RadioLink

CrossFlight-CE

User Manual for Helicopter

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

14+

Thank you for purchasing RadioLink flight controller CrossFlight-CE.

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 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 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 Pro as example. More details about how to use flight controller please refer to:

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1. CrossFlight-CE Introduction

1.1 Spare Parts

CrossFlight-CE x1


Power Module
(Support 2-12S)x1


Buzzer x1


I2C Transfer
Board x1


FC Status
Indicate LED x1


Double-sided
Adhesive Tape x2


4G TF (MicroSD)
Card 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

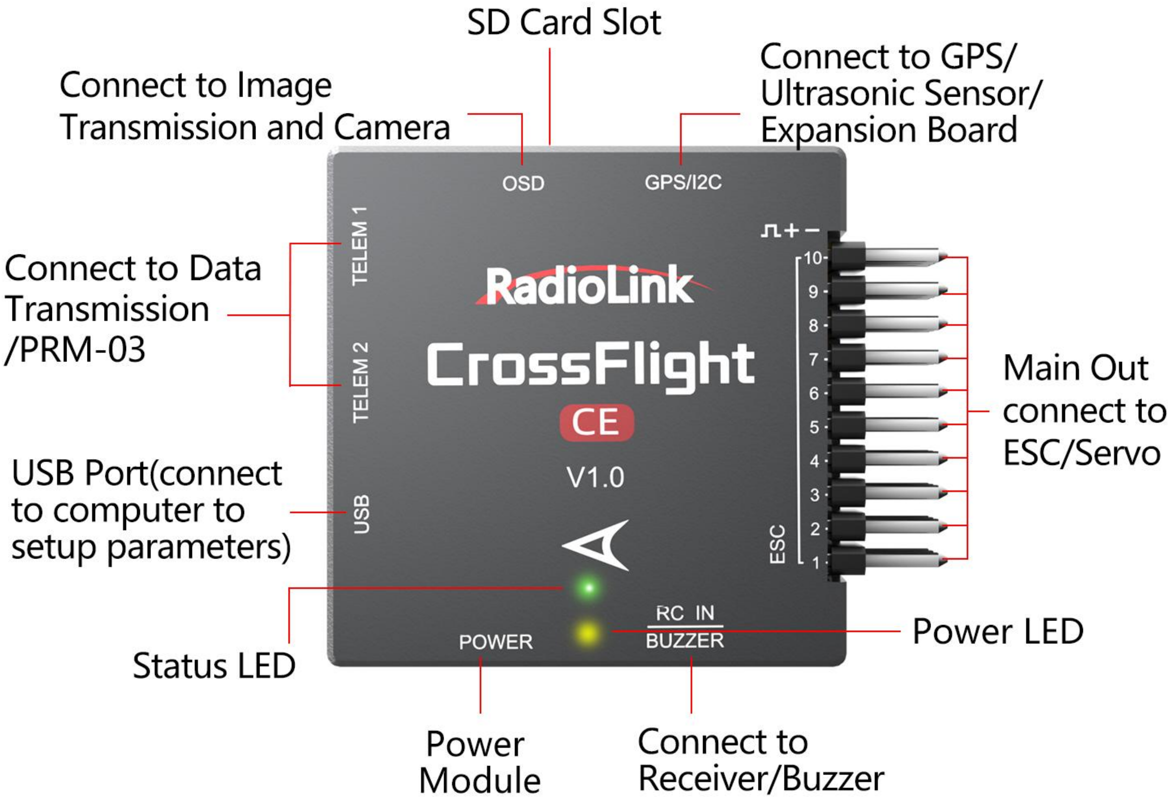

I2C Transfer Board
Connect Cable x1

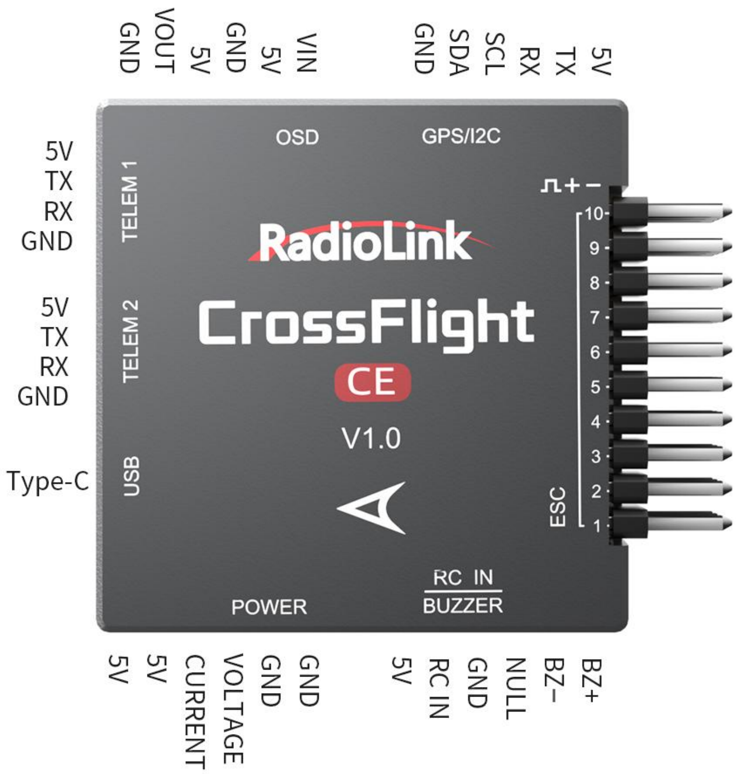

USB Type-C
Cable x1

Quick Start
Guide x1

Packing Box x1

1.2 Connectors and Specifications





Specifications

Weight & Dimension	Dimension	39.7*39.7*13mm (1.56"*1.56"*0.52")
	Weight	16.5g (0.58oz), 54g (1.9oz when all the connect wires included)
Hardware	Processor	HC32F4A0PITB
Sensor	Gyro & Accelerometer	QMI8658A
	Compass	VCM5883L
	Barometer	SPA06-003
	OSD Chip	AT7456E
	FRAM	Without FRAM, use the internal flash to store parameters, 2617 waypoints for multicopters, and 2623 waypoints for airplanes/ cars/boats.
	Buzzer	1
	Safety Switch	None
Connector	Type	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
	Signal Input	PPM/SBUS/CRSF
	RSSI Output	Support
	OSD Module	OSD Module integrated
	ESC Protocol	PWM, DShot, and OneShot Protocol
	RTK	Support
Power Module	Weight	16.5g (0.58oz) without wire
	Input Voltage	2-12S
	Maximum Detection Current	90A

	Output Voltage (BEC)	5.3V±0.2V
	Output Current (BEC)	2A
	Single ESC Maximum Detection Current	22.5A
Adaptable Models	Airplane/2-8 Copters/Helicopter/Car/Boat/Submarine/ Radartracker/Robot	
Operating Parameters	USB Voltage	5V±0.3V
	Servo Voltage	Not applicable
	Operating Temperature	-30~85°C

1.3 Advices

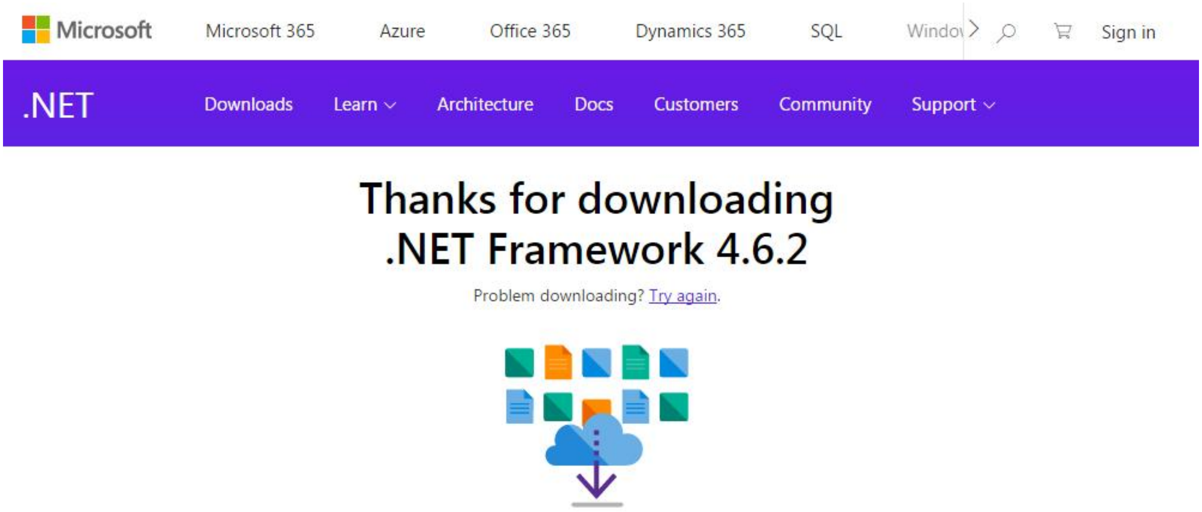
For the users who firstly use CrossFlight-CE, we suggest that you use CrossFlight-CE following below steps:

1. You have to install the mission planner and driver from here and familiar with the menu.
Download the latest Mission Planner from https://www.radiolink.com.cn/crossflightce_missionplanner
Download the driver from
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

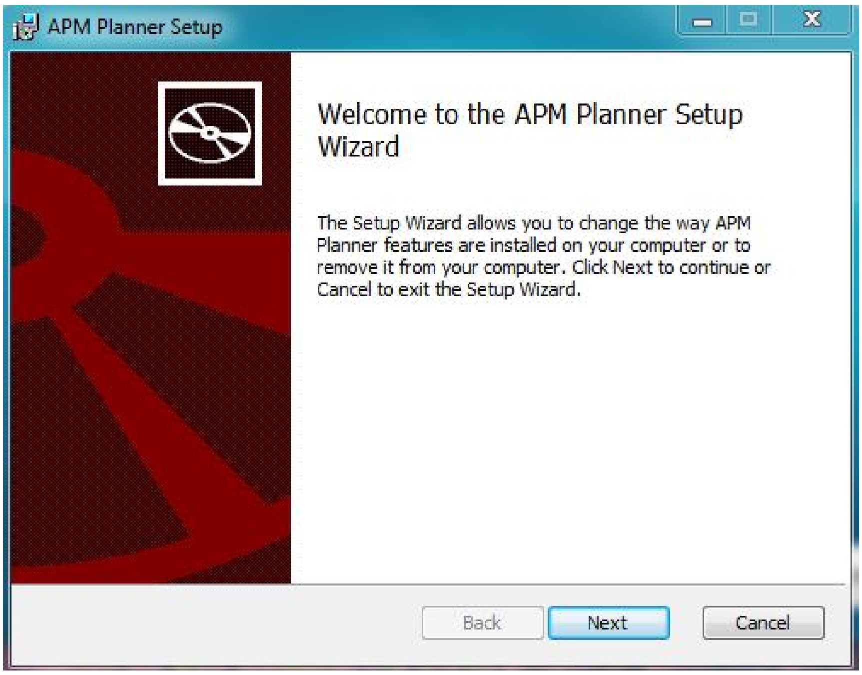
2.1 Install Mission Planner

Net Framework 4.6.2 need to be installed first before Mission Planner:
Download Net Framework 4.6.2 here



Then you can download Mission Planner for CrossFlight-CE on RadioLink official website:
https://www.radiolink.com.cn/crossflightce_missionplanner

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

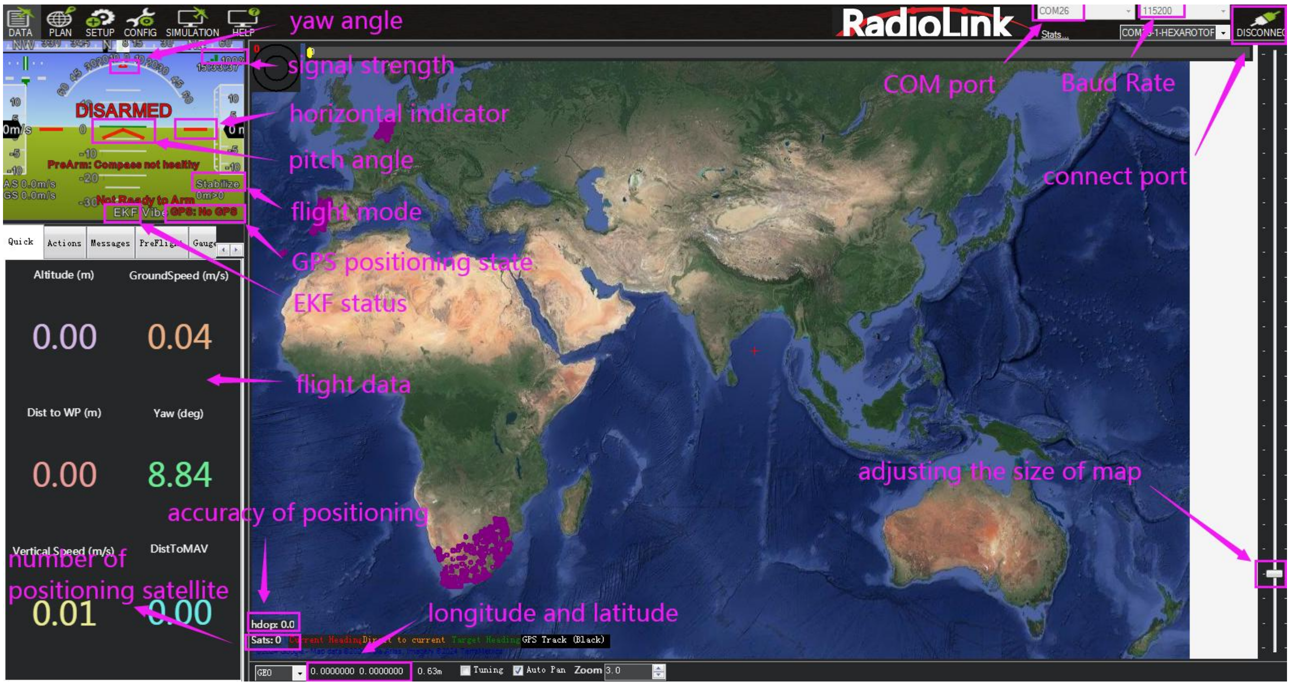


2.2 Mission Planner Introduction

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.
INTIAL SETUP: for firmware installation and update, Mandatory Hardware and Optional Hardware setup.
CONFIG/TUNING: including detailed PID setup and parameters change.
SIMULATION: make CrossFlight-CE 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-CE can only upgrade the firmware from RadioLink.
* CrossFlight-CE can set parameters by RadioLink Mission Planner, ArduPilot Mission Planner, and QGC Mission Planner.
* CrossFlight-CE can upgrade the firmware by both RadioLink Mission Planner and ArduPilot Mission Planner (Firmware can only be upgraded by loading custom firmware).

CrossFlight-CE firmware download link:www.radiolink.com.cn/crossflightce_firmware

CrossFlight-CE 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

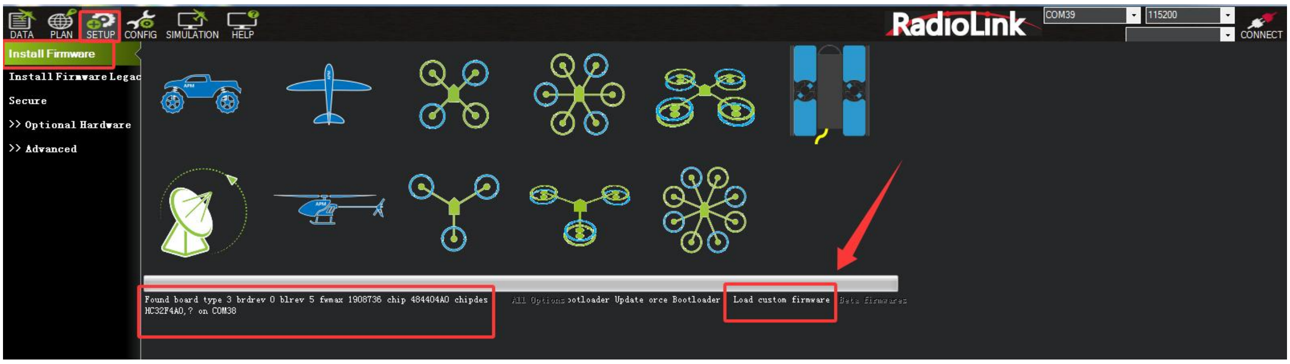
Firmware update steps:

Open Mission Planner. Click SETUP--Install Firmware. Connect CrossFlight-CE to the computer via a Type-C cable. Found board appears in the lower-left corner, indicating that the flight controller has been recognized. Click Load custom firmware in the lower-right corner (as shown below) and select the firmware downloaded from RadioLink official website. Follow the prompts to complete the firmware installation and wait for the flight controller firmware to install.

