

SIYI

N7

AUTOPILOT

ARDUPILOT USER MANUAL



SIYI Technology (Shenzhen) Co., Ltd.

SIYI.biz/en

Thank you for purchasing SIYI product.

The N7 flight controller is equipped with the H7 double-precision floating-point unit processor. It adopts built-in dual IMU redundancy and internal shock absorption structure design, which endows the aircraft with high reliability. The N7 flight controller is compatible with both ArduPilot and PX4 open-source ecosystem to achieve abundant application scenarios and provide stable and comprehensive systematic solutions for enthusiasts and industry application explorers of drones, unmanned vehicles and ships, smart robots.

To ensure you a good experience of the product, please read this manual carefully. If you encounter any issue using the product, please consult the manual or check the online pages of this product on SIYI official website (<https://siyi.biz/en>). You can also write an email to SIYI official A/S center (support@siyi.biz).

Contact Us: **SIYI Official Website** (<https://SIYI.biz/en>)

SIYI User Group - Facebook	
Facebook	
LinkedIn	
YouTube	

User Manual Update Log

Version	Date	Updates
1.0	2023.11	Initial version.

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READ TIPS

Icons

Please pay more attention to content indicated with the following marks:

 **DANGER** Dangerous manipulation probably leads to personal injuries.

 **WARNING** Warnings on manipulation possibly leads to personal injuries.

 **CAUTION** Cautions on what manipulation may lead to economic losses.

 **Prohibited**  **Mandatory**  **Mark**

Safety

N7 autopilot is designed and manufactured for professional application scenarios. Operators need to have certain basic skills, so please use it with caution. SIYI Technology does not assume any responsibility for any unnecessary product damage caused by irregular or irresponsible operation of this product, economic losses or even personal injury to the user or others. Minors must have professionals present to supervise and guide minors when using this product. SIYI Technology's products are designed for commercial use, and it is prohibited to use SIYI products for military purposes. It is prohibited to disassemble or modify this product without SIYI Technology's permission.

SIYI

To jointly maintain flight safety and allow you to better utilize the features of this product, please pay special attention to the following matters:

 It is prohibited to operate in crowded places (squares, parks, etc.), places with many obstacles (streets, parking lots, etc.), places with strong magnetic fields or signal interference sources (high-voltage lines, railway lines, radar stations, etc.) or other places that may cause using SIYI products to control aircraft, vehicles or models in areas where unnecessary economic losses or even personal injuries will occur.

 During operation, never cover the remote controller antenna or otherwise block signal transmission.

 The top of the standard omni-directional antenna on the remote controller is the part where signal transmission is weakest. Avoid pointing it at your aircraft, vehicle or model while working.

 It is prohibited to use SIYI products to control aircraft, vehicles, or models when you are tired, drunk, or unwell.

 Without special operation permission, it is prohibited to use SIYI products to control aircraft, vehicles, or models in rainy days, at night or in strong wind environments.

 When the engine or motor on your aircraft, vehicle or model is still running, do not cut off the power to the remote controller in advance.

 For flight safety, please keep the aircraft within sight when operating the aircraft.

 When working, be sure to return to the main page from the system parameter setting page.

 Before starting the operation, be sure to check the power of the remote controller and the power supply voltage of the air unit.

 When finishing the operation, first power off the air unit and then the remote controller.

 Before setting the remote controller parameters, be sure to power off the engine and motor to prevent accidental start.

 Before starting the operation, be sure to pre-set the fail-safe function on the remote control or in the ground station software.

 When installing, please avoid installing the air unit and GPS module too close to avoid interference. It is recommended that the distance between the air unit and the GPS module be longer than 20 cm.

Storage / Carrying / Recycling

When the SIYI product you own is idle, or you want to take the SIYI product out for work, or the product has reached the end of its service life, please pay special attention to the following matters:

DANGER

When SIYI products are not in use, they should be kept away from areas easily accessible to children.

Please avoid placing SIYI products in an environment that is too hot (above 60 degrees Celsius) or too cold (below minus 20 degrees Celsius).

 **CAUTION**

Please avoid placing SIYI products in humid or sandy environments.

When carrying and transporting SIYI products, please avoid operations that may damage components such as vibration or impact.

1 INTRODUCTION

1.1 Product Features

Systematic Solution

The N7 flight control system supports a series of feature-rich SIYI products and open-source ecosystem products to easily meet different application requirements. Combine high-performance firmware and software including PX4, ArduPilot, QGroundControl, and Mission Planner to support a wide range of application scenarios and provide users with powerful systematic solutions. At the same time, it lowers barriers to use, provides developers with a complete development platform, and facilitates application development.

Internal Shock Absorption Structure

IMU and Magnetometer Dual Redundancy

IMU Thermostatic Control

The internal shock absorbing structure design of the N7 flight control can meet the working requirements of multiple models. Built-in dual IMU redundancy design, GPS module magnetometer and flight control board magnetometer dual redundancy design, built-in heating resistors to ensure that the flight control IMU can still work at a constant temperature in low temperature environments, and the systematic comprehensive design greatly improves flight stability and reliability.

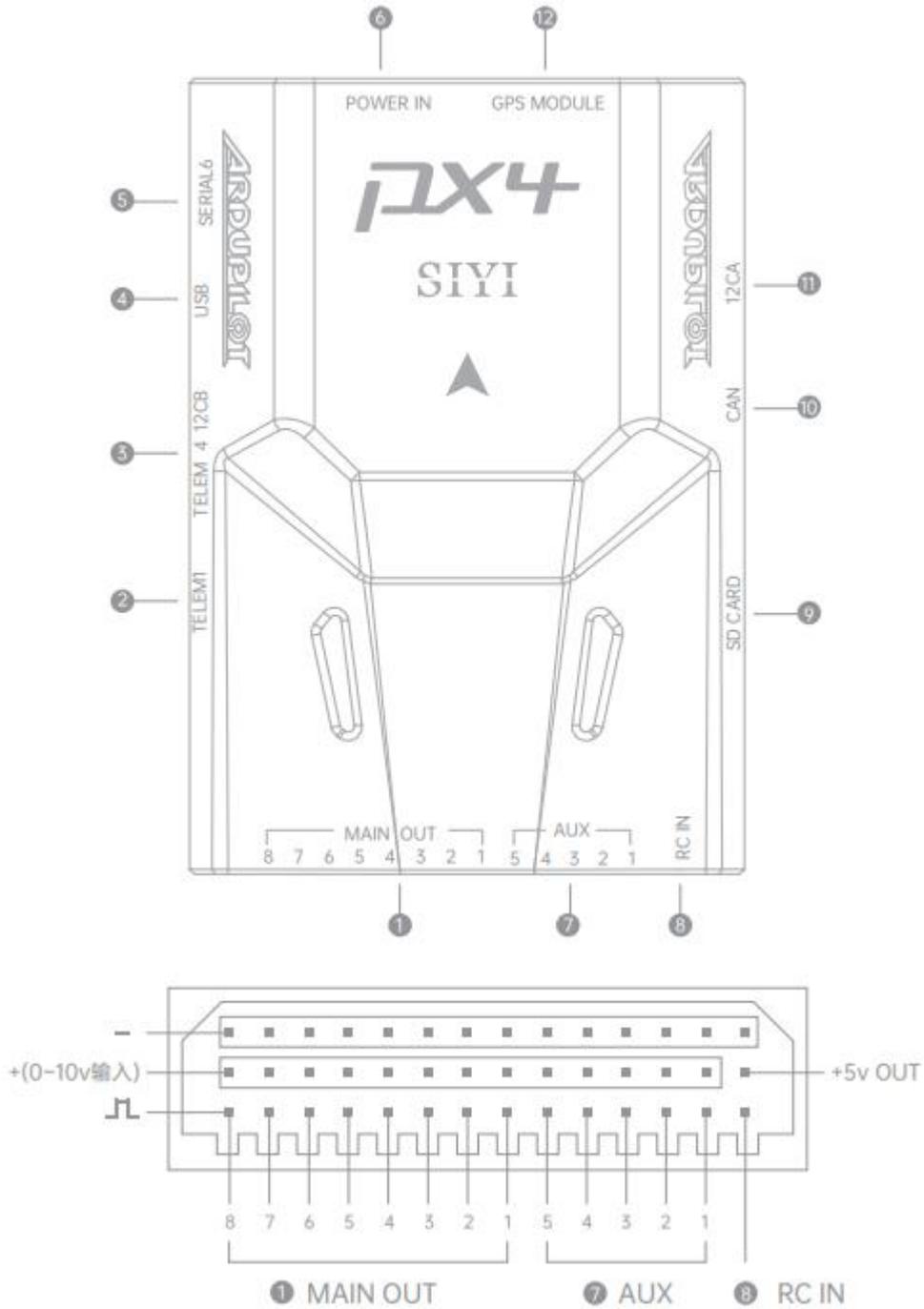
H7 Double Precision Floating Point Unit Processor

SIYI

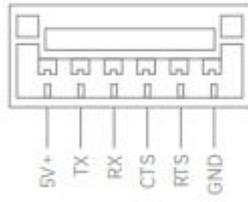
The N7 flight controller is equipped with an STM32H743IIK6 processor, equipped with a double-precision floating-point unit (DSP & FPU), up to 480 MHz main frequency, 2 MB flash memory, and 1 MB memory, bringing powerful computing capabilities, high-speed data processing capabilities, significantly improving flight stability, and creating a broader space for functional development.

