# BABY SHARK 260 VTOL

## User Manual

V2.1   2019.07



**FOXTECH**

# Contents

# Specifications

| Aircraft | |
|---|---|
| Structure | |
| Item Name | FOXTECH BABY SHARK 260 VTOL |
| Version | RTF Combo |
| Material | Kevlar and High Density Composite Material |
| Shipping Dimension | 1260x440x460mm |
| Shipping Weight | 35kg |
| Wingspan | 2500mm |
| Length | 1440mm |
| Max. Flying Height | 3000m |
| Max. Flying Speed | 100km/h |
| Stall Speed | 15m/s-16m/s |
| Frame Weight(No Electric) | 2.68kg |
| Self Weight(No Payload, No Battery) | 5.5kg |
| Max. Take-off Weight | 12kg |
| Max. Payload | 6.5kg(Including Battery) |
| Suggested Battery | Foxtech 6S 12500mAh Li-ion Battery x3 |
| | 6S 5000mAh Lipo Battery x2 |
| Servo | DS135MG x4 |
| Flight Controller | Pixhawk 2.1 Standard Set with Here 2 GNSS x1 |
| Controller | DA16S+ Radio Controller x1 |

| Optional |
|---|
| -SEEKER-20 20X Optical Zoom Camera with 3-Axis Gimbal |
| -SEEKER-30 Max 30X Optical Zoom Camera with 3-Axis Gimbal |
| -FOXTECH 3DM V2 Oblique Camera for Mapping and Survey |

# Basic Theory

BABY SHARK 260 VTOL features a highly advanced aerodynamic design. It is made of high density composite material, which features high strength and very light weight. BABY SHARK VTOL adopts quick-detach design which makes the plane easy to set up and transport. The fuselage also has big inner space to hold flight controller, batteries or other equipments.

BABY SHARK can take off and land vertically in a small area, and fly like a multicopter. Self weight(no payload, no battery) is 5.5kg, and max take-off weight is 12kg, the stall speed of the BABY SHARK is 15m/s-16m/s, the highest speed is about 100km/h. In this Baby SHARK VTOL plane we suggest to use two 6S 5000mah lipo batteries for lifting motors, and 30000-40000mah Li-ion battery for cruising motor and propeller, so except the battery, motors, ESCs, propellers and other necessary equipments still has 1.5kg payload left for zoom or mapping cameras. BABY SHARK can perform most tasks like long range inspection, survey and mapping etc. This plane is painted in grey color, and if you need other colors, we also can customize the color for you.
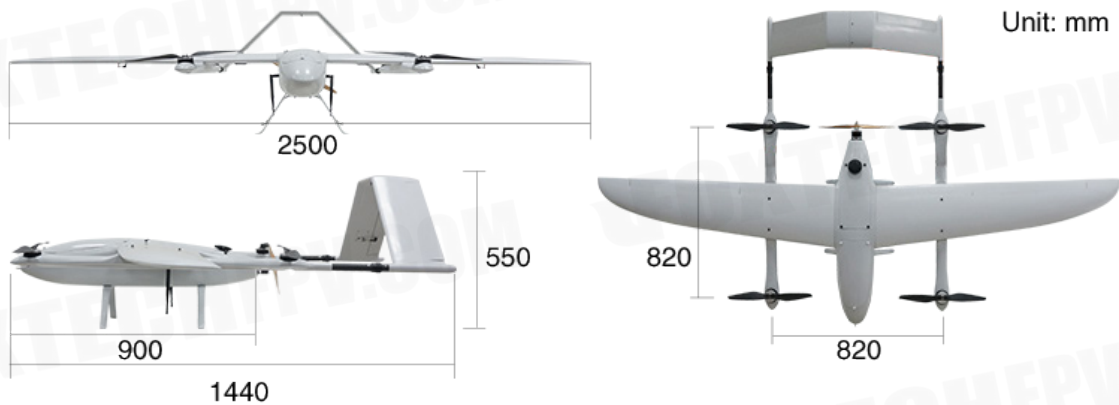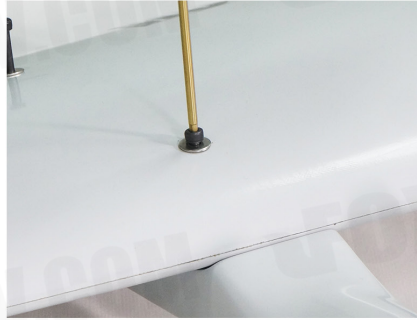
# Setup and Calibration

## Assembly
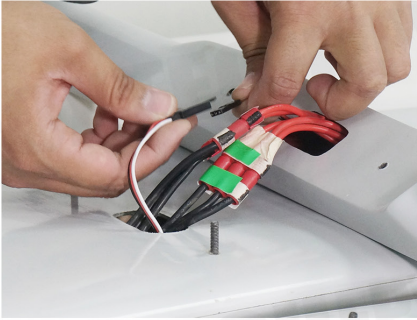
1.Connect the two motor cables and the signal cable.

2.Fix the arm on the aileron with the two screws.

3.Insert the two carbon fiber tubes in the body.

4.Install the wings.

5.Tighten the four screws for the aileron inside the body.(Two screws are in the central section and two are in the front section.)

6.Mount the cover.

7.Assemble the tail.

8.Tighten the tail with two screws.

9.Connect the servo cable.

10.Twist the tail part on the arm.

11.Install the receiver antenna.

## Check Radio Control

1.Check transmitter mode(left hand throttle or right hand throttle).
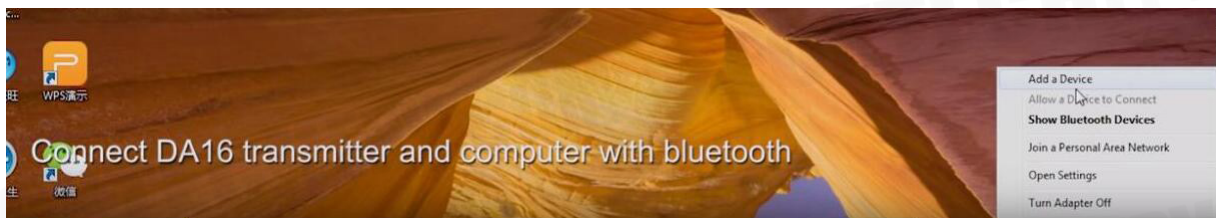2.Check channels on the transmitter.