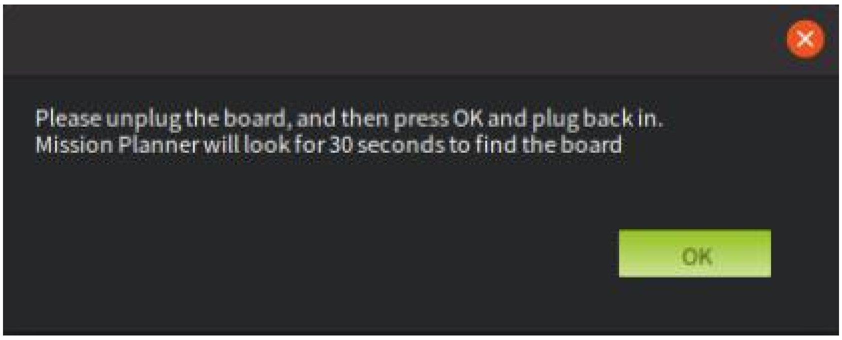
Attention:

(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.



In some situation, it may prompt you to unplug the board, click OK and plug in the board (as shown below). Please disconnect the USB cable, click OK and then reconnect USB cable immediately.

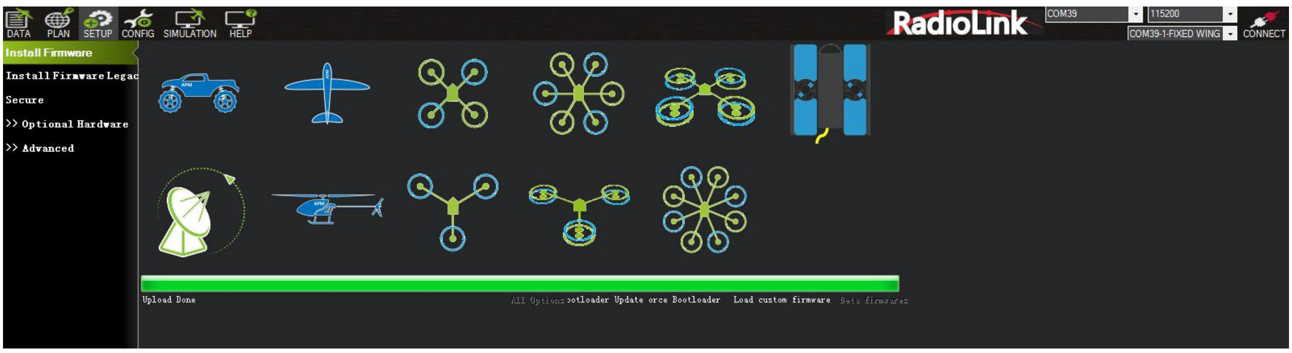


Pay attention: If there are multiple COM port names, connection may fail. Please remove other equipment first.

Red status LED means the CrossFlight-CE 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.

After it prompts Upload Done, you can click CONNECT in the upper right corner to connect your CrossFlight-CE to Mission Planner and set it.



Pay attention:

(1) It needs to take a long time to read the parameters.

(2) There is no option of Load custom firmware in Mission Planner.

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

If you meet the above three problems, please set Layout from "Basic" to "Advanced" in CONFIG/TUNING menu if any of the three questions as below encontered when you installing the Mission Planner.

3.2 Accelerometer Calibration

Make sure the CrossFlight-CE 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.

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

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

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

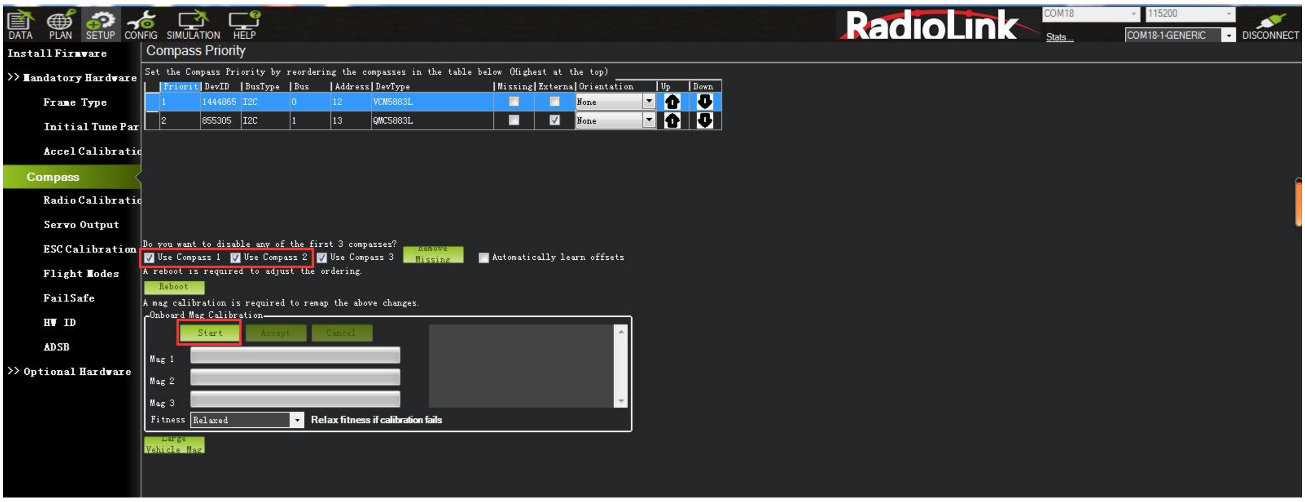
6. Place vehicle on its BACK and press any key to save setting.

3.3 Compass Calibration

There are two situations about compass calibration:
1. With external GPS, use external and internal compass at the same time.
2. Without external GPS, use internal compass.

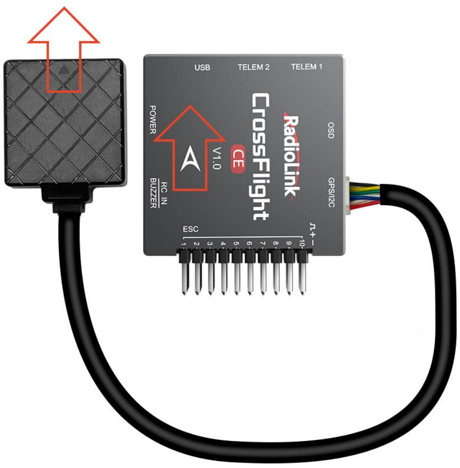
You can also check the video tutorials on how to calibrate the compass:
https://www.youtube.com/watch?v=XR_4e18F5W0

1. When external GPS are used, compass calibrate interface will shows as picture below when use with GPS. Check Compass 1 and Compass 2. Please fixed CrossFlight-CE and GPS, then click “Start” and turn CrossFlight-CE and GPS till the progress bar of Mag 1 and 2 to the end.



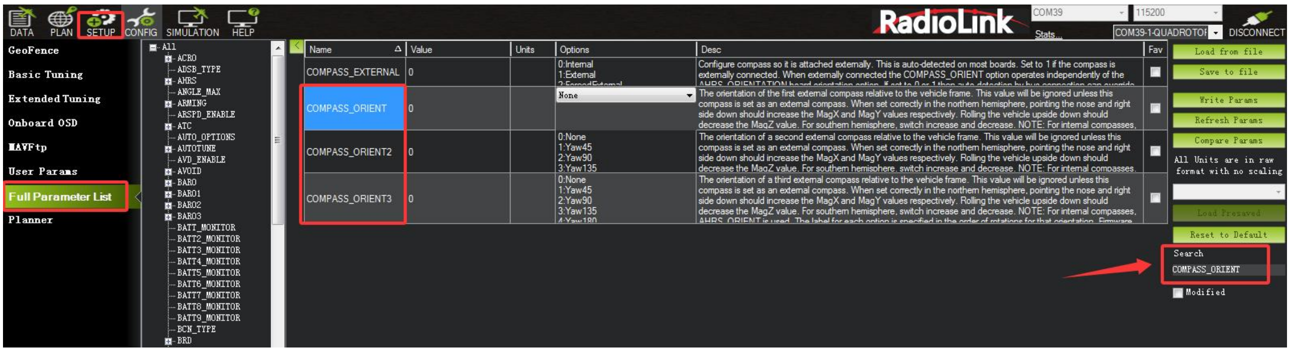
Of the two compasses, one is the built-in compass of the flight controller and the other is an external compass (the compass on the GPS). The External option of the external compass will be checked.

If the GPS mounted with the same direction with flight controller, you don’ t need to set the direction of GPS in MP.

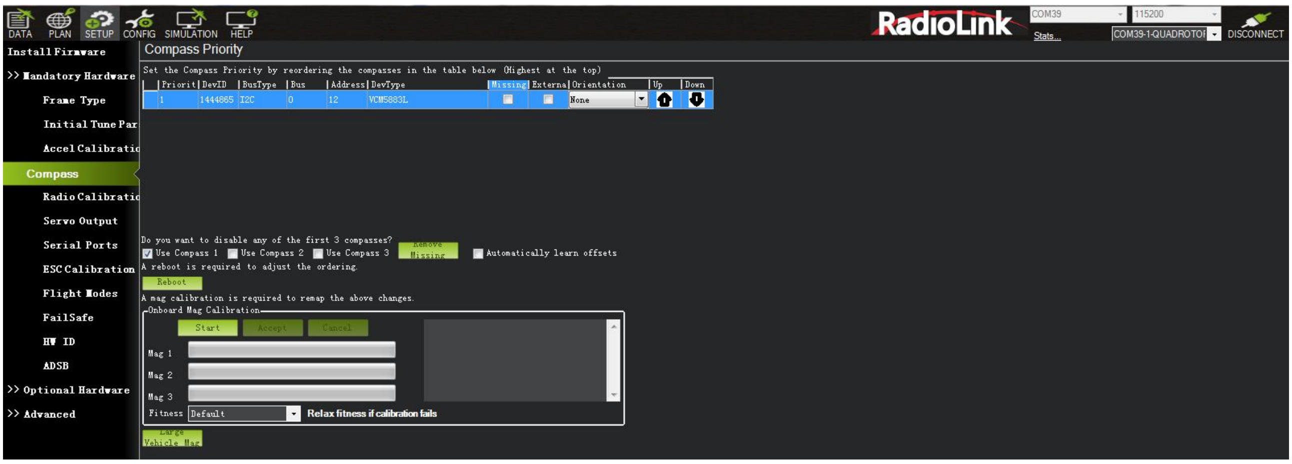


In this picture, the direction of the flight controller and GPS is the same.

If you mount the external GPS with the different direction of CrossFlight-CE, you have to search for COMPASS_ORIENT in Full Parameter List and set the direction of the GPS. Then click Write Params to save the modification.

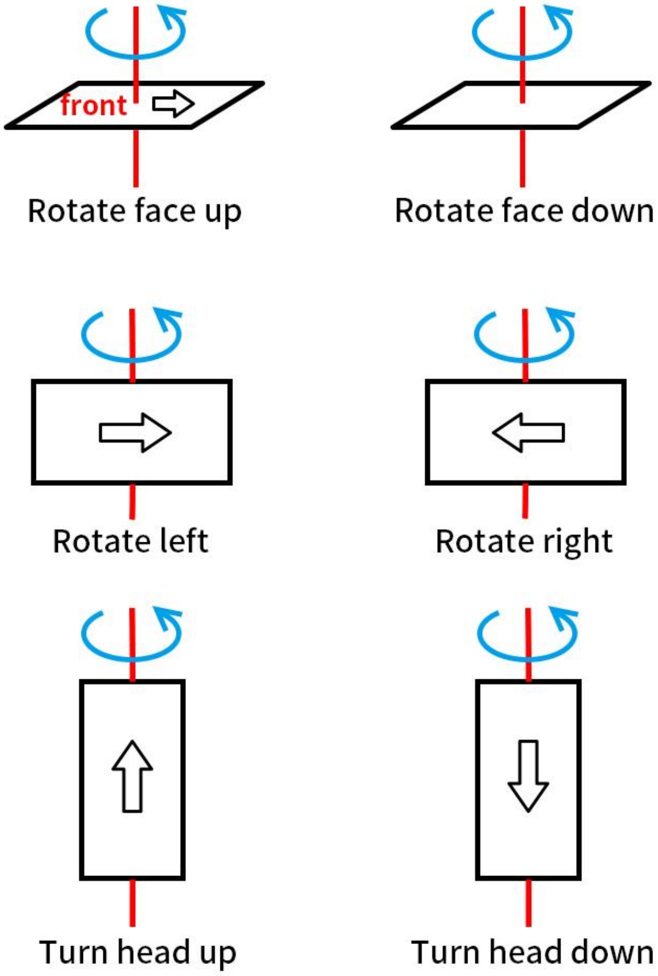


2. When external GPS are used, compass calibrate interface will shows as picture below.

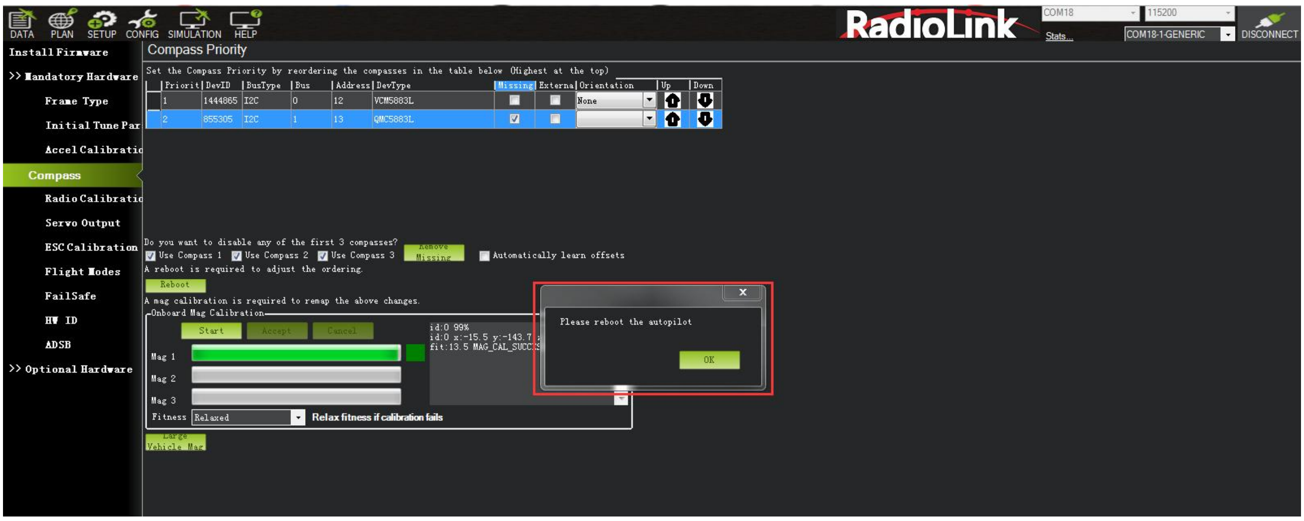


Calibrate the compass as these steps below:

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

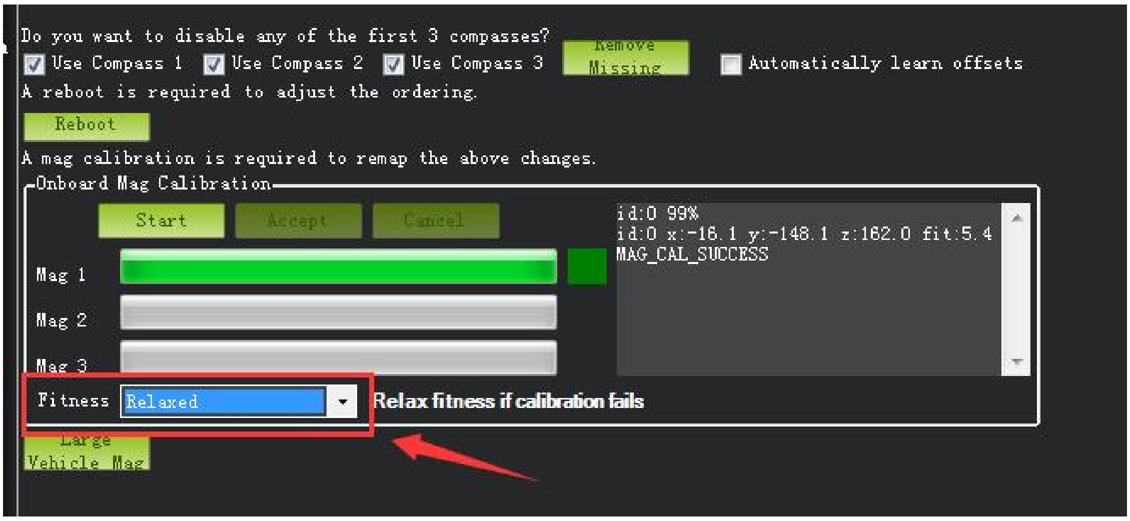


The mission planner will keep recording the data that collected by the compass sensor and the progress bar and the percentage will keep change when you calibrate the compass, if the percentage have not changed, please check if the compass is connect success.
The mission planner will prompt a notice: Please reboot the autopilot when the compass calibration is successful.



Click OK and then reconnect CrossFlight-CE to computer, compass calibrate success after restart the CrossFlight-CE.

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.



