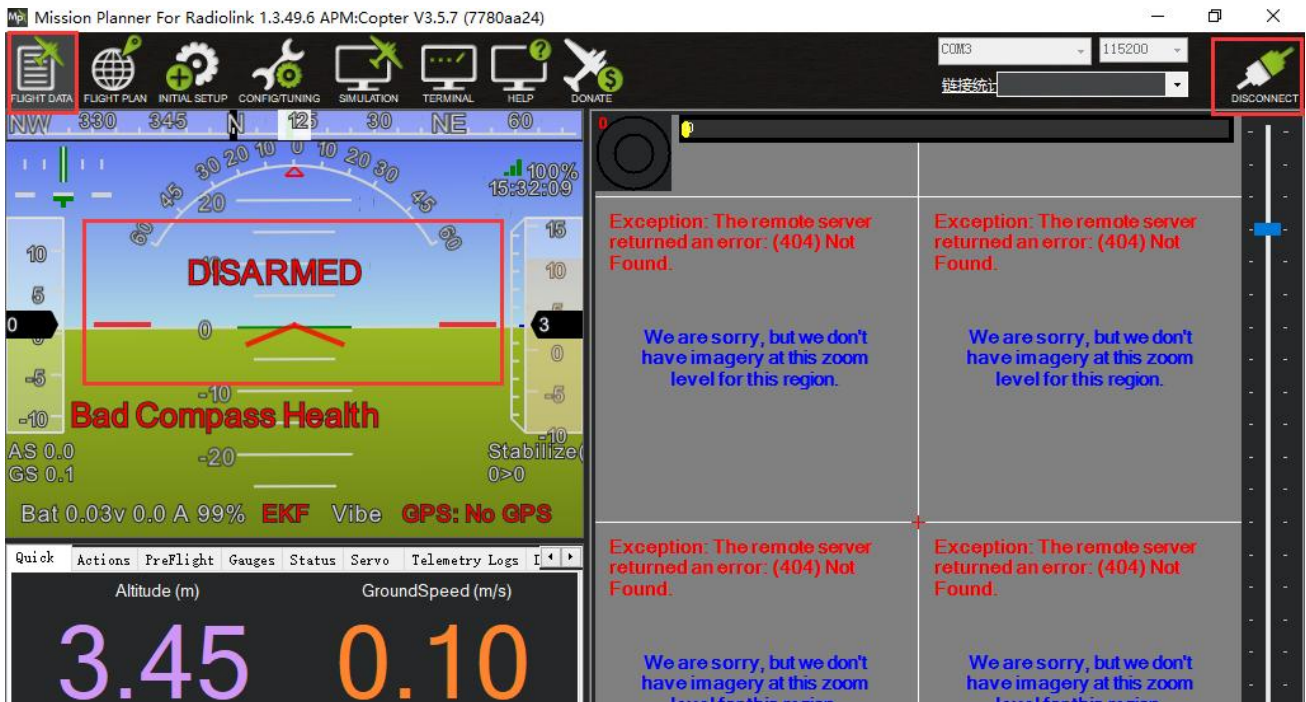
monitor:0:disable

When the setting is turned on, there may be no data. At this time, please disconnect the flight controller, re-power the flight controller, and then open this interface, enter the measured battery voltage, and when the same voltage as the input measurement value appears in the 2. battery voltage (calculated) box, and no longer jumps, it means that the setting is normal. If it is not the same, please reopen the interface and input the measurement voltage.

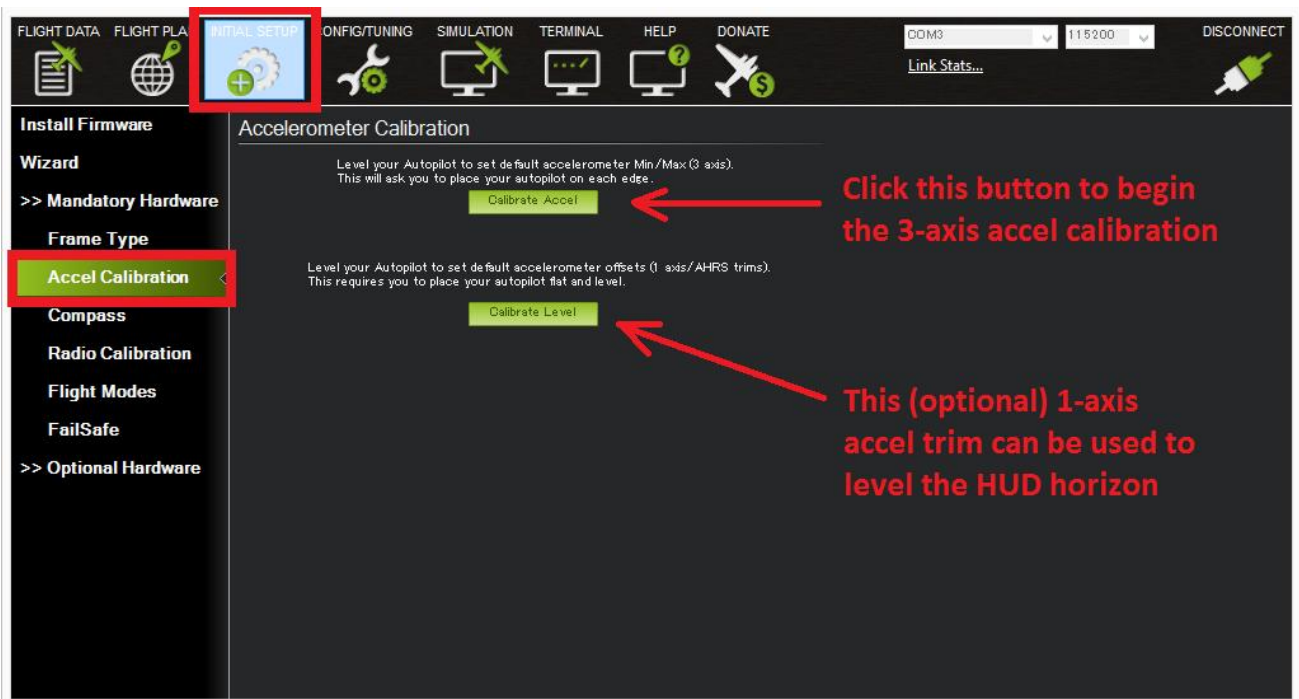
**Note:** When the setting is inaccurate, it may fail to arm, or the buzzer beeps quickly after arming. It means that the power supply is not set correctly at this time. Please reset it correctly. If the fault protection situation occurs all the time, it may be that the battery low voltage protection is turned on at this time, and the battery monitoring is inaccurate

## 5.4 Level Calibration

If the Mission Planner shows the drone not level when you put it horizontal as this picture, You can setup as below to solve the problem.



Under Initial Setup--Mandatory Hardware--select Accel Calibration from the left-side menu--Click Calibrate Level to start the calibration.

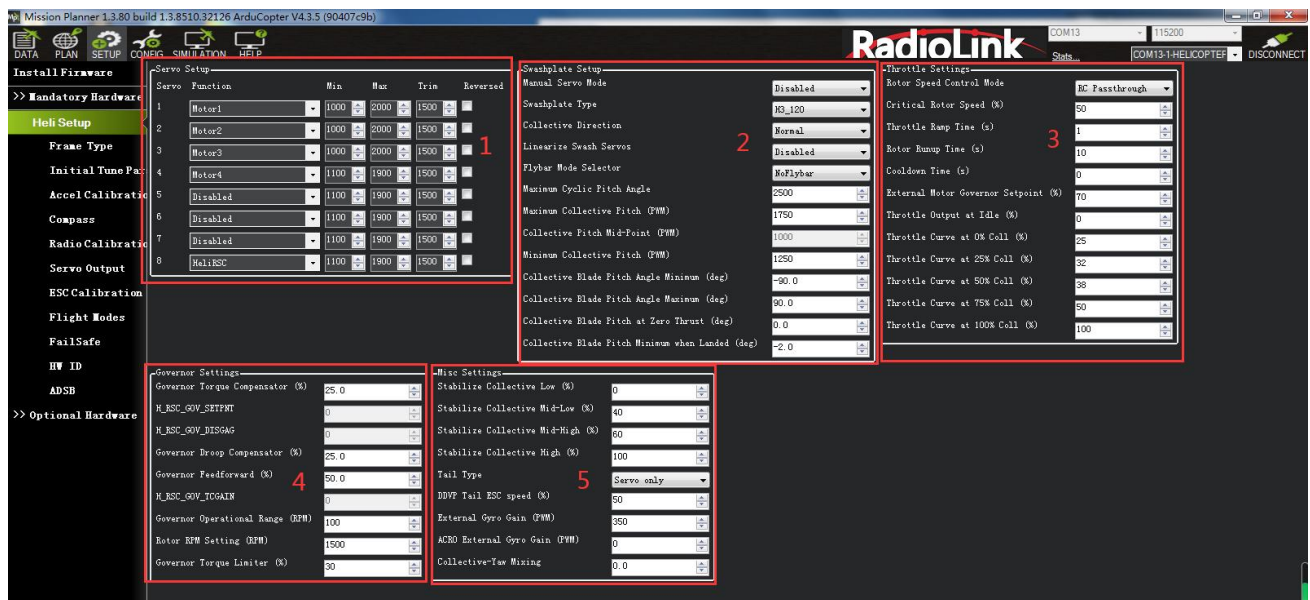


## 5.5 Helicopter Setup

Before your first flight, please follow these pre-flight checks:

1. Disconnect the three connecting wires between the ESC and the motor to ensure that the armed motor will not rotate.
2. Connect lithium battery for power supply.
3. Connect the flight controller and Mission Planner on computer via USB.
4. Open SETUP—> Mandatory Hardware—> Heli Setup in Mission Planner.
5. Please note that the output control is only available in Stabilize mode or Acro mode, and the adjustment test cannot be performed in other modes.