SIYI

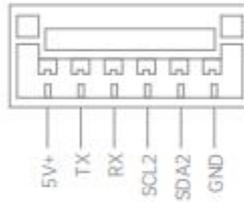
1.2 Interface & Pinouts



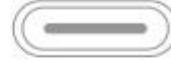
② TELEM 1



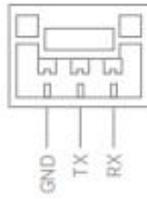
③ TELEM 4 12CB



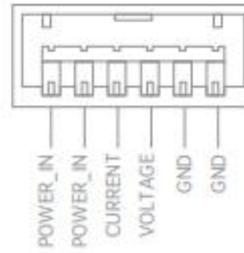
④ USB



⑤ SERIAL 6



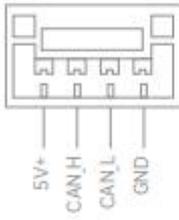
⑥ POWER IN



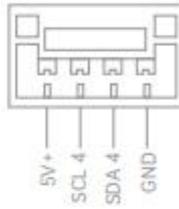
⑨ SD CARD



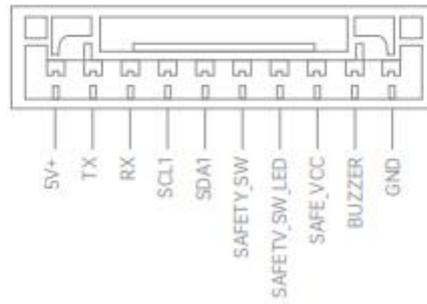
⑩ CAN



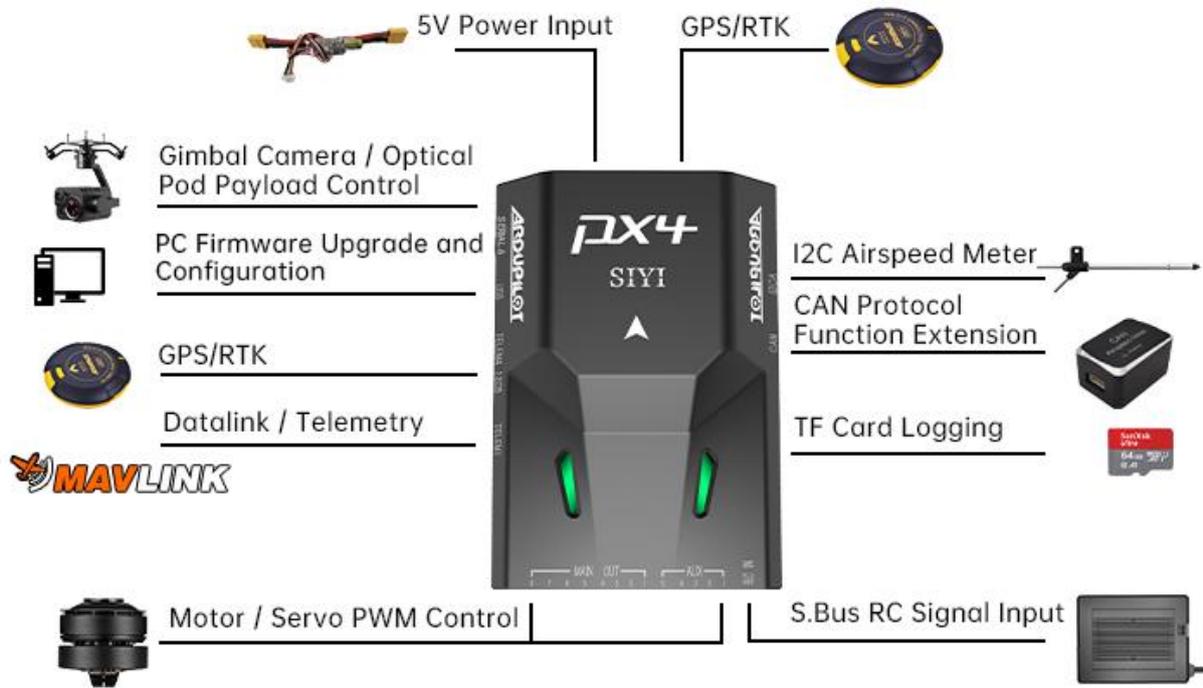
⑪ I2CA



⑫ GPS MODULE



1.3 Typical Connection Diagram



*The diagram only shows typical usage, N7 flight controller supports more powerful and richer application expansion, welcome to join us to explore together!

1.4 Technical Specifications

Hardware

Main Processor	STM32H743IIK6 (32 Bit Arm® Cortex®-M7, 480 MHz, 2 MB memory, 1 MB RAM)
Co-processor	STM32F103 (32 Bit Arm® Cortex®-M3, 72 MHz, 20 KB SRAM)

Sensors

Accelerometer / Gyro	BMI088 / ICM20689
Electronic Compass	IST8310
Barometer	MS5611

External Interface

UART Serial Port	4
I2C	3
CAN	1
PWM Output	8 x Standard PWM IO 5 x Programmable IO
RC Input (S.Bus)	1
Power Module Input	1
GPS & Safety	1
USB (Type-C)	1
TF Card Slot	1

Overall

Compatible Model	PX4 / ArduPilot Firmware (Planes / Multirotors / Helicopters / VTOL / UGV / USV)
Power Module Voltage Input	4.5 ~ 5.5 V

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USB Voltage Input	5 V (± 0.25 V)
Servo Voltage Input	0 ~ 10 V
Working Temperature	-20 ~ 65 °C
Dimensions	47 x 68 x 19 mm
Weight	57 g

Mark

To make sure your flight log is recorded smoothly and stably, please format your SD card to FAT32 format and make the minimum storage unit as 64 KB.

The default firmware for N7 autopilot is ArduCopter v4.3.7.

To have a stable flight, please assign the external compass as main compass.

1.5 Packing List

Basic Combo	GPS Combo
1 x N7 Autopilot 1 x Power Module	
	1 x M9N GPS
2 x I2C / CAN Cable	
1 x TELEM1 Cable	
1 x S.Bus Cable	
1 x TELEM4 to I2C Cable	
1 x SIYI Gimbal to PX4 / ArduPilot Flight Controller UART Cable (Connect SIYI gimbal's UART port to PX4 / ArduPilot flight controller's UART port for communication and gimbal control)	
1 x USB to Type-C Cable (Connect flight controller to PC for firmware upgrade and configuration)	
3 x 3M Double-Sided Tape (4 x 2 cm) (Fix and mount N7 autopilot)	

1.6 GPS Indicator Definition

-  Red-Blue Blinks: Initialing (Gyro calibrating, etc.)
-  Red-Green-Blue Blinks: Saving configuration / Compass calibrating / ESC calibrating.
-  Red-Yellow Blinks: Kalman filter failsafe.
-  Blue-Yellow Blinks: GPS fail.
-  Fast Yellow Blinks: Radio / GCS / Batt failsafe.
-  Solid Green: Armed - GPS 3D Fix
-  Solid Blue: Armed - No GPS positioning.
-  Double Yellow Blinks: Disarmed - Arm check failed.
-  Fast Green Blinks: Disarmed - DGPS Fix
-  Slow Green Blinks: Disarmed - GPS Fix
-  Slow Blue Blinks: Disarmed: No GPS positioning.

2 FIRST TIME SETUP

If you are new to ArduPilot, welcome to visit the official ArduPilot documentation for step-by-step instructions.

ArduPilot Official Documentation

<https://ardupilot.org/copter/docs/copter-introduction.html#>

2.1 Ground Control Station

Ground Control Station (GCS) software provides a means to configure your autopilot system as well as providing an in-flight means of monitoring and controlling all aspects of the vehicle operation.

Mark

It is suggested to configure ArduPilot flight controller in Windows Mission Planner.