3.4 Radio Calibration

This article shows how to perform radio control calibration in 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)

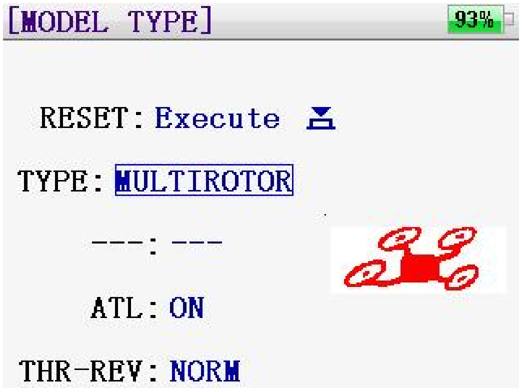
Unused channels can be mapped to control additional peripherals.

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

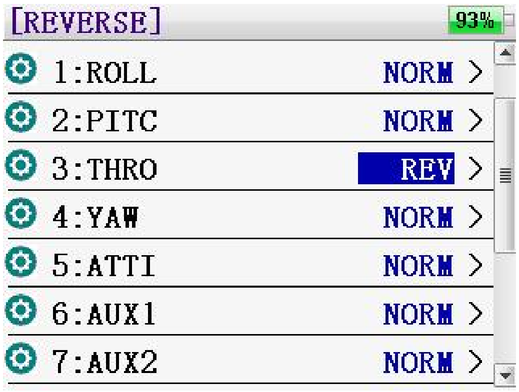
Bind your transmitter and receiver before calibrate radio, connect CrossFlight-CE to computer via USB cable and then turn on transmitter. The RC receiver ask to connect to the RC port of CrossFlight-CE.

The transmitter will make AT9S Pro as an example in this manual. Here are the settings on the transmitter:

1. Press Mode button to select MODEL MENU--MODE TYPE and select MULTIROTOR.



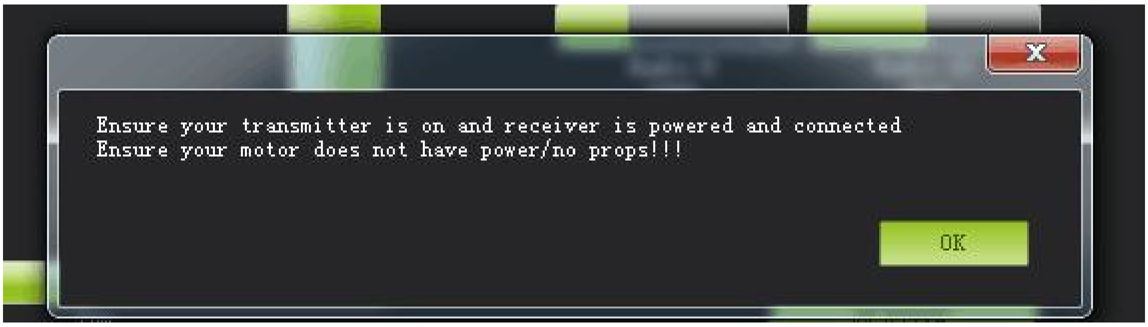
2. Setup CH3: THRO REV in REVERSE menu. Press Mode button to select MODEL MENU--REVERSE. Set the throttle channel to REV.

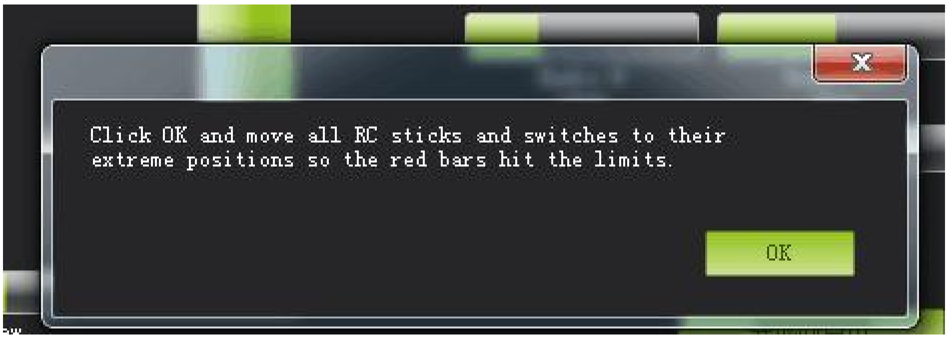


Radio Calibration Steps:

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.

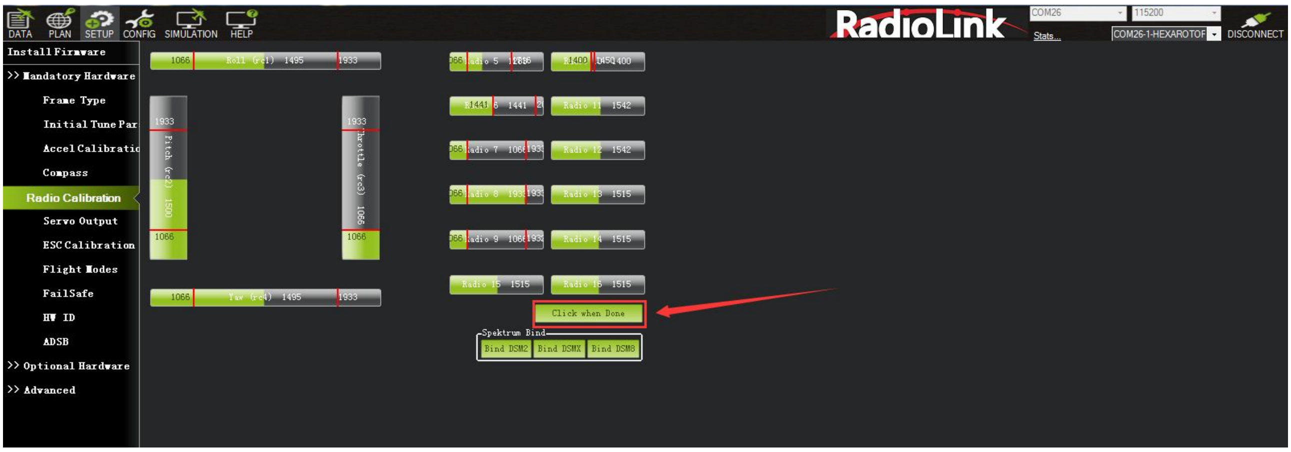
If the red bars have not any change when you move the sticks, please check the receiver have connect success or not, make sure the receiver (maybe R9DS) is output SBUS signal (the blue LED of R9DS means work as SBUS signal). You can check if every corresponding red bar for every channel is work as below:

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

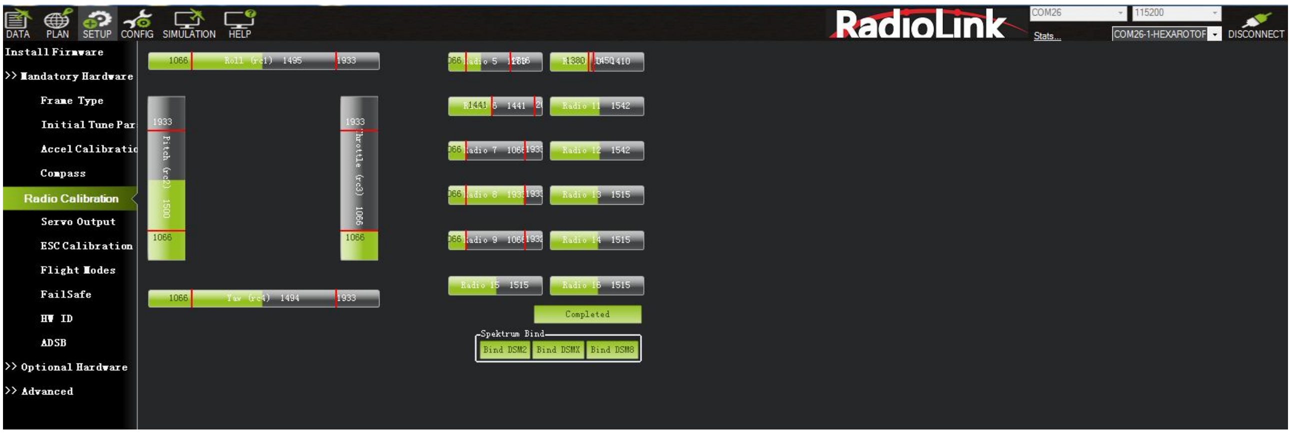
CH2: low position =pitch(forward), up position =pitch(backwards).

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 Setup

CrossFlight-CE has multiple flight modes, 6 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:

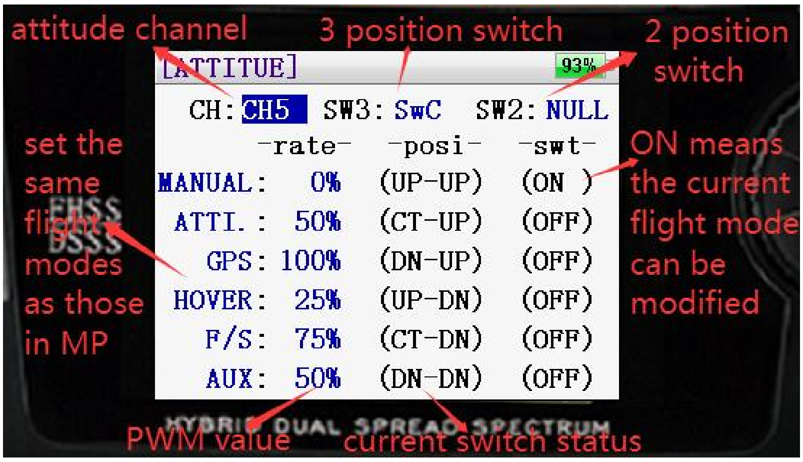
1. Connect CrossFlight-CE and receiver (connect the RC port of CrossFlight-CE, and make sure receiver work as SBUS signal).
2. Make sure transmitter bind to receiver success.
3. Make sure CrossFlight-CE connect to Mission Planner success and click INITIAL SETUP—Mandatory Hardware—Flight modes, you can 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. (For the flight mode settings of CH7 and CH8, open Mission Planner---configuration/debugging---extended parameters---Channel 7 opt/Channel 8 opt, and then assign 2 control switches for the two channels in the transmitter.)

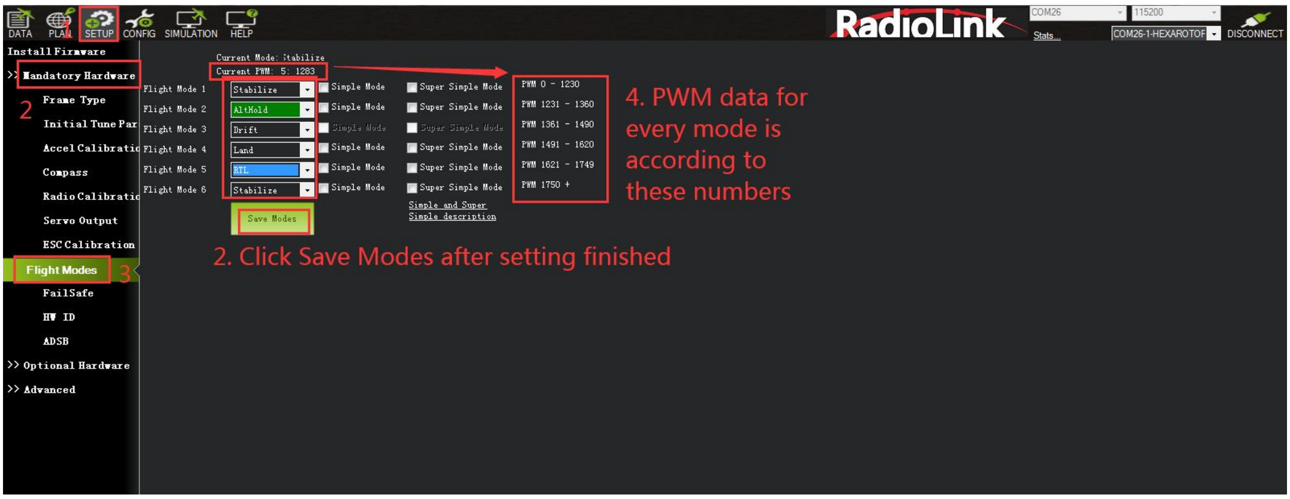


3. Setup Flight Mode 1 is Stabilize both in Mission Planner and transmitter.

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.)

4. Mode 4 needs a two-way switch. Turn the switch to the corresponding mode. Set it in the same way as step 3.
5. Please check the introduction of simple mode and super simple mode, and then you can choose whether to start simple mode or super simple mode in the mode.



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.

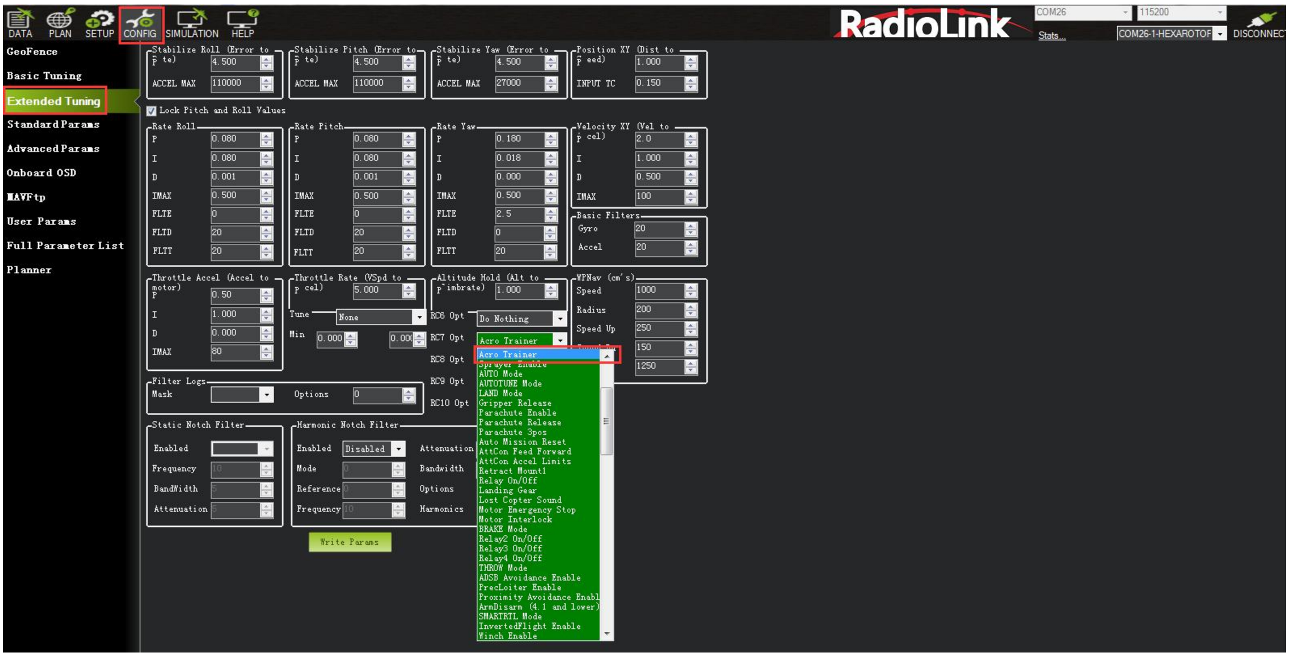
3.6.2 Acro Mode (FPV)

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_RATE controls the rotation rate of the roll and pitch axes, by default 360, which represents a rotation rate of 360 degrees/second. Higher values result in higher spin rates, lower values result in lower spin rates.

ACRO_Y_RATE controls the rotation speed of the yaw axis. By default 202.5, like roll and pitch, represents a rotation rate of 202.5 degrees/second.

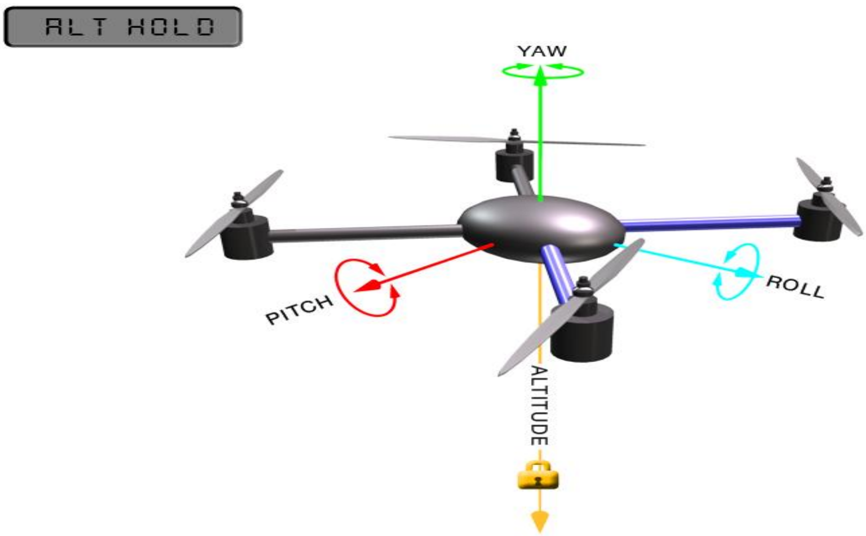
ACRO_RP_EXPO Acro roll/pitch Expo to allow faster rotation when stick at edges.

ACRO_Y_EXPO Acro yaw expo to allow faster rotation when stick at edges.

