Step by step autopilot setup instructions

Autopilot control signals

Autopilot is controlled by typical PPM signals sent directly from the RC receiver. The system can be connected by a multicore cable directly to each output channel of the receiver (parallel mode) , S-Bus (Futaba serial mode) or by single PPM signal sum cable (serial mode), in this case the autopilot performs sum decoding to each channel and assigns individual channels to specific autopilot functions.

Autopilot analyzes the correctness of the input pulses (pulse duration) and rejects incorrect pulses of less than 850 microseconds, and higher than 2200 microseconds (these are not subject to processing and are not passed to output). In particular, when on-board devices power is switched on when the receiver does not pass RC output signals, there are no output pulses at the autopilot output.

In the OFF mode the autopilot transmits correct PPM impulses from the input to the output without any interference in their length. In AUTO and STAB mode, the autopilot processes and limits to the nominal PPM range pulse 1000us .. 2000us. In the current version of the autopilot it is not possible to set own PPM output pulses range. Please keep this in mind, if the transmitter uses other end ranges of the(EPA) signals for each channel.

Autopilot operating modes

Autopilot has 3 modes of operation, controlled by a single channel of the receiver. The choice of the modes done by three-position switch in the transmitter.

In the case of a parallel connection of receiver control channel of the operating mode is connected to the input I6 of autopilot. In the case of a serial connection (PPM sum) the appropriate configuration is made at level f the FPV_manager application.

Transparent mode

In transparent mode (OFF) autopilot transmits signals from the receiver directly to the servos and motor controller.

NOTE: The autopilot transmits impulses from the receiver to the servos and control only when the correct voltage, with the range 4 ... 6V, is present.

Stabilisation Mode

The tasks of stabilization mode (STAB) are the following:

- to prevent unexpected and undesirable banks or pitching of the model, for example, due to the wind or turbulence, making the flight quieter. Tilt stabilization works by aileron tilt control to prevent unwanted model banks to the wing and overall rotation around the longitudinal axis of the model. Tilt stabilization works by controlling elevator tilts (or elevons in a flying wing model) to prevent unwanted up and down inclination of the bow of the model.

- to translate the joystick deflection to bank or pitch of the model proportional to it, in particular, moving back (release) of joysticks to a neutral position will cause quick return the model to horizontal flight, regardless of its current position.
This behavior of the model with enabled stabilization clearly differs from that of the model without stabilization and the first time may be a surprise to the pilot. The model performs turns faster and stays in bank after obtaining a suitable pitch angle. The model control is more precise and predictable, thus helping less experienced modelers in learning to fly.

NOTE: For large values of the stabilization force, the maximum bank of the model that can be obtained is about 50 degrees, so it is not possible to make a sudden maneuvers or aerobatics.

NOTE: Without proper stabilization parameter settings autonomous flight is not possible.

Autonomous flight mode
Autonomous flight mode (AUTO) allows for performing (continuing) the flight of the model without the pilot presence.

The main objective of this procedure is to ensure flight safety in an emergency situation and support for the pilot in flight along planned route. Depending on the settings, it can be a stand-alone return to the starting point (e.g. after the loss of range of RC equipment or video link), as well as an automatic flight along predefined waypoints of the route (performing missions).

The automatic mode is controlled by the level of the signal at one of the channels of the RC receiver and can be activated either manually (by switch in the transmitter), as well as automatically after the loss of range of the devices, by correctly programming the FailSafe mode in the RC receiver.

Step-by-step configuration
Installing the autopilot in the model
Autopilot can be placed anywhere in the model cab (not necessarily in the center of gravity). Autopilot PCB must be positioned along the longitudinal axis of the model, with the pin connectors in the direction of the model tail (opposite to the flight direction) and connectors pointing upwards. Please fasten it so that during the horizontal flight (at constant height) the autopilot PCB is horizontal. Error of + / - 10 degrees can be adjusted by programme, but generally the smaller the error of mechanical fastening, the better. PCB fixing should be such that the plate does not move during the flight.