Download Mission Planner:

<https://firmware.ardupilot.org/Tools/MissionPlanner/MissionPlanner-latest.msi>

2.2 Firmware Upgrade

ArduPilot flight controller firmware can be upgraded through Mission Planner GCS.

Before upgrade, it is necessary to prepare the tools, firmware, and software below:

- N7 Autopilot ArduPilot Firmware

Mark

Above tools can be downloaded from the relevant product pages on SIYI official website (<https://siyi.biz/en>).

The N7 ArduPilot firmware uploaded on SIYI official website is the original released version. Mission Planner will notify users if update to the latest ArduPilot firmware when the flight controller is connected. If you are keen to the latest ArduPilot features, welcome to sync your flight controller firmware to the latest version.

- Flight Controller Upgrade Cable (Type-C to USB-A)

Mark

Above tools comes with product package.

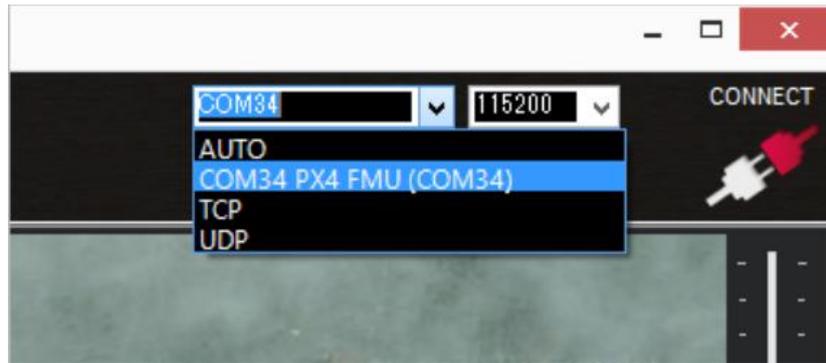
- Mission Planner GCS

Firmware Upgrade Steps

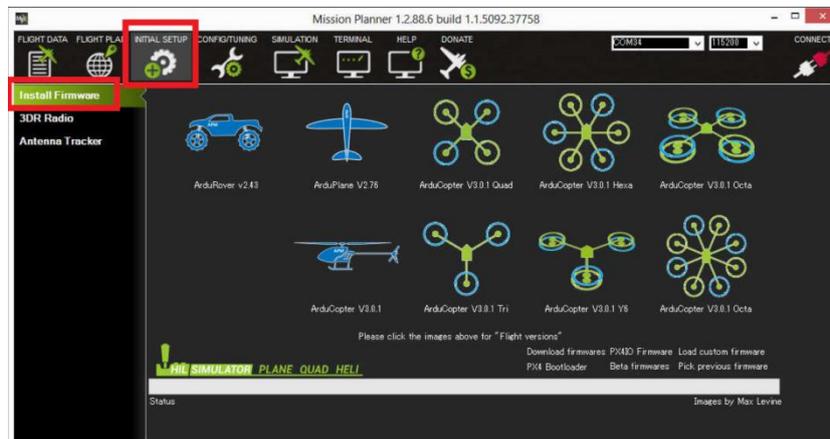
1. Install Mission Planner GCS on your computer.
2. Use the flight controller upgrade cable to connect N7 autopilot to your computer (use a direct USB port, not a USB hub). After a successful connection, Windows system should automatically detect and install the correct driver software.



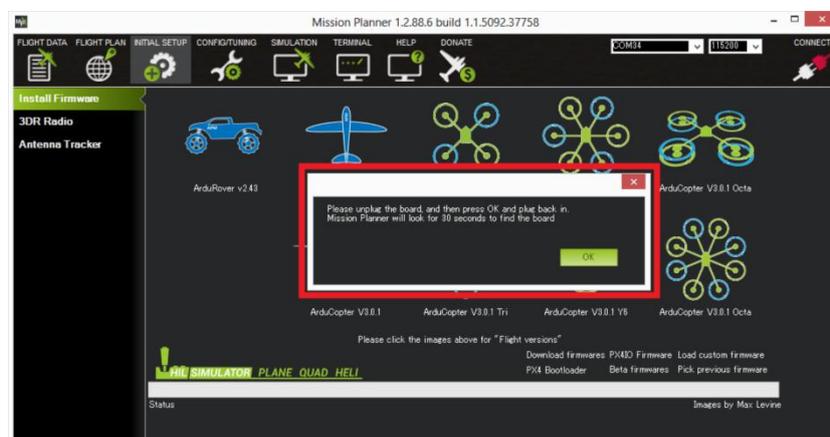
3. Run Mission Planner GCS, select the COM port drop-down in the upper-right corner of the window near the “Connect” button. Select “AUTO” or the specific port for your board. Set the Baud rate to “115200” as shown. Do not hit “Connect” just yet.



- In Mission Planner's **SETUP | Install Firmware** screen select the appropriate icon that matches your vehicle or frame type (i.e., Quad, Hexa). Answer "Yes" when it asks you "Are you sure?".



- Mission Planner will try to detect which board you are using. It may ask you to unplug the board, press OK, and plug it back in to detect the board type.



6. Often you will be presented with a dropdown box of firmware variants for the board, which you can select from (such as bi-directional DShot variants, if available). Select the appropriate firmware for your board.
7. If all goes well, you will see a status appear on the bottom right including the words: “erase...”, “program...”, “verify...”, and “Upload Done”. The firmware has been successfully uploaded to the board.
8. It usually takes a few seconds for the bootloader to exit and enter the main code after programming or a power-up. Wait to press CONNECT until this occurs.

Mark

Updating the firmware to a newer version does not alter existing parameters unless the firmware is for a different vehicle, in which case parameters are reset to their default values for that vehicle. However, it is always a good idea to save your parameters to a file using the “Save to File” button on the Mission Planner’s “CONFIG/Full Parameter Tree” tab before any firmware updates, just in case of any issues while updating.

Do not apply all parameters after upgrading to a new version as some parameters might have a different meaning.

2.3 Mounting the Autopilot

The autopilot should be placed close to the center of gravity of the vehicle (both horizontally and vertically). Generally, this means it should be placed within a few centimeters of the middle of the vehicle and level with the motors. It is not critical that it is placed exactly at the middle but closer is better (there are no recorded cases of problems caused by the controller being far from the center of gravity). If the autopilot cannot be placed at the center of the vehicle setting the IMU position offset parameters may improve performance slightly.

2.3.1 Orientation

The autopilot should be mounted with the white arrow pointing directly towards the front of the vehicle.

2.3.2 Mounting the GPS Module

The GPS module is suggested to be mounted separately from the flight controller so that it can have the best clear (view) of the sky and allows the compass to be distanced from interfering magnetic fields.

Mark

The recommended orientation is to mount the module with the arrow facing toward the front of the vehicle and in the same direction as the arrow on the autopilot.



When mounting the GPS module:

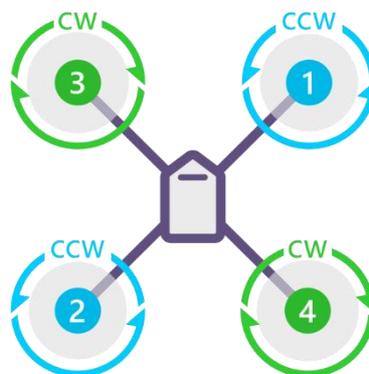
- Place the module on the outside of your vehicle (in an elevated position if appropriate) with a clear view of the sky, as far as possible from the motors and ESCs, with the arrow facing forward.
- Distance the module from DC power wiring and the batteries by at least 10cm. Use of a GPS mast is highly recommended.
- Place the module clear of nearby iron containing metallic objects. (Use nylon or non-magnetic stainless-steel hardware and nylon or aluminum standoffs to mount the module).
- Twist power and ground wires where possible.

2.3.3 Motor Order Diagrams

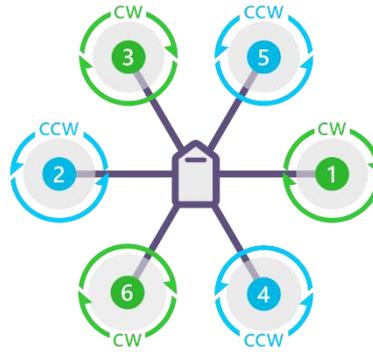
The diagrams below show motor order for each frame type. The numbers indicate which output pin from the autopilot should be connected to each motor/propeller. The propeller direction is shown in green (clockwise, CW) or blue (counterclockwise, CCW).