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

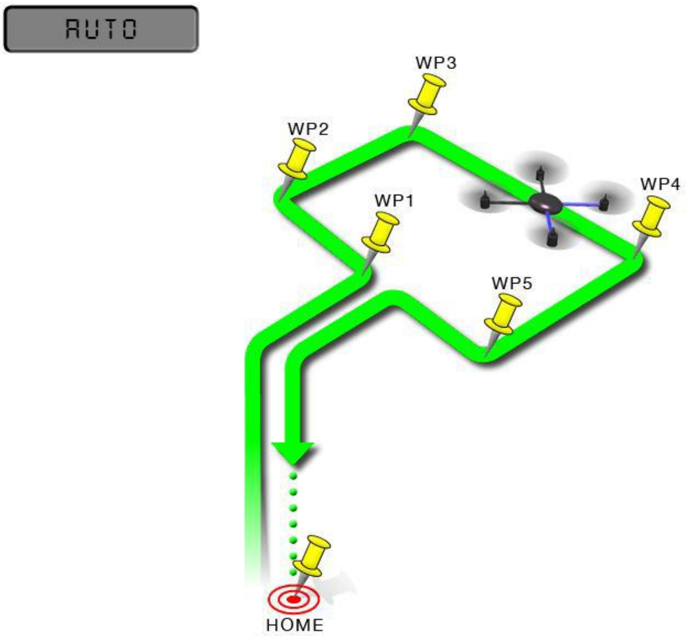
The pilot can control the climb or descent rate of the vehicle with the throttle stick. If the throttle stick is in the middle (40% ~ 60%) the vehicle will maintain the current altitude. Outside of the mid-throttle deadzone (i.e. below 40% or above 60%) the vehicle will descend or climb depending upon 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_SPEED_UP and PILOT_SPEED_DN parameters.

The size of the deadband can be adjusted with the THR_DZ parameter (AC3.2 and higher only). This params 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-CE 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-CE 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 compassand 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).

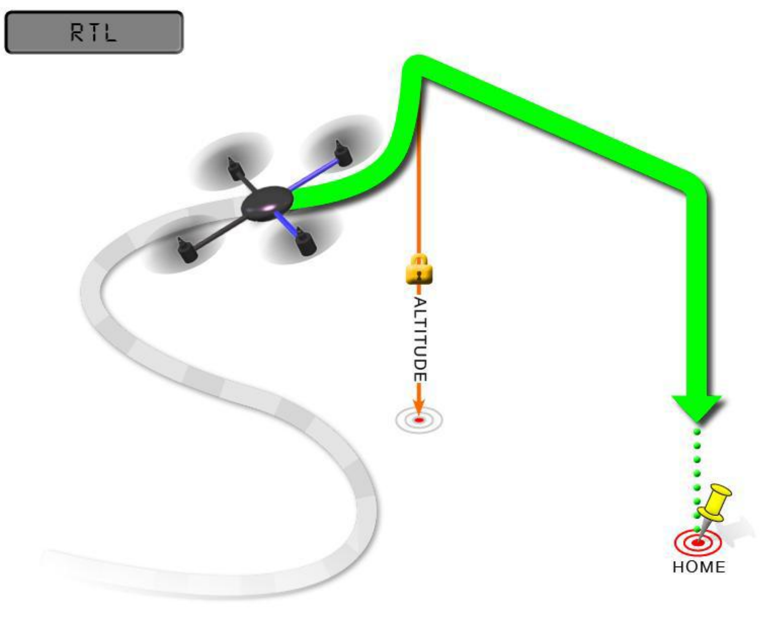
The speed the vehicle rotates back to the maximum angle can be set with the PHLD_BRAKE_RATE parameter (i.e. 8 = rotates back at 8 degrees per second)).

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).

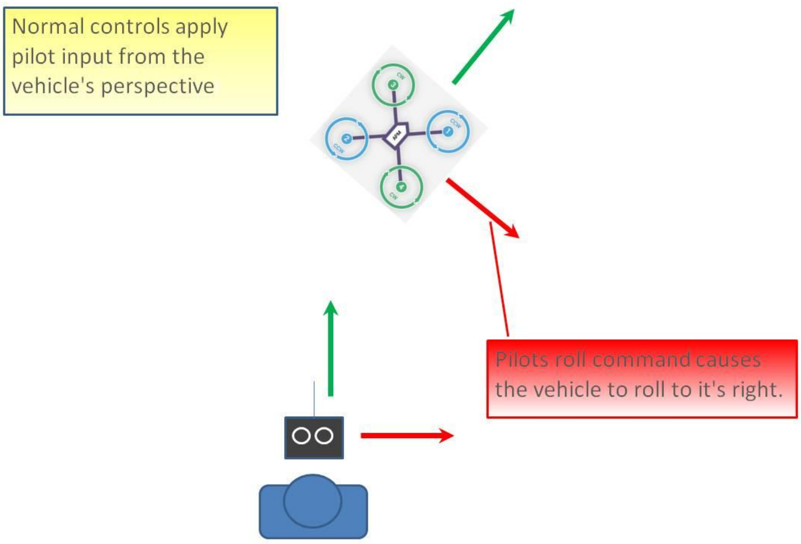
Options (User Adjustable Parameters)
1. RTL_ALT: The minimum altitude the copter will move to before returning to launch.
(1) Set to zero to return at the current altitude.
(2) The return altitude can be set from 1 to 8000 centimeters.
(3) The default return altitude Default is 15 meters (1500).
2. RTL_ALT_FINAL: 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

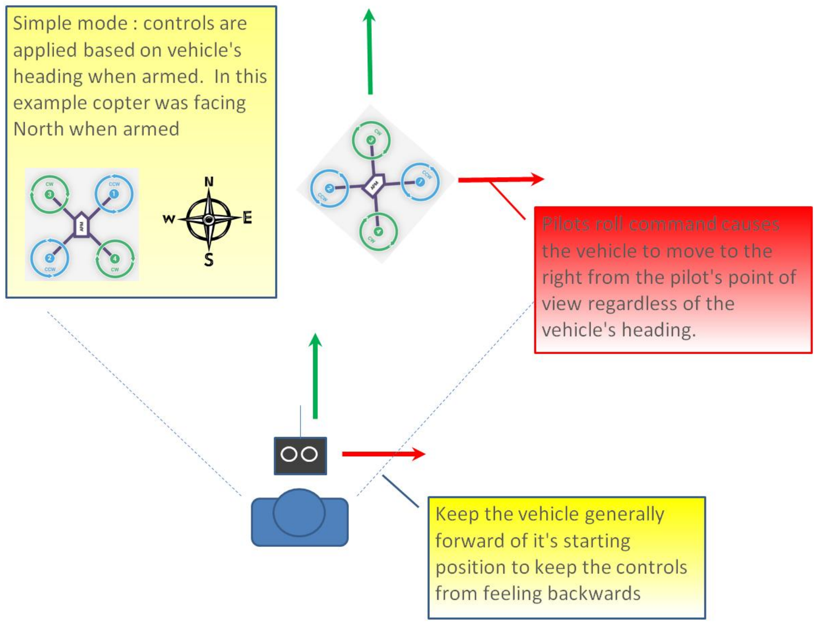
"Simple" and "Super Simple" modes allow the pilot to control the movement of the copter from the pilot's point of view regardless of which way the copter is facing. This is useful for new pilots who have not mastered adjusting their roll and pitch inputs depending upon which way the vehicle is facing 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

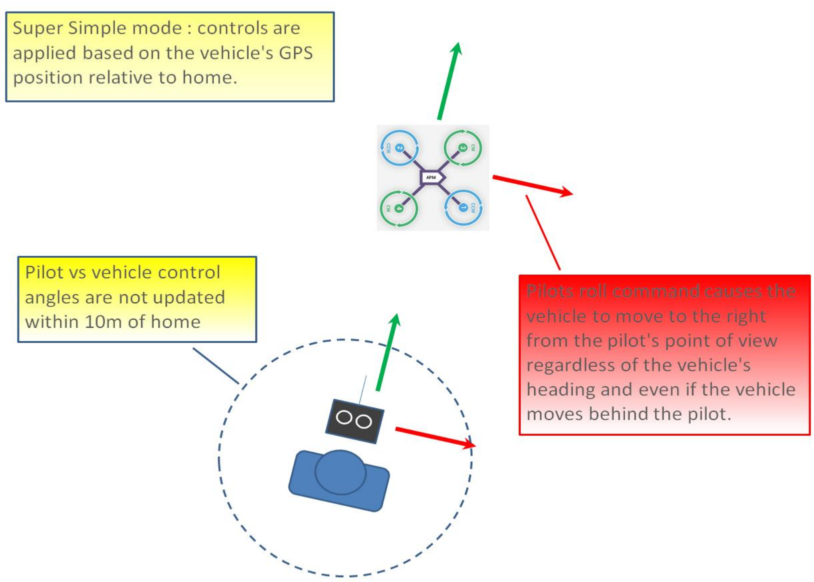


Similar to the "care free" mode on other systems, this mode allows you to fly your copter as though it were pointed in the direction it was pointed when it was armed regardless of its current heading orientation. So, if you hold the pitch stick forward the copter will fly away from you, pull the pitch 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 detailed introduction about more flight modes, please check on website here:
http://ardupilot.org/copter/docs/flight-modes.html
http://www.ncnynl.com/archives/201608/417.htmlk

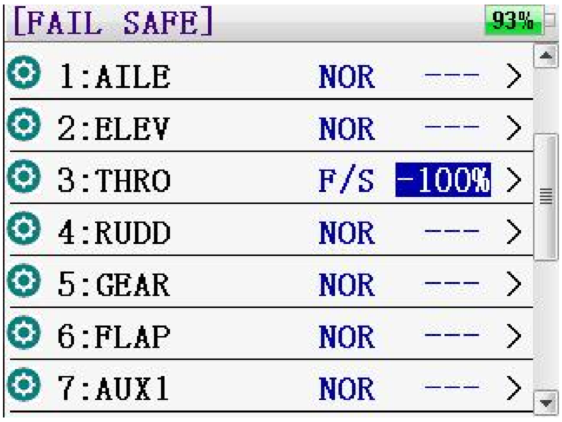
4. F/S(failsafe) Setting

4.1 Radio Failsafe Setup

CrossFlight-CE 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.

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-CE 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.

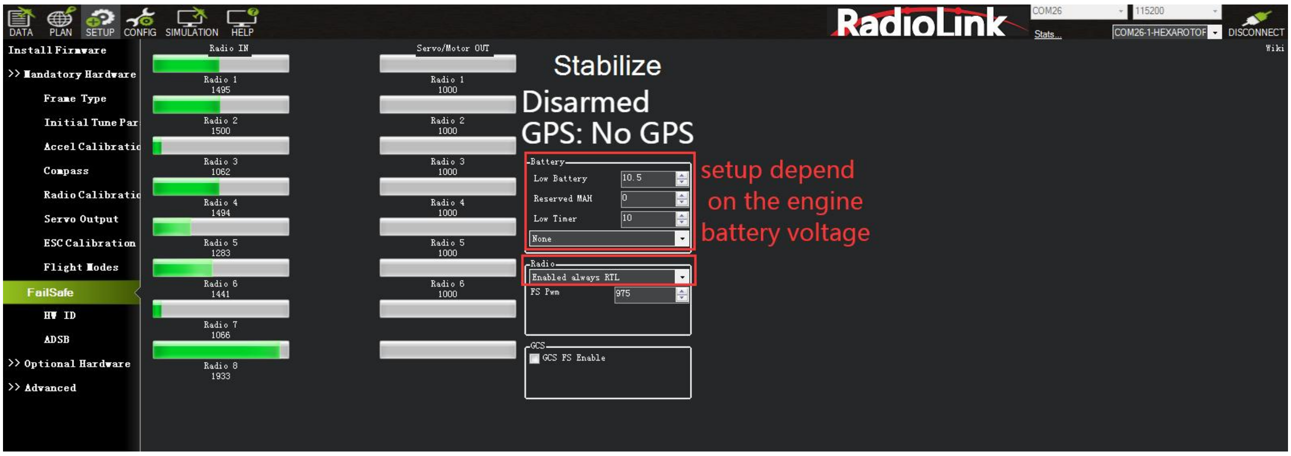
Set the “FS PWM” value to be:

(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).

1. Set battery fail safe
Set battery fail safe according to the aircraft power consumption, battery voltage, and flight distance. When the battery voltage is lower than this value, there will be enough battery voltage to return the aircraft. Set the low battery value (This value is set according to the battery voltage. When you fly long distances, Please set the single cell to 3.8V, the voltage value is 3.8V*S, the 3S battery is 3.8*3=11.4V; when at a close distance, you can set 3.6V for each cell), and set the action to RTL (return to home).

2. Set the radio fail safe（throttle fail safe）. Set the action to RTL , and set the fail safe PWM (generally no need to change). Set the fail-safe setting in the transmitter, because we set the fail safe to start after the throttle is lower than 975, so we need to set the throttle fail safe value. Push the throttle trim button in the transmitter and check the input value of channel 3 in the transmitter in fail safe, so that the value is less than 10 or more than 975. Take RadioLink AT9S Pro as an example. Press the Mode button to enter the basic menu and select FAIL SAFE. Press Push to select Channel 3: Throttle. Turn the

dial to select F/S and press Push button. When a value appears, the setting is successful. Remember to turn trim button to restore.

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

- Nothing if the vehicle is already disarmed.
- Motors will be immediately disarmed if the vehicle is landed OR in stabilize or acro mode and the pilot’ s throttle is at zero.
- Return-to-Launch (RTL) if the vehicle has a GPS lock and is more than 2 meters from the home position.
- 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”
- Continue the task if in automatic mode and the failsafe option is Enabled_continue_in_auto_mode.
- If the failsafe is cleared (the throttle is above 975), the aircraft will continue to fly in the flight mode corresponding to the previously set failsafe, and will not automatically return to the previous flight mode of normal flight.

For example: the RTL mode is set for the fail safe, and the aircraft is flying normally in stabilize mode. Suddenly the fail safe is triggered due to signal loss, causing the aircraft's flight mode to automatically change from the stabilize mode to the previously set RTL mode. Even if the transmitter and receiver signals are reconnected during the return journey and the fail safe is released, the aircraft will still fly in the RTL mode. If you need to fly in stabilize mode again, you need to move the flight mode switch to another position and then back to the position of stabilize mode.

3. Set attitude fail safe in the transmitter. The prerequisite for setting attitude fail safe is that there is a fail safe mode in the flight mode settings. Taking RadioLink AT9S Pro as an example. Turn on the transmitter, flip the setting switch to RTL mode or the fail-safe mode you want to set, press Mode to enter the MODEL MENU--FAIL SAFE. press Push to select 5: Attitude, Toggle to select F/S, hold Push, and the numbers below will change. Open Mission Planner to verify it. Turn off the transmitter and check that it is RTL in Mission Planner.

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.

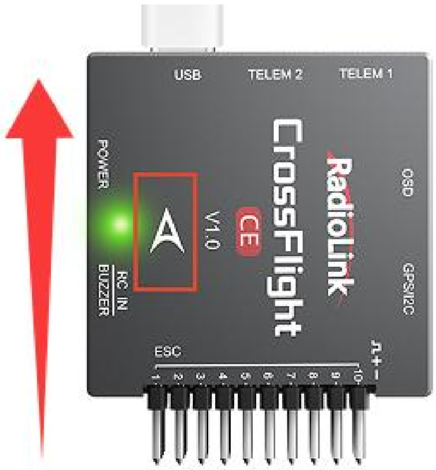
FS_EKF_THRESH
Note: This parameter is for advanced users.
Allows setting the maximum acceptable compass and velocity variance.

Values
0.6:Strict, 0.8:Default, 1.0:Relaxed

5. Installation and setup of CrossFlight-CE

5.1 Install CrossFlight-CE

Mount the CrossFlight-CE at the barycenter of the drone, make sure the arrow of the CrossFlight-CE is point to the front.



Keep the GPS with the same direction of CrossFlight-CE if you need to use CrossFlight-CE with GPS.

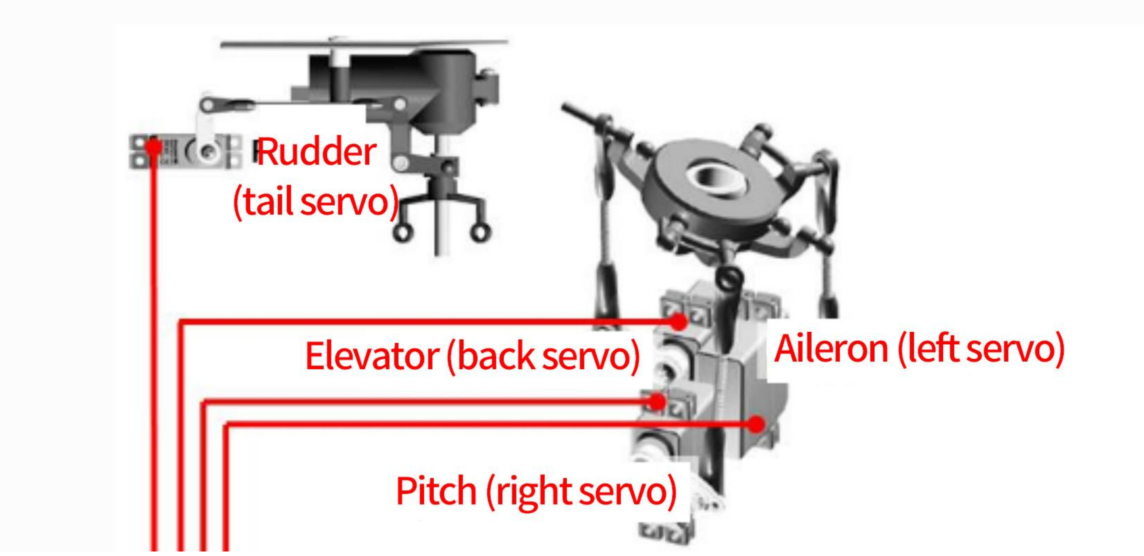
If the installation can’ t be done with the default direction, parameters need to be setup according to the installation direction.

