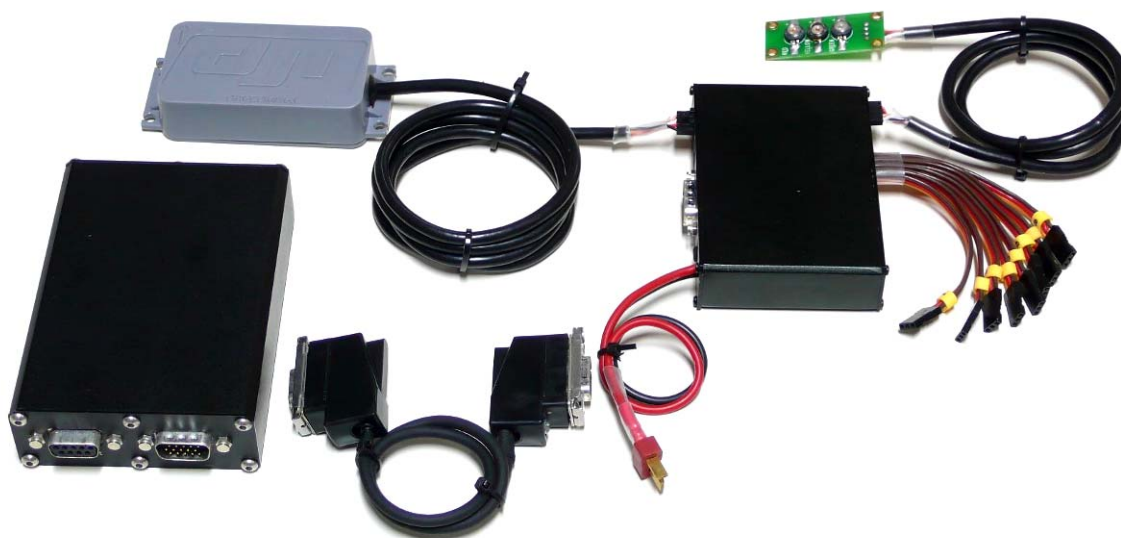


DJI XP3.1 Standard Manual

V 1.01



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Preface

Please read this brochure carefully before using DJI XP 3.1. If you have any questions, please contact with us. We will give you satisfying answers as quickly as possible. Our company will not supply service to the product from improper channel or with unclear functions.

Our company reserves the right to revise any part of this brochure without informing users beforehand.

1 Introduction

1.1 Function Introduction

DJI XP3.1 is a controlling system for unmanned system, integrated with GPS, 6-DOF inertial measuring unit, Magnetic-field meter and barometer. The system could control the helicopter precisely and reliably at any flight altitude, in most weather conditions, and even under the short-interruption of GPS signal situation.

1.1.1 System Features

Helicopter, a non-stable platform itself, needs continuous observation and controlling to keep steady flight. DJI XP3.1 provides excellent auto stable hovering and flight performance by adopting GPS/INS inertial navigation technology, which is widely used on cruise missile, and advanced controlling algorithms.

Main Characteristics of DJI XP3.1

1. Autonomously hovering with high precision.
2. When autonomously hovering, the helicopter altitude and position can be locked. Flight velocity in one direction corresponds a given RC stick volume, so users can control a fool-style flight(can only control one channel at one time)
3. Under the locked altitude, with the help of XP 3.1, operators can easily control the helicopter to do the turn-coordination.
4. Amend errors raised between hovering and flying automatically.
5. The main differences between DJI XP3.1 and the stability augmentations stem based on CCD sensor: DJI XP3.1 can to any altitude within the remote

control smoothly, without the height and surface texture restraints. No frequent switching between various modes, the speed can be accreted to 0.1m/s or less.

6. Automatically turn into hovering state when receiver signal is lost (enter the Fail Safe mode).

1.1.2 Hardware System

1. Improve the accuracy and real-time performance of the controller by using 2 separate DSPs (digital signal processor) to calculate altitude and control algorithm.
2. Provide superior position accuracy by using a high performance 16-channel GPS receiver.
3. Enclose high-reliability tri-axial gyroscopes and accelerometers of MEMS.
4. Building algorithm can facilitate users to do the hard and soft iron magnetic field compensation for eliminate the magnetic interference.
5. The system dedicates CPLD to decode and encode servo signal for higher reliability and compatibility for most RC receivers.

【The Basic Performance Parameters】

Hover positioning accuracy ①		Maximum wind resistance
Vertical	± 1m	5.5~7.9m/s
Horizontal	± 2m	

Note:

①: These parameters are measured in the condition of breeze (wind speed less than 3.3m/s). If in heavier wind, the accuracy will be little lower.

1.1.3 Control Mode

【Autopilot Mode】:

In this mode, the altitude can be locked; the nose direction and the helicopter's velocity command, back and forth, left and right, up and down, can be issued by RC separately and get accurate feedback control through on-board automatic control algorithm. Even people, who are flying the RC helicopter for their first time, can learn to control the helicopter in few minutes.

There is a hovering zone^① in the middle of the RC stick. When the RC stick goes back to the middle and enters the hovering zone, the system will make the

helicopter enter auto-hovering in a short time.

After entering autopilot mode, the flight speed is in proportion to the volume of RC stick^②.

When the RC stick is pushed to the limit, the corresponding maximum flight speeds are as followings:

Forward-Backward	Left-Right	Up-Down
$\pm 30\text{km/h}$ ^③	$\pm 14.4\text{km/h}$	$\pm 7.2\text{km/h}$

Note:

- ①: The small section of the hovering zone on the RC is determined by the system controller.
- ②: The ROTOR EPM is locked by GV1 or ESC.
- ③: In order to keep helicopter in safe range, system velocity is intentionally limited within 30m/h.

【Pure Manual Mode】:

The system remains the traditional manual mode. Under this mode, operator can control the helicopter as ordinary RC helicopter.

1.2 System Requirement

Helicopter Types	Applicable to electrical and gas/fuel powered helicopters	
Swash Types	Ordinary mode CCPM	1_Servo_Norm
	CCPM mode	<ol style="list-style-type: none"> 3_Servo_120° 3_Servo_140° 3_Servo_90° 4_Servo_90°
Remote Controller	<ol style="list-style-type: none"> 7 channels or more All channels have the Fail Safe function ① 	
System Operating Temperature	-10 ~ +70°C	
System Operating Voltage	7.4~12V(DC)	
Recommended System Power Supply	<p>The specifications of lithium battery as followings: ②</p> <p>Voltage: 7.4V ③</p> <p>Battery capacity: More than 2000mAH</p> <p>Discharging current: Larger than 5C</p>	
Recommended Accessories	<ol style="list-style-type: none"> Gyroscope: GY401 ④ Speed controller: ESC (electromotion), GV1 (kerosene-powered) practicably locking the revolving speed) ⑤ Receiver(PCM)⑥ or 2.4G 	

Note:

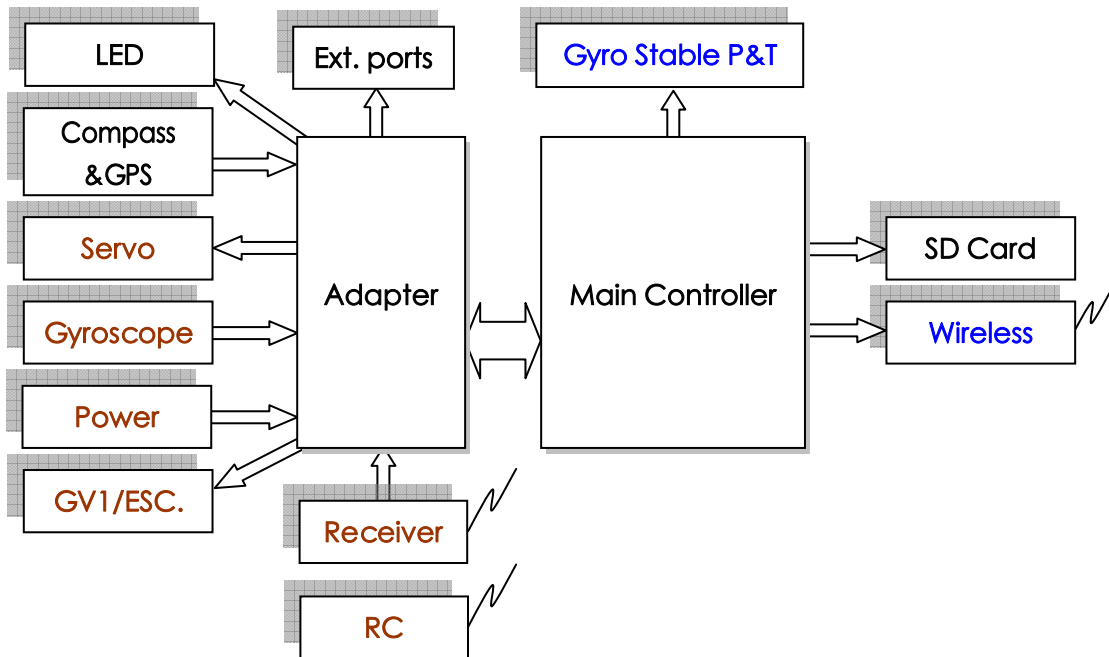
- ①: Some of the RCs (like some kinds of Spektrum RC), only the throttle (the first channel) has the function of Fail Safe, none of the other channels have Fail Safe function. Under such situation, it cannot guarantee that the helicopter can enter the auto-hovering state when the RC is in the out of range.
- ②: For the lithium battery of these specifications, the voltage can reach more than 8V when it is at full power state (there are two 3.7V batteries connected in series inside. If there are three 3.7v batteries connected in series, it may exceed the system operating voltage, so it is not recommended). If the measured voltage is 7.4v, the battery is at the edge of being empty. As a result of adopting powerful DSP+ARM to process efficient attitude control algorithms, the system working current may approach

more than 1A. By using the lithium battery with capacity is over 2000mAh, the system can work for around 2hours

- ③: *System alarming voltage is 7.4v (under this condition the red LED status indicator will always on)*
- ④: *The gyroscopes will induce this change (and confirm it is not artificial operation), and emend this impact. After testing, the compatibility between GY401 and XP3.1 is higher than that between GY601 and XP3.1, so GY401 is recommended.*
- ⑤: *Engine governor such as GV-1 or RPM lock-able motor drivers are required to maintain a constant rotor RPM and XP3.1 will leave the Thro channel in the original position in the autonomous mode.*
- ⑥: *PCM or 2.4 G receivers has Fail Safe function, but PPM Do not.*

2 System

2.1 System Framework



Note:

- Black: Normal configured mode
- Blue: Optimal configured mode
- Brown: User-configured mode

2.2 Module Introduction

2.2.1 Main Controller

Main Controller, which calculates the flight attitude and control the helicopter's flight by sending orders to Adapter under autopilot mode, is the heart of the control system.



Figure 2. 1 Main Controller

2.2.2 Adapter

Adapter acknowledges signals from RC receiver, process controlling signal and control the servo operation with cooperation of Main Controller.



Figure 2. 2 Adapter

2.2.3 GPS & Compass

External GPS and compass are integrated in one box. Both of them must be placed far away from interference. It is used to receive GPS signals and direction signals, and send them to Main Controller.



