



FY-DOS Manual For Multi-rotors Control

Installation & Operation Multi-rotor firmware above V2.20

Dear Customer:

Thank you for choosing DOS as your autopilot system. Please read this manual carefully before using the system to ensure proper use and operation.

The installation and use of this device require some skill and knowledge in flying remote controlled airplane model.

- If you are a complete beginner and have never flown one before, we do not recommend you install this device on your own.
- Please find assistance from an experienced RC pilot who may provide you with the basic knowledge required to use this device successfully.
- If you are already an experienced flyer, you will find the DOS installation to be easy and logical. Just follow this manual and you won't go wrong.

If you need any technical support you can send e-mail directly to: service@feiyu-tech.com

DOS Module

DOS is an Attitude Flight Stabilization System (AFSS) and autopilot system. Now can be used for automated stabilization of fixed wing aircrafts, and after upgrade firmware can be used for other aircraft and equipment control (For more details of DOS, please refer to the latest firmware and the instructions).

DOS has integrated three-axis gyro, three-axis accelerometer, three axis magnetometer and barometric pressure sensor. DOS can accurately measure flight attitude, the earth azimuth and through the barometer to measure relative altitude. ***This manual mainly introduces DOS firmware for Multi-rotor flight system.***

The firmware for Multi-rotor flight system above V2.20 can realize the following functions: (We will continue updating new firmware to improve performance and update functions, please pay attention to the latest news FeiYu official website (www.feiyudz.cn) posted.)

● Attitude Stabilized Mode

DOS can auto stabilize the aircraft flight attitude in this mode, pitch and roll stick center position for 0° attitude, its endpoint is 45°, pitch and roll stick can linear control the flight attitude, maximum angular velocity is 150° / s. Yaw stick in the center position will lock current course, its endpoint corresponding maximum rotation rate 135° per second, yaw stick can linear control the aircraft rotation rate. Throttle stick direct control aircraft climb and decline, climbing and declining rate is directly related to the throttle.

● Hovering Mode

The GPS Module must be connected to the DOS with at least 5 GPS satellites detected. In this Mode, yaw control method is the same as Attitude Stabilized Mode. DOS can auto control flight altitude. Climbing and descending rate is directly related to the throttle, when the throttle stick is in the center position, DOS auto locks the altitude, in maximum means climb rate is 3 m/s, in minimum means decline rate is 1.5 m/s. Throttle stick can linear control the aircraft climb and decline rate. Pitch, roll sticks released will lock the position when GPS signal is adequate. And non-releasing is stand for the aircraft movement speed in the corresponding axial

direction(Maximum 6m/s),not aircraft attitude.

● **Auto Return To Launch Mode(RTH)**

The GPS Module must be connected to the DOS with at least 5 GPS satellites detected. In this Mode, DOS is take over all the control, the RC aileron, elevator, throttle and rudder stick is no control function anymore. When you switch into RTH mode, DOS (**DOS has 20m altitude protection limit, if the switch point altitude below 20m, DOS will automatic climb to 50m**) will first automatic adjust the aircraft heading to the home point and automatically fly the aircraft back to the take-off point, while maintaining altitude. Upon reaching the launch area, the unit will automatically landing and closed the engine.

● **Camera Gimbal Stabilization**

DOS multi-rotor firmware,when is used to control the aircraft under 6 axis, can simultaneously control two axis Camera Gimbal Stabilization.

● **DOS can connect with the Hornet-OSD and the Data Radio**

DOS has one UART interface for connecting the FY-data radio and the OSD module. It can realize the following function by combing them.

First Person View (FPV) : Can be connected to the Hornet - OSD, the flight data overlay to video output,and through the vodo transmission system to send back, let you enjoy the fun of FPV. And it will be easier to operate FPV with the functions of automatic balance, Hovering and Auto Return To Launch.

Real time telemetry-real time monitor : Real time telemetry-real time monitor the flying state, using the Data Radio to lengthen the remote control distance.