AHRS_ORIENTATION

AHRS_ORIENTATION	0		0:None 1:Yaw45 2:Yaw90 3:Yaw135 4:Yaw180 5:Yaw225 6:Yaw270 7:Yaw315 8:Roll180 9:Roll180Yaw45 10:Roll180Yaw90 11:Roll180Yaw135 12:Pitch180 13:Roll180Yaw225 14:Roll180Yaw270 15:Roll180Yaw315 16:Roll90 17:Roll90Yaw45 18:Roll90Yaw90 19:Roll90Yaw135 20:Roll270 21:Roll270Yaw45 22:Roll270Yaw90 23:Roll270Yaw135 24:Pitch90 25:Pitch270 26:Pitch180Yaw90 27:Pitch180Yaw270 28:Roll90Pitch90 29:Roll180Pitch90 30:Roll270Pitch90 31:Roll90Pitch180 32:Roll270Pitch180 33:Roll90Pitch270 34:Roll180Pitch270 35:Roll270Pitch270 36:Roll90Pitch180Yaw90 37:Roll90Yaw270	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 oriented in your vehicle at any 90 or 45 degree angle. This option takes affect 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-CE to Helicopter

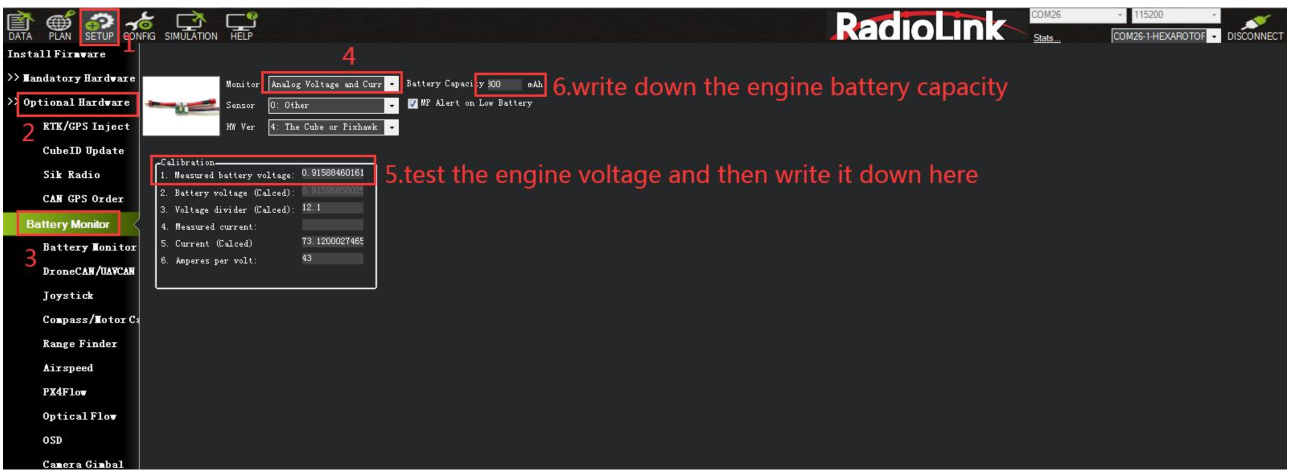


CrossFlight-CE connection instructions:
CrossFlight-CE ESC1 -- aileron, left servo.
CrossFlight-CE ESC2 -- pitch, right servo .
CrossFlight-CE ESC3 -- elevator, back servo .
CrossFlight-CE ESC4 -- rudder, tail servo.
CrossFlight-CE ESC6 -- ESC.

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

Battery Monitor 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

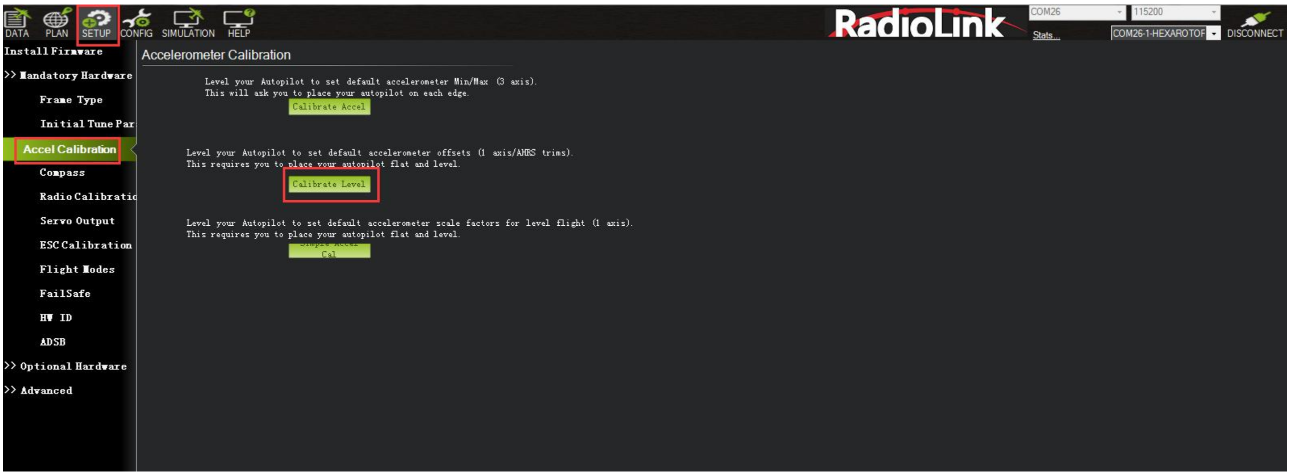
When the setting is turned on, there may be no data. At this time, please disconnect the flight controller, re-power the flight controller, and then open this interface, enter the measured battery voltage, and when the same voltage as the input measurement value appears in the 2. battery voltage (calculated) 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.

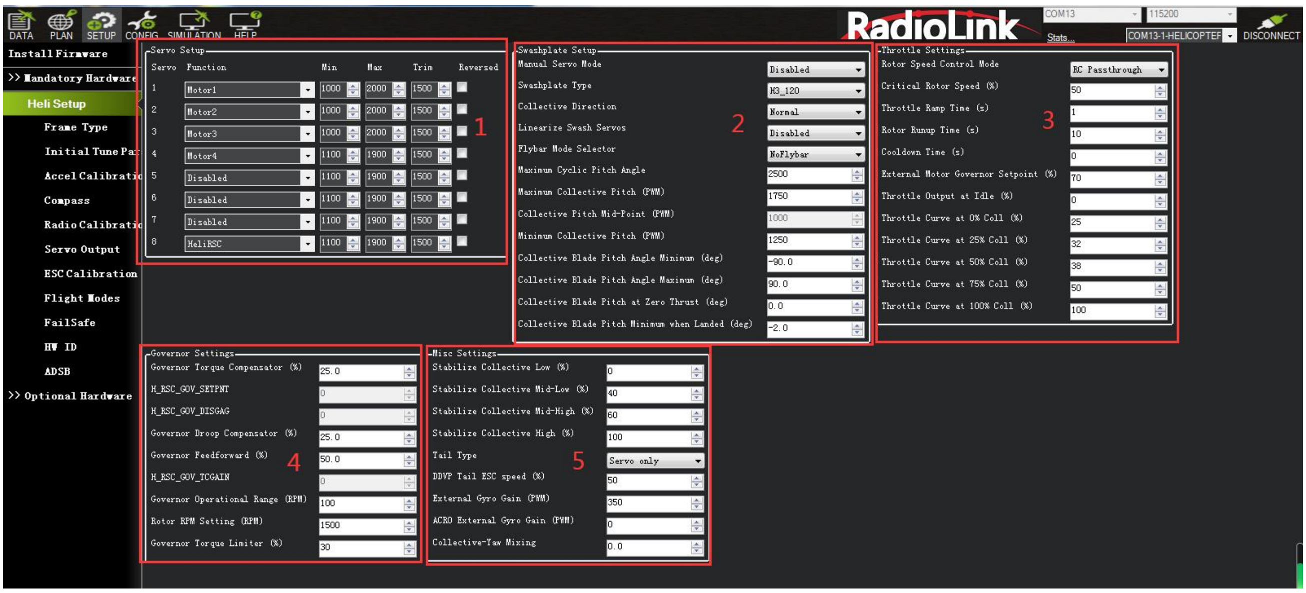


5.5 Helicopter Setup

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.

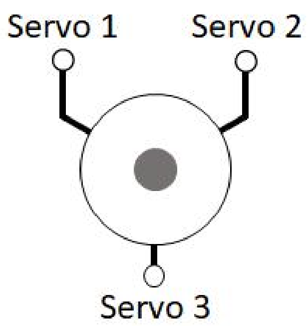
For single heli, the servo function assigned to Servo 1 is motor 33, Servo 2 is motor 34, and Servo 3 is motor 35. These assignments are the same for swashplate 1 for a dual heli frame. Swashplate 2 for a dual heli defaults to servo outputs 4, 5, and 6 with motors 36, 37 and 38 assigned respectively.

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.

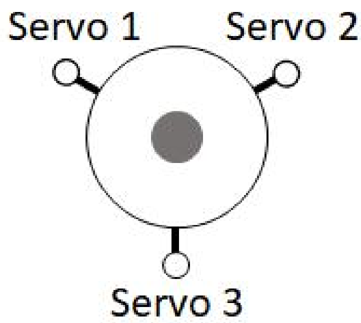
H3 Generic - Allows servo positions and phase angle to be set by user. Assumes all swashplate ball links are the same distance from the main shaft.

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

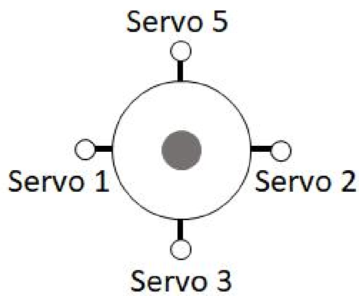
H3-140



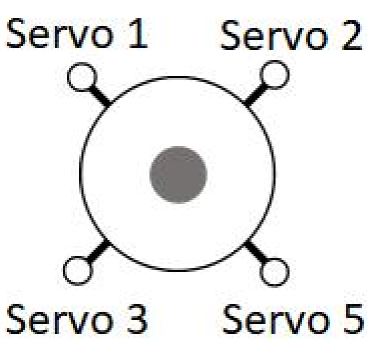
H3-120



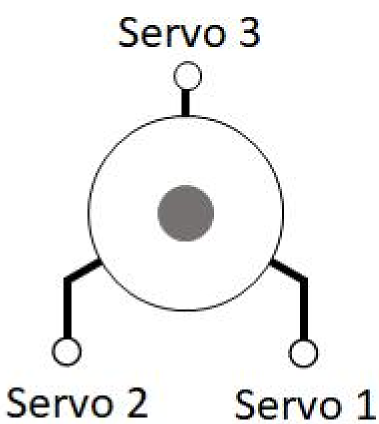
H4-90



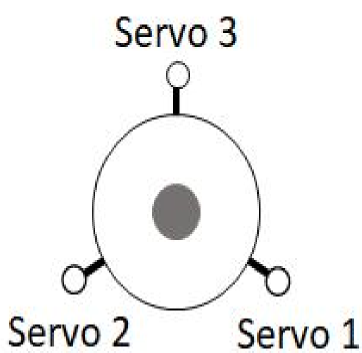
H4-45



H3R-140



H3R-120



5.5.3 Swashplate Setting

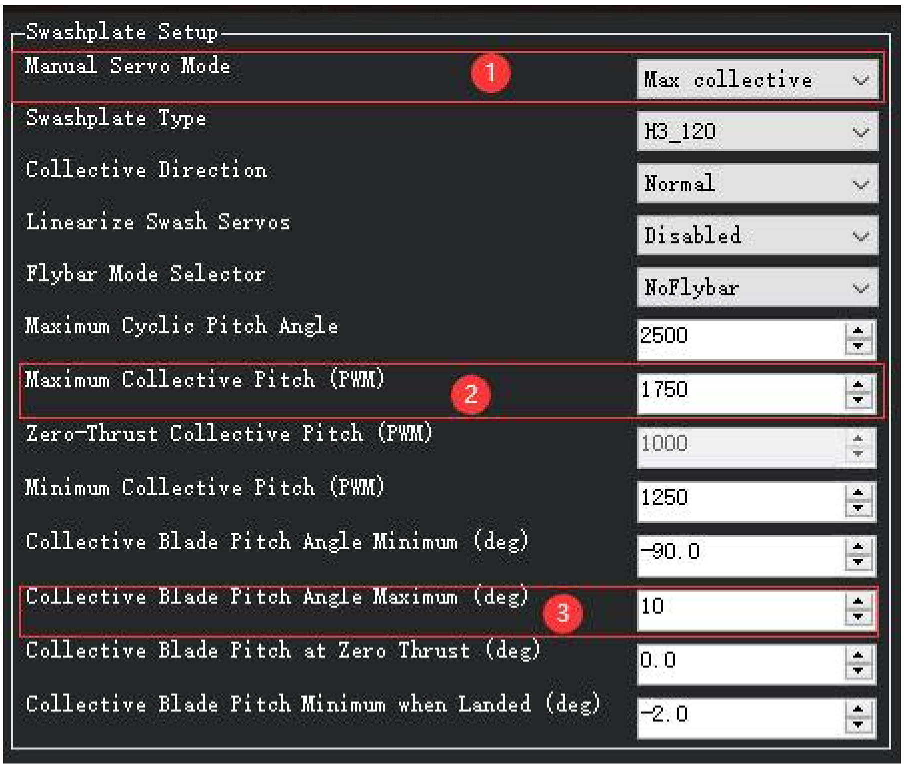
1. Check Proper Swashplate Movement.
Use your transmitter to check for proper swashplate response to cyclic and collective inputs.
Push forward on the elevator stick and swashplate tilts forward; pull back on the elevator stick and swashplate tilts aft.
Push right on the aileron stick and the swashplate 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.

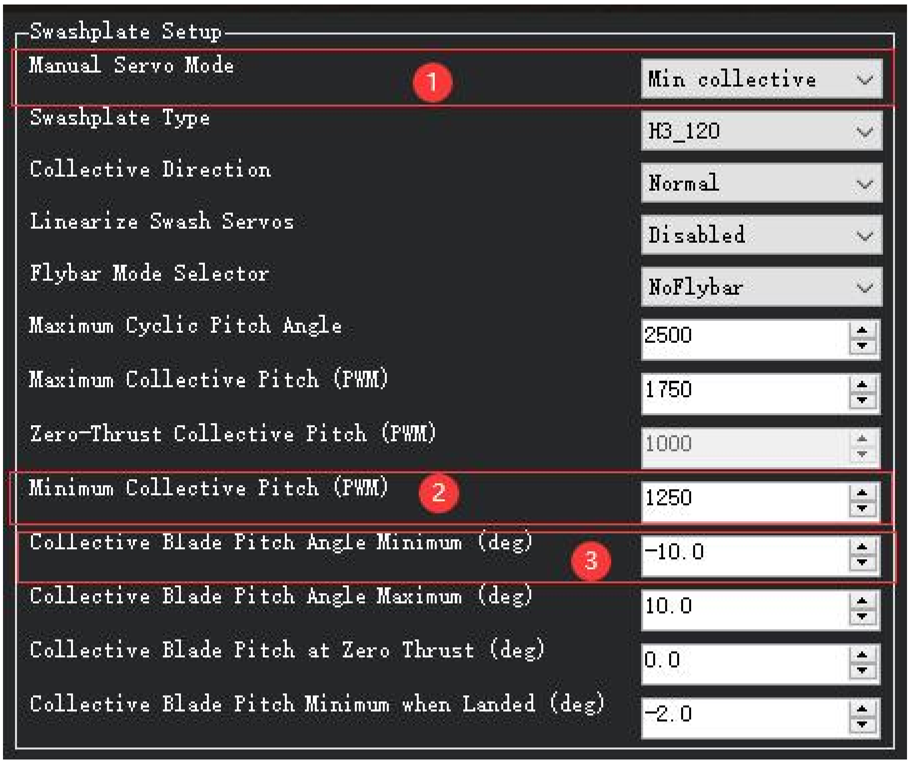
(1) First install the pitch gauge on the propeller.

(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.