Figure 2. 3 GPS&Compass

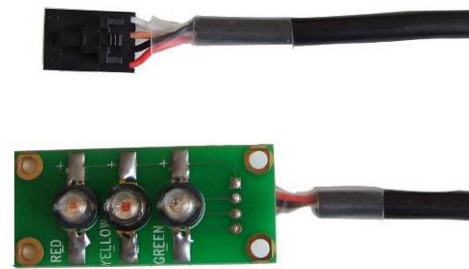


Figure 2. 4 LED Status Indicator

2.2.4 LED Status Indicator

LED with red, white and green ones will have constantly on, sparkling, flashing and constantly off states. They represent different control status respectively (Refer Appendix A for details).

2.2.5 Software

A PC software named XP configure is for the system adjustment. Users need to set different parameters for different helicopter to make sure the system operate normally.

3 System Installation and Adjustment

★ Users should dedicate special circumspection and patience to the installation, adjusting, flying and maintenance of the system. Any improper operation may lead losses of helicopter, life or property. Please pay special attention to the following steps and introductions of installation and adjustment. Do not try to skip any step. ★

⚠ This sign stands for “Fatal Danger” . Users should pay special attention to it and handle with care.

3.1 Hardware Installation

Before you install XP 3.1, please make sure the mechanical structure of the helicopter has been adjusted completely^① and the helicopter can process normal manual flight in the absence of this system.

Note:

①: Try to eliminate all kinds of vibrations by adjusting mechanical structure and motor system, since the oversize vibration will influence the normal operation seriously.

3.1.1 Main Controller Installation

1. Please assemble the anti-vibration frame of the main box first. The Main Controller can be fixed on the anti-vibration frame of main box by 4 neoprene isolators, as shown in Figure 3.1.



Figure 3. 1

2. Main Controller installation can follow the following two ways, with reference of the coordinate frames of Main Controller (Figure 3. 2) and helicopter(Figure 3. 3). Inversion or installation in other angles is not allowed.



Figure 3. 2

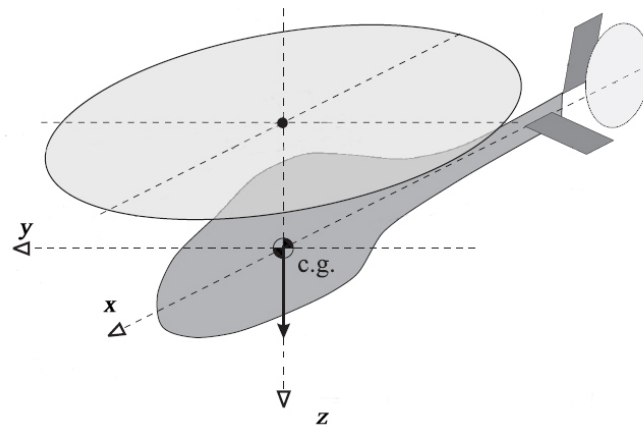


Figure 3. 3

- a) (Figure 3.4) Make Main Controller box frame the same direction as the helicopter frame, which means the side with two DB ports faces the head of the heli, corresponding to the “Forward” set by the [Install Parameters] in XP configure(adjust software).
- b) (Figure 3.5) Make Axis X of Main Controller the same as axis Y of helicopter, which means the side with two DB ports faces the right direction of the heli, corresponding to the “Right” set by the [Install Param] in XP configure. Make Axis X of Main Controller the same as axis Y of helicopter, which means the side with two DB ports faces the right direction of the heli, corresponding to the “Right” set by the [Install Param] in XP configure.



Figure3. 4



Figure3. 5

Attention:

- 1) For the helicopter with gasoline engine and electric motor, the minimum distance between the Main Controller and the engine/motor is 10cm; but for the heli with methanol machine, one does not need to consider the distance between them.
 - 2) The distance between the Main Controller and the center of gravity should be close enough, the shorter the better. Also to avoid being blown by the airflow caused by the rotation of the main rotor.
 - 3) The installation direction should be as straight as possible, or it will decrease the control accuracy.
 - 4) The Main Controller should be far away from heat sources, electromagnetic interference and servo.
 - 5) 在 Users should reserve enough space for the insertion of connecting wires to Adapter or to the computer in front side of the Main Controller (the side with two DB ports).
3. Users can find a suitable position^① for the Main Controller according to the above requests and helicopter's structure. Followings are two installation examples (Figure3. 6 and Figure 3. 7).

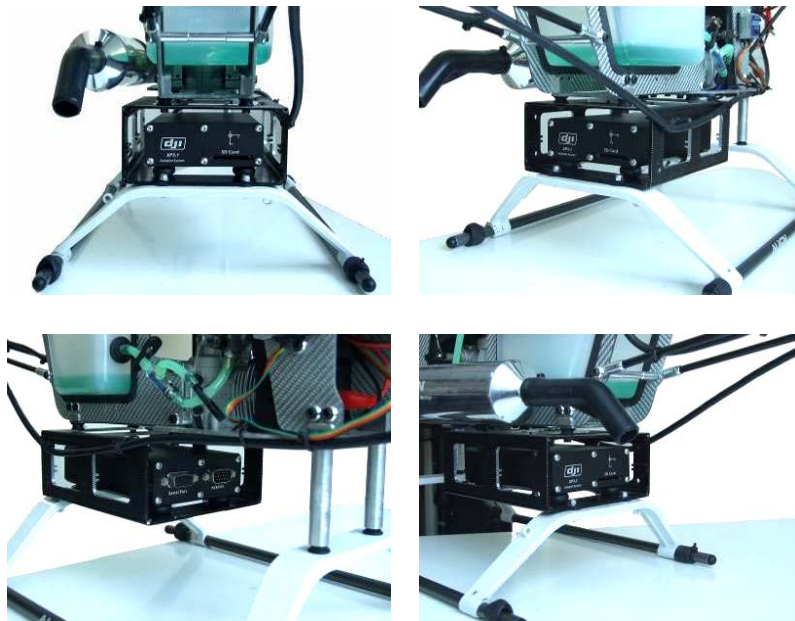


Figure3. 6

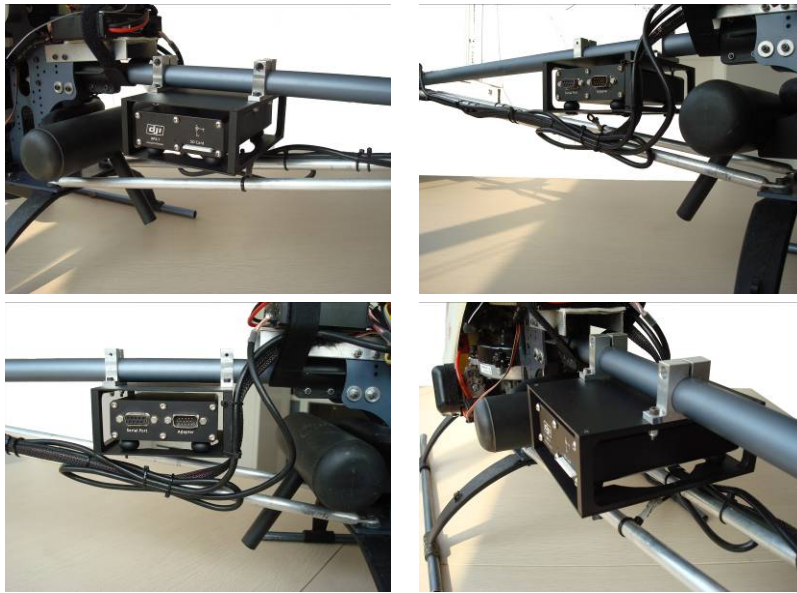


Figure 3.7

Note:

- ①: Drill proper holes on anti-vibration frame and helicopter. Then fix the anti-vibration frame to the helicopter.

Attention:

Check the bearing capacity of neoprene isolator regularly to see if it has the tendencies of weakness or aging, in order to replace it in time.

3.1.2 Adapter installation

1. **【Position Choice of Adapter】:**

- 1) The minimum distance between the Adapter and the engine (gasoline engine or electric motor) must be 10cm at least, or normal work will be disturbed.
- 2) Arrange a proper position for Adapter installation to reduce the using of the extension wire because there are many links between Adapter and RC receiver, servo respectively.
- 3) Do not fix the Adapter to the helicopter after choosing a proper position. Fix it after all the adjustment.

2. **【Connection between Main Controller and Adapter】:**

Connect them by DB 15 cable (Figure 3. 8), which matches DJI XP3.1. The clasp of DB 15 cable must be locked (Figure3. 9 DB15 open status) (Figure3. 10 DB15 closed status). The looseness of DB15' s clasp must be avoided.

⚠ Pay attention to protect DB15 cable and avoid long-time friction, which may leads short-circuit or open-circuit!

The routing should not be pulled to tightly (Figure 3. 11) longer wire in advance is preferred and. Do not constrain the DB15, which links to the port of the Main Controller. Keep it reflex to avoid affecting the attitude of the Main Controller or reducing the efficiency of isolators. The recommended way is shown in Figure 3. 12



Figure 3. 8 DB15 Cable

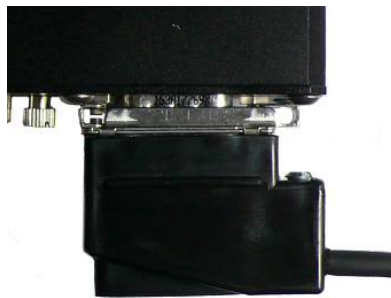


Figure 3. 9 Open Status



Figure 3. 10 Closed Status



Figure 3. 11



Figure 3. 12

- 3. [Connection between RC Receiver and Adapter]:** Fix the RC receiver first. And then connect Adapter' s input wire to the RC receiver according to the label on them (Figure 3. 13) and the power polarity. No external power supply is needed for RC receiver, because its power has been supplied by Adapter directly (Figure 3. 14).



Figure 3. 13



Figure 3. 14

Definitions of the RC receiver input wires are shown as follow:

Label	T	A	E	R	U ^①	P	G ^②	X
Definition	THRO	AILE	ELEV	RUDD	AUTO	PITCH	GYRO	AUX

Note:

- ①: Autopilot/ manual channel
- ②: Gyro sensitivity channel

Connection schematic diagrams:

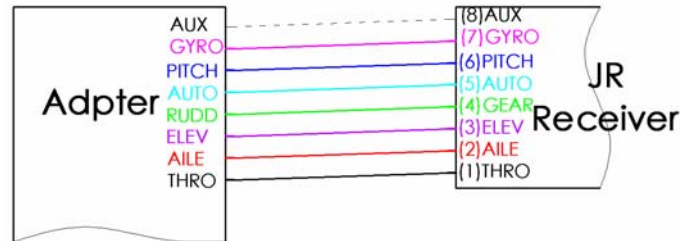


Figure 3. 15

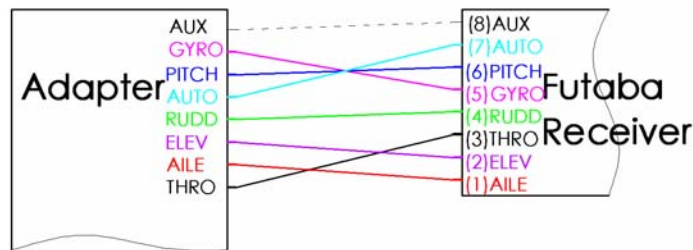


Figure 3. 16

Attention:

JR and Futaba RC receivers are promoted, because in this manual we set them as examples. By using them users could make connection according to the above two charts. Please check if the channel definition of the RC receiver corresponds to that of the above charts. If not, the former is promoted. If the RC receivers are other models, users should connect them with definitions of wires.