For more information, please refer to the FY-OSD and FY Data Radio manual.+

1. DOS standard configuration

Standard configuration

- DOS control module *1;
- RC receiver connecting wires * 1;
- USB cable *1;
- Velcro double sided tape * 2;

Optional accessory

- DOS vibration absorbing mount *1;
- GPS module *1;
- Hornet OSD module;
- Data Radio;
- Remote Adaptor;

2. Technical Specification

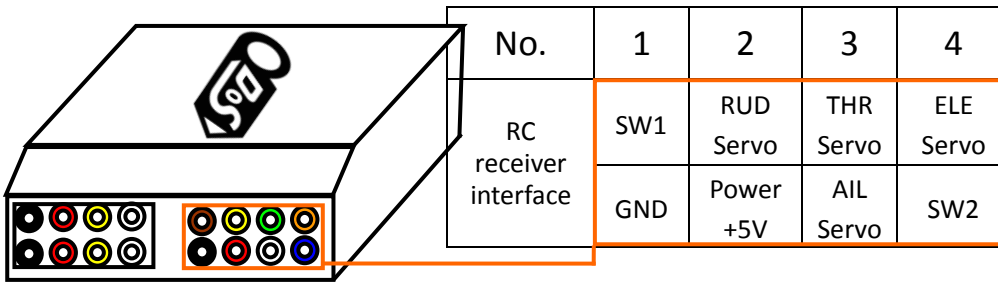
DOS module

Input voltage : 4.0 ~ 6.0 Volt;

Current : 50mA (5V);
 Size : 47 x 30 x 11 mm;
 Weight (excluding wires) : 25g;
 Temperature range : -25 ° C ~ +70 ° C;
 Control frequency :400HZ ;
 Maximum rate of rotation : ≤ 2000 °/s.

3. Interface specifications

■ Remote receiver input interface

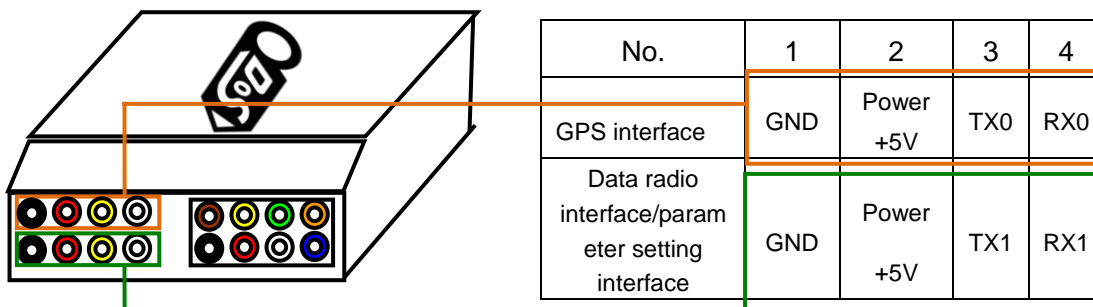


SW1 default setting state

Position	1	2	3
servo signal output	900 ~ 1200US	1200~1800US	1800~2100US
function	stabilized mode	Hovering Mode	Auto Return To Launch Mode

Attention: SW1 can be used to switch DOS flight modes by any 3-position switch. SW2 is unnecessary in firmware V2.2

■ GPS and UART interface



GPS module interface

The GPS pin interface consist of: GND, +5V , RX0. The characteristics are:

Baud rate: 38400

Data bits: 8

Stop Bits: 1

Parity: None

Interface Features: TTL level

This port is use for GPS Receiver. The GPS data protocol is standard NEMA0183.

Attention :DOS multi-rotor firmware version V2.2 and above is not support connect the Hornet-OSD. Please do not connect the Hornet-OSD to DOS GPS port.

Data Radio interface

The UART pin interfaces consist of: GND, power 5V , TX1, RX1.

The characteristics as follows:

Baud Rate: 19200

Data bits: 8

Stop Bits: 1

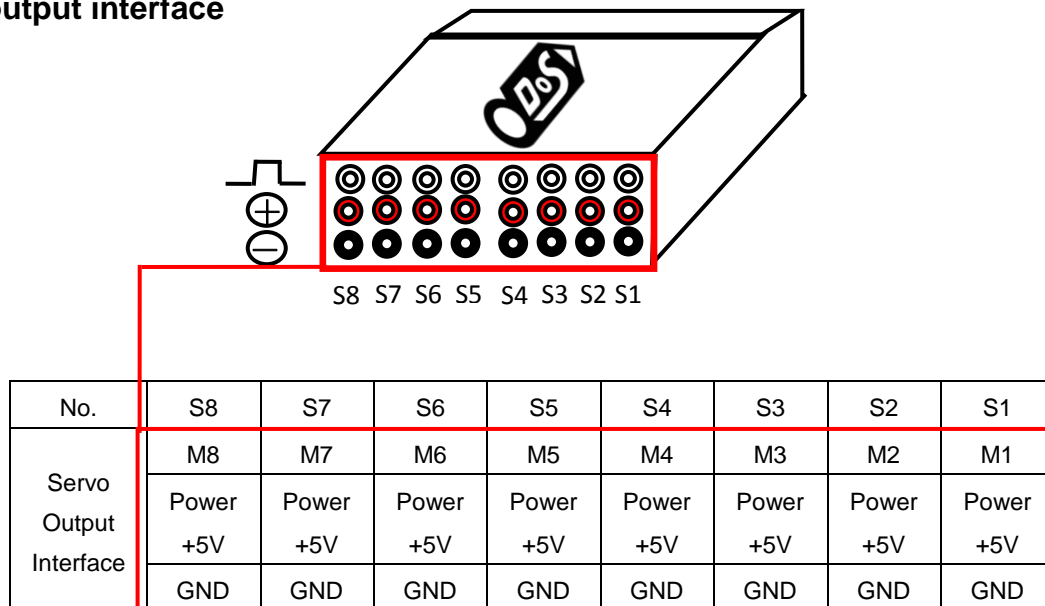
Parity: None

Interface Features: TTL level

This pin interfaces connects to the Hornet-OSD, Data Radio, PC computer serial port or OSD module. You can set DOS control parameters and upgrade DOS firmware through this interface. For the firmware upgrade, please refer to the firmware update operation manul.

Attention : DOS multi-rotor firmware version V2.2 and above you can only connect the Hornet-OSD to DOS UART port. Please do not connect the Hornet-OSD to DOS GPS port. And please upgrade Hornet-OSD firmware to V1.7.

■ **ESC output interface**



DOS's S1 ~ S8 ports are connected separately to ESC M1 ~ M8.

Typically 1020us is lower limit, 1520us is neutral and 2020us is upper limit, frequency is 400Hz.

4. Camera Gimbal Stabilization

DOS multi-rotor firmware, when is used to control the aircraft under 6 axis, can simultaneously control two axis Camera Gimbal Stabilization. S7 port is connected Camera Gimbal's roll servo, S8 port is connected Camera Gimbal's pitch servo.

Attention:

- (1) You must use 400Hz high-speed servos for Camera Gimbal, if you use normal servos for a long time, will cause the Camera Gimbal servos overheat.
- (2) If you use DOS to control Octocopter aircraft, S7 and S8 ports will not output Camera Gimbal control signal any more.

5. Power Supply

- DOS input voltage is 4.0 ~ 6.0 V, you can use a stabilized voltage supply, or directly use ESC's +5 V power supply, most of the ESC power supply can meet the requirements;
- DOS and the RC receiver use the same power supply via the RC receiver connection wiring.
- **VERY IMPORTANT:** Only one BEC power source should be used. If all four ESCs have internal BEC, choose only one to supply power. Disconnect the red wire (positive) of the other ESCs, but reserve the GND and Signal wirings.

6. Indicator light instruction

NO	Operating mode	LED	GPS location fixed (normal)	GPS location fixed (good)	GPS location fixed (very good)
1	Stabilized mode	Single flash	Single flash	Double flash	Triple flash
2	Hovering Mode	Double flash	Single flash	Double flash	Triple flash
3	Auto Return To Launch Mode	Triple flash	Single flash	Double flash	Triple flash
4	Gyro needs Reset or is moving	Red light continuous flash			
5	During the gyro reset	Flash white light for almost one second			
6	Too much vibration	red light stay on solid			

Attention:

Vibration LED takes precedence over GPS positioning LED, you must make sure that the gyro is not need

to initialize (Red light continuous flashing), only in that you will know the GPS positioning success or not.

7. Vibration damping installation

Damping installation: Good damping installation is the basis of DOS can do normal work, also can decide whether DOS to maximize play flight performance or not, and make sure you have a great flight. Otherwise may cause serious flight accidents, for example: flight jitter, flight attitude gradually deviation and tilt from the balance position, and Hovering mode unable to keep the flight altitude and position. You can use your own DIY shock absorbing devices to do the shock absorbing, but we recommend using suspending damping installation, especially use DOS vibration absorbing mount which product by FeiYu Tech,it can meet the requirements of most of the conditions, and in addition you need to try to reduce the vibration of the motors and oars.