### 5.5.1 Heli Setup Interface Introduction



#### Function introduction

1. Servo Setup. The function of each PWM output channel can be set.
2. Swashplate Setup
3. Throttle Settings
4. Governor Settings
5. Misc Settings

### 5.5.2 Select Swashplate Type

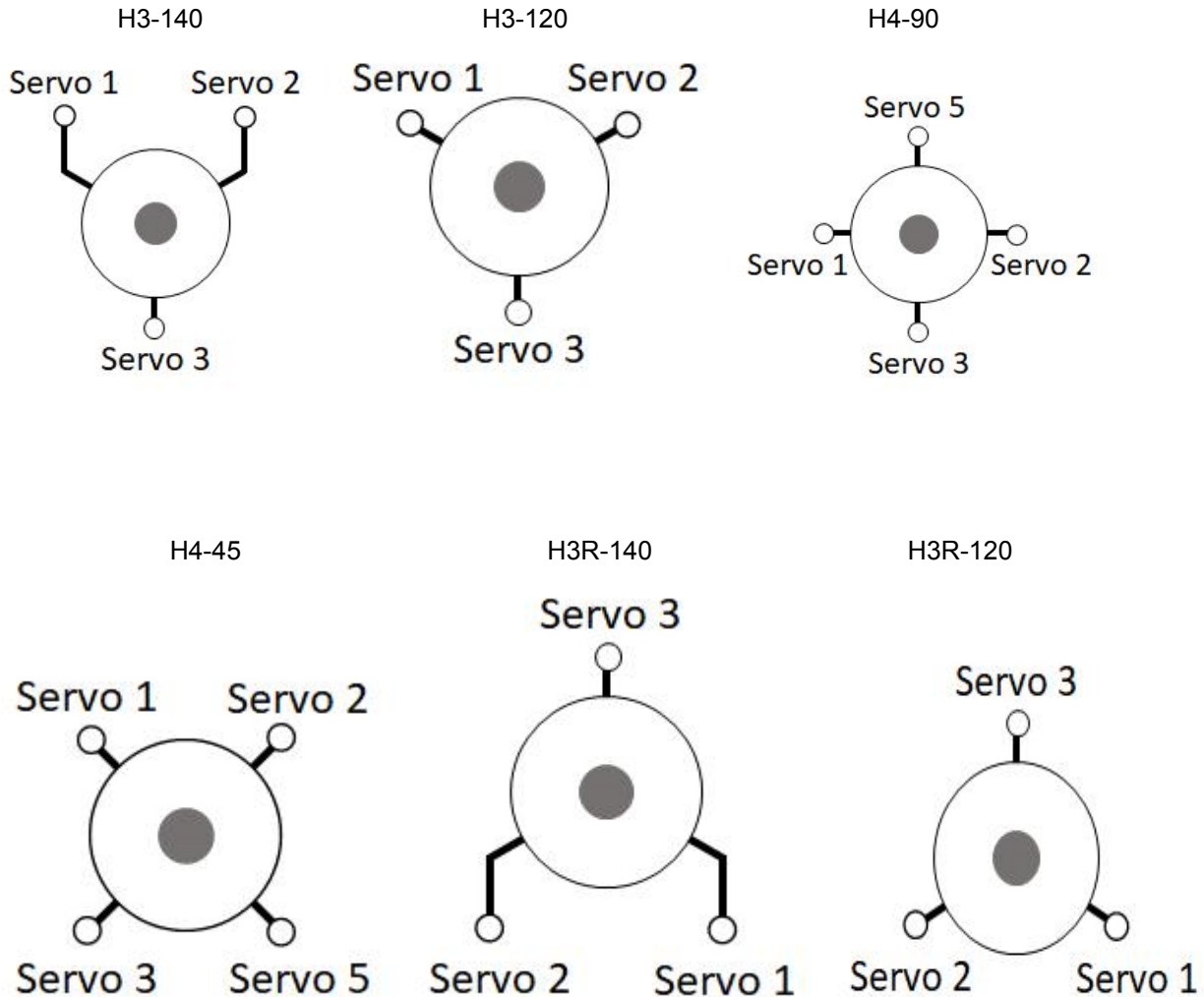
Below are the swashplate type selections using the H\_SW\_TYPE parameter. The diagrams shown label the servo attach positions as Servo 1, Servo 2 and Servo 3 for the three servo swashplate types. These also correspond to the default output functions for servo outputs 1 thru 3 on the autopilot for the servos used with these swashplate types.

For single heli, the servo function assigned to Servo 1 is motor 33, Servo 2 is motor 34, and Servo 3 is motor 35. These assignments are the same for swashplate 1 for a dual heli frame. Swashplate 2 for a dual heli defaults to servo outputs 4, 5, and 6 with motors 36, 37 and 38 assigned respectively.

For four servo swashplates, the fourth servo (Servo 5) on the single heli frame defaults to servo output 5 and is assigned motor 37. For the dual heli frame, the fourth servo (Servo 7) on swashplate 1 defaults to servo output 7 and is assigned motor 39. The fourth servo (Servo 8) on swashplate 2 defaults to servo output 8 and is assigned motor 40 function.

H3 Generic - Allows servo positions and phase angle to be set by user. Assumes all swashplate ball links are the same distance from the main shaft.

H1 non-CCPM - Servo1 is aileron, Servo 2 is elevator and Servo 3 is collective



### 5.5.3 Swashplate Setting

#### 1. Check Proper Swashplate Movement.

Use your transmitter to check for proper swashplate response to cyclic and collective inputs.

Push forward on the elevator stick and swashplate tilts forward; pull back on the elevator stick and swashplate tilts aft.

Push right on the aileron stick and the swashplate tilts right; Push left on the aileron stick and the swashplate tilts left.

Push up on the throttle stick (collective) and the swashplate will rise; pull down on the throttle stick (collective) and the swashplate will lower.

Set the SERVO1\_REVERSED, SERVO2\_REVERSED, SERVO3\_REVERSED, and H\_SW\_COL\_DIR parameters so that your swashplate responds correctly to your collective and cyclic inputs.

#### 2. Leveling your Swashplate

When the swashplate is not level, adjust SERVO1\_TRIM, SERVO2\_TRIM, and SERVO3\_TRIM until the swashplate is level.

#### 3. Collective Blade Pitch Angle

For example, the collective blade pitch range is -10 degrees to +10 degrees.

- (1) First install the pitch gauge on the propeller.
- (2) Open the Helicopter Setup interface in Mission Planner. Modify the Manual Servo Mode in the figure ① below to Max collective, then check the degree display of the pitch scale. And adjust the number in the figure ② below until the pitch scale shows +10 degrees. Finally, modify the number in the figure ③ below to 10.

Swashplate Setup	
Manual Servo Mode	Max collective
Swashplate Type	H3_120
Collective Direction	Normal
Linearize Swash Servos	Disabled
Flybar Mode Selector	NoFlybar
Maximum Cyclic Pitch Angle	2500
Maximum Collective Pitch (PWM)	1750
Zero-Thrust Collective Pitch (PWM)	1000
Minimum Collective Pitch (PWM)	1250
Collective Blade Pitch Angle Minimum (deg)	-90.0
Collective Blade Pitch Angle Maximum (deg)	10
Collective Blade Pitch at Zero Thrust (deg)	0.0
Collective Blade Pitch Minimum when Landed (deg)	-2.0

- (3) Set -10 degrees. First modify the Manual Servo Mode in the figure ① below to Min collective, and then check the pitch scale number. And adjust the Minimum Collective Pitch(PWM) in the figure ② below, so that the pitch scale is -10 degrees. Finally modify the Collective Blade Pitch Angle Minimum (deg) in the figure ③ below to -10.

Swashplate Setup	
Manual Servo Mode	Min collective
Swashplate Type	H3_120
Collective Direction	Normal
Linearize Swash Servos	Disabled
Flybar Mode Selector	NoFlybar
Maximum Cyclic Pitch Angle	2500
Maximum Collective Pitch (PWM)	1750
Zero-Thrust Collective Pitch (PWM)	1000
Minimum Collective Pitch (PWM)	1250
Collective Blade Pitch Angle Minimum (deg)	-10.0
Collective Blade Pitch Angle Maximum (deg)	10.0
Collective Blade Pitch at Zero Thrust (deg)	0.0
Collective Blade Pitch Minimum when Landed (deg)	-2.0

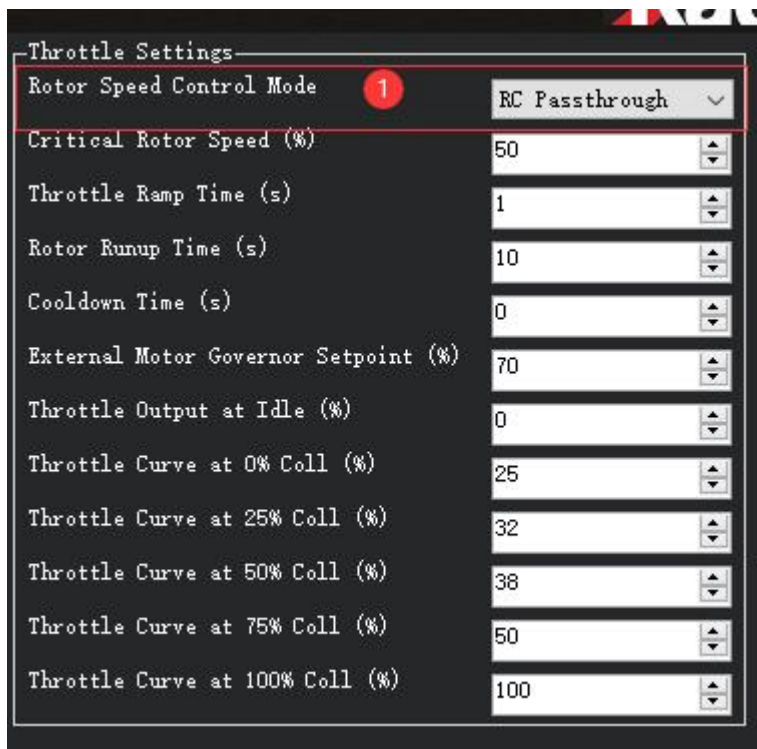
- (4) Set Zero Thrust Point. First modify the value in the figure ① below to have swashplate move to zero thrust position and verify the pitch angle corresponds the collective blade pitch in the figure ② below.