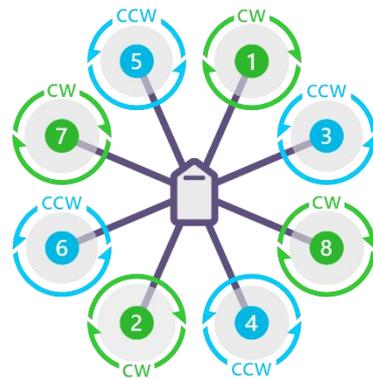
Common Frame Types & Their Motor Diagram



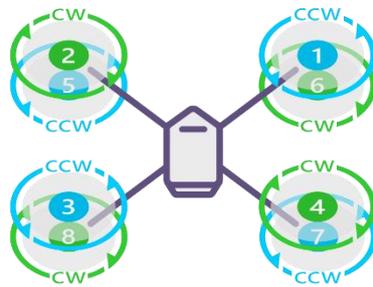
QUAD X



HEXA X



OCTO X



OCTO QUAD X8



For more ArduPilot supported frame types, please visit:

<https://ardupilot.org/copter/docs/connect-escs-and-motors.html>

2.3.4 Vibration Damping

Autopilots have accelerometers that are sensitive to vibrations. These accelerometer values are combined with barometer and GPS data to estimate the vehicle's position. With excessive vibrations, the estimate can be thrown off and lead to very bad performance in modes that rely on accurate positioning (e.g., on Copter: AltHold, Loiter, RTL, Guided, Position and Auto flight modes).

Mark

For suggestions on measuring vibration, please visit:

<https://ardupilot.org/copter/docs/common-measuring-vibration.html#common-measuring-vibration>

The goal of vibration damping is to reduce high and medium frequency vibrations while still allowing low frequency actual board movement to take place in concert with the airframe.

Mark

N7 autopilot's internal anti-vibration structure can handle vibration on normal drones. It is suggested to use an external anti-vibration board on drones with a lot of vibration.



Advice for Reducing Vibrations

For copters the largest source of vibration is normally the blades passing over the arms, but other sources of vibration also exist and may be reduced by following this advice:

1. Frame flex especially arm flex is a big cause of asynchronous vibration, Frame arms should be as rigid as possible.
2. Motor to frame arm and frame arm to central hub mounts need to be secure and flex free (sometimes a problem for carbon tube arms).
3. Motors need to run smoothly (bearings not worn-out or “screeching”).
4. Prop adapters connecting the propellers to the motors need to be concentric and very straight. Propellers should be fully balanced using a good manual prop balancer.

5. Propellers are in good dynamic balance and the blades have no visible deformation or damage.
6. Cables between parts must be well fixed and do not jump.
7. It is suggested to use soft cables for connection to flight controller.

2.3.5 Magnetic Interference

Magnet Interference on a compass can have a serious impact on navigation on all vehicle types. This chapter explains what hardware changes you can make to reduce magnetic interference on the compass.



DANGER

Multi-rotor drones rely on compass navigation very much. It is suggested to use RTK modules instead of GPS compass.

Reducing Compass Magnetic Interference by Optimizing Installation

1. Always use an external compass first and install the compass module on a bracket away from sources of magnetic interference, including away from the power distribution board.

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2. Keep the cable length between the power distribution board, ESC, and battery as short as possible. The three-phase wires from the ESC to the motor are less important because they are AC and produce less interference.
3. Wrap the wires between the distribution board, ESC and battery and use shielded wire.
4. Replace the distribution board and ESC with a 4-in-1 ESC as they tend to produce less interference, probably because they have shorter cables closer to each other and have an aluminum plate on top to help reduce interference.
5. Adding aluminum foil shielding around the ESC to motor cable may reduce AC interference. But aluminum foil does not help reduce DC interference.

Mark

For more suggestions on magnetic interference, please visit:

<https://ardupilot.org/copter/docs/common-magnetic-interference.html>

2.4 Mandatory Hardware Configuration

As part of first-time setup, you'll need to configure some required hardware components.

Mark

This chapter is edited mainly for SIYI ecosystem based on N7 autopilot. If you expect for a more universal ArduPilot system, welcome to visit:

<https://ardupilot.org/copter/docs/configuring-hardware.html>

2.4.1 Basic System Overview

SIYI will show you some typical examples how a productive system is built with N7 autopilot, stay tuned.

2.4.2 Frame Class and Type Configuration

The `FRAME_CLASS` and `FRAME_TYPE` parameters should be set to match the physical frame being used. Please refer to Chapter 2.3.3 for more detail.

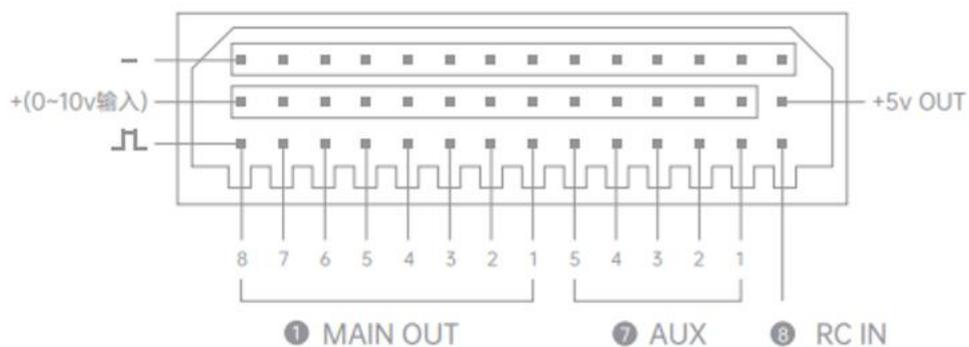
2.4.3 Motor Numbering and Direction

Please refer to Chapter 2.3.3 for basic information of motor numbering and direction.

Connect ESCs and Motors

This article explains how to connect the ESCs, motors and propellers to N7 autopilot.

1. Connect the power (+), ground (-), and signal (s) wires for each ESC to the autopilot's main output pins by motor number.
2. Refer to your frame type to determine the assigned order of the motors.



2.4.4 Remote Controller Calibration

This chapter shows how to perform remote controller calibration using Mission Planner GCS.

RC Calibration involves capturing each RC input channel's minimum, maximum and “trim” values so that ArduPilot can correctly interpret the input.

Calibration Steps

1. Ensure your remote controller has been bound to the receiver, and their communication to flight controller is good.
2. Connect the flight controller to PC and run Mission Planner GCS.
3. On the Mission Planner press the “Connect” button and open Mission Planner’s **INITIAL SETUP | Mandatory Hardware | Radio Calibration** page.
4. Check the channel mapping in the remote controller (ie. check which inputs channels are controlled by the sticks, switches, and knobs) by moving the sticks, knobs and switches and observing which (if any) green bars move.



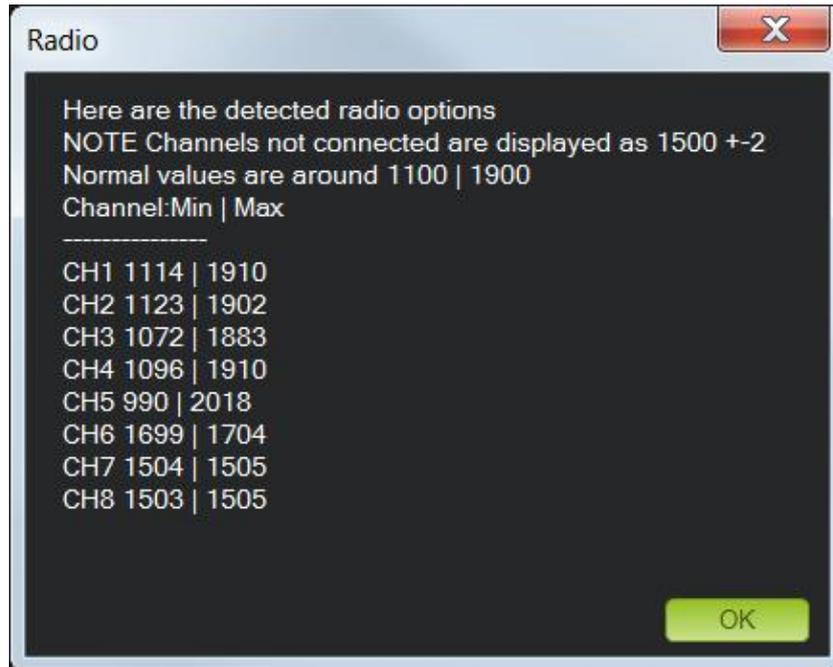
5. Click on the green “Calibrate Radio” button on the bottom right. Press “OK” when prompted to check the radio control equipment is on, battery is not connected, and propellers are not attached.



6. Move the transmitter's control sticks, knobs and switches to their limits. Red lines will appear across the calibration bars to show minimum and maximum values seen so far.