## Download Mission Planner

Download the latest Mission planner online or copy it from the SD card.
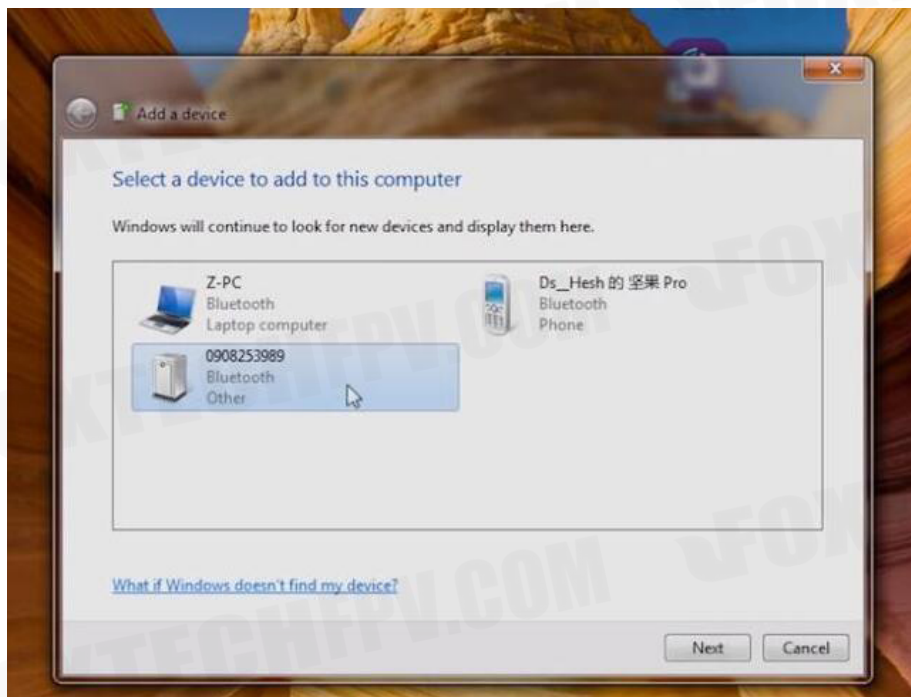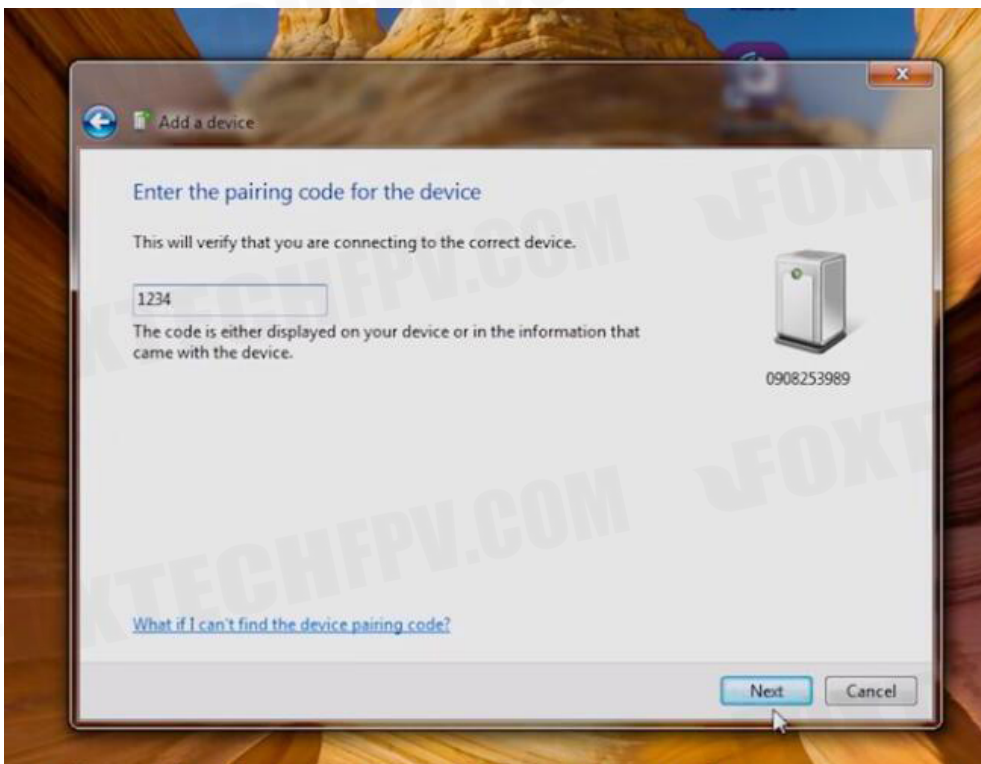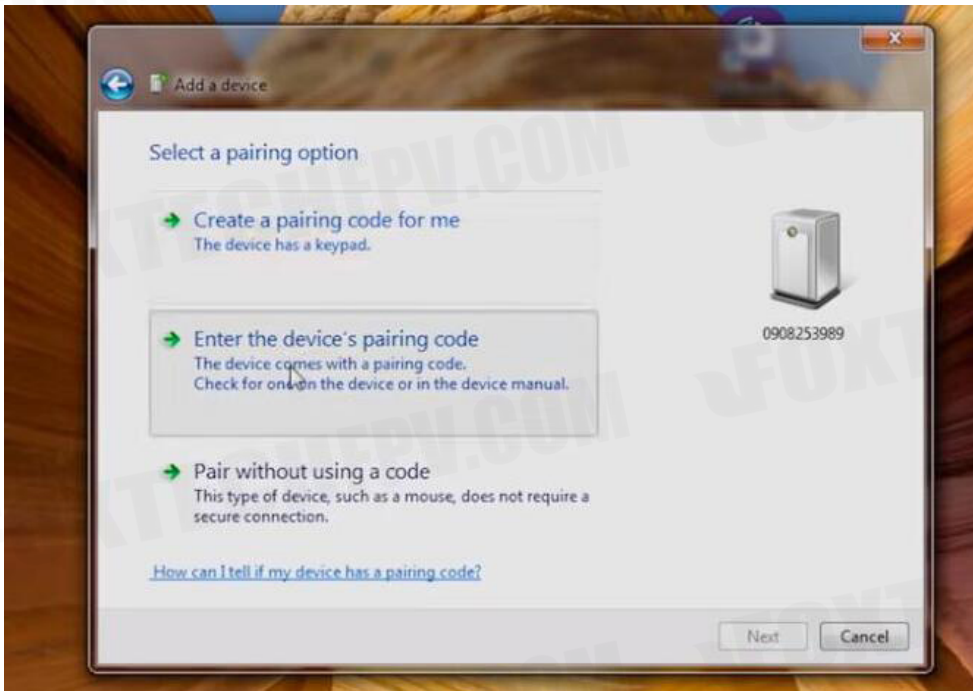Download link: http://firmware.ardupilot.org/Tools/MissionPlanner/