Swashplate Setup	
Manual Servo Mode	Zero thrust coll
Swashplate Type	H3 Generic
Collective Direction	Normal
Linearize Swash Servos	Disabled
Flybar Mode Selector	NoFlybar
Maximum Cyclic Pitch Angle	2500
Maximum Collective Pitch (PWM)	1750
Zero-Thrust Collective Pitch (PWM)	1000
Minimum Collective Pitch (PWM)	1250
Collective Blade Pitch Angle Minimum (deg)	-10.0
Collective Blade Pitch Angle Maximum (deg)	10.0
Collective Blade Pitch at Zero Thrust (deg)	0.0
Collective Blade Pitch Minimum when Landed (deg)	-2.0

- (5) The H\_COL\_LAND\_MIN parameter is used as the lower collective pitch limit in degrees for modes that use altitude hold in the vertical axis. This keeps the autopilot from driving collective too low resulting in ground resonance and is also used to detect landing in these modes. The default angle for H\_COL\_LAND\_MIN parameter is set to -2 degrees collective blade pitch angle and would allow symmetrical blade equipped vehicles to descend at a reasonable rate, yet avoid being too negative on the ground. If you have non-symmetrical blades, then set it to a blade pitch that is lower by the amount used as the zero thrust pitch angle. For example, if the H\_COL\_ZERO\_THRST is determined to be -3 deg then H\_COL\_LAND\_MIN should be set to -5 degrees.

### 5.5.4 Rotot Speed Control Setup

1. Set the RSC Mode parameter (H\_RSC\_MODE). Click the drop-down menu in the figure ① below to select RSC modes.



There are different RSC modes. The RSC modes are listed below with a short description.

- (1) RC Passthrough - this mode passes through the RC channel input on which the Motor Interlock (RCx\_OPTION =32) is assigned. The channel must be over 1200us in order for the heliRSC output to follow the RC input. Otherwise, heliRSC will be H\_RSC\_IDLE.
- (2) RSC setpoint - this mode is used for helicopters utilizing either an electronic speed controller or an external governor for internal combustion engines. The PWM passed to the HeliRSC output is determined from the External Motor Governor Setpoint (H\_RSC\_SETPOINT) parameter. The output PWM is calculated by the following equation:  $\text{PWM output} = \text{RSC\_SETPOINT} \times 0.01 \times (\text{SERVOx\_MAX} - \text{SERVOx\_MIN}) + \text{SERVOx\_MIN}$  where SERVOx is the output assigned to Throttle. This mode will be the most commonly used mode for electric helis having an ESC with governor mode built in.
- (3) Throttle curve - This mode is an open loop control of the HeliRSC servo output. Users will need to fine-tune the throttle curve to maintain the desired rotor speed throughout the flight envelope. The throttle curve is a five point spline curve fit set by the H\_RSC\_THRCRV\_x parameters. It is used to determine

the HeliRSC servo output based on the collective (throttle stick) on the RC transmitter. This mode can be used for open loop control of the heli motor, providing no constant head speed control, but is usually used to setup the feed-forward throttle curve baseline for the Governor mode below. Having a RSC governor is highly desirable in order to maintain a steady tune point for the stabilization parameters.

- (4) AutoThrottle - AutoThrottle requires a rotor speed sensor, and incorporates an advanced autothrottle governor. This mode will be used if no external RSC governor is present. Primarily for ICE and Turbine engines. The H\_RSC\_GOV\_x. The parameters needed to set the Throttle Curve mode above, also should be set correctly for this mode since it uses them as a basis for feed-forward control in the Governor.

Warning ; Setting the RSC mode to RC Passthrough requires configuring the RC receiver to hold last value for the Motor Interlock channel (default is channel 8). If the receiver loses connection to the transmitter and receiver is not configured correctly, the motor will shutdown and the helicopter will crash! It also means that the pilot has to be in control of throttle during any altitude holding or autonomous modes. This can be very difficult, can lead to a crash, and is strongly discouraged. This mode is provided only for some very specialized, advanced users.

## 2. Rotor Speed Ramp and Idle Settings

The rotor speed control features an idle setting and start up and shut down logic for throttle control. The throttle output at H\_RSC\_IDLE parameter determines the output to heliRSC servo output after the aircraft is armed, but before the motor interlock is enabled.

When the motor interlock is enabled the rotor speed control will ramp the throttle from the idle setting (H\_RSC\_IDLE) to flight setting (this depends on the H\_RSC\_MODE chosen) based on the H\_RSC\_RAMP\_TIME parameter . The RSC will prevent take off in non-manual throttle modes and auto mode until the timer has reached H\_RSC\_RUNUP\_TIME. It is very important to set H\_RSC\_RUNUP\_TIME to the amount of time it takes for the rotor to spin up to the flight rotor speed. This parameter has to be equal to or greater than the Throttle Ramp Time parameter (H\_RSC\_RAMP\_TIME).

When the motor interlock is disabled with the rotor at flight rotor speed, the rotor speed control will count down the same amount of time as specified by the H\_RSC\_RUNUP\_TIME. The RSC will declare rotor speed below critical based on the Critical Rotor Speed parameter (H\_RSC\_CRITICAL) and will reset the runup complete flag. It is best to set the Critical Rotor Speed parameter (H\_RSC\_CRITICAL) for a percentage of the runup timer that equates to about three seconds. For example if you had a 10 second runup timer, setting the Critical Rotor Speed parameter (H\_RSC\_CRITICAL) to 70% will cause the RSC to declare rotor speed below critical three seconds from when Motor interlock is disabled. For versions 4.0 and earlier, the autopilot is able to disarm the aircraft during auto landings after the RSC declares the rotor speed below critical. For versions 4.1 and later, the autopilot waits the length of time of the H\_RSC\_RUNUP\_TIME to disarm the aircraft during auto landings.

## 5.5.5 Internal RSC Governor

ArduPilot provides an internal RSC governor (H\_RSC\_MODE =4) for those applications which do not have one externally to assure constant rotor head speed. This mode requires the setup of the H\_RSC\_THRCRV\_x and H\_RSC\_GOV\_x parameters and the use of an RPM sensor for the rotor head speed. The governor maintains desired rotor speed through a proportional controller adjusted through the droop compensator and a feedforward controller that uses the throttle curve to help respond to sudden loading and unloading of the rotor system. The governor is designed to handle changes in environmental conditions and even changes in the desired RPM from the nominal settings for which the throttle curve was originally tuned. This is accomplished through the torque compensator which adjusts the reference from the throttle curve to maintain the desired rotor speed. The governor is designed to maintain the desired RPM

within the governor range. If the RPM falls outside this range for more than 0.5 seconds, the governor will declare the appropriate overspeed or underspeed fault and the throttle output is reverted back to the throttle curve. The motor interlock has to be disabled to reset the governor.

H\_RSC\_GOV\_COMP: Governor Torque Compensator - Determines how fast the governor will adjust the base torque reference to compensate for changes in density altitude.

H\_RSC\_GOV\_DROOP: Governor Droop Compensator - Proportional gain to compensate for error in rotor speed from the desired rotor speed.

H\_RSC\_GOV\_FF: Governor Feedforward - Feedforward governor gain to throttle response during sudden loading/unloading of the rotor system.

H\_RSC\_GOV\_RANGE: Governor Operational Range - RPM range above or below H\_RSC\_GOV\_RPM setting where governor is operational.

H\_RSC\_GOV\_RPM: Main Rotor RPM - Main rotor RPM that governor maintains when engaged.

H\_RSC\_GOV\_TORQUE: Governor Torque Limiter - Adjusts the engine's percentage of torque rise during ramp-up to governor speed.

You must first set your throttle curve and properly tune it. If the sensor fails, control fails over to the throttle curve. Without a properly tuned curve, your helicopter will crash. When tuning your throttle curve, tune it for an rpm that the aircraft can be easily flown. It doesn't have to be perfectly tuned, but it should be "close enough" to fly the heli with no surprises. You can tune your curve with H\_RSC\_MODE =3.

For ICE and turbine powered helicopters, H\_RSC\_IDLE is set so the engine can be started and run without engaging the clutch or turning the main rotor. Arming the autopilot before engaging motor interlock will set the RSC output to the idle position. Dis-engaging the motor interlock in ArduPilot will set the RSC output for motor throttle to H\_RSC\_IDLE. With auto landings or the LAND mode, upon detecting landing, the system will disable motor interlock which will disengage the governor and set the RSC output to idle (H\_RSC\_IDLE). Once the spool down is complete, it will auto-disarm and shutdown the engine.