7. Select "Click when Done". A window will appear with the prompt, "Ensure all your sticks are centered and throttle is down and click ok to continue". Move the throttle to zero and press "OK".
8. Mission Planner will show a summary of the calibration data. Normal values are around 1100 for minimums and 1900 for maximums.



Mode 1 and Mode 2 Transmitters

There are two main transmitter configurations:

- Mode 1: left stick controls pitch and yaw, the right stick will control throttle and roll.
- Mode 2: left stick controls throttle and yaw; the right stick will control pitch and roll.

Channel Mappings

Copter default channel mappings are:

- Channel 1: Roll

- Channel 2: Pitch
- Channel 3: Throttle
- Channel 4: Yaw
- Channel 5: Flight modes

Mark

N7 autopilot's "RC IN" port supports S.Bus or PPM signal input.

2.4.5 Accelerometer Calibration

This article shows how to perform basic accelerometer calibration (using Mission Planner). Accelerator hexahedral calibration can calibrate the accelerator's sensitivity, zero bias, and inter axis error, etc. During calibration, the vehicle should be placed in all hexahedrons to record accelerator's output value on each orientation and build the error model. Hexahedral calibration can keep the accelerator's accuracy and reliability.

CAUTION

Accelerometer calibration is mandatory in ArduPilot.

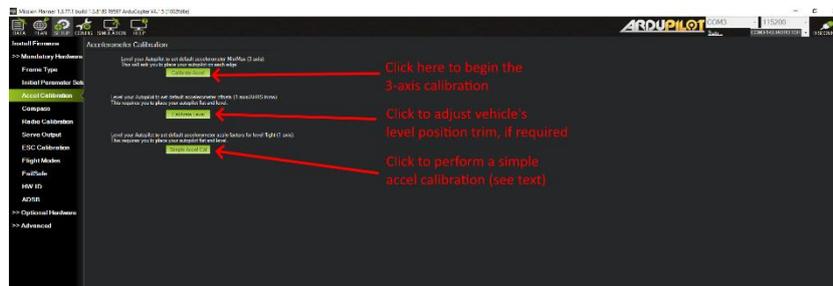
DANGER

Accelerometer calibration cannot be performed while the vehicle is armed.

If the board is mounted in a non-standard orientation (i.e., arrow is not pointing forward) then please ensure the `AHRS_ORIENTATION` is properly set before doing the accelerometer calibration.

Calibration Steps

1. Under **Setup | Mandatory Hardware**, select **Accel Calibration** from the left-side menu.



2. Click **Calibrate Accel** to start the full 3-axis calibration.
3. Mission Planner will prompt you to place the vehicle on each axis during the calibration. Press any key to indicate that the autopilot is in position and then proceed to the next orientation.

The calibration positions are:

Level, Left Side, Right Side, Nose Down, Nose Up, and Back Side.



4. The vehicle must be kept still immediately after pressing the key for each step. This is more important than getting the angle exactly right, i.e., left being 90-deg to horizontal, etc. Except for the first “LEVEL”, the positions can be within 20 degrees of being exact. Being still in each position as you press the key is much more important.

Calibrate Level

The level position is the most important to get right as this will be the attitude that your controller considers level while flying.

You can recalibrate this Level position using Mission Planner after you have installed the autopilot and are ready to fly. Place the vehicle in its level flying attitude and use the **Calibrate Level** button.

Mark

This **Calibrate Level** operation can only correct up to a 10-degree difference between the initial calibration and the final position in the vehicle, and only corrects pitch and roll differences, not yaw.

2.4.6 Compass Calibration

Before compass calibration, it assumes that you have at least one compass, either internally or externally in the system, and it has been enabled.



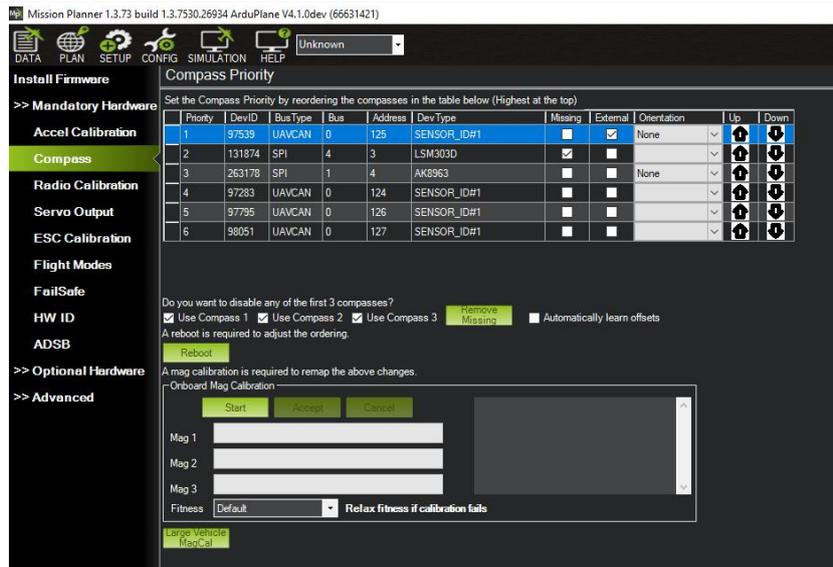
CAUTION

Do not calibrate the compasses near any metallic or magnetic field producing object (computers, cell phones, metal desks, power supplies, etc.) or incorrect calibration will occur.

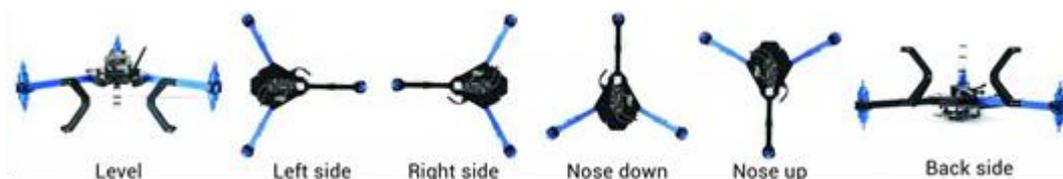
Please configure the external compass as the main compass in priority.

Calibration Steps

1. Under **SETUP| Mandatory Hardware** select **Compass**.



2. Make the external compass as the main compass.
3. Click the “Onboard Mag Calibration” section’s “Start” button. If your autopilot has a buzzer attached, you should hear a single tone followed by short beep once per second.
4. Hold the vehicle in the air and rotate it so that each side (front, back, left, right, top and bottom) points down towards the earth for a few seconds in turn. Consider a full 360-degree turn with each turn pointing a different direction of the vehicle to the ground. It will result in 6 full turns plus possibly some additional time and turns to confirm the calibration or retry if it initially does not pass.



5. As the vehicle is rotated the green bars should extend further and further to the right until the calibration completes.

6. Upon successful completion three rising tones will be emitted and a “Please reboot the autopilot” window will appear, and you will need to reboot the autopilot before it is possible to arm the vehicle.

If calibration fails:

1. You will hear an “unhappy” failure tone, the green bars may reset to the left, and the calibration routine may restart (depending upon the ground station). Mission Planner will automatically retry, so continue to rotate the vehicle as instructed above.
2. If a compass is not calibrating, consider moving to a different area away from magnetic disturbances, and remove electronics from your pockets.
3. If, after multiple attempts, the compass has not passed the calibration, Press the “Cancel” button and change the “Fitness” drop-down to a more relaxed setting and try again.
4. If compass calibration still fails, it may help to raise COMPASS_OFFS_MAX from 850 to 2000 or even 3000.
5. Finally, if a single compass is not calibrating and you trust the others, disable it.

Some datalink station working under 900 MHz may bring unexpected interference to the compass.

2.4.7 Remote Controller Flight Mode Configuration

This chapter shows how you can enable up to 6 autopilot control / flight modes to be set from your remote controller.

The mapping between switch position and flight mode is set in the Mission Planner Flight Mode screen.



Steps

1. Connect the autopilot to the Mission Planner.
2. Go to the **Initial Setup | Mandatory Hardware | Flight Modes** page.
3. Use the drop-down on each line to select the flight mode for that switch position.

4. (Copter) Ensure that at least one switch position is left assigned to STABILISE.
5. When finished press the Save Modes button.

Mark

ArduPilot support diverse flight modes, welcome to visit the ArduPilot link for more detail:

<https://ardupilot.org/copter/docs/common-rc-transmitter-flight-mode-configuration.html>

2.4.8 Electronic Speed Controller (ESC) Calibration

Electronic speed controllers are responsible for spinning the motors at the speed requested by the autopilot. Most ESCs need to be calibrated so that they know the minimum and maximum PWM values that the flight controller will send. This chapter provides instructions for calibrating ESCs.