⚠ No other links except input wires of Adapter are allowed to connect to the RC receiver, for example: Servo or electronic shutters.

4. **【Connection between Servo and Adapter】:** As in Figure, the 8 marked ports are output channels to the Servos (Figure 3.17). Servo power supply (4.8v) is connected to the BATT channel of Adapter. The connection is the same as that of connecting between RC receiver and Servo. The followings are the schematic diagrams of swash plates with three servos (including normal mode, 90° CCPM, 120° CCPM, 140° CCPM) and four servos (90° CCPM). Please follow the following connection(Figure3. 18 and Figure 3. 19)

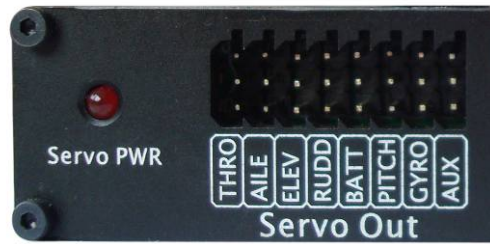


Figure 3. 17

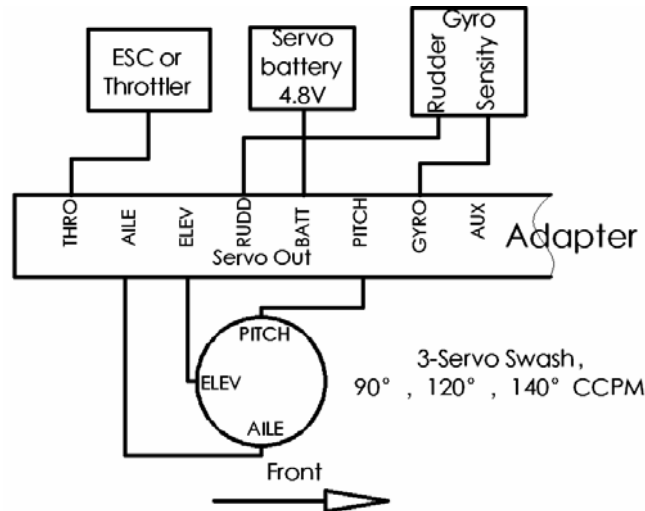


Figure3. 18 3-servo Swash

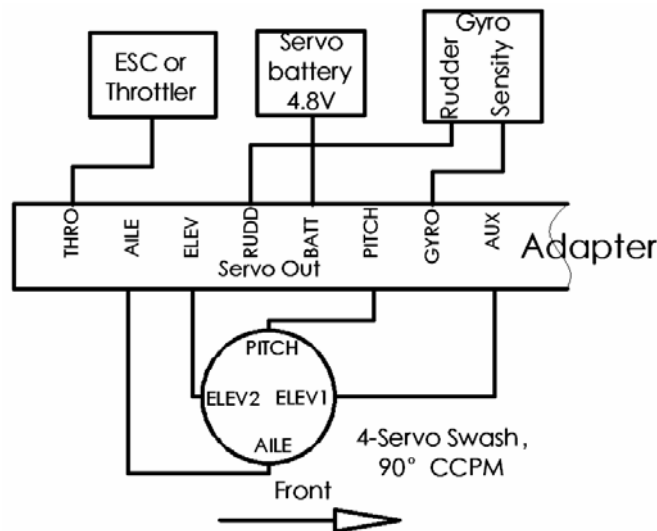


Figure 3. 19 4-servo Swash

Attention:

Power supply of the Servos and the control system are two mutually independent and different ones. The Servos are supplied by power source of 4.8v battery and is inserted in the BATT port. Please install a switch between the servos'

battery and the port. The controller system is supplied by the 7.4v battery. The switch on Adapter is the power switch of control system.

5. **【Connection between LED Status Indicator and Adapter】**: Connect LED status indicator (Figure 3.20) to the interface of the status indicator on the Adapter according to the corresponding joint of the status indicator (Figure 3.21) please install the indicator in the place where can be seen easily from different directions when helicopter flying. Users can refer to the following graphic (Figure 3.22).

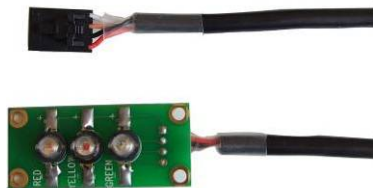


Figure 3.20



Figure 3.21

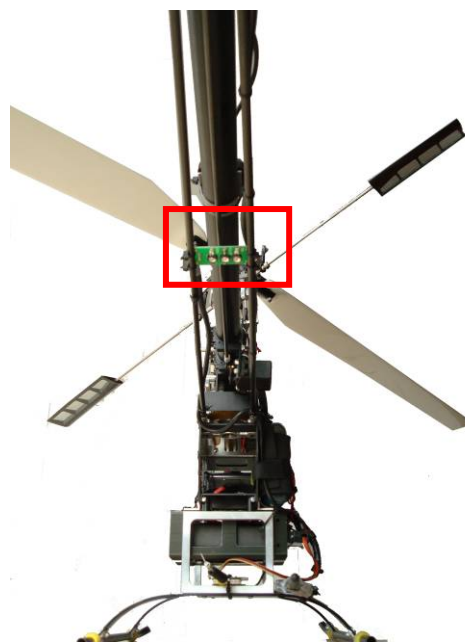


Figure 3.22

6. **【Connection between the External GPS & Compass and Adapter】**: There are four extended ports on the Adapter to connect some relevant airborne modules such as the external GPS & Compass, wireless video transmission (matching), ground station radio (professional edition matching) and so on. **No. 1** port is the input port for GPS & Compass signal (Figure 3.24). The upper surface (DJI trademark surface) of GPS & Compass should be upward. It should be laid flat in the

⚠ No GPS & Compass cannot work normally if access to other ports.

coincident direction of the coordinate frame on box and one of the helicopter (output wire points to the head of helicopter). No occluded objects are allowed around. It should be installed at the half of the tail pipe approximately, and let it be far away from the servo.(Figure 3.25)



Figure 3.23



Figure 3.24

Recommended Installation:



Figure 3.25

Attention:

- 1) Signals' reception will be affected if GPS is too near to the main rotor or Servo; the accuracy of the GPS data computation may decrease when it is too near to the tail rotor
- 2) Distance between the external compass and servo should be more than 20cm, while that between compass and the engine should more than 30cm.
- 3) The tail boom must be adopted carbon fiber and nonmagnetic material (the material will not be absorbed by magnet). The screws near the compass must be adopted stainless steel. If you are not sure if the material near the compass is magnetic, you can use the magnet or the ordinary compass to check.
- 4) If there are some ferromagnetic materials which the maximum dimension is x near the compass, the minimal distance between ferromagnetic materials and the compass should be $2x$

3.2 System Parameters Tuning and Setting

If users follow the above installment process, then you should finish the connection of the hardware. Now we will start the parameter tuning and the setting by software.

3.2.1 Tuning Preparation

1. **【Software Installation】**: Please install the USB to Serial Port Cable driver. exe of the ancillary CD and XP Configure 1.20(system parameters tuning software)
2. **【Power and Connection】**: Connect Adapter to the 7.4v power. Link one end of the cable (Figure 3. 26) to the DB9 port of the Main Controller' s front panel (Figure 3. 27), and link the other end to the USB connection of the computer. Servo power is not turned on if it is not related to Servo.



Figure 3. 26



Figure 3. 27

3. **【System Booting】**: Turn on the system power switch and pay attention to the LED Status Indicator. Refer to appendix A1 [[normal booting mode](#)] to see if booting is normal. If not, please refer to appendix A4 [[error status](#)], check if the installation is correct and reboot it. Refer to appendix A2 [[normal operating mode](#)] to check the twinkle of the indicator after normal booting. If users tuning indoor, the red LED indicator should flash for no GPS signal.
4. **【Software Connecting】**: Open XP configure software, and then it will search for available COM port automatically. If no mistake happening when connecting, it will connect to the Main Controller automatically. It shows the system has been connected normally and smoothly when the connection indicator of the software turns to green. As the chart.

3.2.2 The Primary Setting of Remote Control

All the settings made through remote controller by users have been reserved. Among them, two places are needed to be set first, swash type setting and autopilot switch setting.

1. **【Swash Type Setting[®]】**: Regardless of the brands of the remote controller,

please alter the swash type in remote controller to helicopter-Normal one. That' s means, each servo link to the swash plate independently.

Note:

①: *JR RC: Choose NORM in SWASH TYPE*

Futaba RC: Choose HELICOPTER, H-1 in PARAMETER

2. **【Autopilot Switch Setting】:** Users need to set a two-position self-convenient switch on RC as the autopilot switch to switch between manual mode and autopilot mode

Attention:

If users make connections according to the above explanation completely, the channel 5 of JR RC is the autopilot setting channel, while the channel 7 of FUTABA RC.

3.2.3 Completion of the First Test Flight Adjustment by Software Wizard

Users can turn on the control system power (Don' t turn on the servo' s power) after finishing preparation and remote control setting. Enter the software adjustable interface after the normal starting of the system. When the indicator on the left of the window turns to green from red, the software begins to work. And then, users can enter adjusting wizard interface (Figure 3. 29) by single-click “Wizard” button upleft (Figure 3. 28).

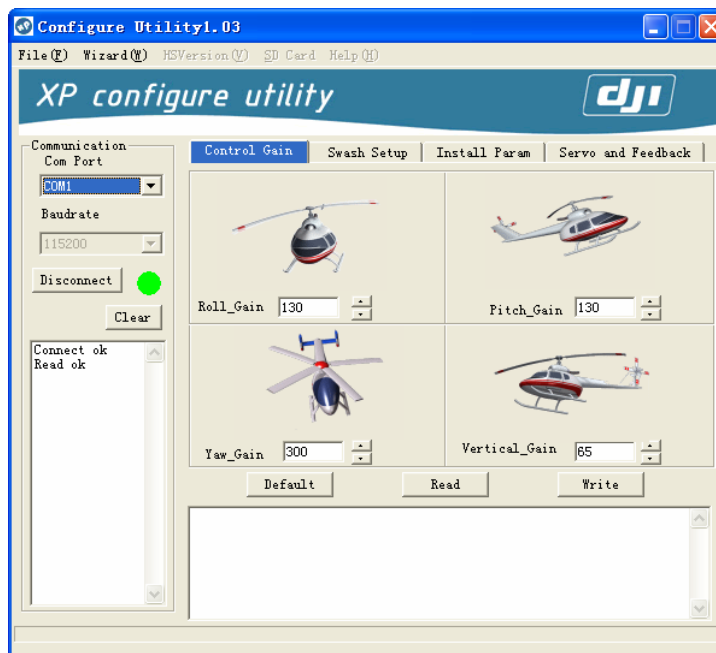


Figure 3. 28

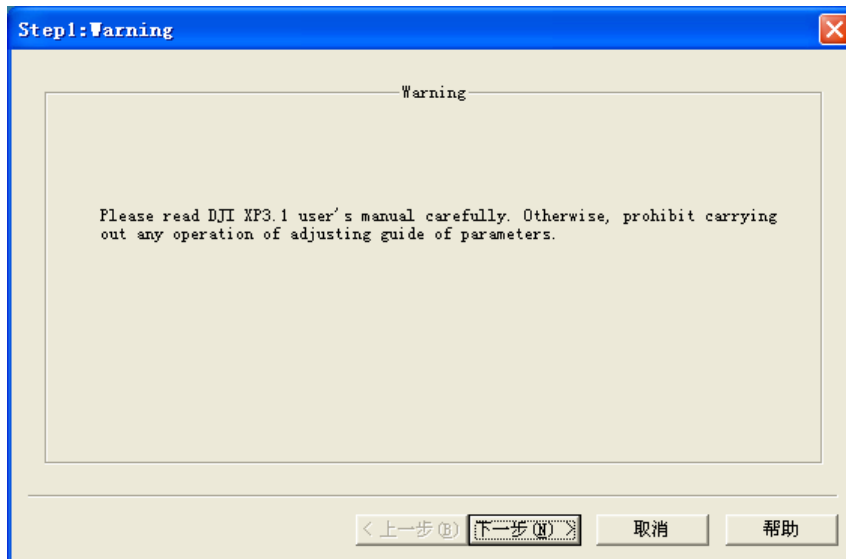


Figure 3. 29

Attention:

Please don't turn on the servo power in case of being burnt out because of the locking braking.