## Connect Baby Shark to Computer

1. Connect DA16S transmitter and computer with bluetooth.
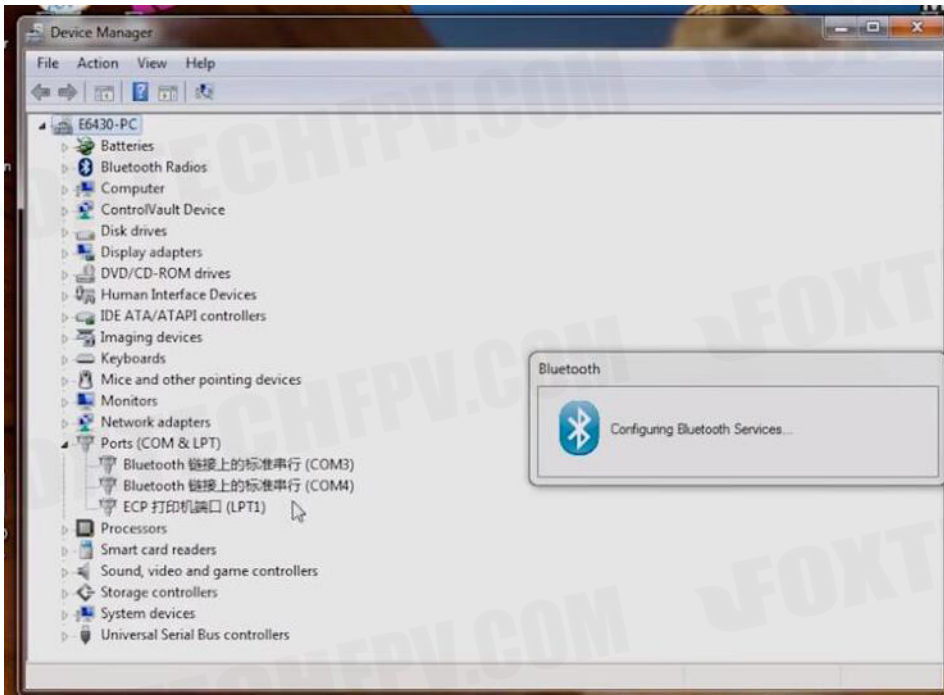


2. Find the corresponding device and enter password.

3. Enter the "Device Manager" interface and find its COM.



4. Select correct Com port, and click CONNECT.
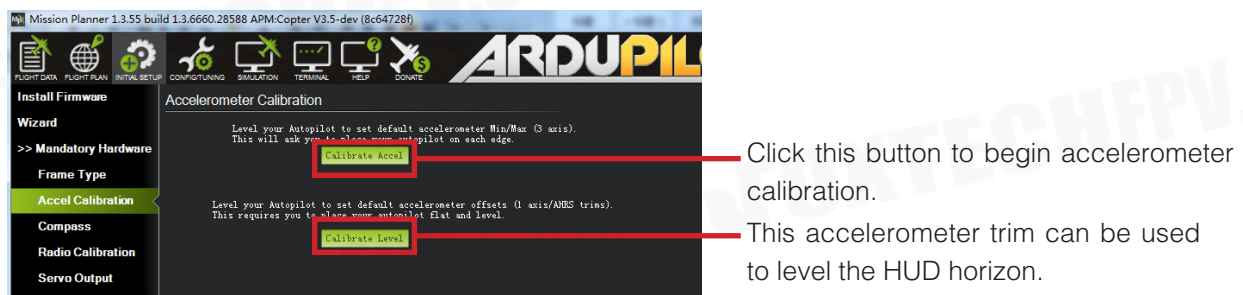
5. Connection completed.



## Connect the Datalink and Check Flight Controller

**1.Calibrate the Accelerometer**

Although the accelerometer was calibrated already for the PNP version before shipping, please calibrate it again since it might be affected in the transportation.

Under Initial Setup, select Accel Calibration from the left-side menu. Mission Planner will prompt you to place the vehicle each calibration position. Press any key to indicate that the autopilot is in position and then proceed to the next orientation.

The calibration positions are: level, on right side, left side, nose down, nose up and on its back.



Click this button to begin accelerometer calibration.

This accelerometer trim can be used to level the HUD horizon.

💡 1.It is important that the vehicle is kept still immediately after pressing the key for each step.
2.The level position is the most important to get right as this will be the attitude that your controller considers level while flying.

## 2. Compass Calibration

Baby Shark VTOL uses high sensitivity compass and it has to be re-calibrated when fly in a new place.

Enter the compass setting page and click"start" , hold the plane and rotate it in order to hit all directions on a sphere to calibrate the compass, when it's done, a new offset would be given to the flight controller, and a reboot is necessary.
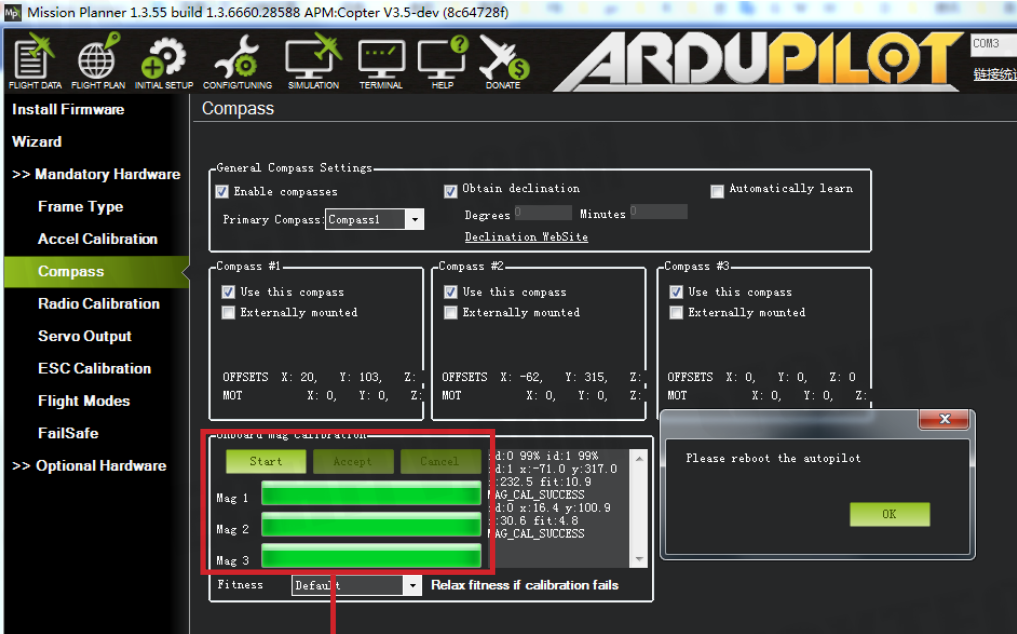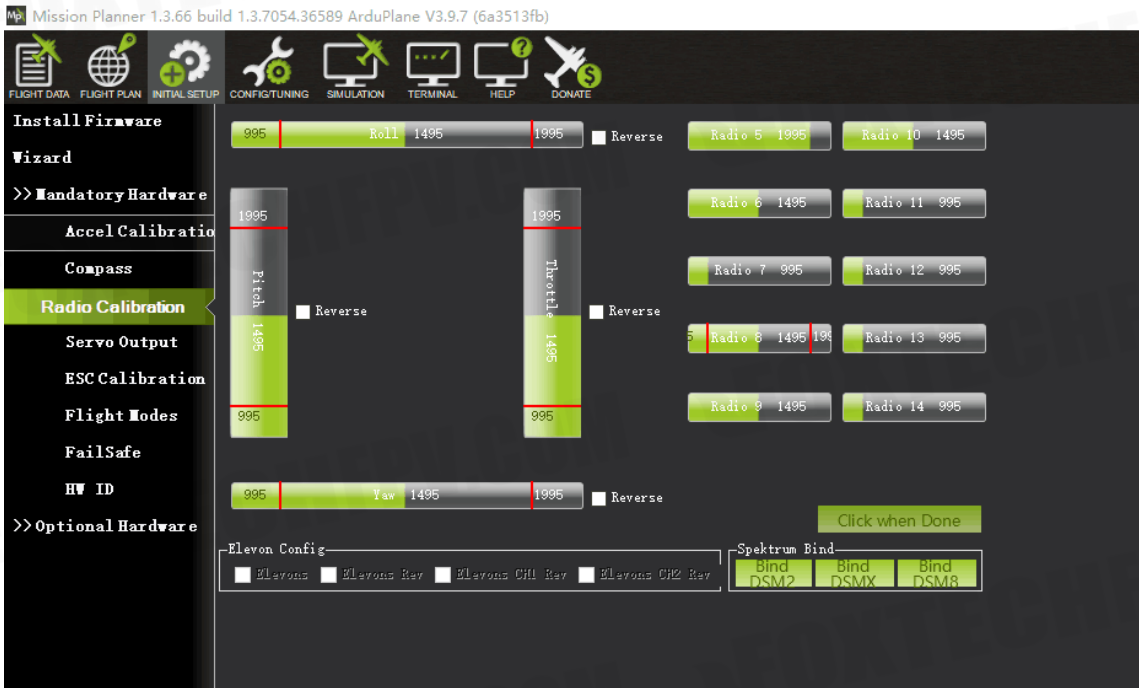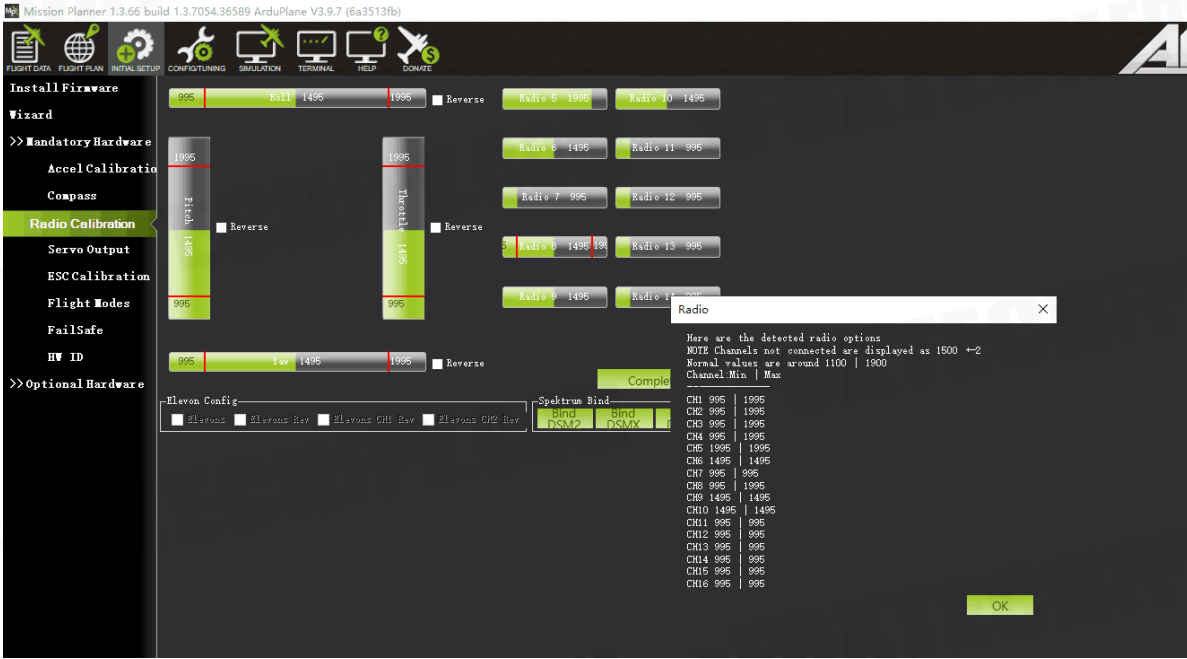