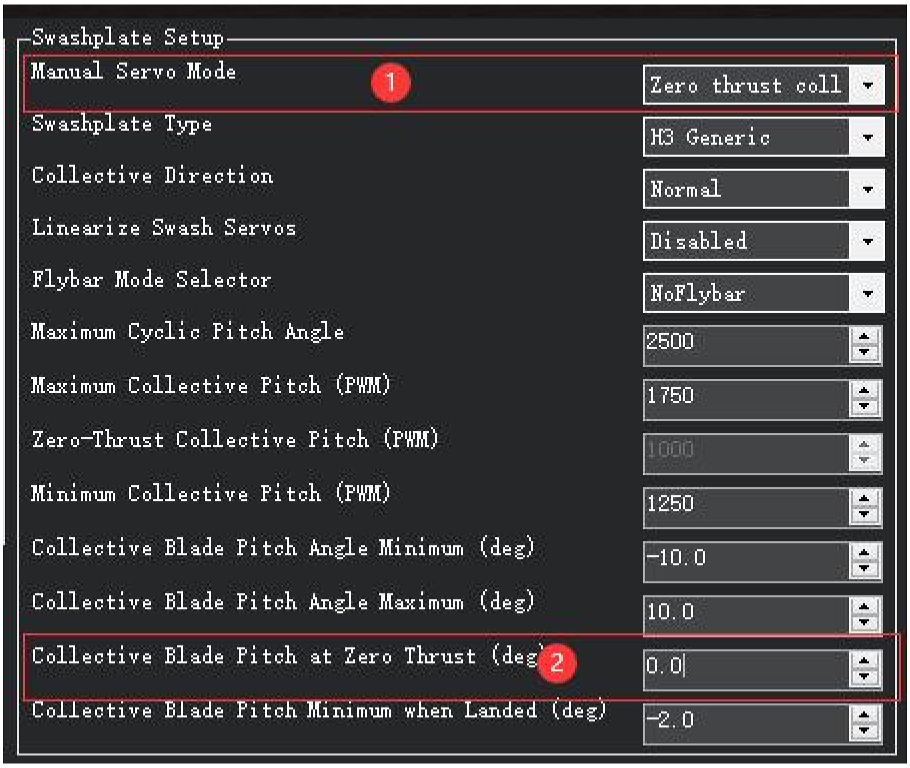


(3) Set -10 degrees. First modify the Manual Servo Mode in the figure ① below to Min collective, and then check the pitch scale number. And adjust the Minimum Collective Pitch(PWM) in the

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.



(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.

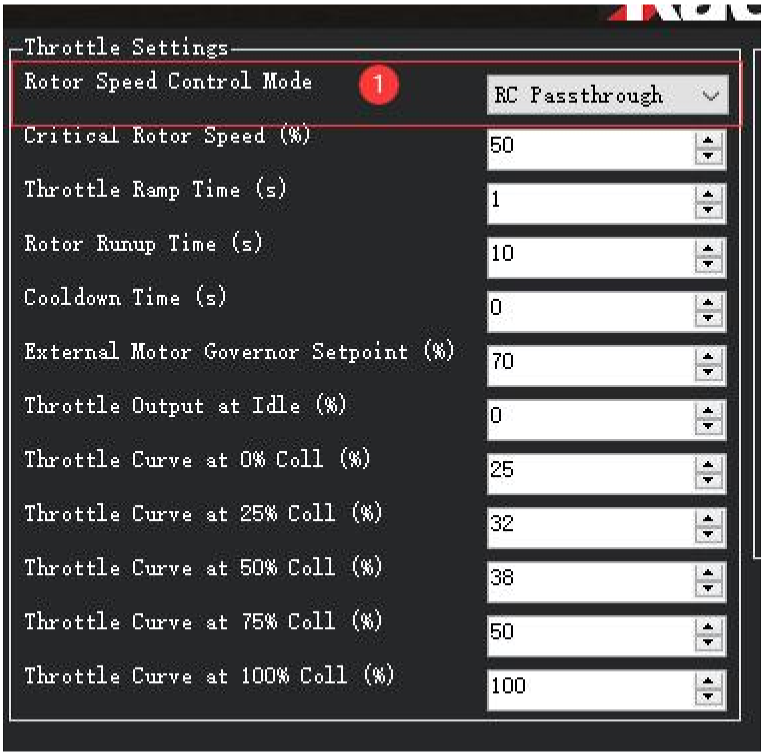


(5) The H_COL_LAND_MIN parameter is used as the lower collective pitch limit in degrees for modes that use altitude hold in the vertical axis. This keeps the autopilot from driving

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: PWM output = RSC_SETPOINT*0.01*(SERVOx_MAX - SERVOx_MIN) + 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.

Waringing ; 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 aicraft 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 be 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.

5.5.6 Tailrotor Setup

There are several ways for controlling the tailrotor to maintain yaw stabilization and provide yaw control, and each have a unique setup. Search H_TAIL_TYPE in Full Parameter List. The H_TAIL_TYPE parameter is used to specify method for controlling the tailrotor. A list of available tail types is given below:

1. Servo Only: ArduPilot will supply the tail rotor stabilization like a tail rotor gyro and control the pitch of the tail rotor blades. As shown in Figure 1 below, select Servo Only in the Tail Type drop-down menu to configure it to use only servo control. As shown in Figure 2 below, set the parameter SERVOx_FUNCTION to Motor4 to control the tail servo. (The default output channel is channel 4.)

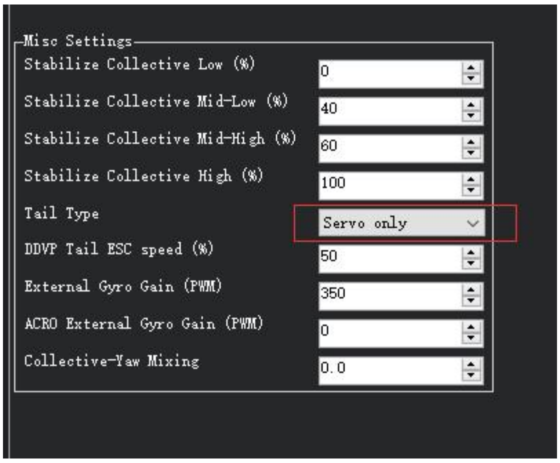


Figure 1 Select Servo Only

Figure 2 Set Output Channel

2. Servo with External Gyro: ArduPilot will output yaw demands without direct yaw attitude stabilization which is provided via an external gyro. As shown in Figure 3 below, select Servo with External Gyro in the Tail Type drop-down menu to configure the tail servo control with an external gyro. As shown in Figure 4 below, set the parameter SERVOx_FUNCTION to Motor4 to control the tail servo. (The default output channel is channel 4.)

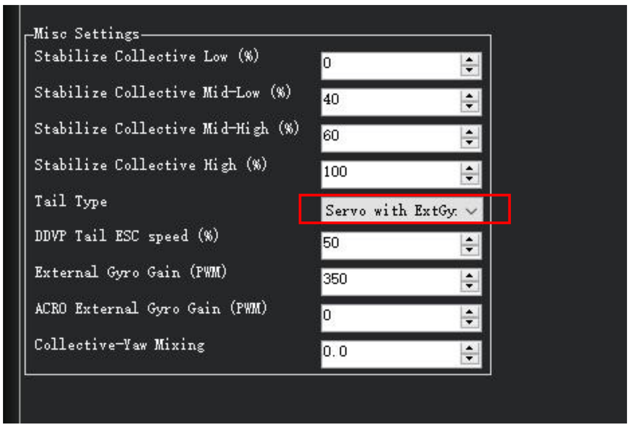


Figure 3 Select Servo with External Gyro

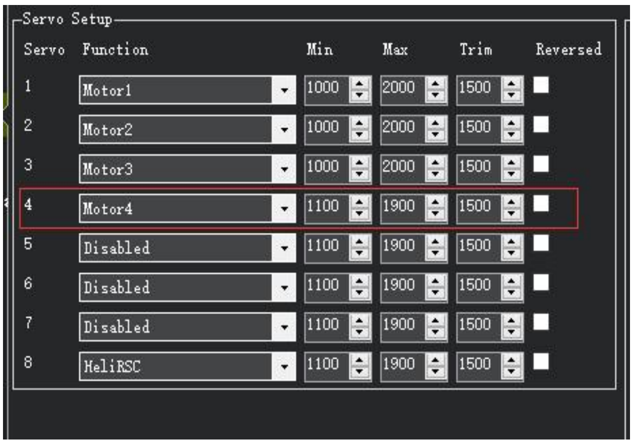


Figure 4 Set Output Channel

3. Direct Drive Variable Pitch (DDVP): The motor drives the variable pitch, and the control system consists of a servo and a motor. The tail rotor is driven by the motor, and the ESC of the motor is controlled by ArduPilot. Yaw is controlled by the tail rotor pitch servo. As shown in Figure 5 below, select Direct Drive Variable Pitch (DDVP) in the Tail Type drop-down menu to configure it to use motor-driven variable pitch to control. As shown in Figure 6 below, set the parameter SERVOx_FUNCTION to Motor4 to control the tail rotor pitch servo (The default output channel is channel 4). Set the parameter SERVOx_FUNCTION to "HeliTailRSC" to control the tail motor. (The default output channel is channel 7.)

Figure 5 Select Direct Drive Variable Pitch (DDVP)

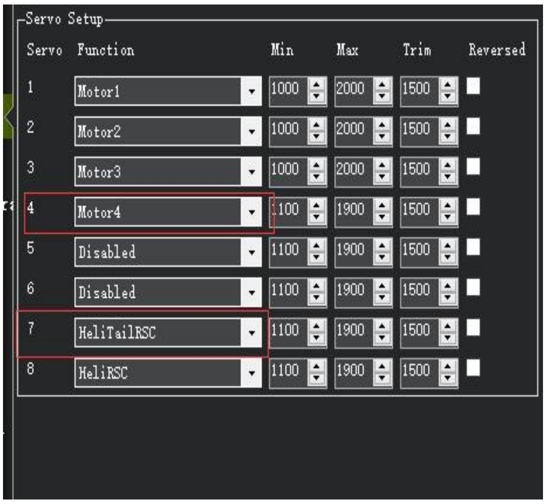


Figure 6 Set Output Channel

4. Direct Drive Fixed Pitch Clockwise (DDFP CW): Tail rotor is driven by a motor whose ESC is controlled by ArduPilot to maintain yaw stability and yaw direction. Used with clockwise rotating main rotors, when viewed from above. As shown in Figure 7 below, select Direct Drive Fixed Pitch Clockwise (DDFP CW) in the Tail Type drop-down menu to configure clockwise motor drive fixed pitch to control. As shown in Figure 8 below, set the parameter SERVOx_FUNCTION to "Motor4" to control the tail motor. (The default output channel is channel 4.)

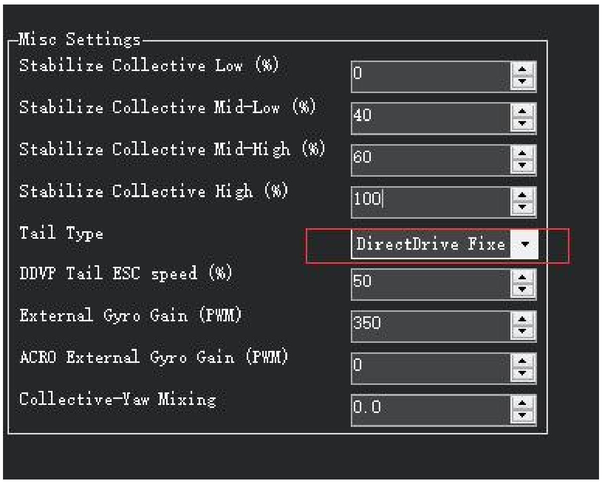


Figure 7 Select Direct Drive Fixed Pitch Clockwise

Figure 8 Set Output Channel

5. Direct Drive Fixed Pitch Counter-Clockwise (DDFP CCW): Tail rotor driven by a motor whose ESC is controlled by ArudPilot to maintain yaw stability and yaw direction. Used with counter-clockwise rotating main rotors, when viewed from above. As shown in Figure 9 below, select Direct Drive Fixed Pitch Clockwise (DDFP CW) in the Tail Type drop-down menu to configure counterclockwise motor drive

fixed pitch to control. As shown in Figure 10 below, set the parameter SERVOx_FUNCTION to "Motor4" to control the tail motor. (The default output channel is channel 4.)

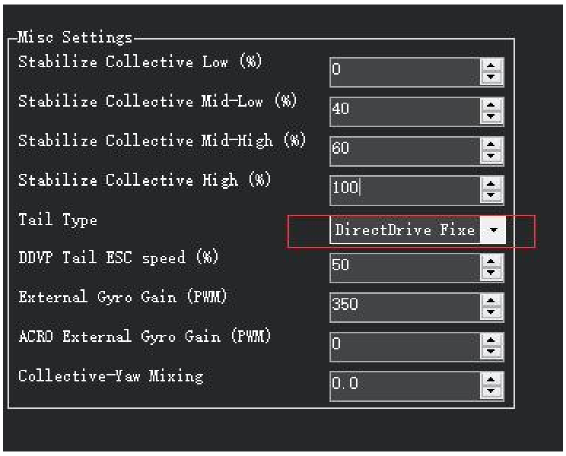
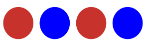


Figure 9 Select Direct Drive Fixed Pitch Counter-Clockwise

Figure 10 Set Output Channel

6. LED Indicator, Arming and Troubleshooting

6.1 LED Indicator

 Blue and red flashing: Initializing

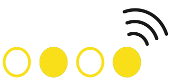
 Yellow flashing twice: Error, Arming rejected

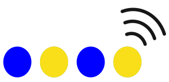
 Blue flashing: Stabilize, can be armed. Fail to RTL or PosHold

 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.

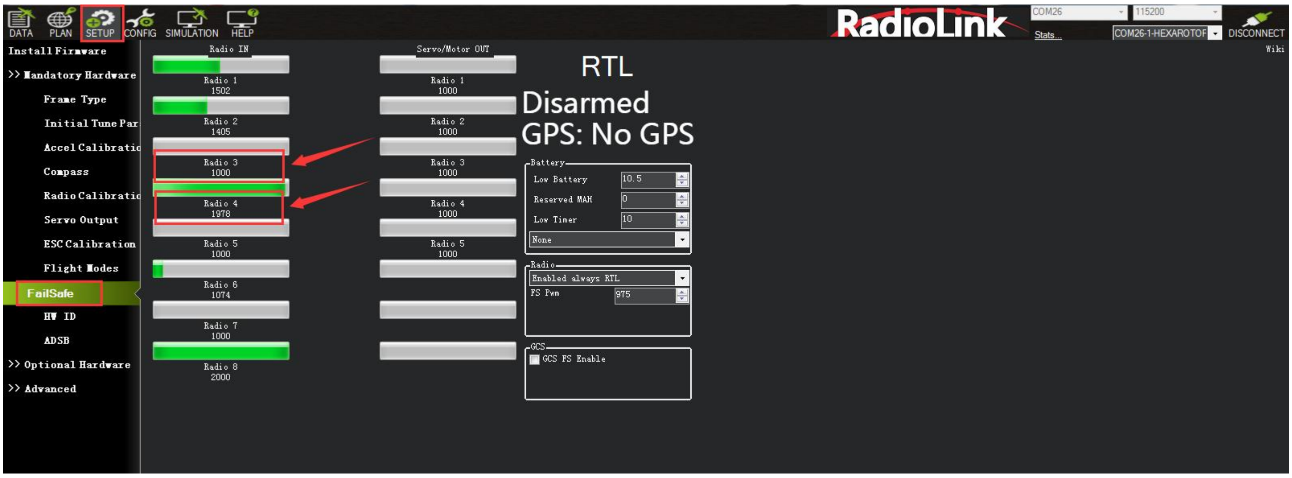
Arm action:

1. Use the left joystick to perform the arm action shown below (The stick mode is mode 2):

2. Hold it 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.

Note:

1. When the stick mode of the transmitter is not mode 2, please make sure Channel 3 is at the lowest and channel 4 is at the highest to perform arming. You can check the action in Mission Planner.



In the above picture, Channel 3 is at the lowest and channel 4 is at the highest.

2. If the buzzer beeps when the arming action is performed, the arming fails. Please connect the flight controller to Mission Planner to check the disarm prompt, and solve the fault according to the fault instructions in the next chapter.

Disarm action:

Hold the left joystick to perform the arm action shown below for 5 seconds. (The stick mode is mode 2). When the LED of flight controller flashes and propellers stop rotating, the disarming is successful.