Installation position: Each modules install to a suitable position is conducive to further enhance the performance of Hovering mode. DOS module installation position should be as far as possible to close to the center of the aircraft, the aim is to reduce the disturbance to the internal IMU position sensing when the aircraft tilt or rotate. In addition also you have to consider a very important factor, that is as far as possible to reduce the interference to the DOS internal magnetic sensor which caused by installation position. There will be caused interference to magnetic sensor,such as surroundings have strong current, motor rotation, battery, etc. We need to do is to give full consideration of these two factors, compromise to select a suitable position for install it. GPS module should be placed as far as possible to the center position,that can reduce the interference to GPS data when it level rotating. Also you can put the GPS module to a high place use a stent (**The GPS support height should not less than 80 mm**) , the practice shows that can effectively reduce the interference to GPS signals which caused by other devices, and improve the positioning performance of GPS module.

We recommed using suspending damping installation, especially use DOS vibration absorbing mount which product by FeiYu Tech.(You can find purchase method from FeiYu official website: www.feiyudz.cn) Installation process as follows:(You need a allen driver)

New DoS vibration absorbing mount like picture below shows:



Install effect chart



If you are using an older DOS vibration absorbing mount, please follow these steps to install:



(1) Use screws to install the four support columns on the baseboard;



(2) Stick the solid foam pads (dampers) to the cover board four interior Angle position;



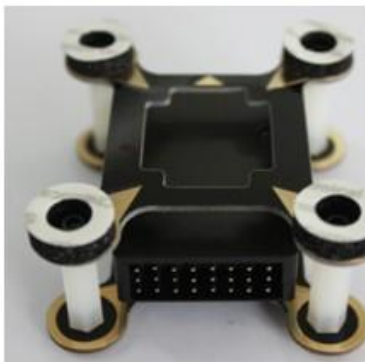
(3) Stick the cover board to the DOS upper surface (LOGO character surface); you can appropriately increase DOS module weight to improve the damping effect, you can stick copper sheet or other sheet metal which cannot be magnetized on the bottom of the DOS (Otherwise the magnetized sheet metal will disturb the internal magnetic field sensors).



(4) Use screws to fix the cover board to the four support columns;



(5) Stick the circular ring foam pads (dampers) to the four rounded corners on the baseboard vibration absorbing mount. Then fix it as far as possible to the position of barycentre on aircraft



8. RC receiver connection

RC receiver and DOS connection wires is included in the DOS product.

Attention: the wires is arranged by the colors.



- a) DOS requires a minimum of 6-channel RC receiver.
- b) 4 Receiver channels are used for aileron (channel 1), elevator (channel 2) , throttle (channel 3) and rudder (channel 4) signal output. Connect these 4 receiver output signals to the DOS with the supplied wires (pay attention to the color of each channel).
- c) A free Receiver channels are required to control the DOS Flight Modes (a 3-position switch ,”SW1”).
- d) The other 3-position switch(SW2) is not used in firmware V2.0,so you do not need to connect.

Wire color	Receive channel	
White (bundled with red & black)	aileron	Channel 1
orange	elevator	Channel 2
green	throttle	Channel 3
yellow	rudder	Channel 4
brown	SW 1 Any free channel controlled by A 3-way switch or dial knob	Channel 5
blue	SW 2(not used) Any free channel controlled by A 3-way switch or dial knob	Channel 6

Attention: RC mode Setting of your controller has to be fixed wing model, and every channels’ maximum and minimum value to be the default value (100%), all the sticks trim to 0, also cancel all the curve set .

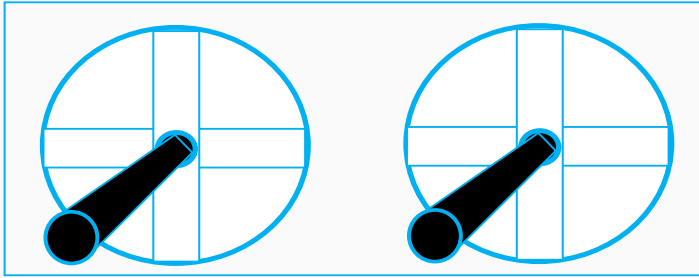
9. Start Motor and check the Motor rotation direction

Start Motor : When using multi-rotor firmware, pushing throttle stick before takeoff will not start the motors. You have to execute Combination Stick Commands (CSC) in stabilized mode or Hovering mode (**Can not in Auto Return To Launch Mode(RTH))** in order to start motors.(please do not install propeller yet.)