Onboard calibration produces better results.

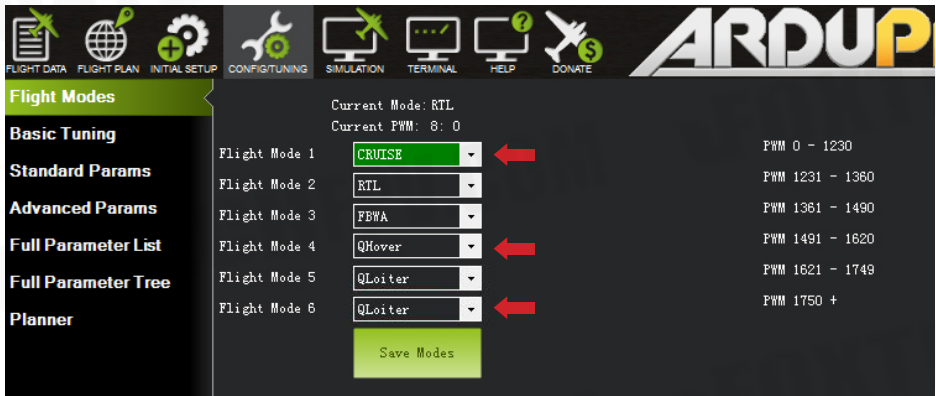## 3. Radio Control Calibration

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.

**4. Check Flight Modes. (Cruise, QHover, QLoiter, Loiter, Auto, RTL)**

### 5. Calibrate the Airspeed Sensor

It is critical that you calibrate airspeed meter to ensure that it is working correctly, and ensure that it is correctly zeroed.

After you start up APM on your aircraft you should wait at least 1 minute for your electronics to warm up, preferably longer, and then do a pre-flight calibration of your airspeed sensor. Your ground station software should have a menu for doing this, usually called "Preflight Calibration". You need to loosely cover your airspeed sensor to stop wind from affecting the result, then press the button. The calibration will take a couple of seconds.
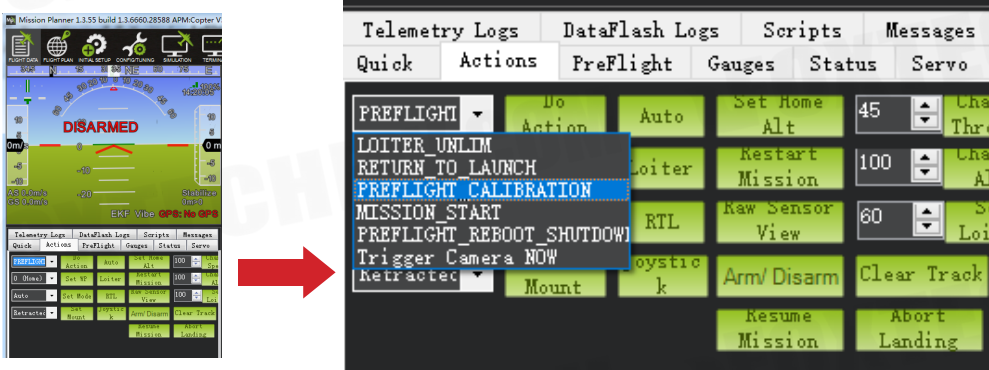


Choosing that action will re-calibrate both your ground barometric pressure and your airspeed sensor.

Next you should check that your airspeed sensor is working correctly before takeoff. To do that you should blow into the airspeed sensor and make sure that the "AS" airspeed sensor value in your HUD rises as you blow into it.

### 6. Check the Two Batteries Voltages

If you find the voltages are not correct, Enter the voltages according to the hand-held volt meter in the "Measured Battery Voltage" field, Press tab or click out of the field and the "Voltage Divider (Calced)" value will update and the "Battery voltage (Calced)" should now equal the measured voltage.
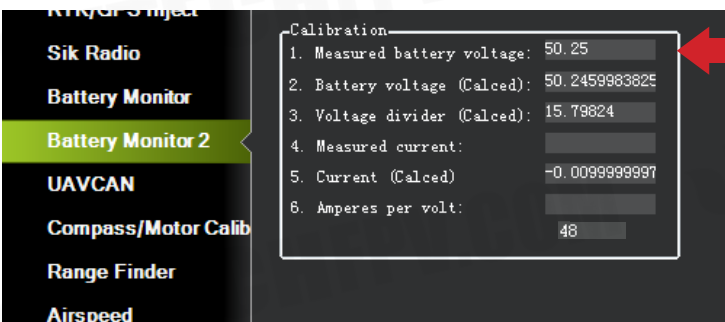


7. Check Before Flight
(1) Connect the internet and load the map.
(2) The plane direction should be same with its direction in mission planner, if not, please calibrate again.
(3) Check plane status, altitude, voltage airspeed meter working fine.

# Checklist before Every Flight

Make sure all items are checked before every flight.

1. The aircraft connection is stable and normal.
2. All screws and nuts are not loose.
3. The propeller is in the normal direction and is fastened.
4. All the Rudders' direction-correction are correct.
5. The airspeed meter reads correctly.
6. Aircraft voltage is normal.
7. The compass is toward the right direction.
8. More than 15 GPS satellites, or displays GPS FIX.
9. No warning words on the ground station.
10. Device SD card is normal.
11. Recording device is recording normally.
12. Aerial survey camera photo test is normal.
13. Exposure check is normal.
14. The remote controller power is normal.
15. Ground station power is normal.
16. Data connection strength is normal.
17. Aircraft H point positioning is normal.
18. Upload and download to check the routes.
19. The antenna is placed in the normal direction, the antenna of the aircraft is facing down or up,  and the two antennas of the receiver are not in contact.
20. Ground device recording is on.
21. Aircraft onboard camera is turned on.
22. Height setting of Return Home Point is normal.
23. Out of control return-to-lanuch setting is normal.
24. Try to vertically take off and land, make sure the direction-correction and direction control  are normal Start flying.

# Test Flight

Before the first flight, it's suggest to check if every component is well connected, Servos working properly, motors spinning to the correct direction and all control surfaces are moving to the desired directions.