Autopilot should be protected against vibration (which affects the position sensors: accelerometers and gyroscopes). You can use the rubber dumper, sponge, or some other own solutions. Vibration dumping elements should suppress vibration and resonance (do not use springs).
NOTE: The greater the mass of an isolated element, the better the vibrations are limited, so it is recommended to fix the whole "sandwich" OSD + autopilot, not the autopilot PCB only.
Vibration level should be checked with the motor running - if shock and vibration exceed 2g the actual value of shock appears on the screen (2g, 3g to 8g).

Too much vibration causes tilting of the artificial horizon on the OSD, although the model is still positioned horizontally. Applied sensors and autopilot algorithms should ensure proper operation up to shock of 5 g, but be aware that there are additional in-flight shocks (turbulence, centrifugal force, etc.). Generally the lower the vibration, the more accurate the operation of the autopilot is. Therefore you should strive to achieve a level of vibration from the engine below 2g.

Autopilot is equipped with an electronic compass, so the autopilot PCB should be placed away from strong magnetic fields and large metallic (iron) objects (e.g. magnetic cab latches, motor). Also, high-current cables (from the fuel pack or the wires going to the motor) should be moved away from the autopilot PCB. Of course, these comments are only relevant when using the magnetometer as a source of information about the course (OSD menu service settings -> course magnetometer / ext)

Initial Settings
For convenience of configuration, and security of the first flights autopilot parameters should be set. They can then be adjusted depending on the characteristics of the model.

Autopilot-> bank stabilization and autopilot-> pitching stabilization, should initially be set at 50%, which will allow us to conveniently verify the correctness of tail configuration settings, and it is a safe value to test the of the stabilization mode.

Set the type of model and tail.
Autopilot supports models with ailerons on one RC channel, aileons split into two channels and the flaperons, both classic with classic rudder as well as a V-type, and a flying wing models (tailless aircrafts).
Appropriate model’s tail type settings is made in the OSD menu : autopilot-> mixers

NOTE: The currently selected settings are marked with an asterisk '*' after the name of setting

Ailerons on one channel RC
Ailerons on one RC channel or one servo that moves both ailerons (for the smallest models), or two aileron servos on one channel RC (on "Y" cable branching signal of one channel into two servos).

For this configuration, the Y wire should be connected to the output of "lotka1" autopilot, and input "lotka1" receiver to the appropriate channel. You can also connect one servo to go "Lotka1" and the second servo to go "lotka2" because the autopilot internally works in this mode as a signal splitter.

Ailerons on two RC channels
This mode is designed for models with ailerons operated by two separate channels of the receiver. Depending on the design of the aileron actuator (Servos can be mounted in the wings in different ways: on the left or on the right side , with tappets from the top or from the bottom) the direction of each movement of servo causing aileron deflection can be different. You should choose such a setting (aligned or opposite ailerons) that in the stabilization mode, when the model is tilted sideways , the ailerons will act like ailerons (i.e. when one tilts up, the other tits down) rather than the flaps (both go up or both go down).

In a separate option we set proper aileron reverse - this is described in the further configuration part

Flying wing (delta)
This setting is for lying wing models (flying wing with ailavators). We have two settings (aligned or opposite). You should choose such a setting (aligned or opposite ailerons) that in the stabilization mode, when the model is tilted sideways , the ailerons will act like ailerons (i.e. when one tilts up, the other tits down) and when the model pitches both ailerons go down at the same time or act as elevator.

In a separate option we set proper reverse aileron / elevator - it is described in the following configuration

Rudlicki tail, i.e. \ / or / \
These options are for models with Rudlicki tail i.e. V type (normal or inverted).
NOTE: This setting does not apply to (and contradictory to setting) the "flying wing" model.
Choose one of the settings (aligned or opposite) so that in the stabilization mode, when the model bow tilts up and down the tail control surfaces behave like elevator and not as a rudder.

In a separate option we set correct reverse of rudder / elevator - it is described in the following configuration

Classic tail, i.e. T or _ | _
For classic tail, with separate rudder and heights control surfaces we do not set the compatibility mode of servo direction, but independent reverses - this is described in the following configurations

Models without ailerons
Autopilot is for models with ailerons, but was also successfully used in Easy Star model, that does not have ailerons. The manufacturer does not guarantee the correct operation of the system in the model without ailerons and cannot be responsible for possible problems in these models. Choose the

option "ailerons on one RC channel " for these types of models, and is connect the rudder to aileron channel, and not to the rudder channel.