Meet the following conditions:

- Put Throttle stick to the lowest position

- Put Aileron stick to any endpoint position
- Put Elevator stick to any endpoint position
- Put Rudder stick to any endpoint position



Please slowly push the throttle and according to the picture “**Motor Mixer**” shows to check the motor rotation direction is right or not.

Attention:

- (1) Altitude Stabilized Mode and Hovering Mode both can execute Combination Stick Commands (CSC) to start the motor.
- (2) In Hovering mode, if you want to take off after execute Combination Stick Commands (CSC), also you need push the RC throttle stick to above half position. Altitude Stabilized Mode did not have this limit.
- (3) If you do not have any control action with 6 seconds after execute Combination Stick Commands (CSC),the DOS will into the state before execute Combination Stick Commands. If you want to take off ,you need to execute Combination Stick Commands again.
 - 1) Altitude Stabilized Mode: If the RC throttle stick is not in the lowest position,DOS will not into the state before execute Combination Stick Commands.
 - 2) Hovering mode: When your aircraft landed into the ground , And DOS detected there is no altitude change, it will closed the engine and into the state before execute Combination Stick Commands.
- (4) Auto Return To Launch Mode(RTH) is all controlled by DOS,RC sticks human intervention is invalid.
- (5) Wind pressure in the volatile situation, due to the throttle closed protection restrictions, hovering mode andAuto Return To Launch Mode(RTH) may appear the situation which can not closed the throttle, then you just need to put the RC throttle stick to the lowest and switch into Altitude Stabilized Mode.

10. Gyroscope Reset

The Red LED flashes continuously even when the DOS remains stationary,that means you need to do the Gyro reset.The Gyro reset must be done before the Combination Stick Commands,after execute Combination Stick Commands you can not do the Gyro reset.

Initialization / Reset Process:

- (1) Power on DOS and keep stationary.
- (2) Switch to stabilized mode.
- (3) On SW1,switch stabilized mode to hovering mode 6 times, time interval has to be less than 3 seconds as follows:
 stabilized mode→hovering mode →stabilized mode →hovering mode →stabilized mode→hovering mode
 →stabilized mode →hovering mode →stabilized mode →hovering mode →stabilized mode →hovering mode.
- (4) DOS indicator will turn white about one second.
- (5) After white LED turns off, the re-setting / initialization is completed.

11. Calibrate the Compass

DOS has a built-in magnetic field sensor which can measure the earth's orientation position, providing the basis of the hover function. If the magnetic field is disturbed, the hovering mode will draw a circle motion and be unable to hover.

DOS internal procedure will correct magnetic field in real time, since the magnetic field will change if the motor starts, so the best way is that control aircraft spin over three circles after take-off. The internal procedure will calibrate the magnetic field automatically. This is very critical, and can affect the hover mode directly.

Attention: If you want to save the compass calibration value permanently, please landing and wait the aircraft automatic into the state before execute Combination Stick Commands (CSC) and do the gyro reset. The compass calibration value will be saved into DOS through the gyro reset procedure.

12. Flight essentials

To achieve satisfactory results, you need to pay attention to the following aspects

- 1). Good shock mounting is very important, which not only can make a more smooth flight, but also conducive to the inertial device for measurement of displacement.
- 2). Try to minimize the interference of the surrounding environment of the internal magnetic field sensor when you install the DOS.
- 3). Adjust altitude balance parameters, try to use the larger parameters if the control parameters do not cause shock. The altitude control has a certain hardness and stability.
- 4). Before take-off, switch to the Altitude Stabilized Mode, check whether the gyro need initialization.
- 5). The GPS module should support installation away from interference. You should wait for the green light double flash each loop or triple flash each loop before take-off.
- 6). After take-off, control the aircraft rotation to make three circles, all while making sure the magnetometer is satisfactorily corrected.

13. Other considerations

(1) Please as far as possible to maintain the current altitude when switching Attitude Stabilized Mode to Hovering Mode. In Hovering Mode, DoS can automatically control flight altitude. Climbing and descending rate is directly related to the throttle, when the throttle stick is in the center position, DOS automatic locks the altitude, in maximum means climb rate is 3 m/s, in minimum means decline rate is 1.5 m/s. The throttle stick can linearly control the aircraft climb and decline rate.