It's suggested to use 3 modes, Cruise, Qhover and Qloiter as the labled modes on a three position switch. It's suggested to do the first flight in a very open area with no buildings or big trees around, and a flat taking off area is necessary.

Use the Qhover(or Qloiter) mode, start the motors by pushing the rudder all to the right with the throttle at the lowest position, the motors should start to spin, gradually increase the throttle until the plane is ready to lift from the ground, move aileron, elevator and rudder stick gently to check if the plane is moving as desired.

Continue to push the throttle until the plane is lifted from ground, it may swing a bit since there should be big airflow hitting the wing, lift the plane to around 3 meters and try to fly it as a multicopter, it should not be a problem for anyone who can play a multicopter.

When you are familiar with all controls, lift the plane to at least 50m from the ground and make sure there is not obstacle in front of the plane.

Switch it to Cruise mode, the Baby Shark VTOL rear motor should work, once the speed is reaching at least 16m/s, the multicopter motors will stop spinning, then the Baby Shark is now transferred to fixed wing.

It's also suggested to active the short and long failsafe, the default action is respectively CIRCLE and RTH. So in case the plane lose RC control, it will go back all by itself.
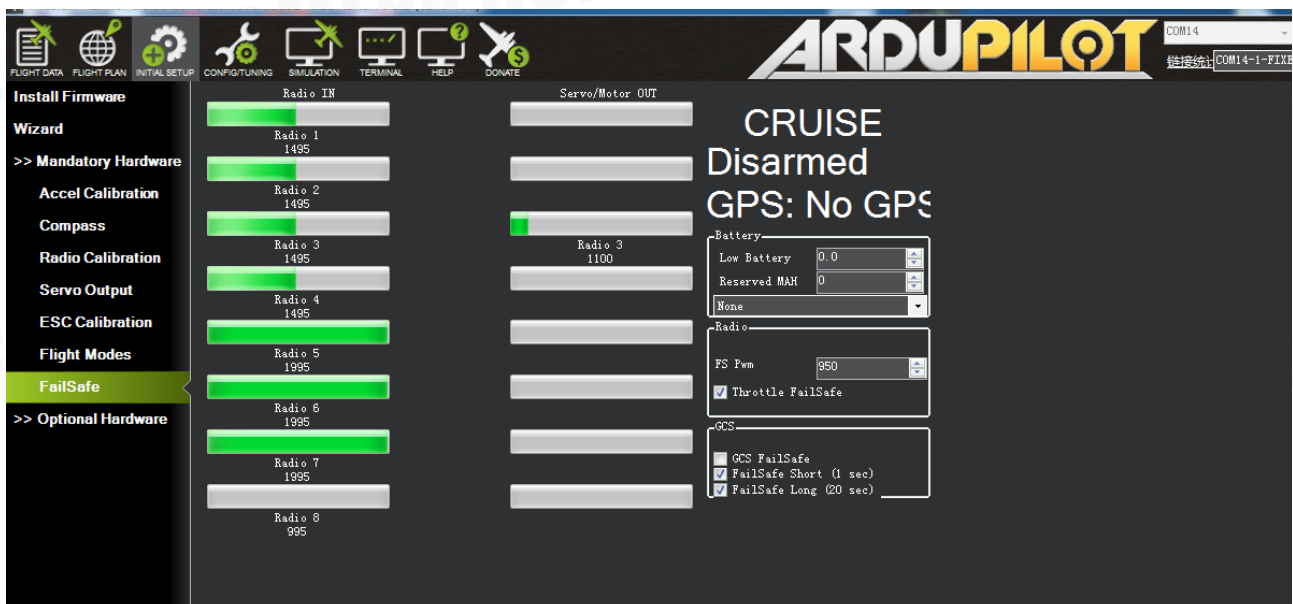


You can fly a while and see if the plane could go straight, if you find the plane is tilting left for example, don't try to trim the aileron with your radio, the trim to aileron(SERVO1) must be done in parameter setting. (If the elevator trim is necessary, please trim the SERVO2 and SERVO4 at the same time with the same trim amount.)

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💡 GCS FAILSAFE disabled as default setting for DA16(S) radio or the control range will be greatly affected.

| Command | Value | Unit | Range | Description |
|---|---|---|---|---|
| SERVO1 | | | | |
| SERVO1_FUNCTION | 4 | | | |
| SERVO1_MAX | 1900 | | | |
| SERVO1_MIN | 1100 | | | |
| SERVO1_REVERSED | 1 | | | |
| SERVO1_TRIM | 1460 | | | |
| SERVO10 | | | | |

If everything goes well, you can try to land. First, reduce the altitude by pushing forward the elevator and when the altitude is around 50m above the ground, switch to Qhover(or Qloiter) Mode. Then become a multicopter again, then you can land it just as a normal multicopter.

# Autopilot

After the first flight, you can try to do autopilot.

You can choose to take off and land either by manual control or automatically.

To use automatic taking off and landing, you can change the first waypoint to VTOL_TAKE OFF, and set an altitude like 50m for this action, then set the next waypoint a bit far (like 100m ) from the first waypoint, the Baby Shark will take off as a multicopter, when it reaches the wanted altitude, it will switch to fixed wing and fly waypoints or missions like a fixed wing.
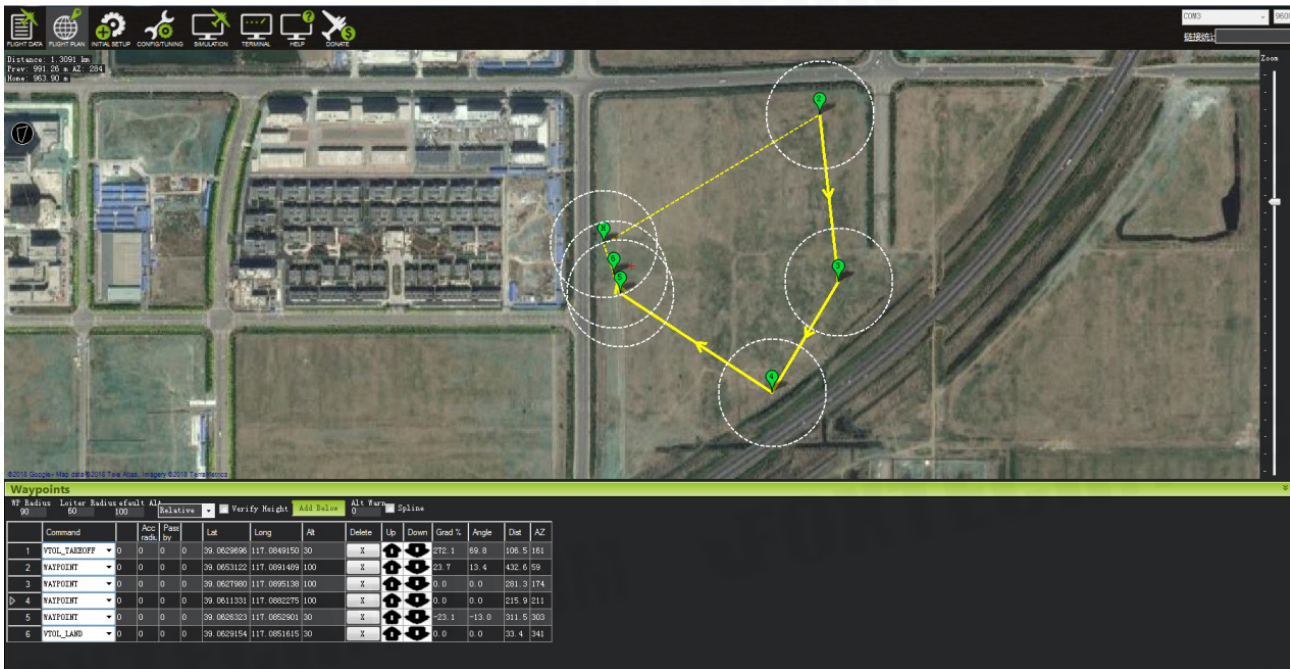


The VTOL landing is also the similar, you can set the last waypoint to VTOL_LAND, but it's suggested to set one waypoint which is around 100m from this one, since the plane will try to turn to multicopter before the last waypoint, if the waypoint before VTOL_LAND is too far, the Baby Shark will finish the final distance all in multicopter mode, the power consumption in mutlicopter mode is 5 times more than in fixed wing mode.