STEP1. 【Main Controller and GPS Offset Setting】

After entering the first interface, click “next” to enter Main Controller and GPS offset setting interface (Figure 3. 30).

1) The Direction of the Main Controller

Please refer to **【3.1.1 Main Controller installation】**, then choose the installation direction of the Main Controller accordingly (forward or right)

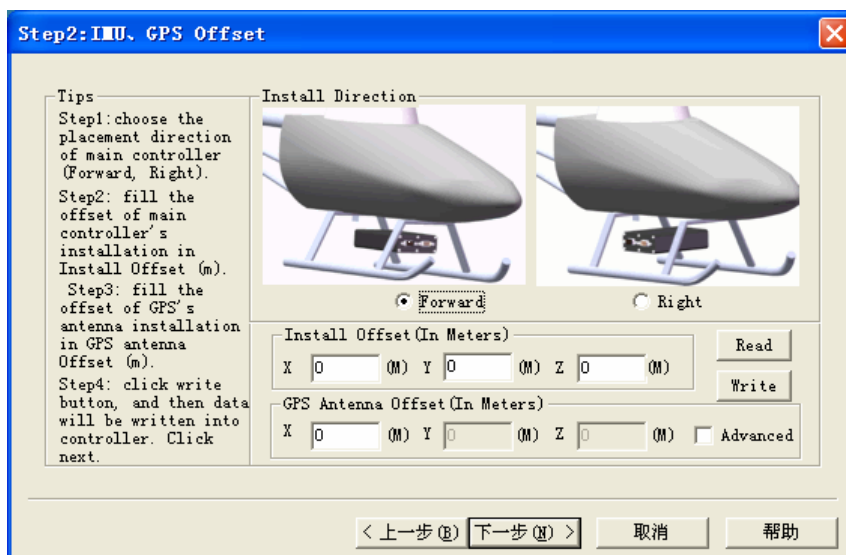


Figure 3. 30

2) the Offset of the Main Controller Installation

Offset: offset is the coordinate value of the target object in a coordinate frame which is an x-y-z coordinate frame with the helicopter's c. g. (center of gravity) the origin point. For example, if the Main Controller is laid at point A, A's coordinate value is the offset of Main Controller (Figure 3.31).

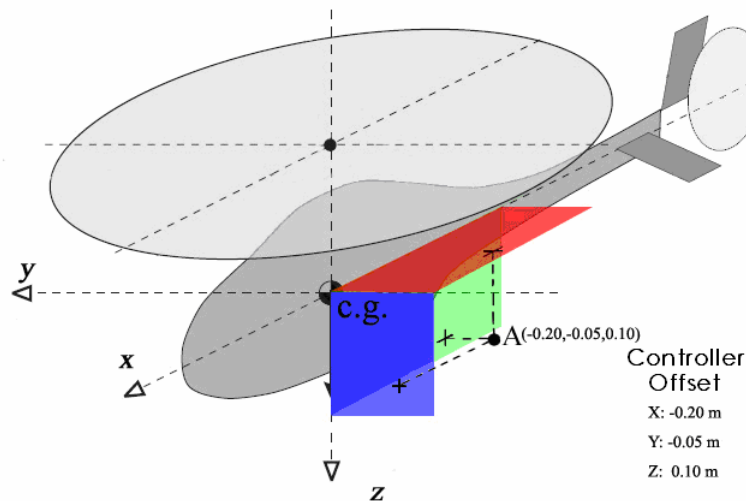


Figure 3.31

Users can measure the offset values according to the position of the Main Controller and the helicopter's c. g., and fill them in the proper position showing as following diagram

Install Offset(In Meters)

X (M) Y (M) Z (M)

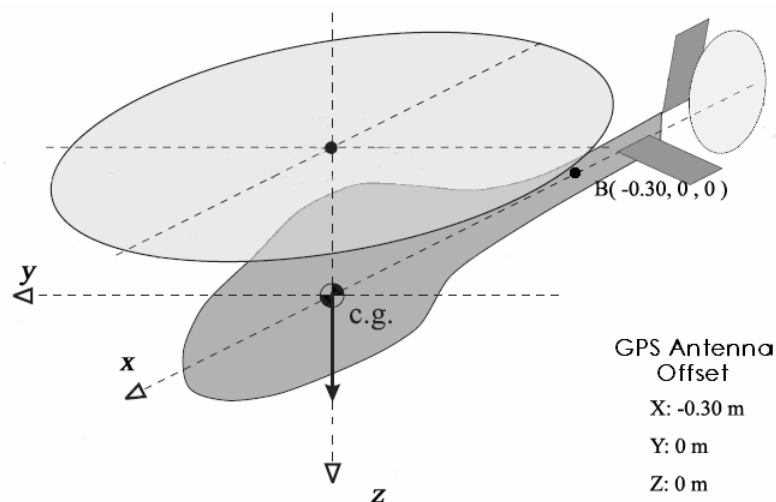
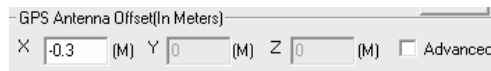


Figure 3.32

- 3) If GPS antenna is laid at Point B, then B' coordinate value is the offset of GPS (Figure 3. 32).

As for the same reason, users can get GPS offset by the position of GPS installation. If users install it at the point of 1/2 length of the tail pipe approximately, the offset values of y and z is usually 0. Then users only need to find out the distance between GPS and the c.g. of helicopter in x direction. Pay attention to the positive and negative of GPS' s offset value in x direction, and it should be always negative.



Attention:

1. By default, users do not need to change the offset value of GPS in y and z directions in the software. But if the users do not install GPS in the recommended position, you can modify the value of y and z by clicking “Advanced” nearby.
2. To set the expected parameters into the Main Controller to finish setting, do click “write” after filling the parameters in
3. “Meter” is the unit of all the offset parameters

Note:

- ①: *The way to determine the c.g. of helicopter: take down the main rotor, tie the long line with gravity hammer to the tail pipe, raise the helicopter's tail, and let the helicopter and the ling hang down naturally. Then the intersection point of the line and the helicopter is the c.g. of helicopter.。*

STEP2. 【Autopilot/Manual Mode Setting】

- 1) Click “next” button after finishing the operations above to enter autopilot/manual mode setting. After turning on the remote control, users can try to shift autopilot/manual switch. Then users can notice the slide also shifts between the topside and bottom side, which shows the autopilot/manual switch, has linked correctly. Users should set the switch normal and reverse according to the slide direction (upward pushing, slide locates upward side, and vice verse)
- 2) ② In the default situation, the TRVL ADJ (End Point in Futaba) of manual/autopilot channel should be 100%. Transfer the up and down TRVL ADJ to 0% and set this position as Fail Safe. Refer to the Figure 3. 34 after turn off the RC. 4.2 Fail Safe setting will lead users to complete the unfinished part of fail safe setting.

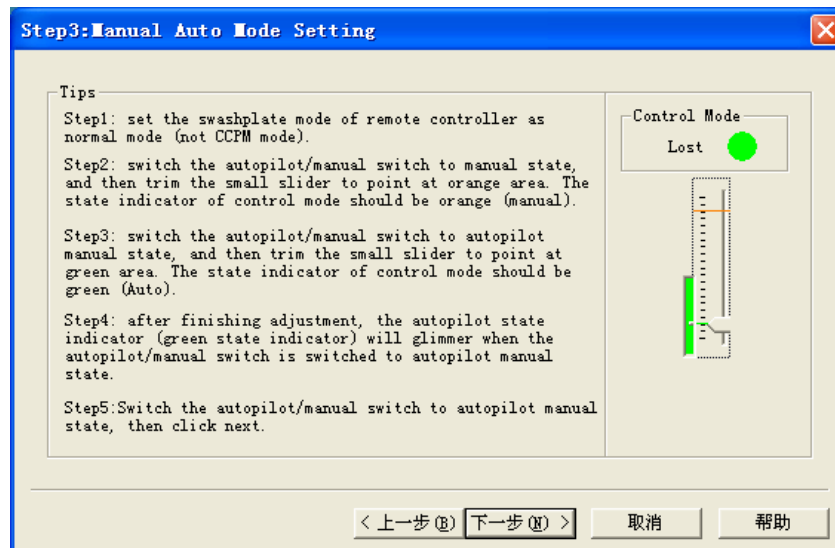
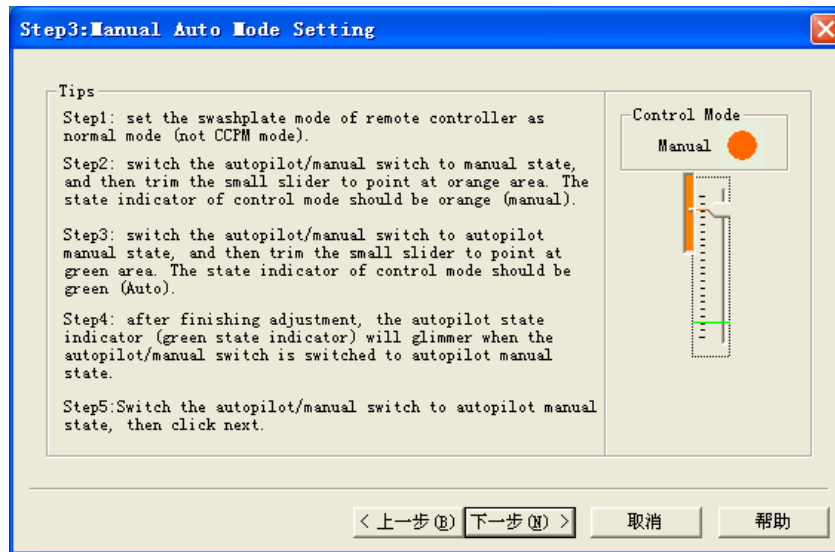


Figure 3. 33

- 3) Users should find out the autopilot/manual switching channel (if you follow the above tips strictly, they should be channel 5 or 7, corresponding JR or Futaba remote controller) to enter TRVL ADJ setting of remote control. Reduce its max value, and users could notice the slide approaches to the red line or green one gradually. When there is a trimming little slide on the left side of the red line or green one, it means the adjustment in this direction has been finished (Figure 3. 33). That of the other direction can be finished in the same way.