Once the throttle curve is tuned, set H\_RSC\_MODE = 4 to have the RSC use the governor. Initially it is recommended that the governor be tuned for the RPM that the throttle curve was tuned. This will minimize the need for the governor torque compensator to be used and allow tuning to be concentrated on the droop compensator and feedforward settings. The feedforward setting adjusts the amount of the throttle curve is used in the governor. The feedforward may need adjusting if the rotor speed droops significantly when loading the rotor system using the collective. The droop compensator ensures the desired rotor speed is maintained very precisely. Higher value is quicker response to large speed changes due to load but may cause surging. Adjust this to be as aggressive as possible without getting surging or RPM over-run when the governor responds to large load changes on the rotor system.

To investigate the effect of the torque compensator, set the desired rotor speed 100-200 RPM from the rotor speed the throttle curve was tuned. The governor torque compensator (H\_RSC\_GOV\_COMP) should slowly adjust the reference output to aid the droop compensator in maintaining the desired RPM. If RPM is low or high by more than 2-5 RPM, increase this setting by 1% at a time until the governor speed matches your RPM setting. Setting the compensator too high can result in surging and throttle "hunting". Do not make large adjustments at one time.

The torque limiter (H\_RSC\_GOV\_TORQUE) should not need to be adjusted unless desired rotor speeds are set above the rotor speed tuned for the throttle curve. The governor failing to engage on spool up is an indication that the torque limiter is too low. Raise this by 5% until the governor reliably engages. It is possible to have this too high which would be indicated by immediately getting a governor overspeed fault (message on GCS) on spool up and RSC will revert to throttle curve.

## 6. LED Indicator, Arming and Troubleshooting

### 6.1 LED Indicator

Blue and red flashing: Initializing

Yellow flashing twice: Error, Arming rejected

Blue flashing: Stabilize, can be armed. Failed to RTL or PosHold

Green flashing: GPS locked, can be armed and take off, RTL

Green always on + a long D sound: Armed and ready to take off

Yellow flashing: Transmitter failsafe activated

Yellow flashing+repeated sounds: Battery failsafe activated

Yellow flashing+High/High/Low sounds: GPS data error or GPS failsafe activated

### 6.2 Arming and Disarming

Connect all the accessories. When you have completed transmitter calibration, acceleration calibration and compass calibration, you can try to arm it.

**When the LED of the flight controller is blue or green, it can be armed.** You can only arm or disarm in Stabilize, ACRO, AltHold, Loiter, and PosHold modes. You cannot arm your copter in AUTO mode.

#### Arm action:

1. Arm the motors by holding the throttle down, and rudder right for 5 seconds.



3. When you hear the buzzer beeping for a long time and the flight controller indicator light is always on, the arming is successful
4. Toggle the 8-channel switch to the maximum value, and wait for the motor to rotate to a constant speed.

Note 1: When it is not stick mode 2, please perform the arm action as the lowest for channel 3, and the highest for channel 4. For details, you can check the Mission Planner for the arming action.

Note 2: When the arming action is performed, but there is a beep from the buzzer, which means that it cannot be armed at this time, and there is a fault. Please connect the flight controller to the Mission Planner to check the disarm prompt, and solve the fault according to the fault description below.

**Disarm action:**

1. Toggle the 8-channel switch to the minimum value and wait for the motor to stop rotating
2. The left joystick executes the action shown in the picture below and holds for 5 seconds. When the flight controller indicator flashes and the motor stops, the disarm is done.



Note: 1. When it is not stick mode 2, please execute the lowest for channel 3 and the lowest for channel 4 to disarm

2. After landing, please wait for the propeller speed to decrease before performing the disarm action, otherwise it may cause the possibility of the aircraft turning over

## 6.3 Failure Messages

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

**safe switch:** The safety switch is not closed. Check the value of BRD\_SAFETYENABLE in all parameter list. If it is 1, modify it to 0.

**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 crossflight the RGB LED will start flashing green.
4. Disconnect the LiPo battery.
5. 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 off 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 crossflight 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.



## 7. Helicopter Advanced Settings

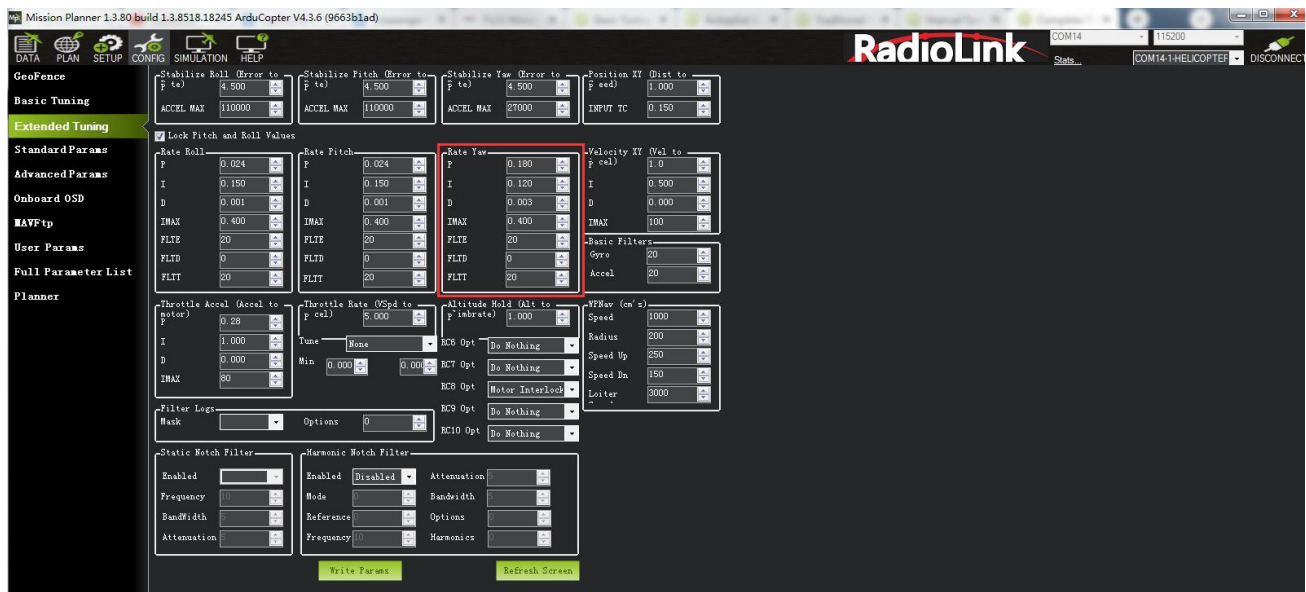
Due to the particularity of the helicopter, the mechanical structure may bring great differences and performance impacts. Please adjust the mechanical structure of the helicopter, which will also bring about a relatively bad vibration effect. The software vibration reduction may not be able to perform very well. When the parameter adjustment can't work well, and altitude hold mode does not work well, please perform a certain structural vibration reduction to make up for the lack of software vibration reduction.

### 7.1 Advanced parameters

Parameter	Meaning	Recommendation
H_PHANG	H3 Generic Phase Angle Comp	According to the actual situation, when the level of the swash plate is normal and the helicopter blades are normal, there is no need to modify
H_CYC_MAX	Maximum Cyclic Pitch Angle	Modify according to actual needs
H_COLYAW	Feed forward compensation to automatically add rudder input	Generally not recommended to modify
H_COL_LAND_MIN	Collective Blade Pitch Minimum when Landed	It is not recommended to increase the value
ATC_INPUT_TC	Attitude control input time constant	According to the actual situation, all actions of the aircraft will be fast
ATC_ACCEL_P_MAX	cceleration Max for Pitch	When you think that the response speed in which direction is slow, you can add it, but note that after the

ATC_ACCEL_R_MAX	Acceleration Max for Roll	modification, the PID in the corresponding direction must also be modified in direction. It is recommended to modify the yaw direction value, because the control algorithm, the tail response will be very slow
ATC_ACCEL_Y_MAX	Acceleration Max for Yaw	

## 7.2 Rate Yaw



Take off to a height of 0.3 meters with default parameters (please pay attention to safe operation because it may be not easy to fly it at the beginning)

To check the tail lock:

Increase Yaw's P if tail won't lock

Lower Yaw's P if the tail is wagging rapidly

It is not recommended to adjust the P value too high. If the adjustment is too large and still cannot be locked, it is suspected of mechanical problems, link delay and other problems. You can increase the corresponding ATC\_RAT\_YAW\_FF to make up for the mechanical delay and other problems. When the tail rudder is adjusted well, the attitude of roll and pitch can be adjusted better.