Reverses

Rudders reverses are set the OSD menu autopilot -> mixers. Proper reverses must be set before the first flight, proper operation of the stabilization mode model and autonomous flight mode operation depend on their settings.

Reverse reverse setting makes the model on the fly not come back to the same level flight, but deepens the bank.

Ailerons reverse

Ailerons reverse is checked when you turn stabilization mode on (on the OSD, next to the symbol of the autopilot STAB should be displayed). Horizontally held model should be tilted on one wing. Ailerons should lean in such a way as to counteract such fly bank, that is, for example, if we tilt the model on the right wing (right wing down), the right aileron should deflect downward. If the ailerons reaction is reversed, change the setting of the reverse.

Reverse of elevator

Elevator reverse is checked when you turn on stabilization mode (the OSD should display the STAB symbol next to the autopilot symbol). Bow the horizontally held model down.

For models with a classic tail the elevator should lean up on so during flight it counteracts such inclination. If the rudder reaction is reversed, change the setting of the reverse.

In the case of flying wing both ailavators should rise up so during flight it counteracts such inclination. If the rudder reaction is reversed, change the setting of the reverse.

In the case of the model with tail \ / two control surfaces should lean inward (up) so during flight they counteract such inclination. If the rudder reaction is reversed, change the setting of the reverse.

In the case of the model with tail /\ two control surfaces should lean inward (up) so during flight they counteract such inclination. If the rudder reaction is reversed, change the setting of the reverse.

Rudder reverse

The rudder is used only in the autonomous flight mode (not involved in the stabilization of bank and pitch stability), so it is not possible to check the correctness of the reverse similarly to the other reverses. To verify the setting, observe the behavior of the rudder at the reverse change in the OSD. Autopilot confirms change the setting of the rudder leaning reverse for about a second to turn to the right. If after changing the deflection is not correct, change it to the opposite again.

Trim saving

Before the first flight, and after each change of model trim, save in the autopilot the linkage positions

(PPM signal values), corresponding to the horizontal model flight. To do this, use option in the OSD autopilot-> save trimmers.
Trimmers saving is important from the point of view of the autopilot, because in AUTO mode the autopilot takes over the role of the RC transmitter and needs to know what value of the PPM signal (driving the servos) correspond to free flight in a straight line, with no model bank and stall. Changing the trim without saving changes to the autopilot will result in tilting and turning the model in the STAB mode, and unsatisfactory operation of autonomous flight mode (asymmetrical turns and, in extreme cases, stall or problems with maintaining altitude).

Trim saving can be done both on the ground and in flight. Model trimming during flight should be made in OFF mode (with disabled stability) to properly observe the behavior of the model in free flight.

NOTE: trim saving should always be made with gas set at a minimum. The gas trim saving function is important for models with internal combustion engine, allowing for maintaining appropriate minimum speed engine in standalone flight mode.

Verification and compensation of autopilot position

After the initial setting of tail and reverses do the test flight with the autopilot in OFF mode. It is recommended to fly during calm weather. We only start after the start of the GPS navigation (you need to know your current speed given by the GPS for horizon to work properly). We rise the model to safe height, we set the minimum speed and bars in the neutral position and observe the position of the artificial horizon. Switch the OSD screen to M644 chip, which shows the value of the bank angle of the horizon pitching. When the horizon is properly both the bank angle of the horizon pitching should not exceed the single degrees. Large deviations are reduced by changing the position of the autopilot in the model, the single degrees can be compensated via OSD-> horizon bank - bank and horizon pitch-> pitch. Compensation can also be made during the flight, watching the effect of the changes on the OSD.

NOTE: OSD allows you to compensate the position by + / - 10 degrees. When the menu appears, extreme values may not be available, then select and confirm the maximum available value, and then re-display the menu - new (moved) range of possible values will be shown.

With the correct position (offsetting) of the autopilot, during horizontal flight at minimum speed when you turn stabilization mode on, the model should still continue to fly in a straight line, with no acceleration or deceleration.

Configuring the stabilization mode

For the first flight, in menu OSD autopilot -> bank stabilization force choose the setting of 50%, similar in the OSD autopilot-> pitch stabilization force select the setting of 50%.