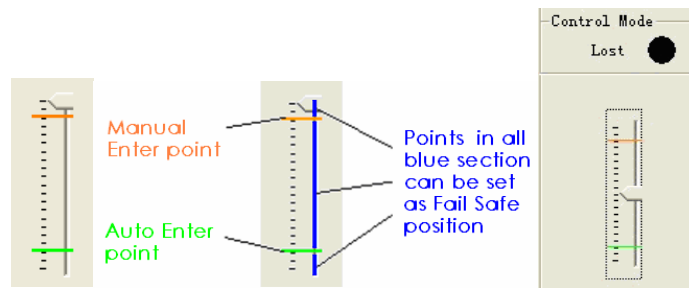


Figure 3. 34

Attention:

If JR remote controller is adopted, the TRVL ADJ setting value should be about 80%, While in Futaba being 60% more or less. Moreover, if FUTABA remote controller is adopted, slide movement can be noticed by reducing fewer than 80%.

- 4) When switch is upside, the slide leveling with the red line, the green LED should vanish constantly, and then it is the manual mode. When switch is downside, the slide leveling with the green line, the green LED indicator should begin to sparkle, which shows having entered into auto mode. If users can get all above, you have finished the adjustment. Please click “next” to continue the next step.

Note:

- ①: It should be TRVL ADJ in JR RC or END POINT in Futaba RC.
- ②: This step has set a third mode beyond autopilot and manual mode. Helicopter will enter fail safe mode if the RC receiver loses signals. Control system will enter fail safe once autopilot/manual switch enter any position beyond the two fixed ones set in step3. So any position (Figure 3. 34) is acceptable if users do not set fail safe as the approach position of autopilot or manual.

STEP3. 【Swash Type Setting】:

Under the manual mode, users can adjust the helicopter according to the requirements for ordinary remote-controller helicopter.

- 1) Before this step, set the swash type as NORMAL mode remote controller first.
- 2) If your helicopter is Not CCPM mode, set the Swash types as NORMAL in the software (Figure 3. 35). click “write ” and then “next” to enter the interface of “Feedback & Servo Calibration” 。

Swash Type:

	Swash Type	Ccpm Parameter
Normal Type	Normal	-
Ccpm Type	1. 3_Servo_120°	Swash Mix
	2. 3_Servo_140°	
	3. 3_Servo_90°	NORM 、 REV (Servo Rotation Direction)
	4. 4_Servo_90°	

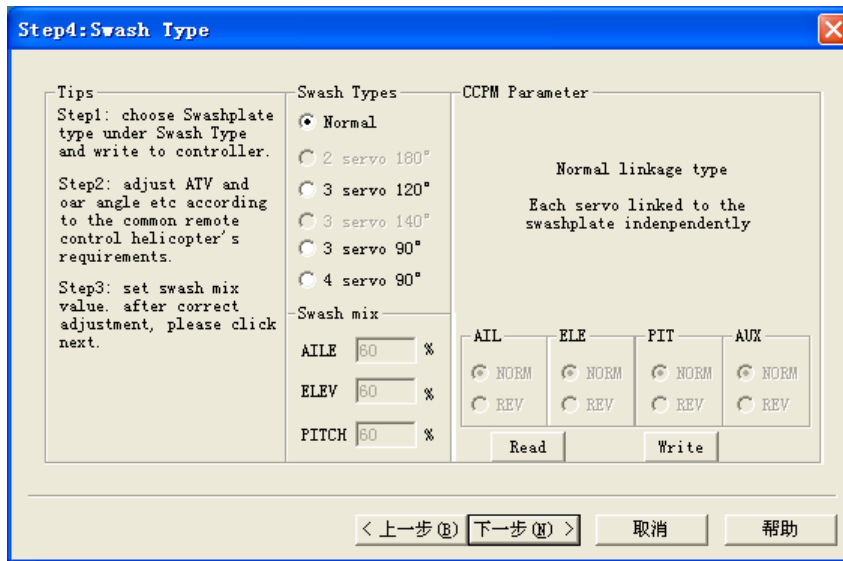


Figure 3. 35

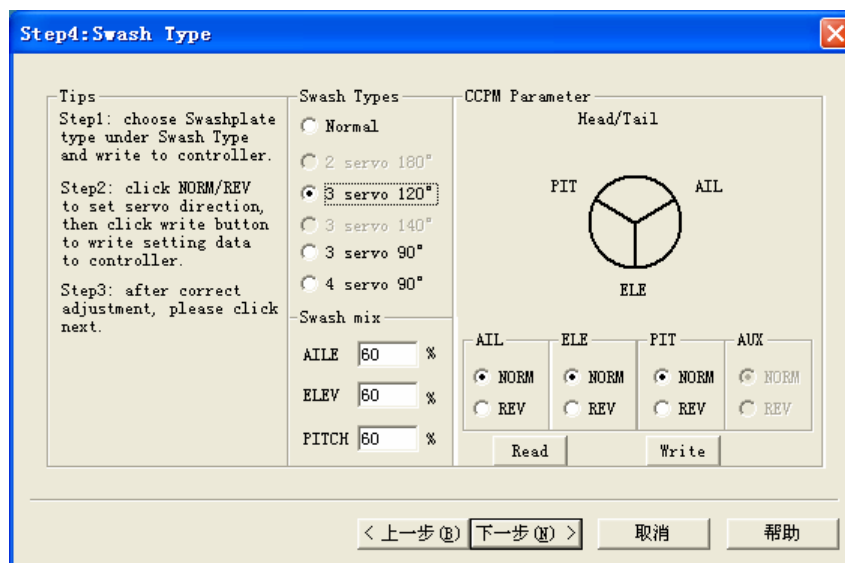


Figure 3. 36

- 3) If it is CCPM mode (Figure 3. 36), parameters of swash mix and Servo direction should be set correctly.
 - a) First turn the TRAV ADJ (End Point) of every channel of control stick which controls PITCH, AILE, RUDD, ELEV to the maxima.
 - b) Check if the setting of swash type is NORM mode in remote controller.
 - c) The moving direction of swash plate is decided by the rotation direction of Servos and the sign (positive or negative) of swash mix, while its motion amplitude is decided by the values of corresponding swash mix.
 - Push PITCH stick up and down and notice if all the Servos lead the

swash plate moving horizontally, that means every servo lets the swash plate up or down coordinately. If not, click “NORM” ” REV” buttons to adjust the direction of Servo.

- Push PITCH stick, the forward and backward movements correspond the changes of collective pitch of main rotor. If the direction is opposite, change the sign of PITCH in swash mix.
 - Push ELEV stick forward and backward should correspond the forward and backward rotation of swash plate. The adjusting methods are the same as above.
 - Push AIL stick right and left should correspond the right and left rotation of swash plate. The adjusting methods are the same as above.
- 4) If the swash slants slightly, users can do trim tuning by remote controller. If the inclination is too big, please adjust the mechanical median of swash plate. Users can refer to the installation manual of the helicopter for details.
-

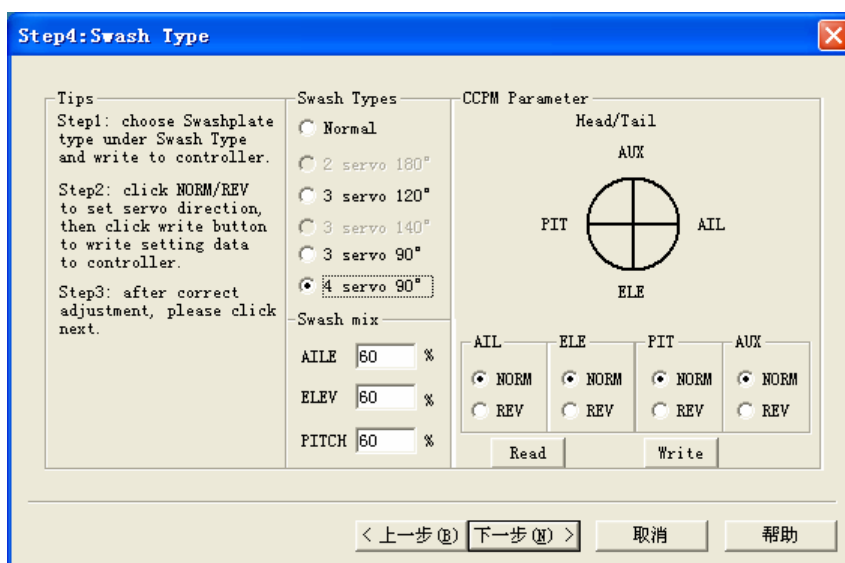


Figure 3. 37

- 5) Pay special attention to CCPM 4_Servo_90 Swash type (Figure 3. 37).
- Connect the pull rods of three Servos, for example, the left, front and right Servos.
 - In the software interface of “swash setup” , configure the Swash types and the directions of the three Servos.
 - Connect the pull rod of the fourth Servo after complete adjustment of the three ones. And adjust the direction of the fourth, to make sure no locking braking^① between Servos and the correct motion of swash.

Note: ①: No “KaKa” sound from Servo.

- 6) Adjust the minimal collective pitch to -2° , maximal one to 10-11 (guarantee the corresponding climbing speed more than 3m/s) and median one 5 by the software and PITCH curve in remote controller.
- 7) Click “next” after finishing the settings, to enter the interface of “Feedback & Servo Calibration” .

STEP4. 【Feedback & Servo Calibration】

This step can get the calibration of stick volume and feedback control. The main purpose is to get positive and negative directions and the maximum minimum values of all channels.

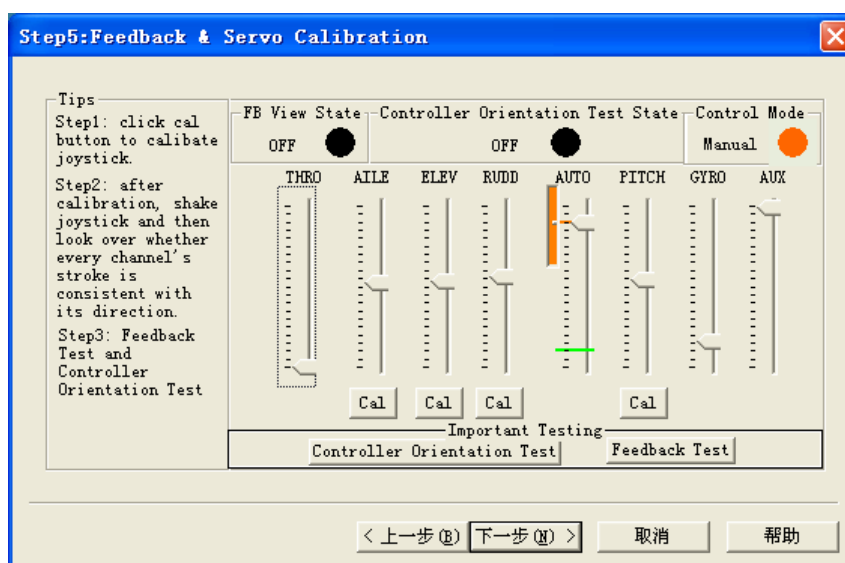


Figure 3. 38

- a) Enter the interface of [Feedback & Servo Calibration] (Figure 3. 38), and click the “Cal” buttons of AILE、ELEV、RUDD、PITCH orderly.