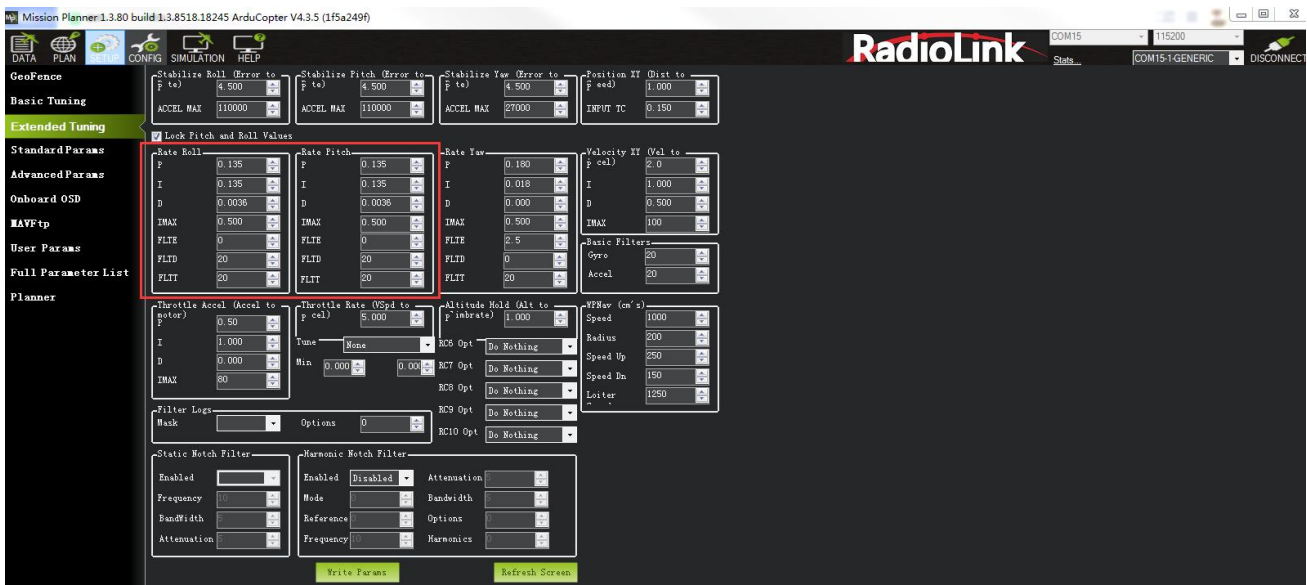
## 7.3 PID Adjustment

**Note:** The adjustment here needs to use the log function, please insert the memory card

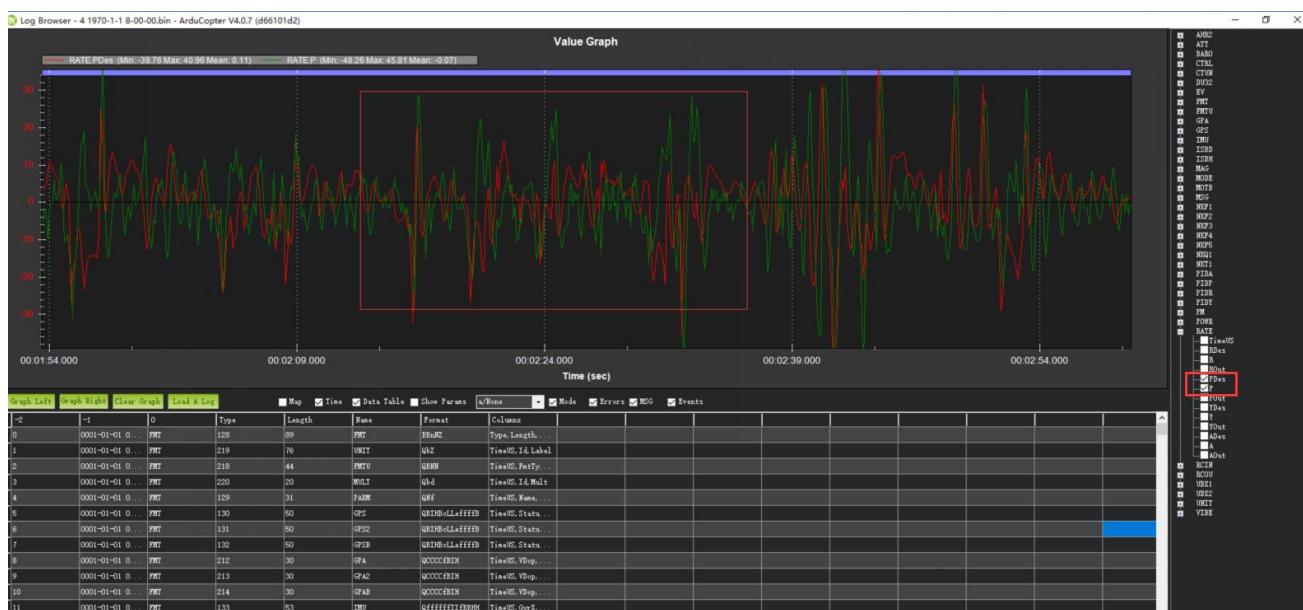
### 7.3.1 Adjust FF (Feedforward Compensation)

The specific parameters corresponding to the three axes are ATC\_RAT\_RLL\_FF, ATC\_RAT\_PIT\_FF, ATC\_RAT\_YAW\_FF; They are used to compensate for the slow response of the servo and the response problem caused by the length of the connecting rod. It is generally greater than 0.22 for those with ailerons, and generally less than 0.22 for those without ailerons. It can also be modified according to the actual test

1. First set the two axes of Roll and Pitch, set the corresponding ATC\_RAT\_RLL\_FF and ATC\_RAT\_PIT\_FF to 0.15, and adjust the PID of the corresponding Roll and Pitch to the minimum first, as shown in the picture below



After that, test the flight in Stabilized mode. Make some quick pitch and roll maneuvers, and then land. Export logs, view logs, and open logs to view RATE.



If RATE.PDes is greater than RATE.P, the corresponding ATC\_RAT\_PIT\_FF value needs to be increased, and vice versa;

If RATE.RDes is greater than RATE.R, the corresponding ATC\_RAT\_RLL\_FF value needs to be increased, and vice versa;

Adjust until the peaks of the two meet and follow.

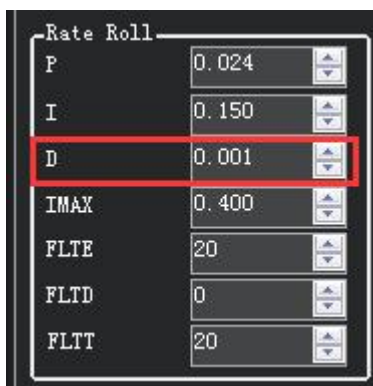
When the peak trend of the two follows too fast, it is necessary to reduce the acceleration limit value of the corresponding axis. If the following is too slow, increase it.

ATC\_ACCEL\_P\_MAX

ATC\_ACCEL\_R\_MAX

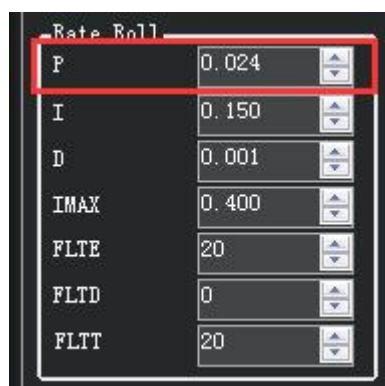
Note: When there is vibration in the pitch direction, it may be due to a mechanical problem, an out-of-level swash plate, or other mechanical problems.

### 7.3.2 Adjust D



Adjust Rate Roll first. Start from the initial setting of 0.001 for D, and increase by 0.001 each time until there is a left and right jitter. Then reduce the value by half as the final value, and the same value is also determined for the pitch direction

### 7.3.3 Adjust P



The adjustment method is similar to the D adjustment. First adjust the P of Rate Roll, and increase it by 0.01 each time until it shakes left and right. Then reduce the value by half as the final value, and set the same value for the Pitch

## 7.3.4 Adjust I and IMAX

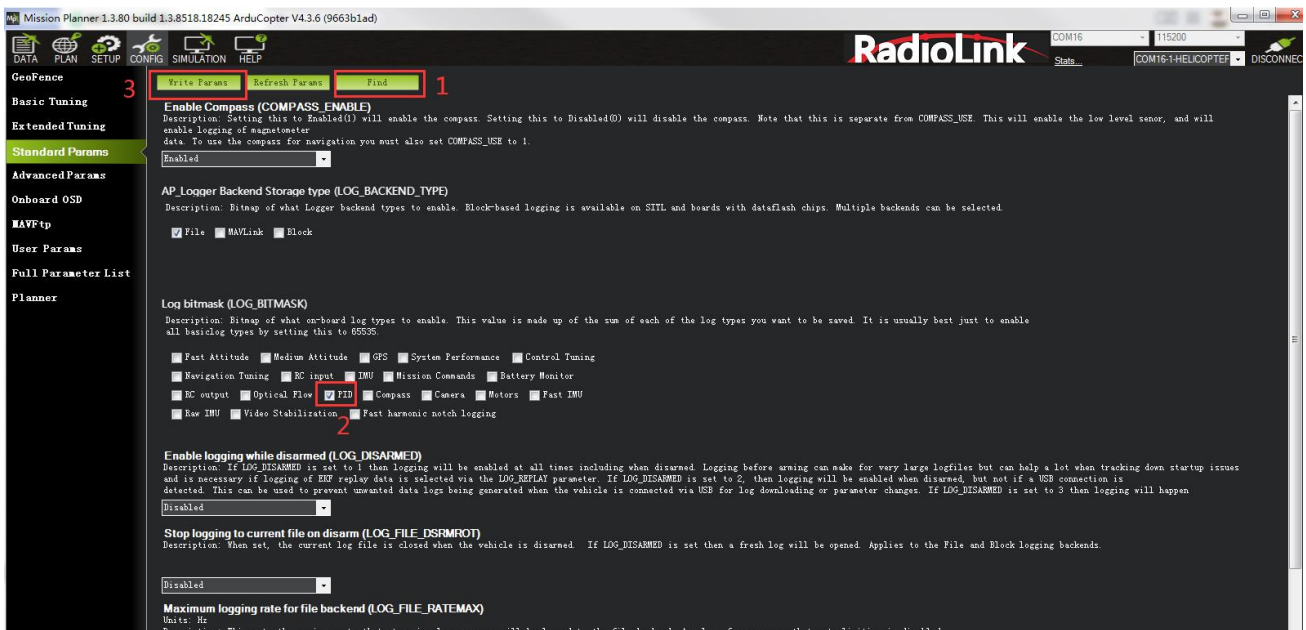
It is recommended to set I to be consistent with the corresponding FF