Mark

This chapter applies ONLY to Copter setups, not Rover or Plane.

Please complete remote controller calibration before performing ESC calibration.

DANGER

Safety Check!

Before calibrating ESCs, please ensure that your copter has **NO PROPS** on it and that the autopilot is **NOT CONNECTED** to your computer via USB and the Lipo battery is disconnected.

Steps

1. Connect the autopilot to the Mission Planner.
2. Go to the **Initial Setup | ESC Calibration** page.
3. Follow the GCS instruction to do calibration.

Mark

For more instruction on ESC calibration with ArduPilot, welcome to visit:

<https://ardupilot.org/copter/docs/esc-calibration.html>

3 FIRST FLIGHT & TUNING

This section covers the information you will need to know for your first flight and some basic configuration to get your copter flying reasonably well.

3.1 Pre-arm Safety Check

ArduPilot includes a suite of Pre-arm Safety Checks which will prevent the vehicle from arming its propulsion system if any of a fairly large number of issues are discovered before movement including missed calibration, configuration, or bad sensor data. These checks help prevent crashes or fly-aways, but some can also be disabled if necessary.



DANGER

Never disable the arming checks (ie `ARMING_CHECK` not = “1”, except for bench testing. Always resolve any pre-arm or arming failures **BEFORE** attempting to fly. Doing otherwise may result in the loss of the vehicle.

Common Reasons for Arm Failure

- check firmware or `FRAME_CLASS`
- 3D Accel calibration needed.
- safe switch
- RC not calibrated.

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- Baro not healthy
- Alt disparity: the barometer altitude disagrees with the inertial navigation (i.e., Baro + Accelerometer) altitude estimate by more than 1 meters. This message is normally short-lived and can occur when the autopilot is first plugged in or if it receives a hard jolt (i.e., dropped suddenly).
- Compass not healthy
- Compass not calibrated.
- Compass offsets too high: the primary compass's offsets length (i.e., $\sqrt{x^2+y^2+z^2}$) are larger than 500. This can be caused by metal objects being placed too close to the compass. If only an internal compass is being used (not recommended), it may simply be the metal in the board that is causing the large offsets, and this may not actually be a problem in which case you may wish to disable the compass check.
- Check mag field: the sensed magnetic field in the area is 35% higher or lower than the expected value. The expected length is 530 so it's > 874 or < 185 . Magnetic field strength varies around the world, but these wide limits mean it's more likely the compass calibration has not calculated good offsets and should be repeated.
- Compasses inconsistent: the internal and external compasses are pointing in different directions (off by >45 degrees). This is normally caused by the external compasses' orientation (i.e., COMPASS_ORIENT parameter) being set incorrectly.
- GPS Glitch: the GPS is glitching and the vehicle is in a flight mode that requires

GPS (i.e., Loiter, PosHold, etc) and/or the cylindrical fence is enabled.

- Need 3D Fix: the GPS does not have a 3D fix and the vehicle is in a flight mode that requires the GPS and/or the cylindrical fence is enabled.
- High GPS HDOP: the GPS's HDOP value (a measure of the position accuracy) is above 2.0 and the vehicle is in a flight mode that requires GPS and/or the cylindrical fence is enabled. This may be resolved by simply waiting a few minutes, moving to a location with a better view of the sky or checking sources of GPS interference (i.e., FPV equipment) are moved further from the GPS. Alternatively, the check can be relaxed by increasing the `GPS_HDOP_GOOD` parameter to 2.2 or 2.5. Worst case the pilot may disable the fence and take-off in a mode that does not require the GPS (i.e., Stabilize, AltHold) and switch into Loiter after arming but this is not recommended.
- INS not calibrated.
- Accels not healthy: one of the accelerometers is reporting it is not healthy which could be a hardware issue. This can also occur immediately after a firmware update before the board has been restarted.
- Accels inconsistent: the accelerometers are reporting accelerations which are different by at least 1m/s/s. The accelerometers need to be re-calibrated or there is a hardware issue.
- Gyros not healthy: one of the gyroscopes is reporting it is unhealthy which is likely a hardware issue. This can also occur immediately after a firmware update before the board has been restarted.
- Gyro cal failed: the gyro calibration failed to capture offsets. This is most often

caused by the vehicle being moved during the gyro calibration (when red and blue lights are flashing) in which case unplugging the battery and plugging it in again while being careful not to jostle the vehicle will likely resolve the issue. Sensor's hardware failures (i.e., spikes) can also cause this failure.

- Gyros inconsistent: two gyroscopes are reporting vehicle rotation rates that differ by more than 20deg/sec. This is likely a hardware failure or caused by a bad gyro calibration.
- Check Board Voltage: the board's internal voltage is below 4.3 Volts or above 5.8 Volts.
- Ch7&Ch8 Opt cannot be same.
- Check FS_THR_VALUE: the radio failsafe pwm value has been set too close to the throttle channels (i.e., ch3) minimum.
- Check ANGLE_MAX: the ANGLE_MAX parameter which controls the vehicle's maximum lean angle has been set below 10 degrees (i.e., 1000) or above 80 degrees (i.e., 8000).

3.2 Arming and Disarming

3.2.1 Arming the Motors

Arming the vehicle allows the motors to start spinning. Before arming, make sure all people, objects, and any body parts (e.g., hands) are clear of the propellers.

Then do the following:

1. Turn on your remote controller.
2. Plug in the LiPo battery. The red and blue lights should flash for a few seconds as the gyros are calibrated (do not move the copter)
3. The pre-arm checks will run automatically and if any problems are found the RGB LED will blink yellow, and the failure will be displayed on the ground station.
4. Check that your flight mode switch is set to Stabilize, ACRO, AltHold, Loiter, or PosHold.
5. Press the safe switch until the light goes solid.
6. If you are planning on using an autonomous mode (i.e., Loiter, RTL, Auto, etc) switch the vehicle to Loiter or PosHold and wait until the LEDs blink green indicating a good GPS lock.

7. Arm the motors by holding the throttle down, and rudder right for 5 seconds. Do not hold the rudder right for too long (>15 seconds) or you will begin the AutoTrim feature.
8. Once armed, the LEDs will go solid, and the propellers will begin to spin.
9. Raise the throttle to take-off.

Mark

If you leave the throttle at minimum for 15 seconds while in any of the above modes, the motors will automatically disarm.

3.2.2 Disarming the Motors

Disarming the motors will cause the motors to stop spinning. To disarm the motors, do the following:

1. Check that your flight mode switch is set to Stabilize, ACRO, AltHold, Loiter, or PosHold.
2. Hold throttle at minimum and rudder to the left for 2 seconds.
3. The LED will start flashing indicating the vehicle is disarmed.
4. Press the safety switch until the LED begins flashing.
5. Disconnect the battery.
6. Turn off your remote controller.

Mark

For more instruction on Arming and Disarming with ArduPilot, welcome to visit:

https://ardupilot.org/copter/docs/arming_the_motors.html

3.3 Getting Off the Ground – Tips for New Operators

This page gives some advice on initial flying strategies for those with limited or no previous experience flying RC aircraft or multi-copters.

3.3.1 First Flight

- Place the copter on level ground and connect the battery - do not move the copter until gyroscope calibration is completed (LED's flashing red and blue). Ensure that your RC mode toggle switch is in Stabilize mode. Slowly raise the throttle until the copter just lifts off the ground.
- If it seems like it's going to flip or otherwise isn't lifting straight up it is possible that you've set the wrong +/- orientation, hooked up your motors in the wrong order or have the prop direction or pusher/puller order wrong.
- If any of the controls are reversed (pitch or roll are backwards, meaning the copter moves in the opposite direction as your stick), you'll need to reverse the affected channel at your RC transmitter side. Please see your RC transmitter's manual if you're not familiar with the process. It's a good idea to re-do your RC calibration in the Mission Planner after you've reversed a channel.

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- If it lifts off smoothly, you may see a little yaw. That shouldn't be more than about 30 degrees and will correct itself with more flying time. There should be no pronounced wobble (if there is, you may have an unbalanced prop or out-of-true motor).
- The copter should also tend to stay in place, and you shouldn't have to fight strong tendencies to move left or right or forward or back. If you do see that behavior, do NOT use your RC trims to correct (this just throws off the calibration). Instead, it probably means that the copter may not have been completely flat during calibration, or the airframe is out of true (one motor tilted). Land and correct that.
- Assuming that all is fine so far, you're ready for more advanced modes, such as Alt Hold and Loiter.

3.3.2 Tips for Your First Flights

- Make sure you are in a wind free environment (wind will play against you on in air auto trim).
- Make sure you have no trim on your Radio (the autopilot is what we want to trim, the radio should never get trimmed).
- Hold the copter still and level after connecting the battery to allow the gyroscopes to initialize.