Attention:

The channels of throttle and PITCH are mixed, so you are adjusting throttle channel either when you calibrate the pitch channel. If it is an electronic helicopter, users need to set the last point of the throttle curve to the maximal when processing calibration of PITCH channel. Do reset it to the settings before after finish pitch channel calibration.

- b) After entering calibration interface, push the stick to the center first; then click “Ok” (Figure 3. 39) and push stick according to the arrow pointing direction shown from software (Figure 3. 40); Return the stick to the center finally. Software will exit the calibration interface automatically after the calibration of the corresponding channels.

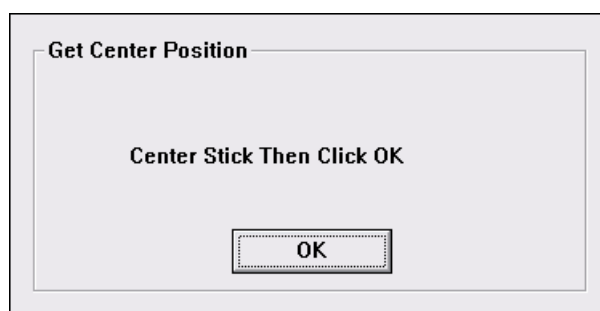


Figure 3. 39

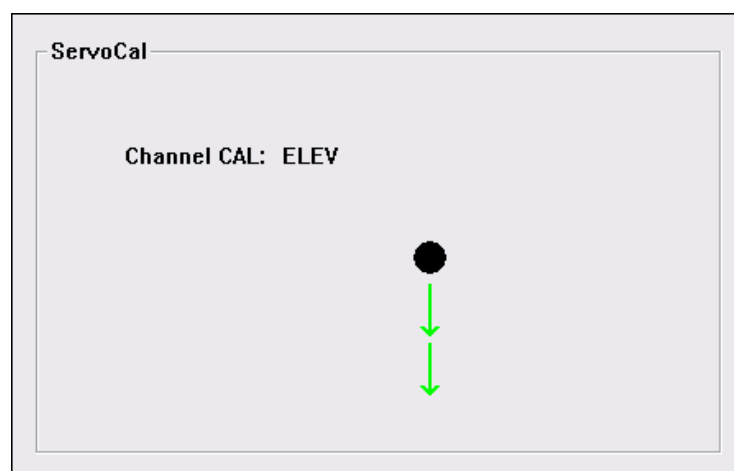


Figure 3. 40

Attention:

Make sure the duration of the stick at the endpoint more than 2 seconds.

- c) Users push the stick and check if the directions of stick is the same as shown in software.(stick to left or upward corresponds the slide shown in software moving upward; stick to right or downward corresponds the slide shown in software moving downward). If calibrated correctly, the top or the left end of the stick should correspond the top position of the slide. Meanwhile, the bottom or the right end of the stick should correspond the bottom of the slide. If the slide reaches the top or bottom too early, or it cannot reach there, re-calibration is needed.
- d) Feedback Test.
 - Switch the remote controller to auto mode or the prompt box will appear (Figure 3.41).
 - Click “Feedback Test” button.
 - Now, users need to check the swash plate. The swash plate will move automatically. The directions as followings: collective pitch: up—down; swash plate tilting: front- back-left-right; Rudder:

left-right; throttle: up- down. If the directions are inconsistent, users need to re-calibration corresponding channels.

- Switch back to the manual mode and withdraw the test.

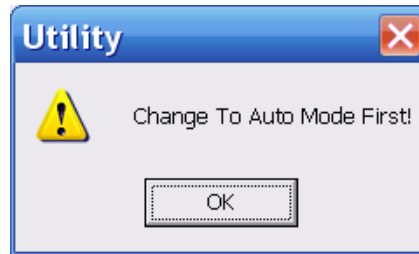


Figure 3.41

- e) Switch the remote controller to auto mode(or the prompt box as above will appear)
- f) After clicking “Controller Orientation Test” button
 - When helicopter inclines left, the swash will tilt right.
 - When helicopter inclines right, the swash will tilt left.
 - When helicopter inclines front, the swash will tilt back.
 - When helicopter inclines back, the swash will tilt front.
 - Switch back to the manual mode and withdraw the test

⚠ The correctness of «Feedback test» and «Controller Orientation Test» will affect the normal operation of the Main Controller.

Note: The Main Controller will keep swash plate as horizontal as possible. Tilting horizontal angle 10° of helicopter will lead biggest moving amplitude of swash.

- g) If the directions are not as the above, users should recheck the installation of the main box. Then re-click “Feedback Test” to check if everything works normally. Or re-calibration the feedback direction. Refer to [Swash setup] [Main Controller Installation] [Instrall Param].

STEP5. After the above tests complete, fix the Adapter on the helicopter to prepare for the outdoors flying test.

4 Outdoors Flying Adjustment

Please read through this chapter before flying outdoors. Peruse **【4.5 Points for Attention in Flying】** before flight. Please operate carefully to avoid any accident!

4.1 Helicopter Flying Adjustment and Test under Manual Mode

- 1) Test the RC antenna's radio distance: take down the main blades and turn on the engine at the first test; then shorten the antenna, do the test about 20m away from the helicopter under manual mode. If the green LED enters the auto mode, which is sparkle, it indicates that RC is out of range. Now, the user need to check if the installation positions of Adapter and RC receiver are far away from interference sources as engine, especially the gasoline engine.
- 2) After completing the installation and adjustment as an ordinary remote-control helicopter, users can process the complete flying adjustment under the manual mode and reach the stable flight performance^①.
- 3) Keep the helicopter stable temporarily even if the helicopter is not in controlling for seconds by tuning the trimming of RC. Now, users need to remember the general position of PITCH stick ^②

⚠ The main purpose is to get the optimum performance under manual mode in this adjustment. Please Never try to shift to auto mode when flying.

Note:

^①: With the inertial system in the control system, vibration of helicopter will cause the control of the Main Controller to be at an unstable state. So, to display the best performance of the whole system, users need to reduce the vibration to the smallest.

- Balance the main rotor to avoid "twin screw phenomenon". Users need to adjust the helicopter to a condition which it is almost impossible to notice the vibration by naked eyes.
- Adjust the mechanical center point of helicopter, especially tail rotor. Under the unlocking mode of the helicopter's gyro, adjust the mechanical center point of the tail rotor. When hands off the stick, no obvious rotation is allowed and guarantee of helicopter's temporary hovering is needed.
- Push the rudder stick to the left/right endpoint and ensure the rotation speed of tail at 1 circle per 2 seconds in left/right direction. After the adjustment, users can switch it to the locking mode of gyro.

②: The reason for making the *PITCH* stick in the center when helicopter is hovering by adjusting *PITCH* curve is to set them as the corresponding fail safe positions in the next step [fail safe setting].

4.2 Fail Safe Setting

The purpose of setting fail safe is to let helicopter hover still under fail safe mode when it loses signals from remote controller. Tips as followings:

- 1) The fail safe position has already been set as 0% (center) when users do PC software setting.
- 2) Set other channels as hovering center points in the fail safe option of remote control, to make it convenient for XP3.1 to supervise if the communication of remote control is normal and respond in time.
- 3) To observe if the green LED Status Indicator will flash after turning off the remote controller.

4.3 Compass Calibration

- 1) **【Entering into the Compass Calibration Mode】**: Under the manual mode, shift the autopilot/manual switch to and fro ten times quickly (being back and forth as one time).then it will enter the compass calibration status and the green LED will be constantly on.
- 2) **【Horizontal Axis Calibration】**: When the red LED is off, keep the helicopter horizon (the white LED will be constantly on) and rotate the helicopter 3-4 circles slowly in horizon. When rotating, make the white LED on as constantly as possible. (Refer the video of compass calibration for details). After finishing the calibration of horizontal axis, continue that of the vertical axis.

Attention:

If the white LED is off, it means the helicopter deviate from the horizontal angle too much. Then, users should adjust the position of helicopter, and keep it at the horizontal position and do rotation again.

- 3) **【Vertical Axis Calibration】**: When erect the helicopter (head down), the red LED will constantly on. Then keep the white LED constantly on and rotate the helicopter 3-4 circles slowly by the longitudinal axis (refer the video of compass calibration for details).
- 4) **【Whether to Save the Calibration Date】**:
 - a) **Saving Calibration Data**: Shift the autopilot/manual switch ten times quickly, then all three LED will flash for 5 seconds, which means the success of the data saving and the existing from the compass calibration mode(the green LED will be off). Please restart the system

after the calibration.

- b) **Quit without Saving:** If users don't want to save the new data, shift the autopilot/manual switch once. Then it will abandon the calibration data and quit from the compass calibration mode (the green LED will be off).
- 5) Reboot the system
- 6) **【Inspection after the calibration】:** Under the normal work mode, rotate the helicopter ten times clockwise, 90° for each time, and notice the white LED on or off. Stay 5 seconds between two operations at least.
 - a) **Calibration Succeed:** After the all rotations, the times of rotations with the white LED no-flash reach 8 in 10 at least.
 - b) **Calibration Failure:** After the all rotations, the times of rotations indicator flash more than 2 in 10. Then users need to do compass calibration once again.

Attention:

- 1) Pay attention that there should not be any magnetic or iron materials near by, such as magnet, automobile, steel bar under ground and so on.
- 2) Ensure the slow rotation during the calibration, and keep the white LED constantly on.
- 3) Maintaining the helicopter horizon and rotating it 3-4 circles is that to guarantee the system can get data for any angle in 360° .
- 4) Recalibration in the following situations:
 - a) Any modification of the helicopter, such as the installation of new electronic equipment, replacement of gyro, the change of Main Controller installation position, changes of other mechanical structure and the change of battery installation position.
 - b) In the flight process, the deviation of flying direction is too big.
 - c) The helicopter turns backward frequently and the orange indicator starts to glitter (but it is normal occasionally).
- 5) DJI-XP3.1 is not suitable to work in Antarctic Circle or Arctic Circle, because the magnetic heading system will be invalidation or near to it.

4.4 Flight Test under Autopilot Mode

The helicopter can fly normally after all adjustment under manual mode. The following steps will help users make parameter tuning in autopilot mode to complete helicopter's autopilot flight.

4.4.1 Setting Meanings and Related Regulation Methods of Parameters

1. The parameter of autopilot is on the first page of XP configure software “control gain” , as shown in Figure 4. 1. At present, 4 parameters on software layout are opened for tuning. Roll_Gain is the parameter to adjust the roll direction(right-left)movement of helicopter, as shown in Figure 4. 2; Pitch_Gain is the parameter to adjust the pitching direction (forward-backward) movement of helicopter, as shown in Figure 4. 3; Yaw_Gain is the parameter to adjust the tail rotation direction movement of helicopter, as shown in Figure 4. 4; Vertical_Gain is the parameter to adjust the vertical direction movement of helicopter, as shown in Figure 4. 5.