Roll I = ATC\_RAT\_RLL\_FF

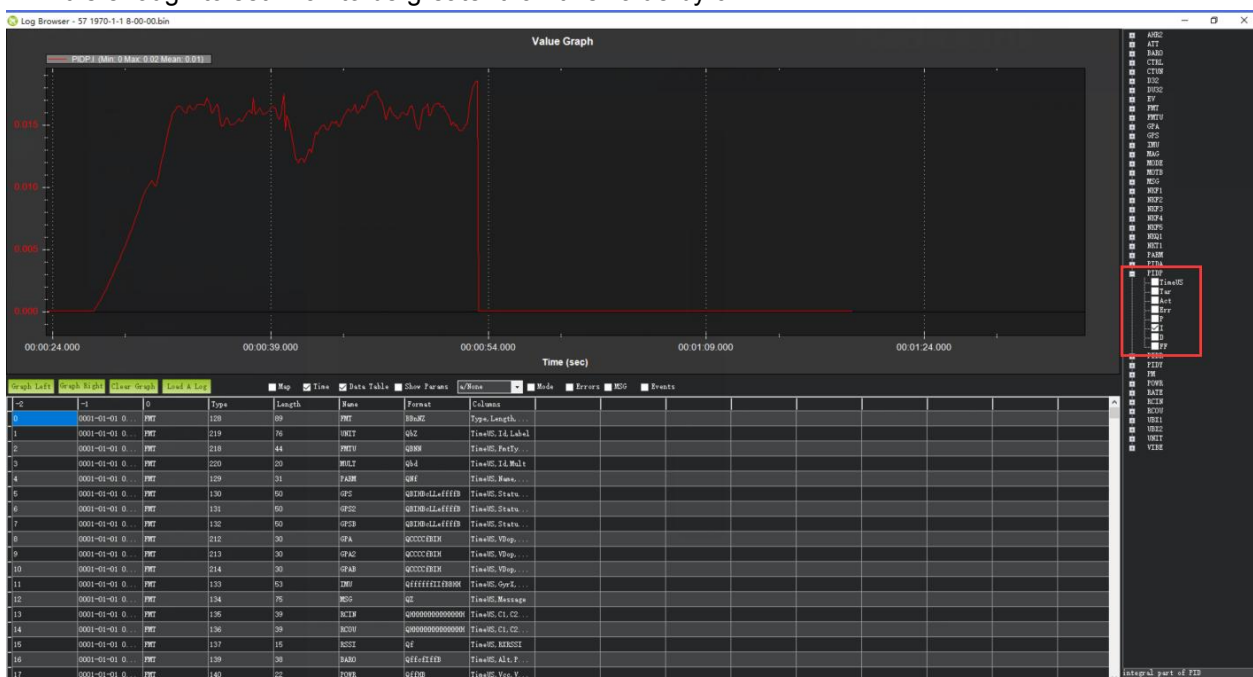
Pitch I = ATC\_RAT\_PIT\_FF

Please enable the PID recording function of the log in advance

1. CONFIG - Standard Params
2. Find log
3. Find log bitmask, tick PID
4. Click Write Params to save it



After that, fly once at the maximum speed. Export the log after landing, and check the maximum value of I in PIDP. It is enough to set I<sub>max</sub> to be greater than this value by 0.1



### 7.3.5 Hover Level Adjustment

The left and right attitude of the aircraft is affected by the rudder, and there may be a left and right tilt angle. In order to compensate for the angle, a parameter can be set to compensate for it.

Search ATC\_HOVR\_ROL\_TRM in Full Parameter List

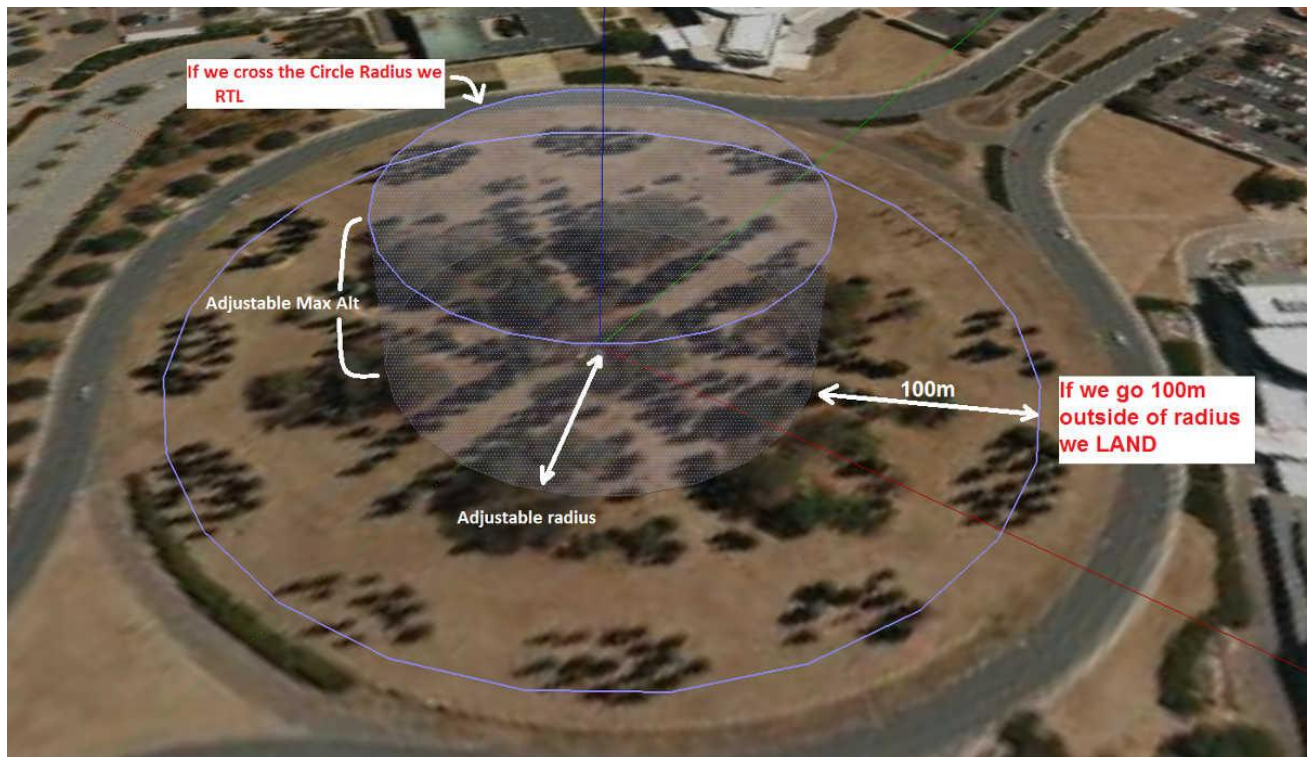
When the main rotor rotates clockwise, a positive value represents the compensation of the right Roll, and 3.5 represents 3.5 degrees.

When the main rotor rotates counterclockwise, the negative value is the compensation of the left Roll. -3.5 means 3.5 degrees.

First, calibrate the level of the flight controller, adjust the level of the swashplate, then hover to check the tilt angle of the aircraft, and input the tilt value to compensate for the tilt. If it is still tilted after modification, please check the installation level of the swashplate or flight controller.

## 8. GeoFence

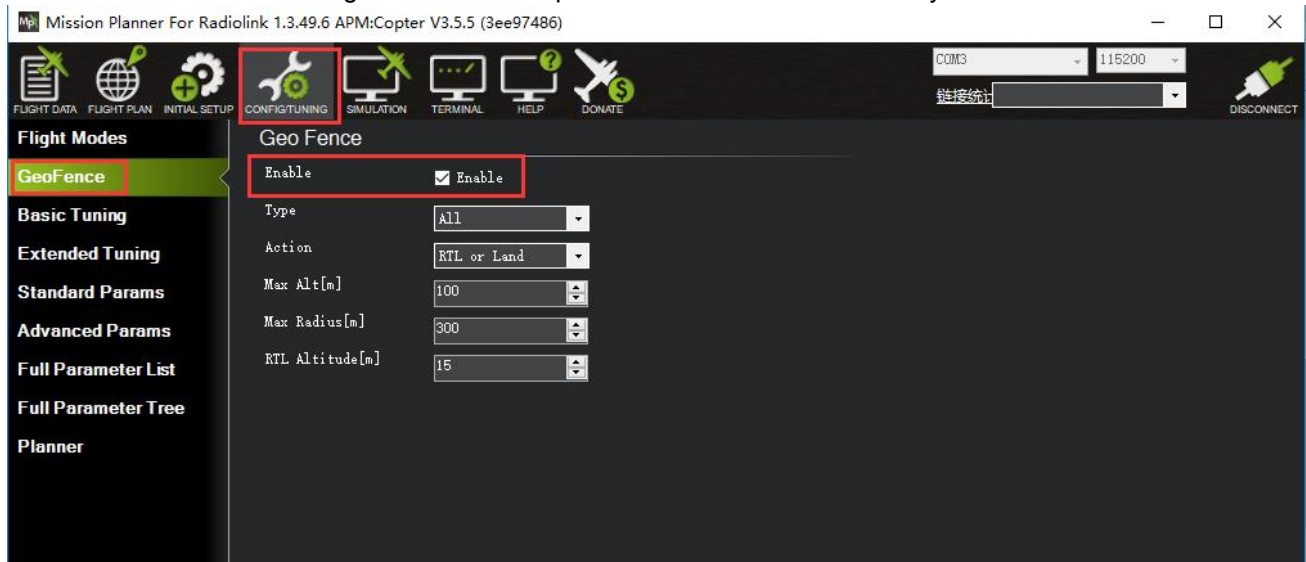
AC 3.0.1 (and higher) includes a simple “tin can” shaped fence centered on home that will attempt to stop your copter from flying too far away by stopping at the fence (if in Loiter mode and using Copter-3.4 or higher) or initiating an RTL. The maximum circular distance and altitude and the vehicle behavior when the fence is reached can be configured using Mission Planner.