We start with the autopilot in OFF mode, and after we obtain the altitude we reduce the amount of gas sufficient to maintain the value of the altitude, we set the bars of the rudder in neutral position, switch on STAB mode and observe the behavior of the model.

NOTE: With control surfaces and servos reverses properly configured, when you turn stabilization mode on, the model should not perform any violent maneuver, but continue in a straight line. If the model made a sudden maneuver (bank, twist, quilting, etc.) you need to verify the correctness of the previous configuration steps.

Settings of the stabilization forces are selected depending on the characteristics of the model and own needs and feelings, guided by the principles set out below.

Banks stabilization force

We set the highest value of the stabilization force at which the model is flying steadily without falling into oscillation. Too high a value is manifested by rapid and short fluctuations in the wings - especially with speed increasing.

NOTE: Too low bank stabilization force can prevent proper flight in AUTO mode (unstable flight, too small or too big model banks during turns)

Pitching stabilization force

Select the average value of the stabilization force, with which the model when aimed sharply down, and the rod released, comes back to the level without pumping, after switching off the gas soars off without deceleration and stall, and with the addition of gas takes up, but also does not pull up too hard.

Small values of stability can cause model pumping, and models with a strong drive too rapid pulling up with gas on.

Too high stabilizing force values can cause quick, short oscillations up and down, especially at higher speeds, and may cause model stall without gas, and poor ascending with the gas on (model accelerates, but does not ascend), causing problems in autonomous flight.

Setting up the auto mode

Presets

Before first use of the AUTO mode we should make the initial settings (in OSD Autopilot menu) to help in further in tuning the autopilot.

autopilot-> gas mode set to constant
autopilot-> gas limit set at 40% (with strong drives 30%)
autopilot-> bank limit set to 20 degrees
autopilot-> force of return to the course set at 50%
autopilot-> turn slow set to 0%
autopilot-> crosswind compensation set at 0%
autopilot-> GPS minimum speed set to off.
autopilot-> altitude limits set at a minimum of 50m and a maximum of 300m

autopilot-> Mixers-> ailerons-way mixer set at 50%
Service settings-> course set the to GPS course

We rise to a safe altitude, then we fly a distance of about 200m and still flying from the base we switch on AUTO mode.
The model should start to turn in the direction of the base, in the direction in which the angle is smaller in the direction towards the base. We observe the angle of the model, the speed of turning, and the course indicator to the base, especially when the model reaches the course towards the base.

Limitation of bank
When turning to the base , the model should obtain the maximum bank of 20-30 degrees during the course from the base, and as the model approaches the course towards the base, the bank should decrease.

NOTE: The specific value of the limitation of maximum bank should be chosen experimentally, the values of degrees given in the menu should be treated with caution, since the actual maximum bank also depends on the model's characteristics (agility).

Too small value of maximum bank increases the maximum radius of the model or may even prevent it from turning during strong wind. Too large values can cause problems with the stability of the model in the air, and cause a significant deviation (delay) of the course given by the GPS in relation to the actual course of the model. This GPS delay causes the autopilot to be well above the base course, and then to start turning to the other way, and again significantly exceeds the base course, oscillating around the course to the base.

Aileron mixer-> direction
Aileron mixer direction supports the turns of the model. Thanks to this mixer turns in AUTO mode are made by the simultaneous deflection of the ailerons and the rudder. Its use and value is selected by the pilot. Too large values of the mixing can cause excessive banks of the model in relation to the value of the bank limit set in autopilot menu.

NOTE: The rudder does not take part in the stabilization of the model.

Force of the return to the course

This parameter determines how the autopilot responds (swings the rudder and banks the model) if the current course of the model does not coincide with the base course (or waypoint). The greater the deviation from the course, the stronger the resulting rudder deflection causing to return to the course is. This means that if the deviation from the course is high, the speed of turning the model is high, and as it gets closer to the expected course the turning speed decreases.

If this value is too low, the model will be turning slowly and will not come to the course on the base. If this value is too high , the model also performs a fast turn when the deviation is small, so the model exceeds course significantly and oscillates around the course flying zigzag.