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- Get above ground effect, around 3-4 feet is enough on most models.
- Make sure to practice a lot before you try the auto trim to find the sweet spot on the Radio right stick to have the copter super stable and not moving (This is where wind affect your inputs).
- We recommend not starting in Simple mode. Begin your flying in the basic Stabilize mode.
- Copter establishes its home position at the time of arming, so arm your copter in the location you wish to designate as the home position.

3.4 Measuring Vibration

Autopilots have accelerometers that are sensitive to vibrations. These accelerometer values are combined with barometer and GPS data to estimate the vehicle's position. With excessive vibrations, the estimate can be thrown off and lead to very bad performance in modes that rely on accurate positioning (e.g., on Copter: AltHold, Loiter, RTL, Guided, Position and Auto flight modes).

This chapter explains how to measure the vibration levels.

3.4.1 Real-Time View in Ground Station

Ground Stations can display a real-time view of vibration and clipping. If using the Mission Planner click on "Vibe" on the HUD to display the current vibration levels.



Vibration levels below 30m/s/s are normally acceptable. Levels above 30m/s/s may have problems and levels above 60m/s/s nearly always have problems with position or altitude hold.

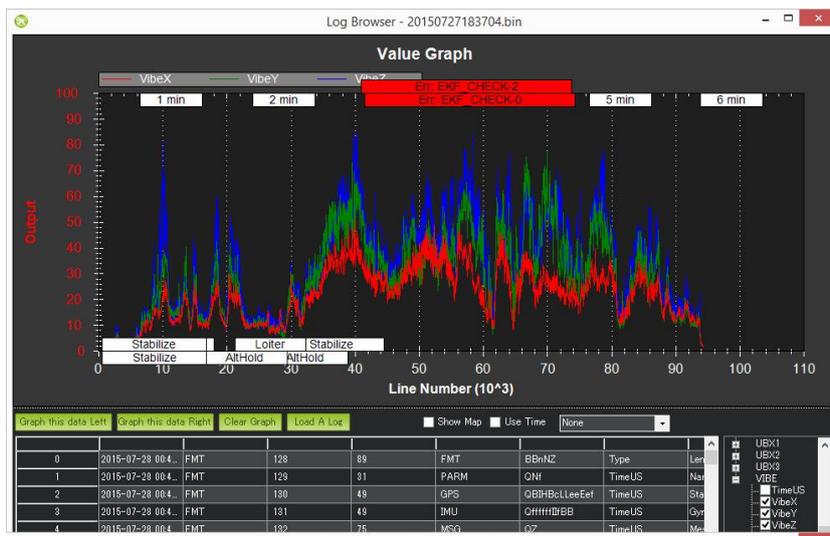
3.4.2 Vibe Dataflash Log Message

Check the recorded Vibe levels are mostly below 30m/s/s.

- Perform a regular flight (i.e., not just a gentle hover) of at least a few minutes and download the dataflash logs.
- Using the Mission Planner or other ground station graph the VIBE message's VibeX, VibeY and VibeZ values. These show the standard deviation of the primary accelerometer's output in m/s/s. The image below shows normal levels which are below 15m/s/s but occasionally peak to 30m/s/s. Maximum acceptable values appear to be below 30m/s/s (see second picture below).
- Graph the Clip0, Clip1 and Clip2 values which increase each time one of the accelerometers reaches its maximum limit (16G). Ideally these should be zero for the whole flight, but low numbers (<100) are likely ok especially if they occur during hard landings.



This is an example of a vehicle that had position estimate problems due to high vibrations.





For more instruction on Measuring Vibration with ArduPilot, welcome to visit:

<https://ardupilot.org/copter/docs/common-measuring-vibration.html>

3.5 Thrust Loss and Yaw Imbalance Warnings

If you see thrust loss or yaw imbalance warnings this page outlines some checks and modifications that should be done to resolve the issue. In most cases these warnings are the result of incorrect hardware selection or setup.

These warnings are designed to detect hardware failures in the propulsion system, if they begin to occur on a vehicle that has been flying without warnings the propulsion system should be checked. Warning is more likely to happen with larger payloads and in strong / gusty winds.

3.5.1 Potential Thrust Loss

If potential thrust loss messages are seen on the GCS or in the data-flash logs investigation should be done to find the cause and remedy. The warning will give a motor number, for example:

“Potential Thrust Loss (3)”

These warnings are the result of a motor or motors saturating at 100% throttle. Because of this saturation ArduCopter can no longer achieve the requested roll, pitch, yaw, and throttle output. If this continues for a prolonged period, the vehicle will have reduced altitude and attitude control and may crash.

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If these messages are seen in hover or relaxed flight, the problem must be fixed in hardware. The vehicle's thrust to weight ratio should be increased, either by a change in propulsion or reduction in mass.

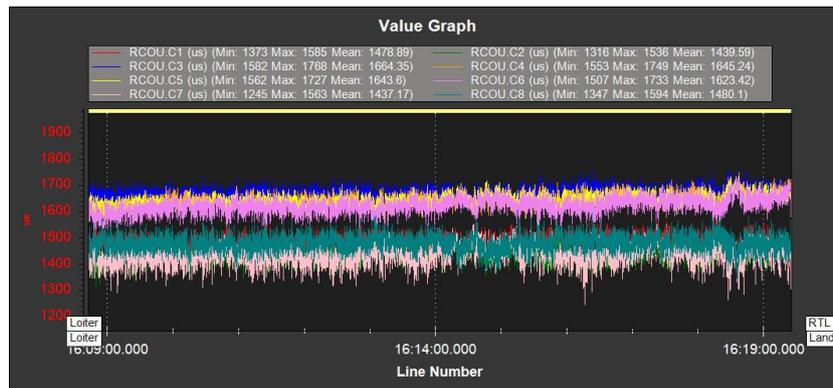
If only seen in climbing and aggressive maneuvers, it may be sufficient to lower the requested accelerations and speeds. Again, the vehicle's thrust to weight ratio can be increased to allow higher accelerations and speeds.

3.5.2 Yaw Imbalance

The yaw imbalance warning is a measure of how hard the vehicle is working to yaw, the warning will trigger before the yaw output is saturated. If the yaw output becomes saturated the vehicle's ability to maintain yaw will be compromised. And, in the worst case, this will result in the vehicle rapidly spinning. The warning message gives a percentage of maximum yaw output. At 100% it is saturated. For example:

“Yaw Imbalance 87%”

If seen in hover, the issue should be resolved in hardware. If the value is increasing with no pilot yaw input, the vehicle should be landed immediately. Yaw imbalance can be recognized in data flash logs by comparing the PWM outputs between pairs of opposing motors. It will present as a large throttle level difference between the clockwise and counterclockwise motors, as shown below:



This should be fixed in hardware. The most common cause is the motors not being vertical on a circular arm. If the imbalance persists the motors can be tilted slightly such that the thrust angle assists the yaw for its rotation direction. Some vehicles can be extremely sensitive to motors thrust vector.

If the warning is only seen in aggressive yaw maneuvers, the warning threshold can be increased by raising `ATC_RAT_YAW_IMAX`. However, it may also be worth revisiting the yaw tune.

Mark

Both the thrust loss and yaw imbalance warnings can be disabled with the `FLIGHT_OPTIONS` parameter. This should only be done after extensive log review and testing to verify the warnings are not picking up genuine issues.

4 ADVANCED CONFIGURATIONS

This section will take you through the more advanced configuration and tuning options for the vehicle.

4.1 Power Module

Common Parameters

BATT_ARM_VOLT: Required arming voltage.

Battery voltage level which is required to arm the aircraft. Set to 0 to allow arming at any voltage.

BATT_ARM_MAH: Required arming remaining capacity.

Battery capacity remaining which is required to arm the aircraft. Set to 0 to allow arming at any capacity. Note that except for smart batteries rebooting the vehicle will always reset the remaining capacity estimate, which can lead to this check not providing sufficient protection, it is recommended to always use this in conjunction with the BATT__ARM_VOLT parameter.

BATT_LOW_VOLT: Low battery voltage

Battery voltage that triggers a low battery failsafe. Set to 0 to disable. If the battery voltage drops below this voltage continuously for more than the period specified by the BATT_LOW_TIMER parameter, then the vehicle will perform the failsafe specified by the BATT_FS_LOW_ACT parameter.

BATT_LOW_MAH: Low battery capacity

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 BATT_FS_LOW_ACT parameter.

BATT_LOW_TIMER: Low voltage timeout

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 to cope with low voltage on long takeoffs. A value of zero disables low voltage errors.