Figure 4. 1



Figure 4. 2
Roll



Figure 4. 3
Pitch

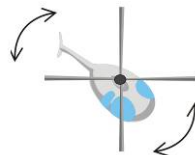


Figure 4. 4
Yaw



Figure 4. 5
Vertical

Special Tips:

The tuning of these four values is similar to the tuning of sensitivity of helicopter's tail gyro. If the value is too big, high frequency shaking in according direction will occur. If the value is too small, it cannot lock the position in this direction and drifts cyclic slowly.

2. Click "Default" to restore the default values, and then click "write". After writing of default values, users can attempt autopilot flight with these parameters.

3. Users should read through this section then entering **【4.4.2 flight test】**. Please make the helicopter hover stable under the manual mode and switch to the auto mode. Please pay close attention to the helicopter status after entering autopilot:

⚠ Before taking off, please read 【4.5 points for attention in flying】. Taking off is forbidden under any unusual

➤ Roll_Gain:

If there is high frequency shaking in the roll direction (refer to video), it means Roll_Gain value is too big. Please switch to manual mode in time, land the helicopter and reduce the according parameter. The coarse tuning can be about 20 each time.

If left-right cyclic drifting appears (refer to the video), it means the Roll_Gain is too small. Please switch to manual mode, land the helicopter and increase this parameter. Regulation methods are the same as above.

➤ Pitch_Gain:

Normally, no high frequency shaking will happen in this direction, so users can set a relatively higher value in this direction. Generally speaking, the value of Pitch_Gain is 1.5 times of Roll-Gain.

➤ Yaw_Gain:

With the existence of the tail-locked gyro and the proper adjustment of its sensitivity, normally no high frequency shaking or low frequency drifting will appear in this direction. This value can be understood as Rudder speed, the higher the faster. But please pay attention, under the auto mode, the tail speed is relatively slow. So please do not compare it with that under manual mode. If the value is too big, high frequency shaking of tail will occur.

➤ Vertical_Gain:

If high frequency shaking happens in the vertical direction (refer to the video), it means the value of Vertical_Gain is too big. Please switch to manual mode in time, land the helicopter and reduce the value. The coarse adjustment can be 3-5each time.

If vertical up-down cyclic drifting appears (refer to the video), it means the Vertical_Gain is too small. Please switch to manual mode, land the helicopter and increase this parameter. Regulation methods are the same as

above.

➤ **Normal status:**

When parameter tuning is proper in every direction, helicopter may hover stable (refers to the video). Users can try to pull the sticks of every direction orderly (one scale is suggested) to perceive the acceleration and the stable level in the process of stopping. If it reacts too slow to start or stop in some direction when flying, please increase the value in this direction.

Attention:

- 1) Two or more phenomenon listed above may appear during adjusting, but please adjust one parameter at one time. After the unusual phenomenon disappears, adjust the parameter in another direction.
- 2) Relatively 15% smaller than the critical value is promoted, to guarantee no high frequency shaking under various flight status will happen (similar to gyro sensitivity tuning).
- 3) During adjusting process, please switch to manual mode at once when any unstable phenomenon appears.
- 4) Users can resume the default parameter in control gain at any time through software.

4.4.2 Flying Test

Before flying test, please read **【4.5 points for attention in flying】** and **【Appendix F Special Security Checking】** and then carry on the following operations.

1. Flying Test: Users must to control helicopter hovering stable in manual mode before the first autopilot hovering. And then switch to auto mode by the autopilot/manual switch of remote controller, to keep it hovering.
 - a) Please switch to manual mode at once when any unstable phenomenon appears. After it hovers stably, make it enter auto mode again.
 - b) If unstable performance appears many times when helicopter enters the auto mode
 - Users need to land the helicopter under manual mode and readjust related parameters. Refer to related tips of adjusting flight parameters in **【4.4.1 Setting Meanings and Related Regulation Methods of Parameters】** (related video).

⚠ When first entering the autopilot hovering mode, please prepare for switching to manual mode momentarily.

⚠ Please land the helicopter under manual mode in all these steps.

- Please check if the helicopter is adjusted as ordinary RC-helicopter. This time, users need to carry out the operations from the step of **【4.1 Helicopter Flying Adjustment and Test under Manual Mode】** .

4.4.3 Flight Success:

Congratulations! If you reach this step successfully, it means your helicopter can work normally. But for the deuteric maintenance, you need to carry out carefully. Before flight every time, please read [4.5 points for attention in flying in flight](#) and [Appendix F special security check carefully] and do the corresponding security check.

4.5 Points for Attention in Flying

4.5.1 Preflight Examination Process

1. Check all the joints and electric wires, to see if the joints loose or the wires are wear.
2. Check if the RC receiver receives signals normally. Do not put out the antenna first. Put it 10-20m far away from the helicopter and remote-control test if the Servo can work normally.
3. Wait for 3 minutes after power on and examine the starting status of the three LEDs:
 - 1) There are two situations when system starts successfully:
 - a) **【With SD Card】**: LEDs will go out orderly.
 - b) **【Without SD Card】**: After the first LED (red) goes off. The second one (white) will go off after the first one (red) flashes 5 times continuously. The green indicator will go off at last.

Attention: SD card is suggested because it can be used as black box.
 - 2) Starting failure and its solutions:
 - a) Check the connection first, and power on again.
 - b) If the LEDs do not go off for more than 2 minutes, reboot
 - c) **【Three LEDs flash simultaneously】**: It means the attitude or controller start unsuccessfully. Please lay the helicopter horizontally and power on again. Parameters can be set by PC software
 - d) **【Three LEDs flash in streamline】**: It means reading failure from E²PROM data. Please reset parameters such as swash type by PC software.
4. Wait until GPS receives the signals, examine the condition of the red LED:
 - 1) **【Constantly off】**: Perfect signals. Good situation for flying.

2) **【Sparkling】**: Strong signals. Taking off is allowed, but the safety coefficient decreases, so users should avoid flying as possible as you can.

⚠ Never try to switch to autopilot mode when the red LED is flashing.

3) **【Flash】**: Weak signals. Taking off is not allowed. Please recheck the connection of GPS antenna or adjust at spacious places.

Note: when there is no GPS, it is normal phenomenon for swash tilting slowly when the system enters the auto mode.

5. Turn on the remote controller. Then shift the autopilot/manual switch and examine the condition of the green LED:

1) **【Sparkling】**: Autopilot mode

2) **【Constantly off】**: Manual mode

6. Switch into the autopilot mode and check if the swash tilts. If it does, reboot system.

Note: If the swash moves up and down when entering the auto mode by autopilot/manual switch, that is because the atmospheric pressure is unstable on the ground. It is normal.

7. Manual test: check if the swash plate movement is correct.

Note: It is normal that the swash move in a small range by pushing the stick under the auto mode.

8. Rotate the helicopter repeatedly for several times, 90° for each time. And check the condition of the white LED.

9. After no abnormalities appear during inspection, start the engine, and examine if the LED status indicator has any abnormality (refer to appendix A for details)

10. If no abnormal status appears, users can take off the helicopter manually (red LED cannot flash).

4.5.2 Flying Attention Points

1. **The points needing attention before entering auto mode**

1) Guarantee the attitude is good (white LED does not lighting).

2) GPS signal is good (red LED does not flash). Users should avoid flying the helicopter at places with shutters, such as tunnels, cities with tall buildings, because these shutters will affect the receipt of the GPS signals. It is suitable to fly at spacious places, such as squares.

Attention: Even when the red LED is under the condition of sparkling in flying, users can also switch to auto mode, but the safety coefficient could reduce. So users should avoid flying in such situations.



- 3) After the helicopter hovering by manual-control, switch to the auto mode. Followings are some possible problems and solutions:
 - a) **【Stick' s offset from center is not big】**: Its influence to the system is small. The system can revise by itself.
 - b) **【stick' s offset from center is big and the helicopter has the drifting tendency】**: Shift the manual/autopilot switch to manual mode to make the helicopter hover stable, and then enter auto mode again.
2. After hovering under manual mode, switch to autopilot mode, then it can enter autopilot mode. Then, users can control the helicopter in the directions of up and down, back and forth, left and right by stick. Shift the autopilot/manual switch at any time may reenter the manual mode.

Attention

Please do not push any stick when shifting the autopilot switch. Or, helicopter may not hover, but drift to some direction slowly after entering the auto mode. If in such situation, users do not need to worry. Please switch to manual mode and then back to auto mode with motionless.

Note: ①: Main controller can set the servo value, the time user shift into auto mode, as the feedback center point.

3. During the auto flight, pay attention to the statement of the white LED:
 - 1) **【Constantly off】**: Good attitude status.
 - 2) **【Sparkling】**: It means there is some slight error about the attitude computation. At this time, don' t make violent movements of helicopter. Especially do not keep the helicopter rotating continuously. Or it will cause the disorder of the attitude computation. So, please keep hovering till the white LED go off.
 - 3) **【Flashing】**:
 - a) If there is no tendency of out of control, it does not matter if it flashes temporarily.
 - b) If the helicopter has the tendency of out of control, it means the attitude computation is unusual. Then users should switch to manual mode and land the helicopter as soon as possible. Flying after rebooting the system.

Attention:

- 1) The probability for the white LED to sparkle or flash is small during the

flight. It may happen only when it is bumped or it rotates with a high speed (4 seconds or less per circle) for a long time.

- 2) Avoid rotation continuously for a long time, for instance: it rotates for more than 3 circles continuously and the speed surpasses 4 seconds per circle.
 - 3) The angular speed should not surpass 300° per second in every flight direction, or problems may rise. In such situation, the system can make the flight attitude recover automatically, but there may be some errors during the recovery procedure.
4. **【Exit From Auto Mode】**: Guarantee remote controller can communicate normally, and users can switch to manual mode to fly momentarily.

4.5.3 Landing Explanation

The helicopter can land under both auto mode and manual mode.

1) **【Landing Under the Auto Mode】**:

- a) Choose the proper landing position.
- b) The helicopter is hovering stable.
- c) Down the helicopter slowly.
- d) At the moment of landing, pull the throttle to the lowest point and switch to the manual mode immediately.

Attention:

There is near surface effect within 1.5 rotor radii, so the helicopter is not stable. It will drift even under the auto mode. So please do not stay within such altitude for a long time.

- 2) **【Landing Under the Manual Mode】**: Landing as the ordinary remote-control helicopter.

3 Appendix

Appendix A: LED status indicator

1. 【Normal starting status】 :

- 1) With SD card: All three LEDs are on, and then go off in the order of red, white and green.
- 2) Without SD card: All three LEDs are on. After the red LED goes off. The white one will go off after the red one flashes 5 times continuously. The green one will go off at last.

2. 【Normal status】 :

Color	Red	White	Green
Constantly Off	GPS Strong ^①	Attitude Good	Manual
Sparkling	GPS Medium ^②	Attitude Medium	Autopilot
Flashing	GPS Weak ^③	Attitude Disorder	Signal Lost
Constantly On	Power Alarm	-	Compass Calibration

Note:

- 1) *Sparkling*: One time per second
- 2) *Flashing*: Five times per second

3. 【compass calibration mode】 : After completeness of the compass calibration and all three LED flash for five seconds, please restart the system.