There are two very important points:

- 1) To prevent sudden change to the altitude caused by the throttle, you have to put throttle stick back to balance flight position when switching off hovering mode.
- 2) After connecting the GPS module, please do not take off yet. You should wait until the GPS positioning LED shows the GPS positioning is in a good condition (Green light double flash each loop or triple flash each loop).

(2)

- 1) Please control your aircraft fly 0.8 meters above to the ground, which will give you a good control effect. And

if you control your aircraft descend to the ground in hovering mode may cause the aircraft altitude volatility which caused by the ground air.

2) Without the GPS module, switching to Hovering Mode or Auto Return to Launch Mode will automatic bring you into Fixed Altitude Flight Mode.

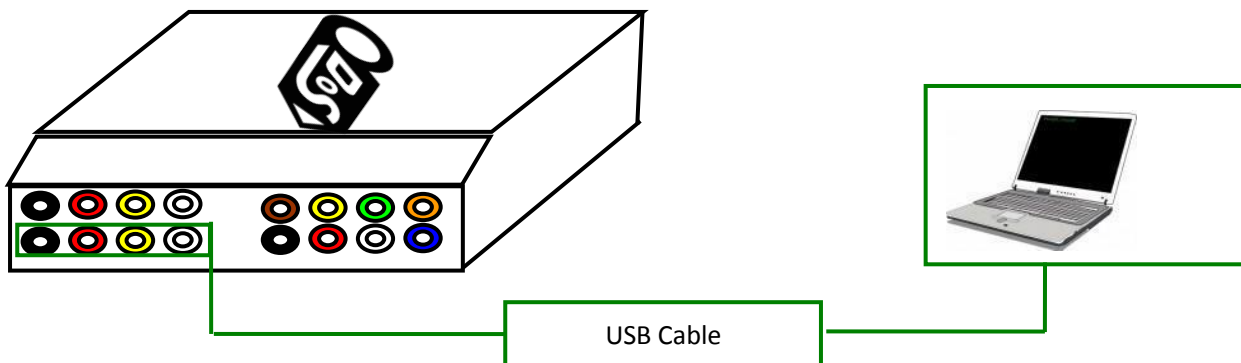
(3)In hover mode, you can change the aircraft position by using the RC sticks. When you release the RC sticks, the aircraft will hover to a new position.

(4)GPS module should be placed as far as possible to the center position, in order to reduce the interference to GPS data when it level rotating. Also you can put the GPS module to a high place using a stunt. This practice can effectively reduce the interference to GPS signals caused by other devices, and improve the positioning performance of GPS module.