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Q_RTL is enabled as default,if the VTOL land command is not added, then the VTOL will go back to HOME position and home altitude(default 50m)and performs automatical VTOL land.

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## ⚠ NOTICE

It is needed to switch to the remote control mode (Q-HOVER, Q-Loiter, FBWA, Cruise, etc.)  when the aircraft is flying in auto mode. After the mode is switched, continuously toggle the Yaw joystick (left and right direction of the left hand in model 1 and Mode 2 ) 3-4 times to realize the drone control. (Because in auto mode, due to the RC signal interruption and reconnection, the aircraft will automatically switch to the current mode of the remote controller, which will lead to an accident.)

# Applications

- Survey
- 3D Survey
- Patrol
- FPV
- Air pollution detection

More autopilot mode can be found in Mission planner manual, like circle survey, Grid, drop an object with hook at desired waypoint.

# Appendix

The following calibrations are for Customers who bought Baby Shark VTOL Kit. For the customers who bought Baby Shark PNP combo, the following calibrations are done before shipping. Please donot change any settings. If the settings are changed by accident, please recover from the param. document in the SD card.
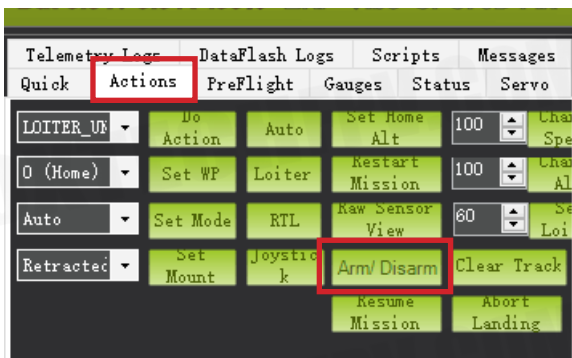
## ESC Calibration

1. Cut off Baby Shark power supply and take off all propellers. Connect Pixhawk flight controller with Mission planner with USB cable. Change "Q_ESC_CAL" value to 1 and write params.
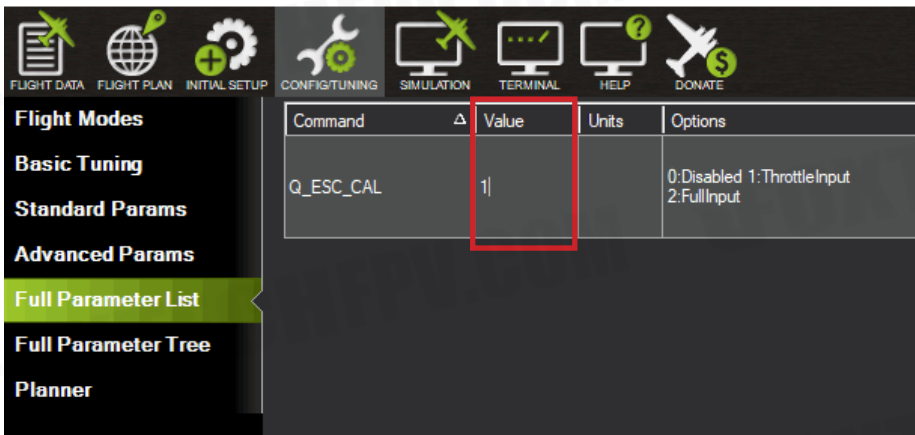


2. Long press **GPS safety switch** until the red light keeps on.



Safety Switch

3. Click **Arm/Disarm**, There will be a sound "Du~"

4. In the following demonstration, Take Left hand throttle as an example. Push throttle to Max.(Pic 4-1), connect Baby Shark with power, when there is "di di ~ di" sound quickly push throttle to Min.(Pic 4-2) When there is "di di di di ~di" sound, ESC calibration is successful. Then cut off power.
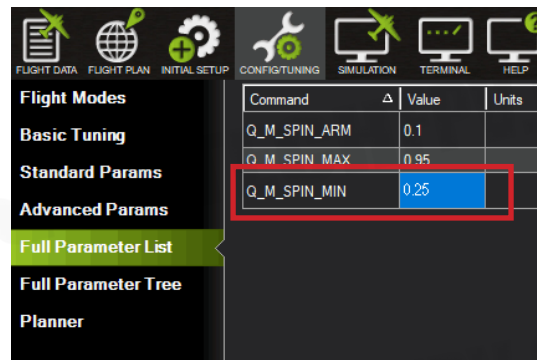


Pic 4-1



Pic 4-2

5. Connect Baby Shark with power again. Long press GPS safety switch. Radio throttle push to Min, direction stick push to right(Pic 5-1), disarm Baby Shark, you can adjust "Q_M_SPIN_MIN"in mission planner. The default value is 0.25. Write the value, it is complete.



Pic 5-1

## Servo Checking and Required Mode Modification

Check the stick function of remote controller. (The follow example is demonstrated as transmitter Mode2 which means left hand is throttle.)

💡 Please take off all propellers before the following calibrations in case any danger occurs.

**Under Manual Mode :**

1. Make sure the aircraft is in centre position.

2. Push the throttle-stick the motor speed will increase,and pull back the throttle-stick, the motor speed will decrease.

3. Push the pitch-stick the two V-type tail will go down.



4. Pull back the pitch-stick the two V-type tail will go up.



5. Turn the aileron-stick to the left, the left aileron will go up, and the right one will go down.



6. Turn the aileron-stick to the right, the right aileron will go up, and the left one will go down.

7. Turn the direction-stick to the left,the left V-type tail will go up, and the right tail will go down.

8. Turn the direction-stick to the right,the right V-type tail will go up, and the left tail will go down.

**Under the Q_STABLIZE Mode**

1.Unlock the plane under the Q_STABLIZE mode. (Click safety switch, set the throttle at minimum speed and turn the direction stick to the far right.)

Safety Switch

2. Check the throttle stick: when you push the throttle-stick, the motors speed will increase, and pull back the throttle-stick, the motors speed will decrease.

3. Push the pitch-stick, the speed of the front motor will decrease and the back motor will increase, the two V-type tails will go down.

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4. Pull the pitch-stick, the speed of the front motor will increase and the back motor will decrease, the two V-type tail will go up.



5. Turn the aileron-stick to the left, the left motor speed will decrease, and the right motor speed will increase left aileron goes up, and the right aileron goes down at the same time.



6. Turn the aileron-stick to the right, the right motor speed will decrease, and the left motor speed will increase left aileron goes down, and the right aileron goes up at the same time.