If the vehicle strays outside these borders it will switch into RTL or LAND. At the moment the fence is breached a backup fence is erected 20m further out (or up). If the copter breaches this backup fence (for example if the vehicle is not set up correctly or the operator takes control but is unable to bring the copter

back towards home) the copter will be switched into RTL again (and another backup fence an additional 20m further out will be created).

If the copter eventually flies 100m outside the configured fence distance, the vehicle will switch into LAND mode. The idea being that it's clearly impossible to get the copter home so best to just bring it down. The pilot can still retake control of course with the flight mode switches. Like with the earlier fences, another fence is erected 20m out which will again switch the copter to LAND if it continues away from home.



#### Enabling the Fence in Mission Planner

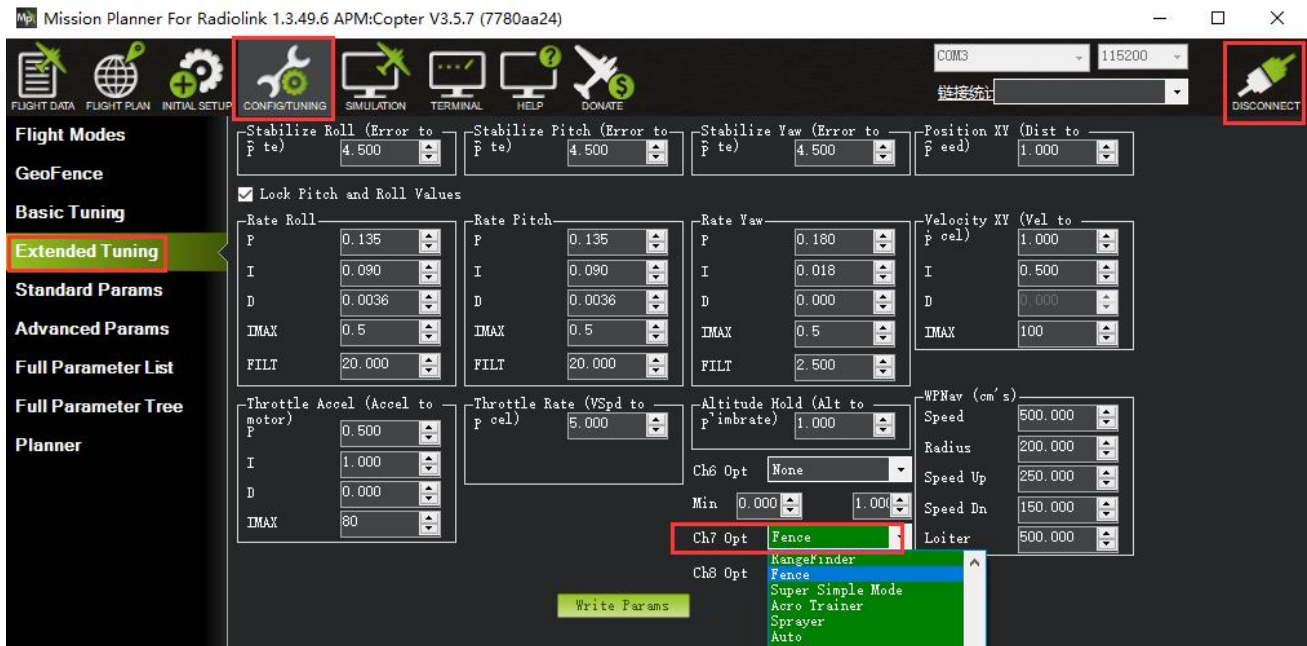
The Fence can be set-up by doing the following:

1. Connect your flight controller crossflight to the Mission Planner.
2. Go to the Config/Tuning -- GeoFence screen.
3. Click the Enable button.
4. Leave the "Type" as "Altitude and Circle" (unless you want only an Altitude limit or only a Circular fence in which case you can select "Altitude" or "Circle").
5. Leave the Action as "RTL or Land".
6. Set "Max Alt" to the altitude limit you want (in meters).
7. Set "Max Radius" to the maximum distance from home you want (in meters). This should normally be at least 50m.

#### Enabling the fence with channel 7 or 8.

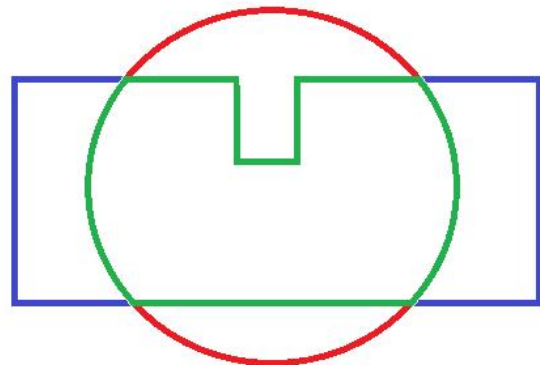
It is not necessary to set-up a switch to enable or disable the fence but if you wish to control the fence with a switch please follow these steps:

1. Go to the Mission Planner's Config/Tuning > Extended Tuning screen and set either "Ch7 Opt" OR "Ch8 Opt" to Fence.
2. Holding the switch high (i.e. PWM > 1800) will enable the fence, low (under 1800) will disable the fence.



### Warning

1. The minimum recommended fence radius is 30m.
  2. The fence requires the GPS to be functioning well so do not disable the GPS arming check nor the EKF failsafe while the fence is enabled. Conversely if you disable either of these checks, disable the Fence.
  3. For the best results, ensure RTL is working on your vehicle.
  4. With the Fence enabled, the pre-arm checks will require you have GPS lock before arming the vehicle.
  5. If GPS failsafe is not enabled and the Fence is enabled and you lose GPS lock while flying the fence will be disabled.
  6. If GPS failsafe is enabled and the Fence is enabled and you lose GPS lock while flying the vehicle will switch to LAND because we no longer know the vehicle position and we want to ensure the copter never travels far outside the fence. This behavior will occur regardless of the flight mode. If a LAND sequence is not desired, the pilot can retake control by moving the flight mode switch.
  7. The backup fences are created 20m out from the previous breached fence not 20m out from the vehicle's position. This means if you choose to override the fence you may have less than 20m to regain vehicle control before the fence switches the copter to RTL (or LAND) again. If you really want to override the fence, you should be ready to switch the flight mode twice or alternatively set-up the enable/disable fence switch.
- Circle and Polygon: Combining with the Circular and Altitude fences.
- The polygon fence can be used in combination with the circular and altitude fences and the failsafe behavior (i.e. stop at the fence or RTL) will trigger at whichever barrier the vehicle reaches first (i.e. the green line shown below).



## 9. Onboard OSD

OSD is the abbreviation of On Screen Display in English. It is a kind of screen display technology, which is used to display characters, graphics and images on the display terminal. The status of the aircraft can be displayed in the returned video, and the data of each module can be integrated into the OSD module, and then the OSD module can return the monitored data to the terminal (FPV glasses or screen) and superimpose it on the video transmission image. crossflight flight controller integrates an OSD chip. Users do not need to connect an external OSD module. They only need to connect the signal lines corresponding to the image transmission and camera to the OSD port of crossflight to use the OSD function.

### 9.1 Setting Introduction

#### OSD Parameters

OSD\_W\_RESTVOLT: RESTVOLT warn level. Set level at which RESTVOLT item will flash Range is from 0 to 100.

OSD\_CELL\_COUNT: Battery cell count. Used for average cell voltage display. -1 disables, 0 uses cell count autodetection for well charged LIPO/LIION batteries at connection, other values manually select cell count used.

OSD\_CHAN: Screen switch transmitter channel. This sets the channel used to switch different OSD screens. The value includes 0, 5-16.

OSD\_SW\_METHOD: Screen switch method. This sets the method used to switch different OSD screens.

0 = switch to next screen if channel value was changed.

1 = select screen based on pwm ranges specified for each screen.

2 = switch to next screen after low to high transition and every 1s while channel value is high.

OSD\_OPTIONS: OSD Options. This sets options that change the display, including Decimal pack, Inverted Wind, Inverted AH Roll.

OSD\_FONT: OSD Font. This sets which OSD font to use. It is an integer from 0 to the number of fonts available.

OSD\_V\_OFFSET: OSD vertical offset. Sets vertical offset of the osd inside image.

OSD\_H\_OFFSET: OSD horizontal offset. Sets horizontal offset of the osd inside image.

OSD\_W\_RSSI: RSSI warn level. Set level at which RSSI item will flash. The range is from 0 to 99.

OSD\_W\_NSAT: NSAT warn level. Set level at which NSAT item will flash. The range is from 0 to 30.

OSD\_W\_BATVOLT: BAT\_VOLT warn level. Set level at which BAT\_VOLT item will flash. The range is from 0 to 100V.

OSD\_UNITS: Display Units. Sets the units to use in displaying items.

0 = Metric (m, km, m/s, km/h)

1 = Imperial (feet, miles, feet per second, miles per hour)

2 = ArduPilot Native (m, km, m/s)

3 = Aviation (feet, nautical miles, feet per minute, knots)

OSD\_MSG\_TIME: Message display duration in seconds. Sets message duration seconds.

OSD\_ARM\_SCR: Arm screen. Screen to be shown on Arm event. Zero to disable the feature.

OSD\_DSARM\_SCR: Disarm screen. Screen to be shown on disarm event. Zero to disable the feature.