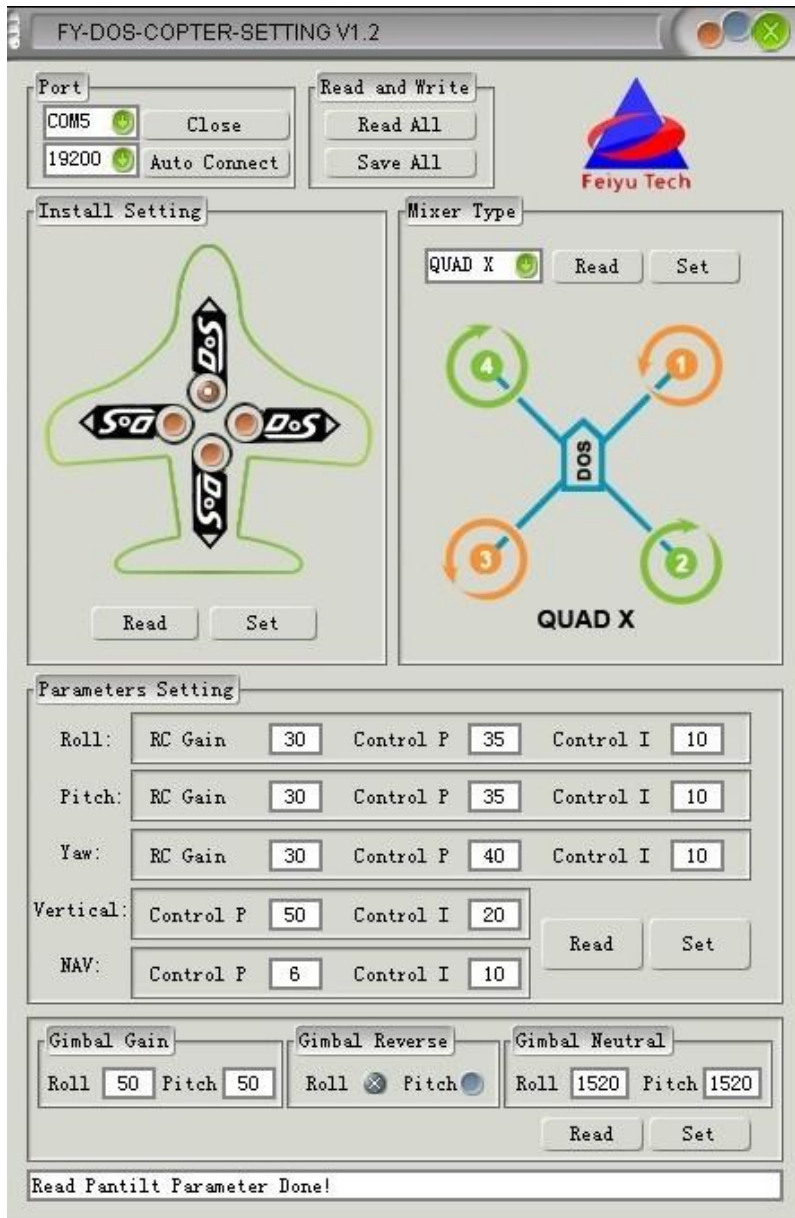


14. DOS Setting Software and installation and debugging instructions

● Connection Mode:



First need install USB-TTL device driver, you can download it form our website: www.feiyudz.cn
Software Interface Description:([Parameter in the following picture is default parameter](#))



● **Install Setting:**



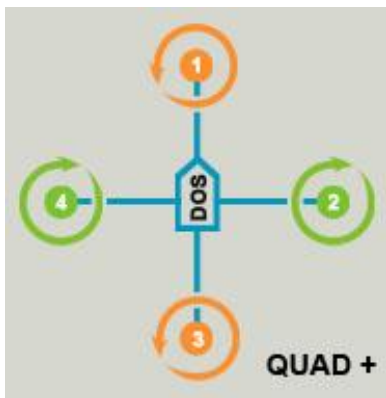
DOS supports four install directions. The LOGO must be installed facing up.

DOS has an arrow printed on the top face. Normally orientate the arrow towards the head of the craft. If adjust the installation direction, you have to set it via the setting software, otherwise will cause the aircraft abnormal condition.

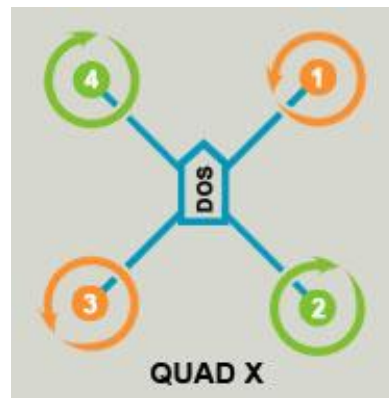
● **Motor Mixer**

The following pictures display the rotation direction and serial number of each motor, each ESC should be connected to the DOS S1 - S8 interface. Pay attention that once you choosed the control type, the corresponding position motor rotate direction have to be completely the same as the picture. (If the motor rotate direction is not correct then exchange any two of the three connect wires between ESC and motor to change the motor rotate direction.)

DOS support the following types of multi-rotors:



Quadcopter +



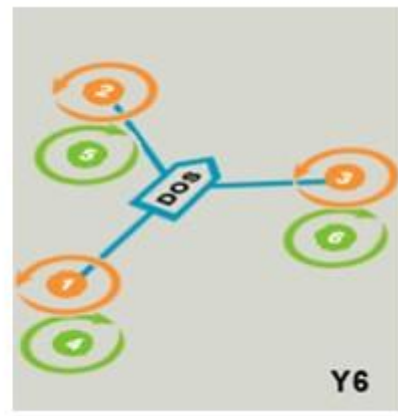
Quadcopter X



Hexacopter +



Hexacopter X



Y6



Octocopter +



Octocopter X

● Control parameters adjustment

Parameters Setting			
Roll:	RC Gain	<input type="text" value="30"/>	Control P <input type="text" value="35"/> Control I <input type="text" value="10"/>
Pitch:	RC Gain	<input type="text" value="30"/>	Control P <input type="text" value="35"/> Control I <input type="text" value="10"/>
Yaw:	RC Gain	<input type="text" value="30"/>	Control P <input type="text" value="40"/> Control I <input type="text" value="10"/>
Vertical:	Control P	<input type="text" value="50"/>	Control I <input type="text" value="20"/>
NAV:	Control P	<input type="text" value="6"/>	Control I <input type="text" value="10"/>
		<input type="button" value="Read"/>	<input type="button" value="Set"/>