## Angle Deviation Compensation Checking

**Unlock the plane under the Q_STABLIZE mode:**

1. Plane leans forward, the speed of the front motors will increase, the back motor-decrease,the two V-type tails go up.

2. Plane leans back, the speed of front motors will decrease, the back motor-increase, the two V-type tails go down.

3. Plane leans to the left, left aileron will go down, and the right aileron will go up, the speed of left motor increases, and the right motor decreases.
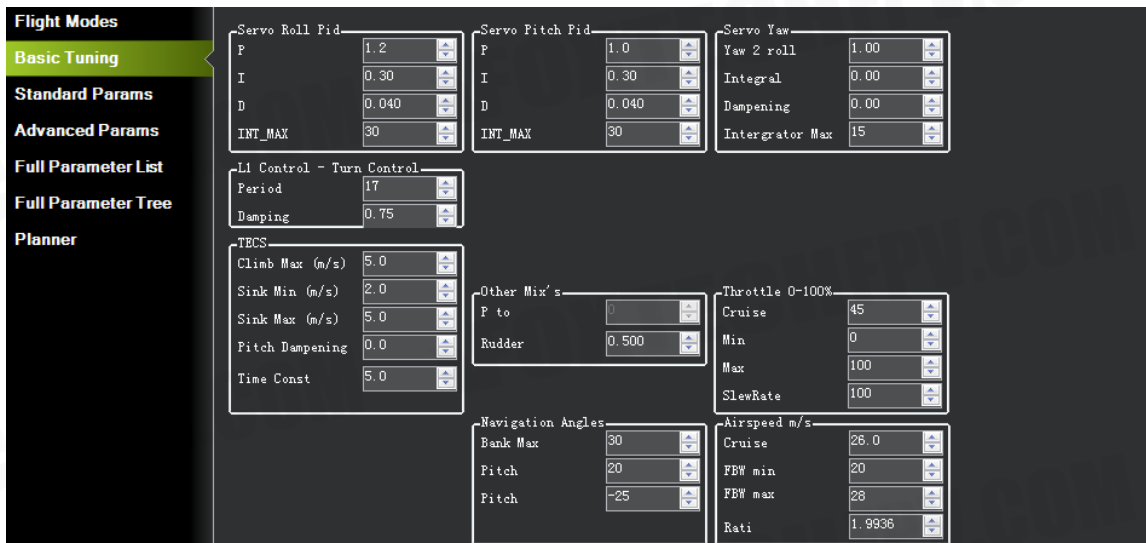
4. Plane leans to the right,left aileron will go down, and the right aileron will go up,the speed of left motor decreases, and the right motor increases;
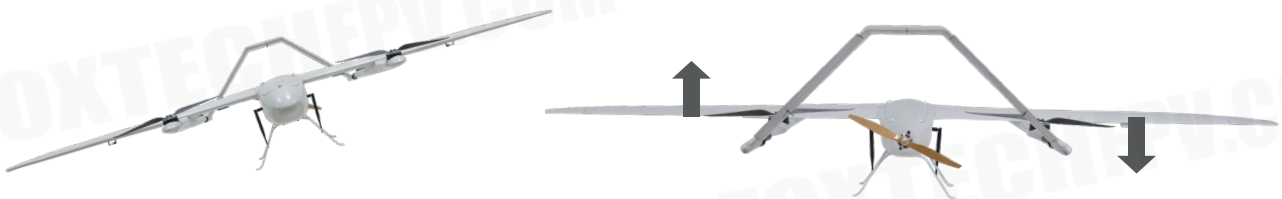
## Default Setttings

Some default setttings in Pixhawk for Baby Shark.

1. Baby Shark Pixhawk Basic Settings for Reference.



2. Suggested "Q_VFWD" is: 0.05 , this setting will increase anti-wind performance in QLOITER mode and Vtol-take off and landing.



3. Suggested "Q_WVANE_MINROLL" value is: 3



4. Suggested "ALT_HOLD_RTL" value is: 5000, default home altitude, 50m is a good number for Vtol-landing.



5. Suggested "Q_RTL_MODE" value is: 1, if you prefer the plane go circles around the Home point instead of go into Vtol-landing during RTL ,change it to 0.



6. Suggested "BRD_SAFETYENABLE" value is: 1, always important to have the safety switch on after power on, you will need to press the safety switch on the GPS for 2 second to active the plane to fly.

7. Suggested "Q_WP_SPEED_DN" is: 250
   Suggested "Q_WP_SPEED_UP" is: 200

| Command | Value | Unit | Range | Description |
|---|---|---|---|---|
| ▣ Q | | | | |
| Q_WP_SPEED | 1000 | cm/s | 20 2000 | Defines the speed in cm/s which the aircraft will attempt to maintain horizontally during a WP mission |
| Q_WP_SPEED_DN | 250 | cm/s | 10 500 | Defines the speed in cm/s which the aircraft will attempt to maintain while descending during a WP mission |
| Q_WP_SPEED_UP | 200 | cm/s | 10 1000 | Defines the speed in cm/s which the aircraft will attempt to maintain while climbing during a WP mission |

8. Suggested "Q_LAND_FINAL_ALT" is: 10
   Suggested "Q_LAND_SPEED" is: 50

| Command △ | Value | Units | Options | Desc | Fav | |
|---|---|---|---|---|---|---|
| Q_LAND_FINAL_ALT | 10 | m | 0.5 50 | The altitude at which we should switch to Q_LAND_SPEED descent rate | ☐ | Load from file |
| Q_LAND_ICE_CUT | 1 | | 0:Disabled 1:Enabled | This controls stopping an internal combustion engine in the final landing stage of a VTOL. This is important for aircraft where the forward thrust engine may experience prop-strike if left running during landing. This requires the engine controls are enabled using the ICE_* parameters. | ☐ | Save to file / Write Params |
| Q_LAND_SPEED | 50 | cm/s | 30 200 | The descent speed for the final stage of landing in cm/s | ☐ | Refresh Params / Compare Params |

9. Suggested "Q_TRAN_PIT_MAX" value is: 7

| Command △ | Value | Units | Options | Desc | Fav | |
|---|---|---|---|---|---|---|
| Q_TRAN_PIT_MAX | 7 | deg | 0 30 | Maximum pitch during transition to auto fixed wing flight | ☐ | Load from file / Save to file / Write Params |

10. Suggested "WP_RADIUS" value is: 30

| | | | | |
|---|---|---|---|---|
| ▣ WP | | | | |
| WP_RADIUS | 30 | m | 1 32767 | Defines the maximum distance from a waypoint that when crossed indicates the waypoint may be complete. To avoid the aircraft looping around the waypoint in case it misses by mor··· |

11. Suggested "BATT2_AMP_OFFSET" value is: 0.027
    Suggested "BATT2_AMP_PERVLT" value is: 54.64481

| Command | Value | Units | Desc | Fav |
|---|---|---|---|---|
| BATT2_AMP_OFFSET | 0.027 | V | Voltage offset at zero current on current sensor | ☐ |
| BATT2_AMP_PERVLT | 54.64481 | A/V | Number of amps that a 1V reading on the current sensor corresponds to. On the APM2 or Pixhawk using the 3DR Power brick this should be set to 17. For the Pixhawk with the 3DR 4in1 ESC this should be 17. | ☐ |

12. Suggested "Q_ASSIST_ANGLE" value is: 30
    Suggested "Q_ASSIST_SPEED" value is: 16
    (For hall sensor only.)

| Command | Value | Units | Options | Desc | Fav |
|---|---|---|---|---|---|
| Q_ASSIST_SPEED | 16 | m/s | 0 100 | This is the speed below which the quad motors will provide stability and lift assistance in fixed wing modes. Zero means no assistance except during transition | ☑ |
| Q_ASSIST_ANGLE | 30 | deg | 0 90 | This is the angular error in attitude beyond which the quadplane VTOL motors will provide stability assistance. This will only be used if Q_ASSIST_SPEED is also non-zero. Assistance will be given if the attitude is outside the normal attitude limits by at least 5 degrees and the angular error in roll or pitch is greater than this angle for at least 1 second. Set to zero to disable angle assistance. | ☐ |

13. Suggested "Q_VELZ_MAX" value is: 250
    Suggested "Q_VFWD_ALT" value is: 4

| Command △ | Value | Units | Options | Desc | Fav |
|---|---|---|---|---|---|
| Q_VELZ_MAX | 250 | cm/s | 50 500 | The maximum vertical velocity the pilot may request in cm/s | ☐ |
| Q_VFWD_ALT | 4 | | 0 10 | Controls altitude to disable forward velocity assist when below this relative altitude. This is useful to keep the forward velocity propeller from hitting the ground. Rangefinder height data is incorporated when available. | ☐ |