BATT_FS_LOW_ACT: Low battery failsafe action

What action the vehicle should perform if it hits a low battery failsafe.

Mark

For full ArduPilot parameter list, please visit:

<https://ardupilot.org/copter/docs/parameters.html#>

For detail instructions on battery failsafe configurations, please visit:

<https://ardupilot.org/copter/docs/failsafe-battery.html#failsafe-battery>

4.2 Safety Switch

A safety switch can be used to enable/disable the outputs to motors and servos. The switch controls the “Safety” state of the vehicle. When in this state, motors are prevented from operating (except in Plane’s MANUAL mode if force armed and the BRD_SAFETY_MASK enables outputs controlling the motors), a pre-arm error condition is generated to prevent accidental arming, and servo outputs have their PWM disabled.

Mark

For detail instructions on battery failsafe configurations, please visit:

<https://ardupilot.org/copter/docs/common-safety-switch-pixhawk.html>

4.3 Serial Port Configuration Options

N7 autopilot's ArduPilot serial port mapping are listed below:

SERIAL 0	USB port
SERIAL 1	Telemetry port 1 (UART2)
SERIAL 2	USER port, disabled.
SERIAL 3	GPS port (UART1)
SERIAL 4	GPS2 Telemetry port 4 / I2CB (UART4)
SERIAL 5	USER port, disabled.
SERIAL 6	SERIAL6 (UART7 Debug port)
SERIAL 7	USB2 (virtual port on same connector)

Mark

TELEM 1 port provides RTS / CTS pins, other UART ports does not.

For detail instructions on serial port configurations, please visit:

<https://ardupilot.org/copter/docs/common-serial-options.html>

4.4 CAN Bus Setup

A Controller Area Network (CAN bus) is a robust vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications

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without a host computer. It is a message-based protocol, designed originally for multiplex electrical wiring within automobiles to save on copper, but is also used in many other contexts.

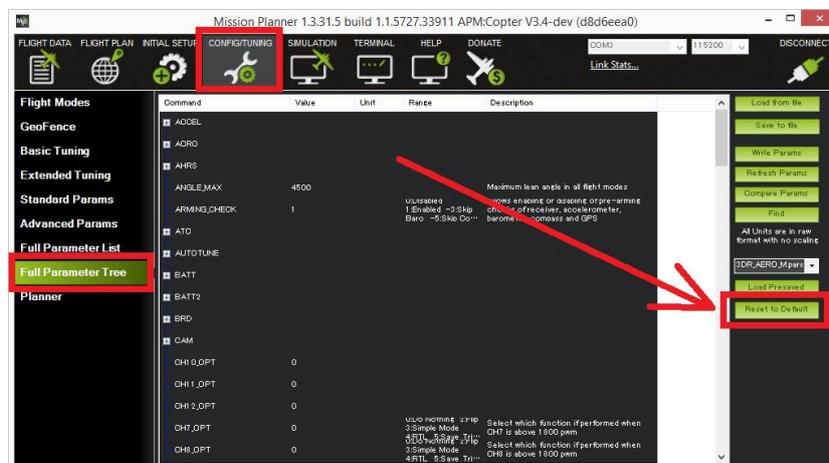
Mark

For detail instructions on can bus setup, please visit:

<https://ardupilot.org/copter/docs/common-canbus-setup-advanced.html>

4.5 Parameter Reset

Mission Planner has a dedicated Reset to Default button. This will reset all parameters to the vehicle's defaults.





For detail instructions on parameter reset, please visit:

<https://ardupilot.org/copter/docs/common-parameter-reset.html>

4.6 Common Parameters for N7 Autopilot

BRD_SAFETY_DEFLT: Sets default state of the safety switch.

This controls the default state of the safety switch at startup. When set to 1 the safety switch will start in the safe state (flashing) at boot. When set to zero the safety switch will start in the unsafe state (solid) at startup. Note that if a safety switch is fitted the user can still control the safety state after startup using the switch. The safety state can also be controlled in software using a MAVLink message.

ARMING_RUDDER: Arming with Rudder enable/disable.

Allow arm/disarm by rudder input. When enabled arming can be done with right rudder, disarming with left rudder. Rudder arming only works with throttle at zero +/- deadzone (RCx_DZ). Depending on vehicle type, arming in certain modes is prevented. See the wiki for each vehicle. Caution is recommended when arming if it is allowed in an auto-throttle mode!

LOG_BACKEND_TYPE: AP_Logger Backend Storage type.

Bitmap of what Logger backend types to enable. Block-based logging is available on SITL and boards with dataflash chips. Multiple backends can be selected.

ARSPD_AUTOICAL: This parameter and function is not used by this vehicle. Always set to 0.

Enables automatic adjustment of airspeed ratio during a calibration flight based on estimation of ground speed and true airspeed. New ratio saved every 2 minutes if change is > 5%. Should not be left enabled.

GPS_TYPE: 1st GPS type

GPS type of 1st GPS

FS_THR_ENABLE: Throttle Failsafe Enable

The throttle failsafe allows you to configure a software failsafe activated by a setting on the throttle input channel.

BATT_LOW_VOLT: Low battery voltage

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Battery voltage that triggers a low battery failsafe. Set to 0 to disable. If the battery voltage drops below this voltage continuously for more than the period specified by the `BATT_LOW_TIMER` parameter, then the vehicle will perform the failsafe specified by the `BATT_FS_LOW_ACT` parameter.

BATT_FS_LOW_ACT: Low battery failsafe action

What action the vehicle should perform if it hits a low battery failsafe

AHRS_ORIENTATION: Board Orientation

Overall board orientation relative to the standard orientation for the board type. This rotates the IMU and compass readings to allow the board to be oriented in your vehicle at any 90- or 45-degree angle. The label for each option is specified in the order of rotations for that orientation. This option takes effect on next boot. After changing you will need to re-level your vehicle. Firmware versions 4.2 and prior can use a CUSTOM (100) rotation to set the `AHRS_CUSTOM_ROLL/PIT/YAW` angles for AHRS orientation. Later versions provide two general custom rotations which can be used, Custom 1 and Custom 2, with `CUST_ROT1_ROLL/PIT/YAW` or `CUST_ROT2_ROLL/PIT/YAW` angles.

Mark

For full ArduPilot parameter list, please visit:

<https://ardupilot.org/copter/docs/parameters.html#>

4.7 Logs

There are two ways to record your flight data. With some exceptions, the two methods record very similar data but in different ways:

1. Dataflash logs are recorded on the autopilot (often to the SD card) so they must be downloaded from the autopilot after a flight.
2. Telemetry logs (also known as “Tlogs”) are recorded by the ground station (i.e., Mission Planner) on the local PC when the autopilot is connected via a telemetry link.

Common Parameters for Flight Logs

LOG_BACKEND_TYPE: AP_Logger Backend Storage type

Bitmap of what Logger backend types to enable. Block-based logging is available on SITL and boards with dataflash chips. Multiple backends can be selected.

LOG_BITMASK: Log bitmask

Bitmap of what on-board log types to enable. This value is made up of the sum of each of the log types you want to be saved. It is usually best just to enable all basiclog types by setting this to 65535.

LOG_DISARMED: Enable logging while disarmed.

If LOG_DISARMED is set to 1 then logging will be always enabled including when disarmed. Logging before arming can make for very large logfiles but can help a lot when tracking down startup issues and is necessary if logging of EKF replay data is selected via the LOG_REPLAY parameter. If LOG_DISARMED is set to 2, then logging will be enabled when disarmed, but not if a USB connection is detected. This can be used to prevent unwanted data logs being generated when the vehicle is connected via USB for log downloading or parameter changes. If LOG_DISARMED is set to 3 then logging will happen while disarmed, but if the vehicle never arms then the logs using the filesystem backend will be discarded on the next boot.

LOG_FILE_DSRMROT: Stop logging to current file on disarm.

When set, the current log file is closed when the vehicle is disarmed. If LOG_DISARMED is set, then a fresh log will be opened. Applies to the File and Block logging backends.

LOG_FILE_MB_FREE: Old logs on the SD card will be deleted to maintain this amount of free space.

Set this such that the free space is larger than your largest typical flight log.

LOG_FILE_RATEMAX: Maximum logging rate for file backend.

This sets the maximum rate that streaming log messages will be logged to the file backend. A value of zero means that rate limiting is disabled.



Mark

For full ArduPilot parameter list, please visit:

<https://ardupilot.org/copter/docs/parameters.html#>

5 After-sale Service

Please visit the SIYI Technology support page at [Service and Support - SIYI Technology | Empowering and Building an Intelligent Robot Ecology](#) for the latest after-sales and warranty information.