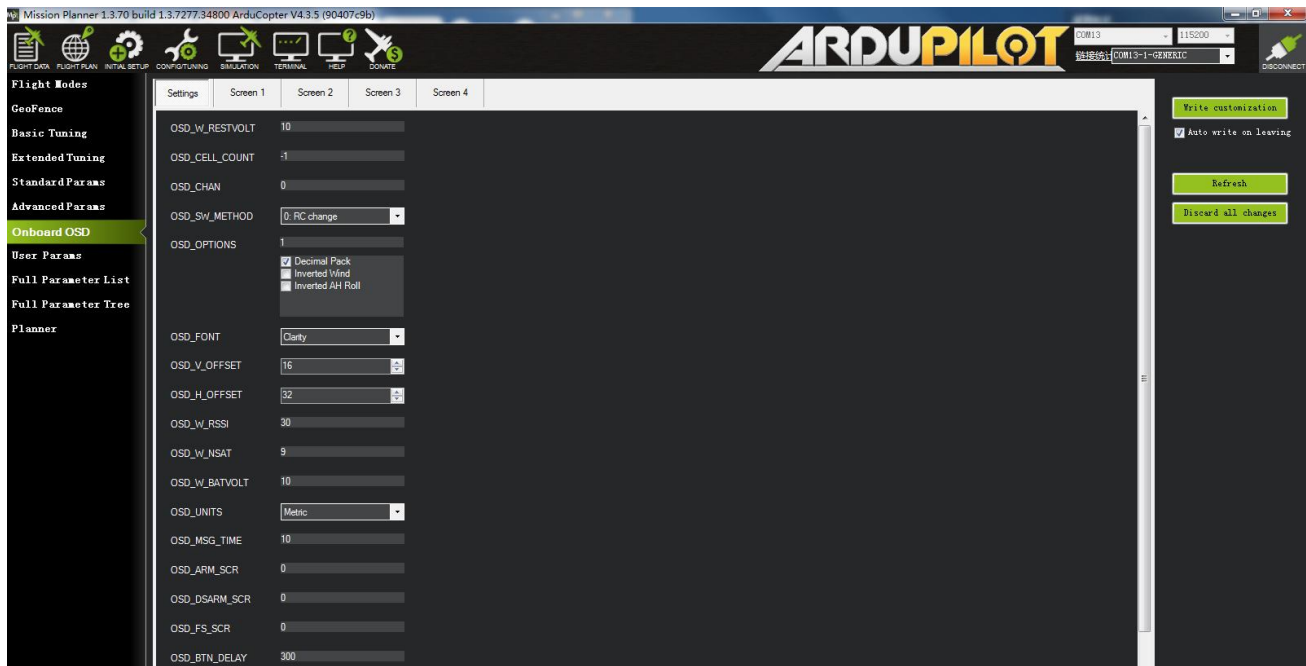
OSD\_FS\_SCR: Failsafe screen. Screen to be shown on failsafe event. Zero to disable the feature.

OSD\_BTN\_DELAY: Button delay. Debounce time in ms for stick commanded parameter navigation.

OSD\_W\_TERR: Terrain warn level. Set level below which TER\_HGT item will flash. -1 disables.

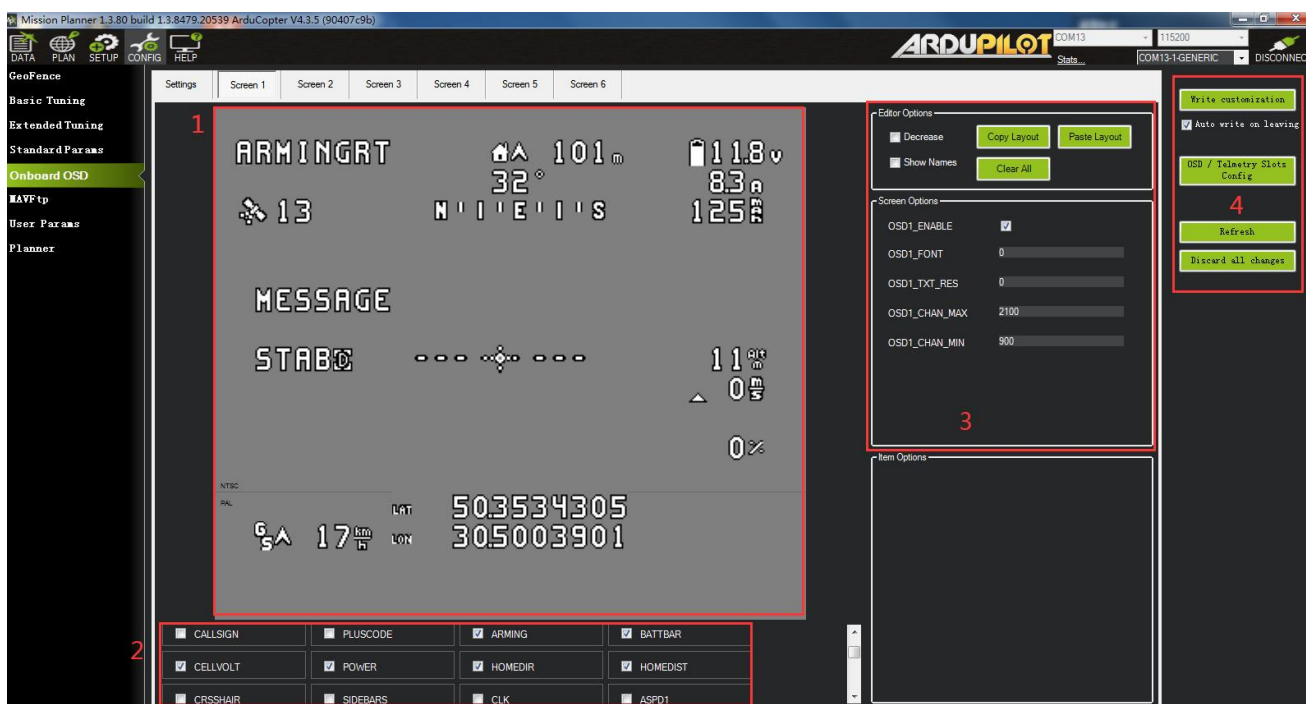
OSD\_W\_AVGCELLV: AVGCELLV warn level. Set level at which AVGCELLV item will flash.

OSD\_TYPE: 1 means the chip of OSD is MAX7456.



## 9.2 Screen Introduction

The Screen interface is the interface displayed on the user's screen, where the user can independently design the interface layout, display options, etc.



- ① The area is the layout displayed on the screen. Users can freely drag and drop the options inside to customize and adjust the layout of the screen.
- ② The area is the content displayed on the screen. Users can tick the content they need and display it on the screen.
- ③ The area can copy the layout of the current screen or paste the layout of other screens to this screen.
- ④ Write all the current settings in the area.

## 10. Parameters Setting

### 10.1 Parameter Introduction

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

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

Left column:

Basic Tuning: Provide simple parameter adjustment , such as climbing response rate

Extended Tuning: provide adjustment of PID, function of channel 7 and 8 channel

Standard Params: Provide some basic settings to unlock detection items, logs, enable additional functions, channel functions, etc.

Advanced Params: Provide some advanced function settings such as PID

Full Parameter List: All parameter list display, parameter name, parameter value, value unit, value range and value options, parameter function introduction etc.

Full Parameter Tree: Related function parameters are similarly displayed. After a function is expanded, the function-related parameters are displayed

Right column:

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 crossflight.

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

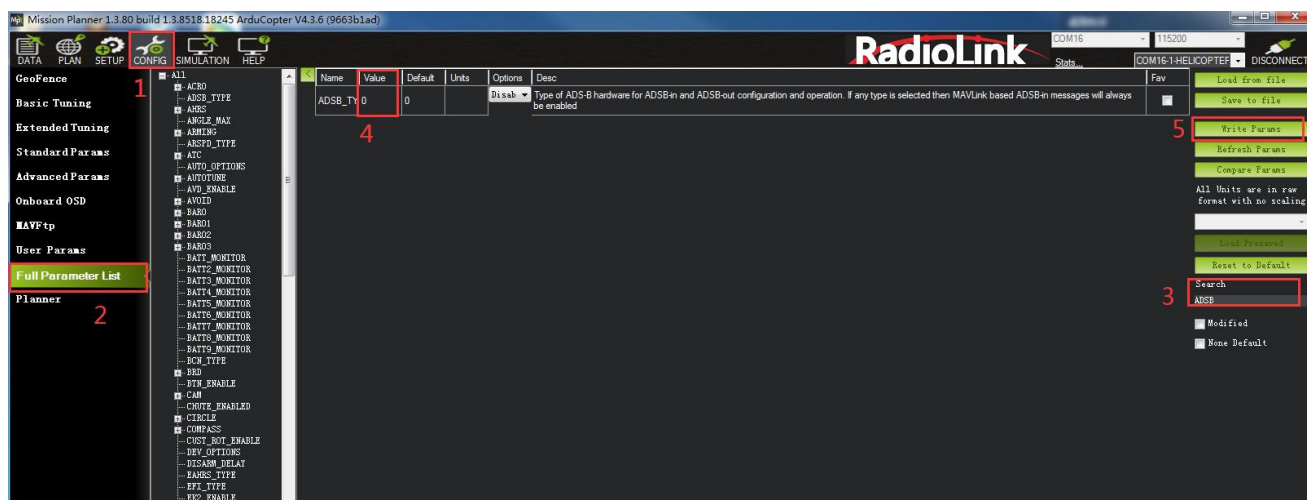
Compare Params: compare the current and the previous parameters.

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

## 10.2 Parameter Modification

All the parameters of crossflight can be adjusted. You can modify it according to the following steps;

1. Enter the parameter name you want to modify in the search box
2. Wait for the refresh and the searched parameters is displayed
3. After clicking in the parameter value box , enter the value you want to modify
4. Click Write Params on the right to save the parameter



## 11. 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 crossflight 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.