## 14. Suggested "BATT2"Values are as follows:

| | | | | | |
|---|---|---|---|---|---|
| BATT2_AMP_OFFSET | 0 | V | | Voltage offset at zero current on current sensor | ■ |
| BATT2_AMP_PERVLT | 24 | A/V | | Number of amps that a 1V reading on the current sensor corresponds to. On the APM2 or Pixhawk using the 3DR Power brick this should be set to 17. For the Pixhawk with the 3DR 4in1 ESC this should be 17. | ■ |
| BATT2_CAPACITY | 5000 | mAh | | Capacity of the battery in mAh when full | ■ |
| BATT2_CRT_MAH | 0 | mAh | | Battery capacity at which the critical battery failsafe is triggered. Set to 0 to disable battery remaining failsafe. If the battery capacity drops below this level the vehicle will perform the failsafe specified by the @ | ■ |
| BATT2_CRT_VOLT | 40 | V | | Battery voltage that triggers a critical battery failsafe. Set to 0 to disable. If the battery voltage drops below this voltage continuously for more then the period specified by the @ | ■ |
| BATT2_CURR_PIN | 14 | | -1:Disabled 1:A1 2:A2 3:Pixhawk/Pixracer/Navio2/Pixhawk 14:Pixhawk2_PM2 101:PX4-v1 | Setting this to 0 ~ 13 will enable battery current sensing on pins A0 ~ A13. On the PX4-v1 it should be set to 101. On the Pixhawk, Pixracer and NAVIO boards it should be set to 3, Pixhawk2 Power2 is 14. | ■ |
| BATT2_FS_CRT_ACT | 2 | | 0:None 1:RTL 2:Land 3:Terminate | What action the vehicle should perform if it hits a critical battery failsafe | ■ |
| BATT2_FS_LOW_ACT | 1 | | 0:None 1:RTL 2:Land 3:Terminate | What action the vehicle should perform if it hits a low battery failsafe | ■ |
| BATT2_FS_VOLTSRC | 0 | | 0:Raw Voltage 1:Sag Compensated Voltage | Voltage type used for detection of low voltage event | ■ |
| BATT2_LOW_MAH | 0 | mAh | | Battery capacity at which the low battery failsafe is triggered. Set to 0 to disable battery remaining failsafe. If the battery capacity drops below this level the vehicle will perform the failsafe specified by the @ | ■ |
| BATT2_LOW_TIMER | 10 | s | 0 120 | This is the timeout in seconds before a low voltage event will be triggered. For aircraft with low C batteries it may be necessary to raise this in order to cope with low voltage on long takeoffs. A value of zero disables low voltage errors. | ■ |
| BATT2_LOW_VOLT | 43 | V | | Battery voltage that triggers a low battery failsafe. Set to 0 to disable. If the battery voltage drops below this voltage continuously for more then the period specified by the @ | ■ |
| BATT2_MONITOR | 4 | | 0:Disabled 3:Analog Voltage Only 4:Analog Voltage and Current 5:Solo 6:Bebop 7:SMBus-Maxell 8:UAVCAN-BatteryInfo 9:BLHeli ESC | Controls enabling monitoring of the battery's voltage and current | ■ |
| BATT2_SERIAL_NUM | -1 | | | Battery serial number, automatically filled in for SMBus batteries, otherwise will be -1. With UAVCAN it is the battery_id. | ■ |
| BATT2_VOLT_MULT | 15.59988 | | | Used to convert the voltage of the voltage sensing pin (@ | ■ |
| BATT2_VOLT_PIN | 13 | | -1:Disabled 0:A0 1:A1 2:Pixhawk/Pixracer/Navio2/Pixhawk 13:Pixhawk2_PM2 100:PX4-v1 | Setting this to 0 ~ 13 will enable battery voltage sensing on pins A0 ~ A13. On the PX4-v1 it should be set to 100. On the Pixhawk, Pixracer and NAVIO boards it should be set to 2, Pixhawk2 Power2 is 13. | ■ |
| BATT2_WATT_MAX | 0 | W | | If battery wattage (voltage * current) exceeds this value then the system will reduce max throttle (THR_MAX, TKOFF_THR_MAX and THR_MIN for reverse thrust) to satisfy this limit. This helps limit high current to low C rated batteries regardless of battery voltage. The max throttle will slowly grow back to THR_MAX (or TKOFF_THR_MAX ) and THR_MIN if demanding the current max and under the watt max. Use 0 to disable. | ■ |

## Pixhawk Connections

USB: Buzzer

GPS

I2C2: Air Speed Sensor

Power 1:Power Monitor
Module for Tail Servo

Power 2: Monitor Module for
Multicopter Servos

1: Aileron Servo
2: Left Tail Servo
3: ESC for Tail Motor
4: Right Tail servo
5: Motor 1
6: Motor 2
7: Motor 3
8: Motor 4
RC in: Receiver
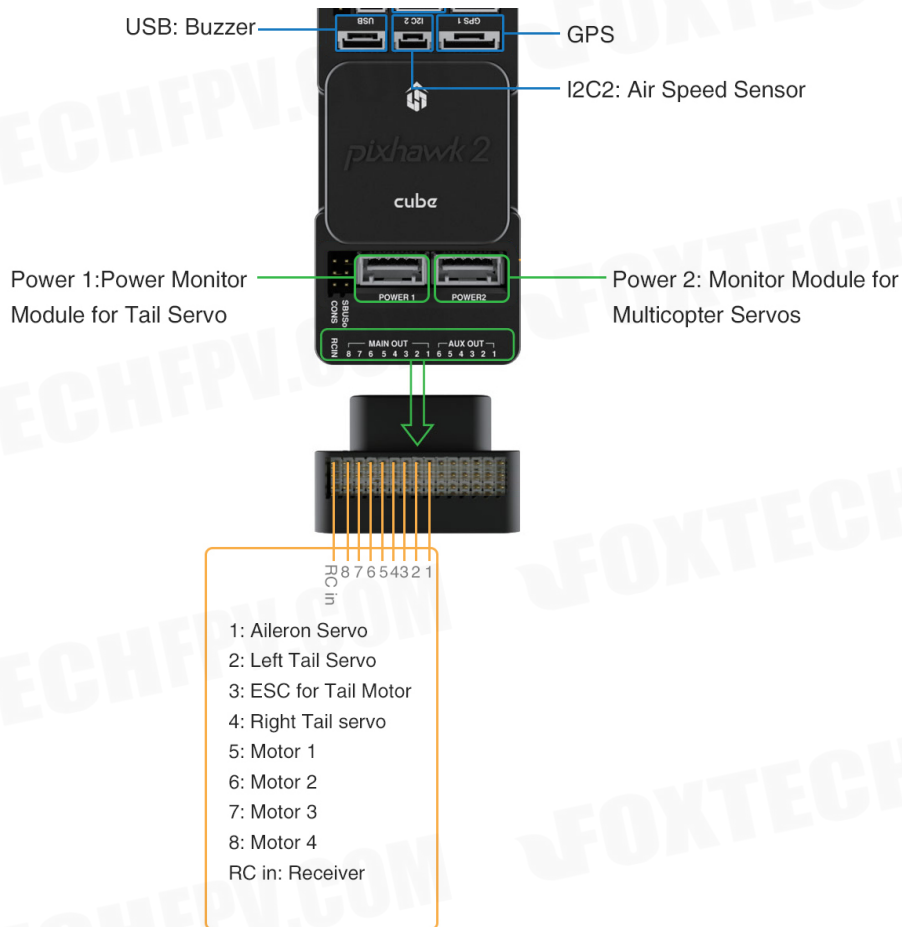
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