Color	Red	White	Green
Constantly Off	Vertical axis Calibration	$\pm 3^\circ$ ^④	Compass Calibration
Constantly On	Longitudinal axis Calibration	Not in proper angle range	-

Note:

- ①: More than 7 satellites
- ②: 5~6 satellite;
- ③: Less than 5 satellites
- ④: $\pm 3^\circ$: When compass calibration, helicopter tilts from horizon within 3°

4. 【Error status】 :

- 1) The three indicators do not go off(for more than 5 minutes): Unknown status.
- 2) All three LEDs flash at the same time: the failure of attitude or controller

starting.

- 3) Three LEDs flash in streamline state: The failure-reading of E²PROM data.

Appendix B: Electrical Characteristics

Operate Temperature	-10 ~ +75°C
Power Consumption	5W
Input Voltage	7.4~12V(DC)

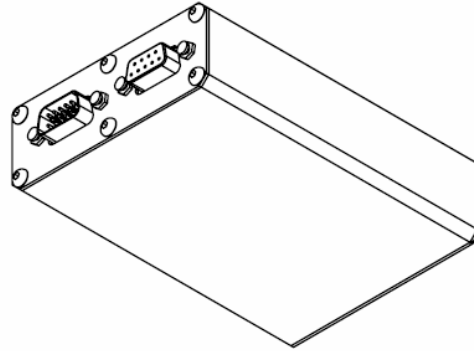
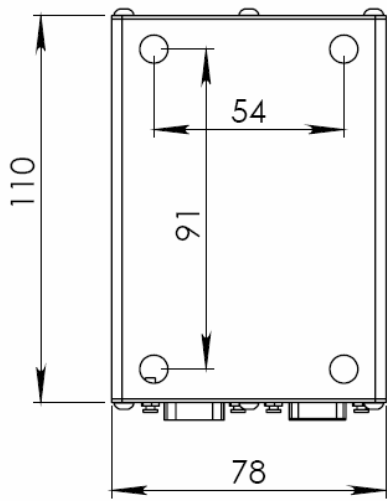
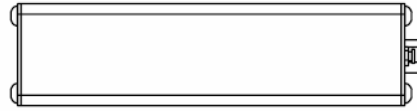
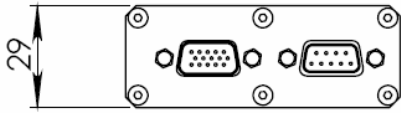
Appendix C: Mechanical Properties

	Weight(g)	Size(mm ³)
Main Controller Box	245	110*78*29
Adapter Box	130	90*62*22
GPS&Compass Box	80	90*44*20

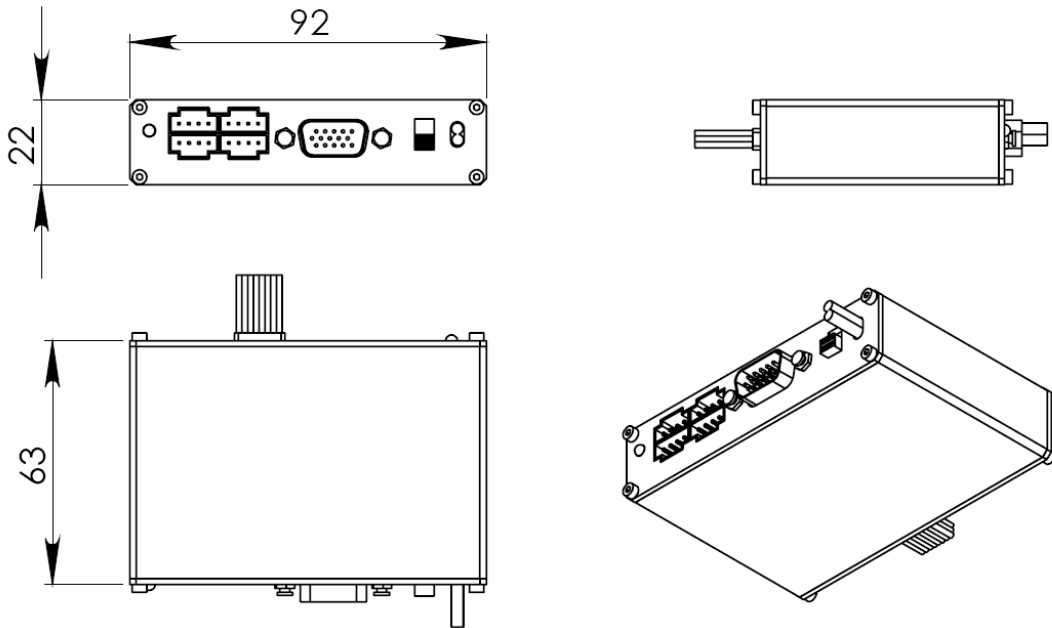
Appendix D: Mechanical Drawing

All units are in millimeter in following

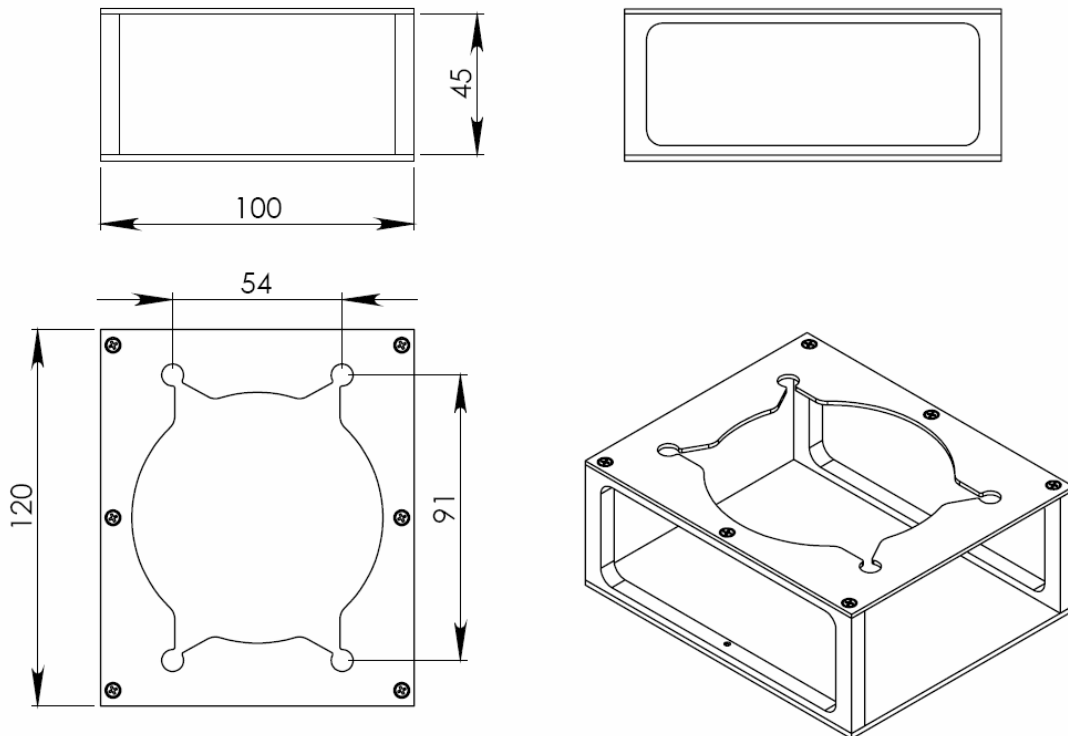
1. 【Structure of Main Controller box】

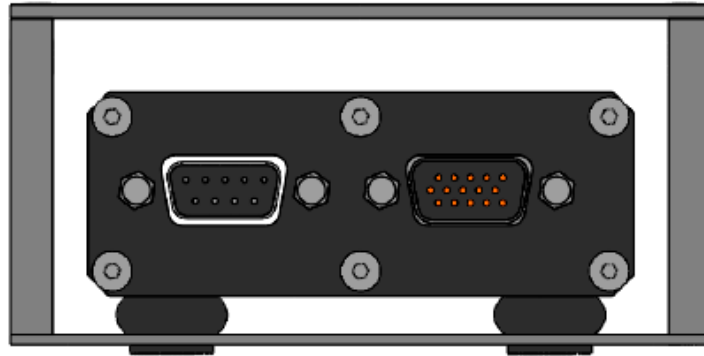


2. 【Structure of Adapter box】



3. 【Structure of anti-vibration frame】



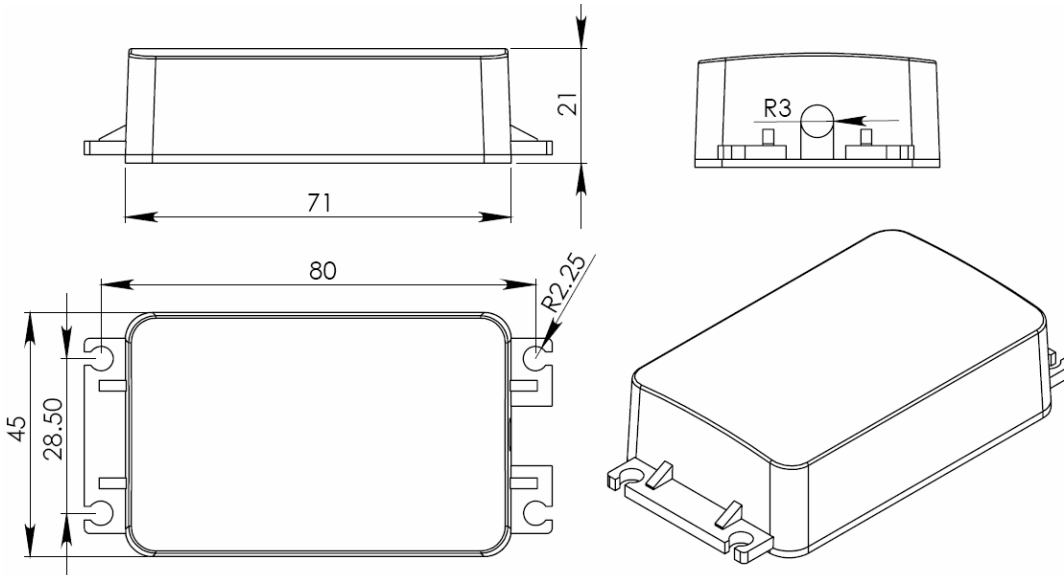


【Front view of Main Controller in frame】



【Right view of Main Controller in frame】

4. 【COMPASS/GPS MODULE DRAWING】



Appendix E: Packaging List

XP3.1 Standard

1)	Main controller	1 piece
2)	Adapter	1 piece
3)	Compass&GPS module	1 piece
4)	Anti-Vibration Frame	1 piece
5)	LED Status Indicator	1 piece
6)	Neoprene Isolators	8 pieces
7)	DB15 connection Cable	1 piece
8)	USB to Serial Cable	1 piece
9)	SD card	1 piece
10)	Product CD	1 piece

Appendix F: Safety Check List

⚠ User should pay special attention to the points listed below, otherwise will lead to Fatal danger!

1. Is adapter installed more than 20cm away from Gas engine?
2. Is the Fail safe function on the RC transmitter correctly set?
3. Make sure the “Feed back Test” and the “Controller Orientation Test” passed correctly
4. Have you done the compass calibration, and check the result?
5. Do a RC transmitter Range test.