Note：

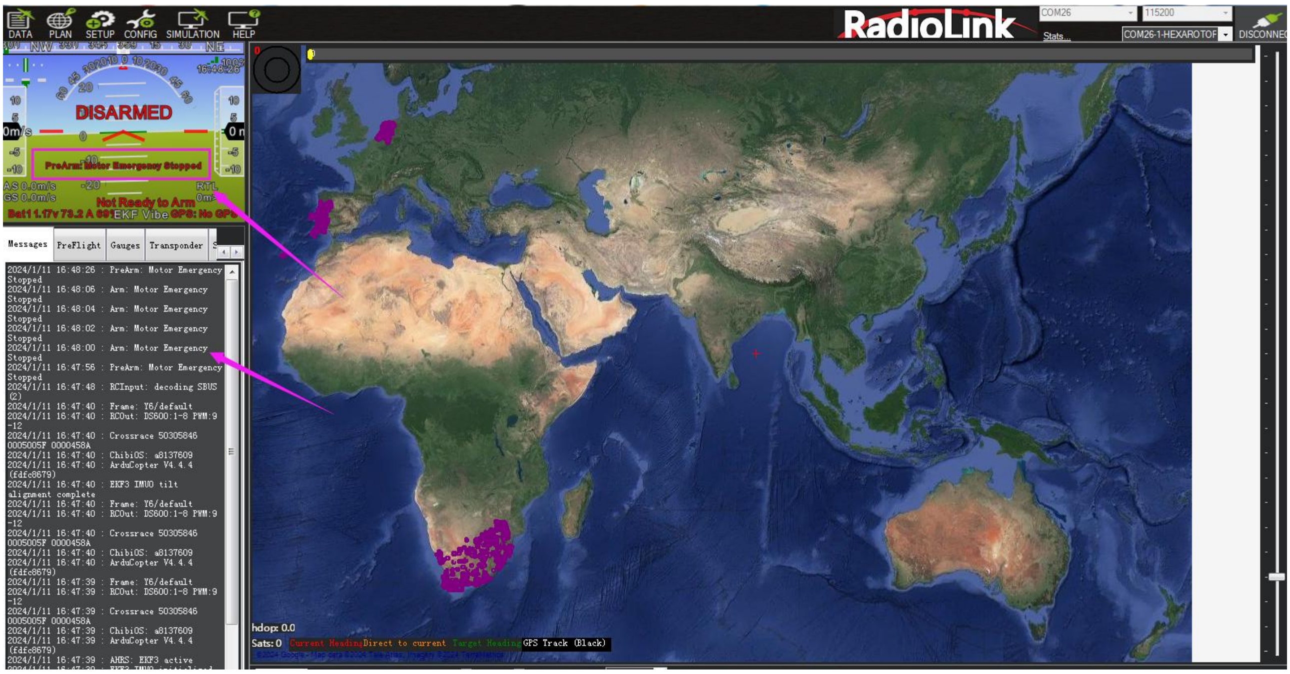
1. When the stick mode of the transmitter is not mode 2, please make sure Channel 3 is at the lowest and channel 4 is at the lowest to perform disarming.
2. In GPS-assisted mode such as Alt-Hold mode, PosHold mode and Loiter mode, please wait for the propeller to stop before performing the disarming action, otherwise the aircraft may flip over.

6.3 Troubleshooting for Arm Failure

Pre-Arm Safety Checks:
1. Radio calibrated
2. Accelerometers calibrated
3. Compass healthy
4. Compass offsets
5. Compass calibrated
6. Compass Field length
7. Barometer healthy
8. Geofencing & GPS lock
9. Board Voltage

For more details of Pre-arm safety check, please refer to the link:
https://ardupilot.org/copter/docs/common-prearm-safety-checks.html

When the arming fails, the flight controller LED indicator flashes yellow, perform arming action, and the buzzer prompts. Connect the flight contrroller to Mission Planner to view the fault prompt. After connecting, view the following interface:



When a prompt starting with PreArm appears in red font, this represents the cause of the fault at this time. For details, you can check the translation and comparison of the prompts below to solve them;
When there is no red font displayed, you can perform the arming action, which will be displayed, or view the top line of text in the message bar;
After solving the fault, power on the flight controller again. After the flight control starts normally, the status indicator light will turn blue and flash, which means it can be armed;

Some failure messages:
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.

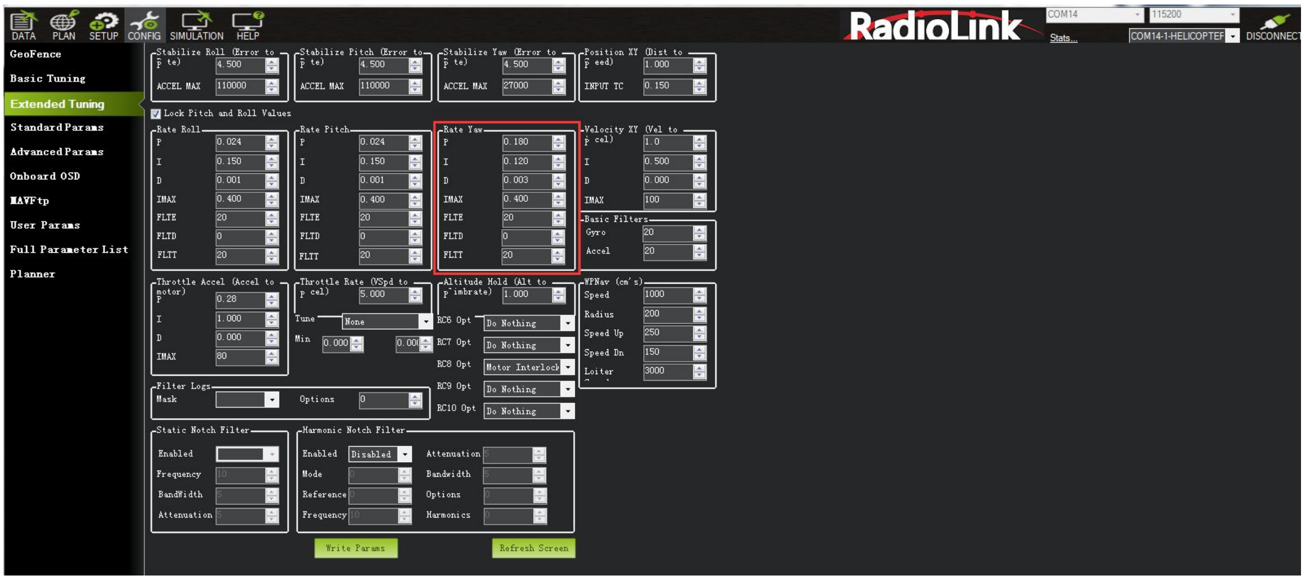
7. Helicopter Advanced Settings

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 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_R_MAX	Acceleration Max for Roll	
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.

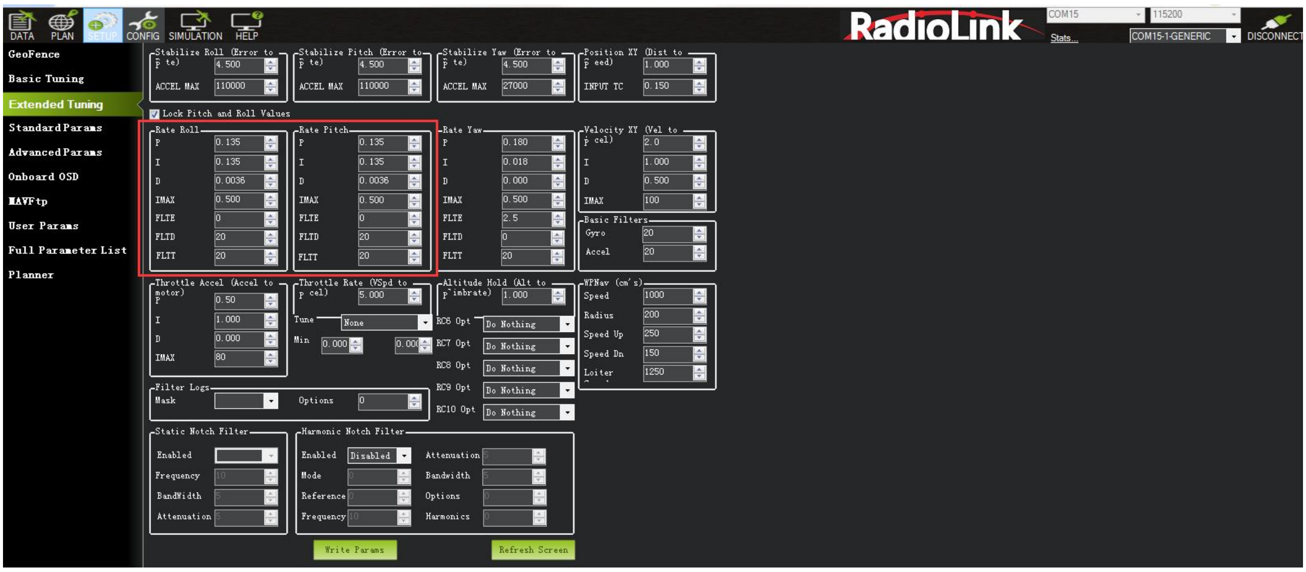
7.3 PID Adjustment

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.

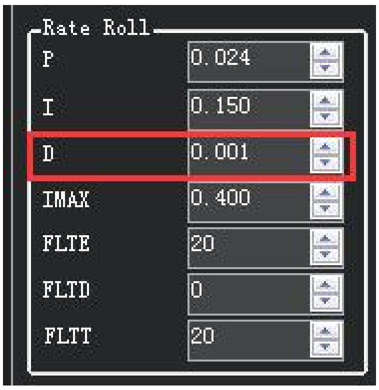
First set the two axes of Roll and Pitch, set the corresponding ATC_RAT_RLL_FF and ATC_RAT_PIT_FF to 0.15, and adjust the PID of the corresponding Roll and Pitch to the minimum first, as shown in the picture below.



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.

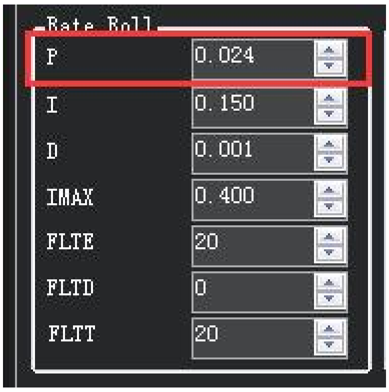
If RATE.PDes is greater than RATE.P, the corresponding ATC_RAT_PIT_FF value needs to be increased, and vice versa;
If RATE.RDes is greater than RATE.R, the corresponding ATC_RAT_RLL_FF value needs to be increased, and vice versa;
Adjust until the peaks of the two meet and follow.
When the peak trend 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.

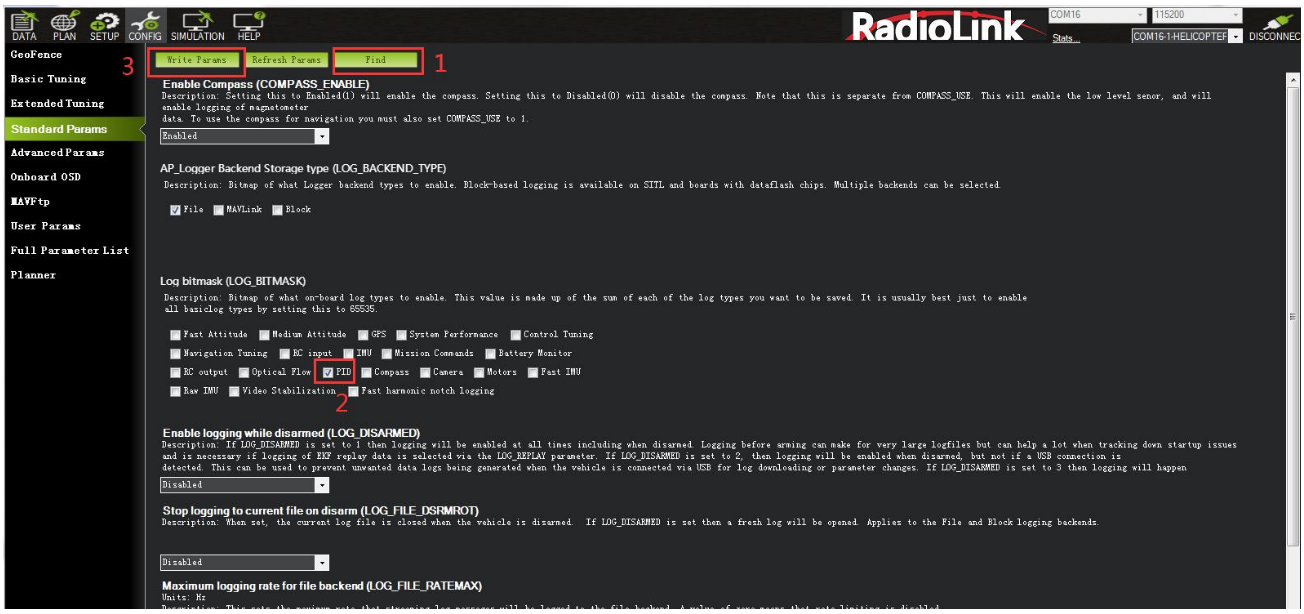
7.3.3 Adjust P



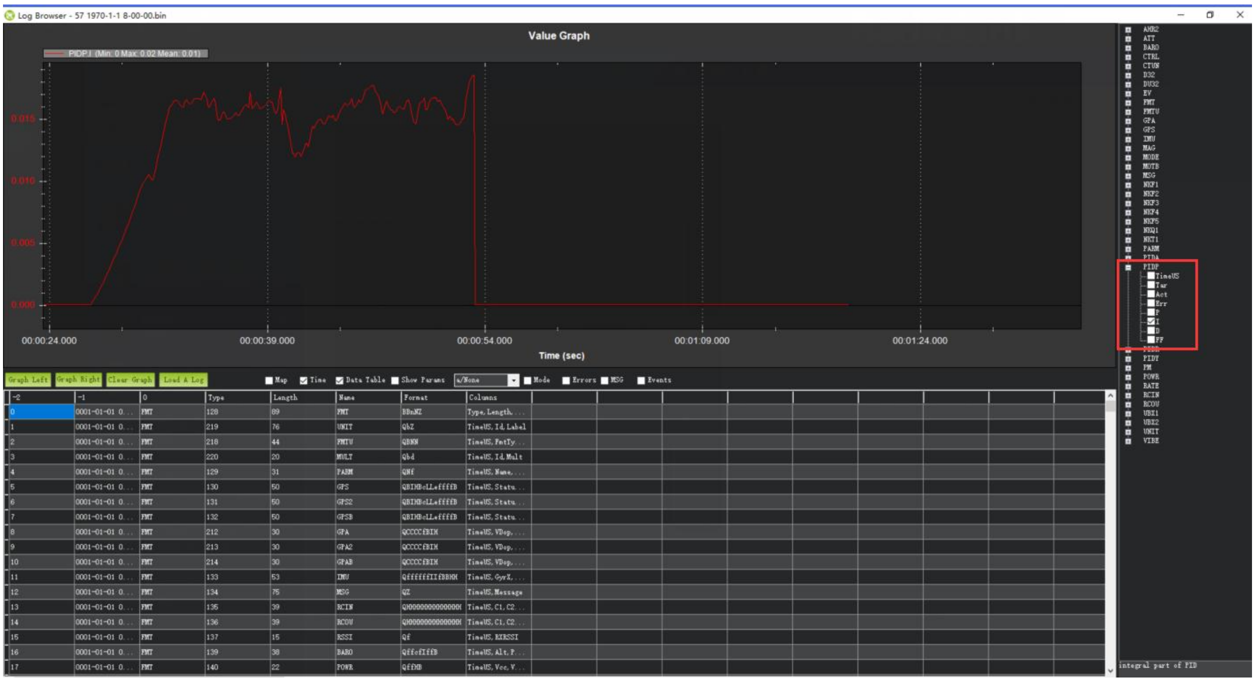
The adjustment method is similar to the D adjustment. First adjust the P of Rate Roll, and increase it by 0.01 each time until it shakes left and right. Then reduce the value by half as the final value, and set the same value for the Pitch.

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 Imax to be greater than this value by 0.1.



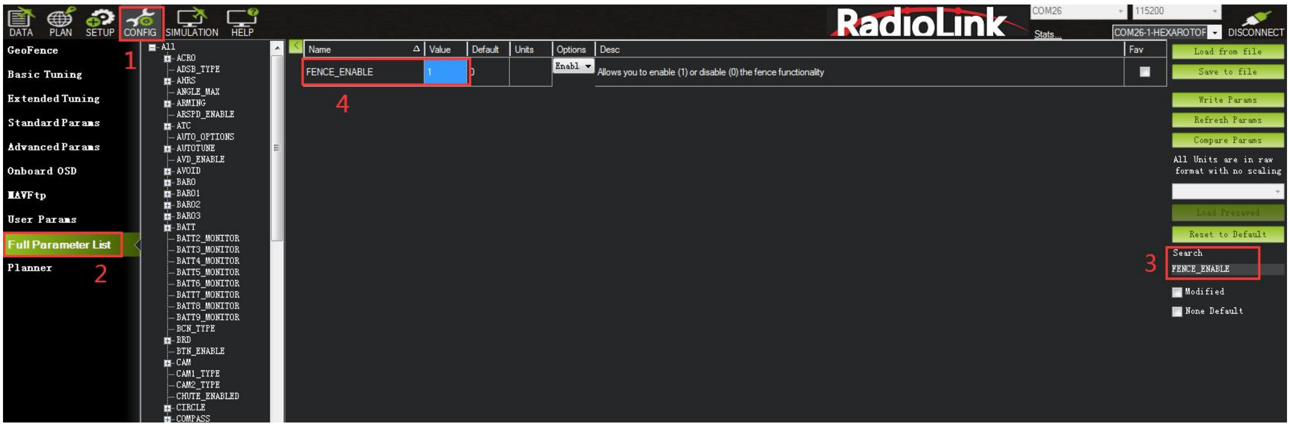
7.3.5 Hover Level Adjustment

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

This is a safety protection mechanism that protects the aircraft from flying out of the range you set. When the function is turned on, it will detect whether the GPS is positioned. If there is no positioning, it cannot be enabled.