● RC Sensitivity

RC Sensitivity determine the reaction speed of attitude from command stick, the bigger the value the quicker the reaction. Increase it for sharper and quicker leveling action after command stick released. Unstable shaking flying and the control feeling will be stiffness and rigid if the value is too high; and sluggish leveling action and slow braking if too small.

● Control Gain

Control gain use for stabilizing the flight attitude. To the gains of Pitch and Roll, if you release the Pitch or Roll stick after command stick, multi-rotor should be back to hovering state.

Control P : If the reaction of multi-rotor in this procedure is too soft (large delay), please increase the basic gain slowly (10%-15% each time) until vibration emerges after you release the stick. Then decrease the gain a little until vibration just disappears. Now the gain is perfect.

Control I : This value generally do not need to adjust

● Course control gain adjustment

The way of tuning the Yaw gain is the same as the way of adjusting the Tail Gyro. If you want fast stick reaction speed, increase the gain, otherwise decrease the gain. However, the spin of multi-rotor is produced by the counter torque force, and the magnitude of which is limited. Therefore, large gain will not produce tail vibration like helicopter, but severe reaction at the start or stop of motors, which will affect the stabilization of the other directions.

● Vertical control Gain

Vertical control Gain is used for hovering Mode.

Control P : You use two methods to judge if the Vertical gain is good enough: 1) The multi-rotor can lock the altitude when the throttle stick is at center position; 2) The change of altitude is small during the flight along a route. You can increase the gain slowly (10% each time) until the vibration emerges along the vertical direction or the reaction of throttle stick is too sensitive, then decrease 20% of the gain. Now it is a suitable Vertical gain.

Control I : This value generally do not need to adjust.

● Navigation control Gain

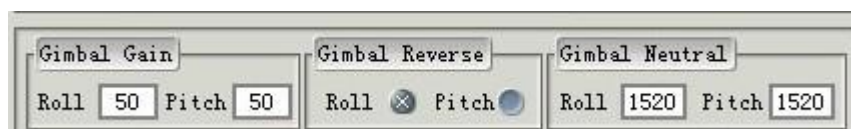
Navigation control Gain is the control parameters use for control hovering point.

Control P : please increase the basic gain slowly (2-3 each time)until the vibration emerges in the hovering point. Then decrease the gain a little until vibration just disappears. Now the gain is perfect.

Control I : This value generally do not need to adjust.

● Camera Gimbal Stabilization adjust instructions

Attention: Please do not adjust the Camera Gimbal Stabilization untill you have finished the multi-rotor aircraft adjust.



Please according to following steps to adjust Camera Gimbal Stabilization :

(1) Gimbal Reverse

1)Shaking the Camera Gimbal on roll direction , if DOS not give the corresponding reverse correction, please choose Roll reverse.

2) Shaking the Camera Gimbal on pitch direction , if DOS not give the corresponding reverse correction, please choose pitch reverse.

(2) Gimbal Gain

The default Gimbal Gain:Roll 50,Pitch 50.

Under the condition of servo no rotation, you should control the camera gimbal with RC stick. If the servo shaking when the stick in the neutral position, that's indicates the sensitivity is too big. As a result, you should slowly decrease(10% -20% each time) corresponding direction Gimbal Gain, until the shaking situation disappear.If the camera gimbal go back to Neutral is too soft, As a result, you should slowly increase(10% -20% each time) corresponding direction Gimbal Gain

(3) Gimbal Neutral

The default Gimbal Neutral is 1520.

Power on and put the camera gimbal into level position,observe the servos position.If the servos is not in the Neutral value,please through adjust the to corresponding servos Gimbal Neutral to make them into Neutral value position.

Adjusting method: According to corresponding servo reaction, appropriate increase or decrease corresponding servo Gimbal Neutral.

—— END ——

Note: We reserve the right to change this manual at any time! And the newest edition will be shown on our website www.feiyu-tech.com.