NOTE: zigzag flight may be due to the delay of GPS data, so you should also watch indicator of the base course and choose the appropriate value of turn delay.

Turn delay
Since too low value of the maximum model bank can cause problems in the event of strong winds, it is necessary to use average values of the bank limit, aided by dynamic limit (delay) of turning speed, which prevents problems with the GPS course.
Too high a value of turn delay may cause loss of steering continuity, the model turns " in jumps" - while turning regularly speeds up and slows down the turn.

NOTE When using the magnetic course it is not necessary to further slow down the turn, as the used magnetometer has a sufficient speed and precision of action, even strong banks and fast turns.

Compensation of crosswinds

If some factor, such as crosswind (but also bad trim or compensation of autopilot position) makes the model still pushed off the course and does not "draws" to the course on the base, then this error is constantly monitored and if it does not disappear, the autopilot steadily increases aileron deflection to compensate for this error. It takes relatively long (up to several seconds or even longer) and causes regular autopilot "drags" to the correct course.

The compensation rate is selected at our discretion, bearing in mind that too high rate can cause the model cross the line of the course and a slow return to the course (or a zigzag flight with slow change of course), because the correction grows as fast as it declines.

Gas limit
Gas limit determines the maximum value of gas the autopilot can use in AUTO mode. Gas limit allows for more economical flight and a maximum cruising speed limit in models with a strong drive. Gas limit also improves the smoothness of gas applying, but can cause problems when flying in strong winds. Gas limit must be large enough to ensure the ascending of the model under adverse temperature conditions ("strangulation by the downdraft”).
NOTE: Save the trims of the gas bar deflected can cause incorrect handling of gas by the autopilot (exceeding the preset limit gas)
Gas mode

Gas mode is selected according to your preferences.
On-off mode is designed for gliders models. In this mode, the motor is switched on with the level of gas, specified by gas limit parameter, and after ascending above additional 50-70m (depending on the altitude of the autopilot activation) the engine is switched off and the model easily glides descending below obtained altitude, and the process is repeated.
In **continuous gas** mode, the engine is controlled by a constant level determined by the limit of gas. This mode is recommended when a quick return to the base or fast flight along the points of the route is required, especially in conditions of high and variable wind, as well as models that poorly soar, with a tendency to still.

Dynamic mode is recommended for most models. In this mode, the gas is set to such a value at which the model maintains a constant altitude. This allows for the most economical flight under moderate wind conditions. The maximum value of the gas used by the autopilot in this mode is determined by the gas limit parameter.

Other Settings
Cruising Altitude
Cruising altitude limit settings include two parameters set in the OSD menu

autopilot -> Cruising altitude:
Minimum altitude: if at the time of activation of the AUTO mode current model altitude is below the specified value, the autopilot will rise the model to the preset minimum altitude and will continue to fly at that altitude. This allows for return to the base at a safe height, for example, above the line of trees or other obstructions.

NOTE: switching off the minimum altitude enables flying along the routing points below the starting point (e.g. when taking off from the hill)

Maximum height: if at the time of activation of the AUTO mode the current altitude of the model is above the specified value, the autopilot will not maintain this altitude, but will reduce flight by the altitude rudder and will not start the engine until the model will reduce its altitude to preset maximum altitude and then will continue to fly at this altitude. This setting allows you to safely return to the area, where it will be possible to obtain the lost remote control, video link or visual contact with the model.

Minimum GPS speed
For flights in strong winds there is a risk that the model sweeping against the wind is stationary or moves backwards (free gliding speed is less than the wind speed), and when the model goes back , the course indicated by the GPS becomes opposite to the direction which the model is to. This causes the autopilot to make a circle, trying to return to the normal course. These phenomena can cause the autopilot to be unable to return the model to base.
Setting the minimum GPS speed (ground speed) causes the autopilot to start the engine whenever

the current GPS speed is below this speed, eliminating the risk of model going back (departing from the base), and turning with the wind.

NOTE: In order to increase the speed (above the set minimum) autopilot can also use the value of the gas above the set limit of gas.

The algorithms are solely designed to eliminate the risk of reversing the model against the wind, control of gas may not be smooth, and altitude maintaining algorithms may work less effectively.