The setup steps are as follows:
1. Open Full Parameter List.
2. Search for FENCE_ENABLE, change the parameter to 1, and save Params.

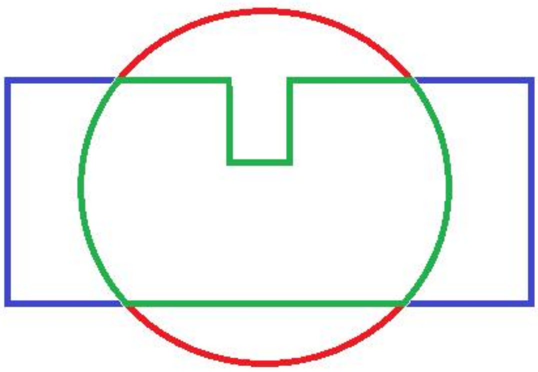


Setting parameters introduction:

When setting GeoFence parameters, please search for the following parameters in Full Parameter List and set them.

FENCE_TYPE (GeoFence type):

- Altitude is the height protection, above which the protection action will be performed.
- Circle is circular protection. Take the take-off point as the center of the circle, set the radius to draw a circle, and perform protection actions beyond this range.
- Altitude and Circle is cylindrical row protection. The take-off point is the center of the circle, set the radius, height, and the surrounding cylinder, and perform protection actions beyond this range.
- Polygon is polygon protection. After drawing the polygon on the map in the flight plan, with the maximum point of 84 points, the protection action will be performed if it exceeds this drawing range.
- Altitude and Polygon is height and polygon protection, which adds altitude protection based on polygon protection.
- Circle and Polygon is circle and polygon protection, which adds circle protection on the basis of polygon, so that the limited range is the green area, and when the green area is exceeded, the protection is performed.

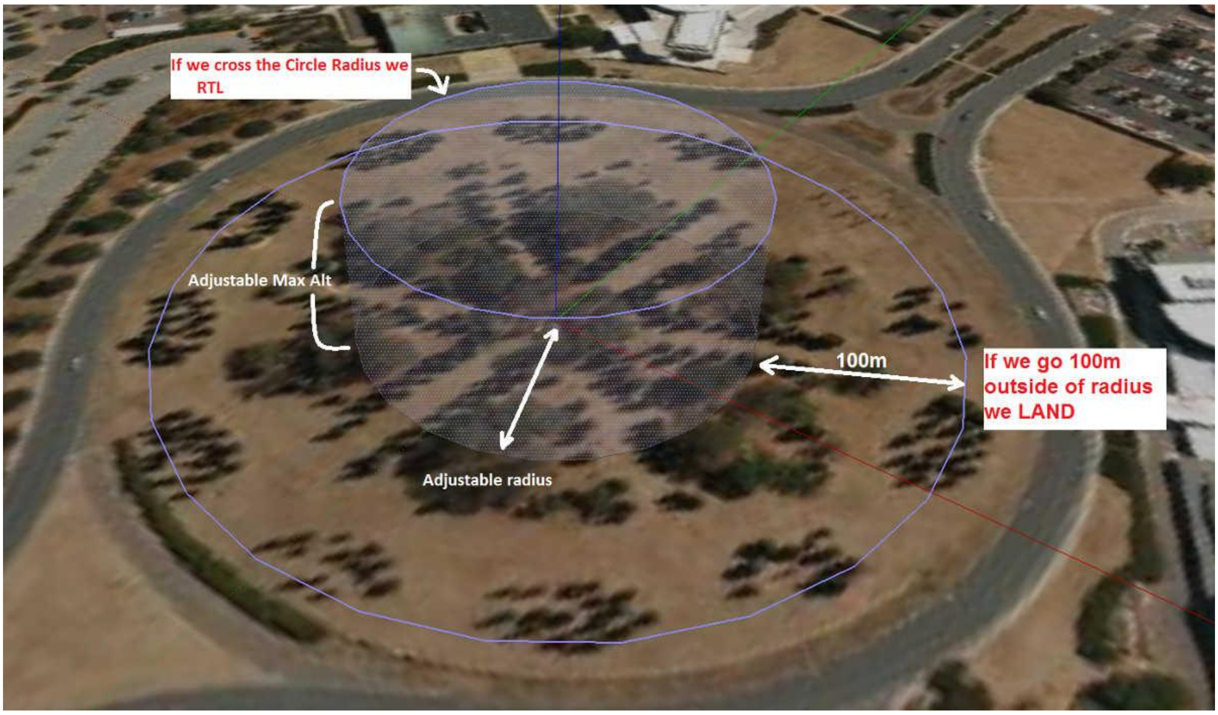


FENCE_ACTION:

All: The above 3 types of protection are involved.

Report Only: When the restricted area is exceeded, only Mission Planner message prompts and no other operations are performed.

RTL or Land: Return or land.



FENCE_ALT_MAX (maximum altitude): protection limit maximum flight altitude (10-1000m)
FENCE_RADIUS (maximum radius): Protection limits maximum flight radius (30-10000m)
FENCE_ALT_MIN (minimum altitude): Protection limit minimum flight altitude (-100-100m)

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-CE 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-CE 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.

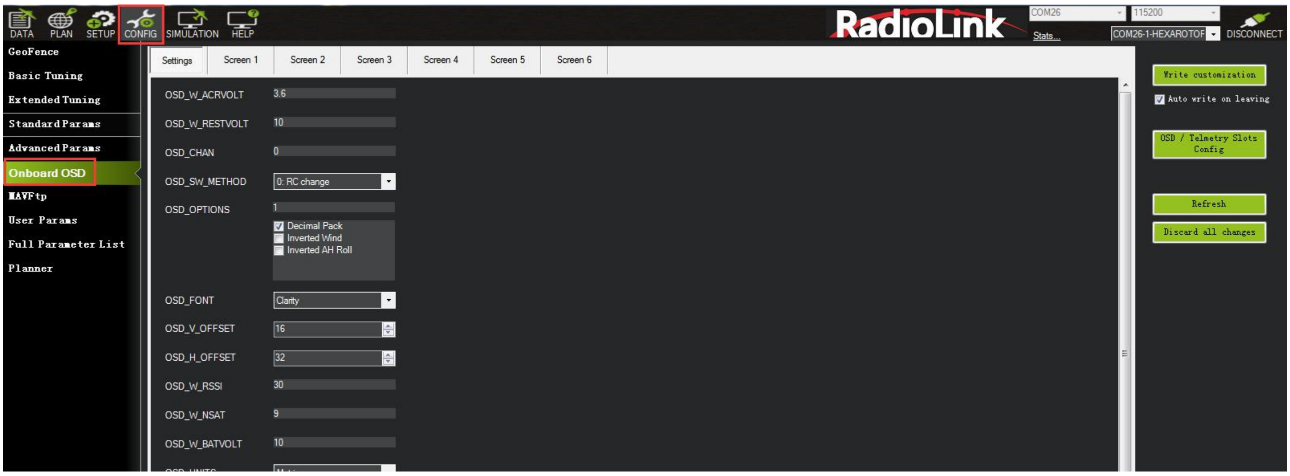
OSD_CHAN: Screen switch transmitter channel. This sets the channel used to switch different OSD screens. The value includes 0, 5-16.

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.

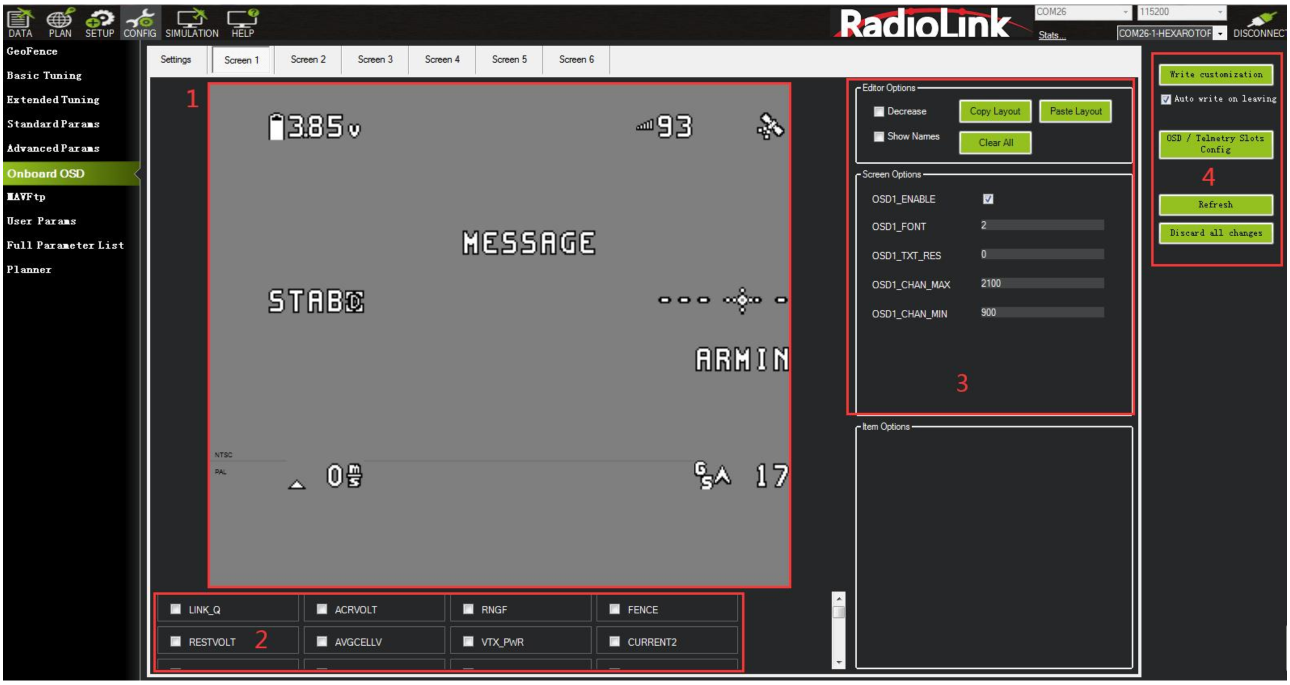
1 = select screen based on pwm ranges specified for each screen.

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 (meters, kilometers, meters/second, kilometers/hour) .
1 = Imperial (feet, miles, feet/second, miles/hour) .
2 = SI (meters, kilometers, meters/second) .
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_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.

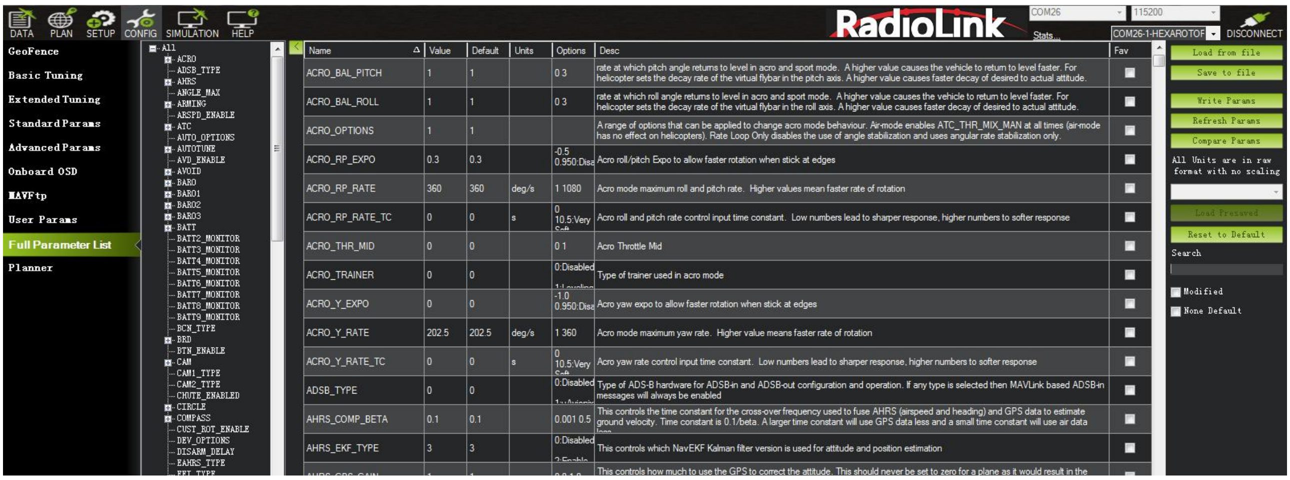
③ The area can copy the layout of the current screen or paste the layout of other screens to this screen.

④ Write all the current settings in the area.

10. Parameters Setting

10.1 Parameter Introduction

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



Parameters on the left:

GeoFence: Refer to Chapter 8 GeoFence.
Basic Tuning: Set Roll/Pitch sensitivity.
Extended Tuning: Adjust PID, 7 and 8 channel function.
Standard Params: Provide some basic settings such as logs, additional functions, channel functions, etc.
Advanced Params: Provide some advanced function settings such as PID.
Onboard OSD: Refer to Chapter 9 Onboard OSD.
MAVFtp: In firmware versions 4.1 and above, integrated FTP (File Transfer Protocol) is implemented, allowing access to the SD card (if there is one) and the internal flash file system through this interface. (It is not recommended to use this system to download logs. Please refer to Chapter 8 to download the log, which is faster).
User Params: Quickly set the functions of the auxiliary channel of the transmitter.
All parameter trees: Related function parameters are displayed closely. After a function is expanded, the function-related parameters are displayed.
Planner: Related settings of Mission Planner.

Parameters on the right:

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-CE.
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-CE.
Reset to default: reset all the parameters to default files. Please recalibrate and re-setup all the parameters after reset.
Search: write down the name of parameters you want to setup, much same as the keyboard shortcuts function.

10.2 Parameter Modification

All settings of the flight controller can be set or adjusted. You can enter Full Parameter List to search the parameter you want to modify and then modify it. After the modification, please remember to click Write Params on the right.

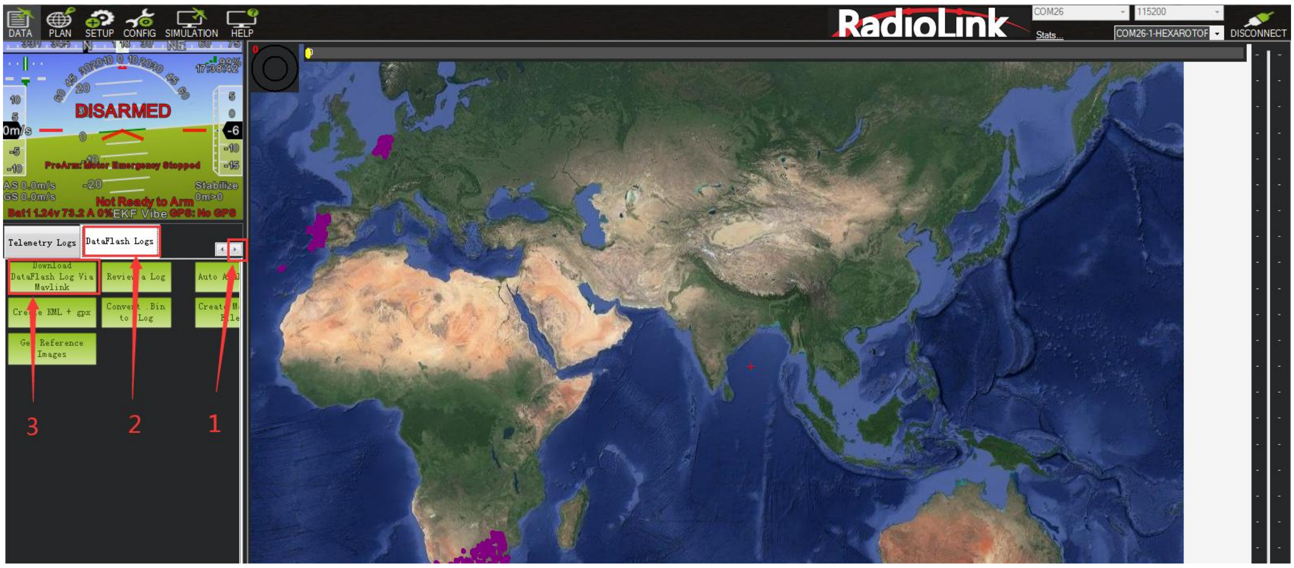
11. Download DataFlash Log

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-CE onboard dataflash memory, which you can download after the flight. On Copter dataflash logs 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.



Note: Because the download thread will block the main thread of the flight controller when downloading the log, an internal error will be reported after downloading the log. Please restart the flight controller before the next flight.

Open the log file through the steps below：

Files available for reference: http://ardupilot.org/copter/index.html