Takeoff Support
In Pitlab FPV system v4

Functionality

Pitlab's takeoff support functionality helps launch an airplane by keeping the plane level and climbing at a desired takeoff angle without unwanted roll or the risk of a stall – all without assistance from the pilot. The autopilot's reaction to airplane movements is much faster than a human's reactions, so takeoff with autopilot support is faster and safer than with manual takeoff. This is very helpful for people that fly alone and have no one helping them launch. This is especially so in the case of heavy airframes where a hand launch will most likely require both hands. Additionally throttle may be disabled before takeoff and started delayed after takeoff to prevent accident with spinning propeller, especially for pushers or flying wing.

The only actions needed from the pilot to use takeoff support are to activate takeoff mode, put the throttle at maximum (as in full manual launch) and throw the airplane into the air at a normal takeoff angle and into the wind. The autopilot will keep the airplane horizontally level and maintain the climbing speed (pitch angle) to gain altitude in a controlled way. Just after throwing airplane autopilot enables throttle and continues climbing with engine on. After reaching a cruise altitude the system automatically turns off launch mode and engages regular STAB mode. At this point the pilot should take back full control of the airplane (or engage AUTO mode).

Note: Takeoff mode is a modification of Stab (manual control with stabilization) mode. When the autopilot is in takeoff mode, the pilot can still take control of all airplane steering surfaces and the throttle after takeoff. When the transmitter sticks are in the neutral position the plane will fly straight and with a climb angle specified in the OSD menus. But if the transmitter sticks are moved out of the neutral positions, the pilot will temporarily override the autopilot and have complete control. Releasing the sticks to a neutral position returns control to the autopilot and takeoff mode resumes. This allows the pilot to take control over the Autopilot's behavior at any time or in case of an emergency.

Takeoff mode of operation is indicated on the OSD screen by the text "**TAKE**" (instead of "**STAB**") in the Autopilot mode field.

Note: present version of the firmware does not yet support fully automatic takeoff with wheels (only hand or catapult launch). The pilot must manually use the rudder or steering controls to keep the plane rolling straight until airborne.
The Autopilot does not use the rudder to actively control the course of the airplane during takeoff. However, due to the fact that it controls airplane roll angle (to keep the airplane level) it also reduces unexpected turns making the flight path relatively straight.

Manual activation of takeoff mode

To manually activate takeoff mode open **OSD menu -> Takeoff** and select the **Activate Take-off now** option. The selection will be confirmed on the OSD screen with the text "**TAKE**" in the Autopilot's mode field.

Note: takeoff mode will be activated only when an airplane is below cruise altitude and Autopilot's mode is set to STAB.
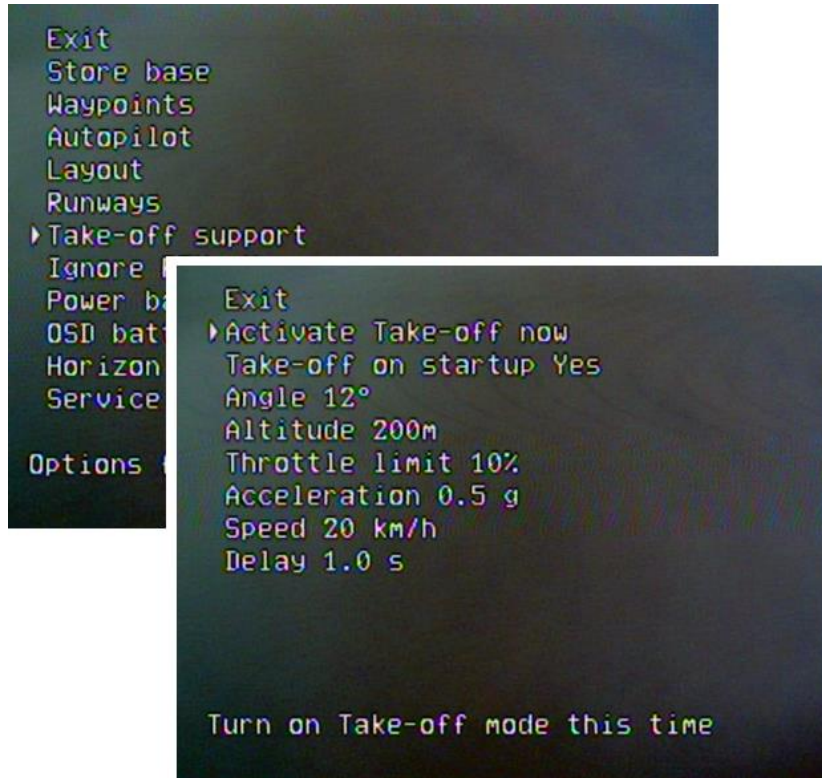
Figure 1 – Takeoff support in the OSD

Automatic activation of takeoff mode

Takeoff mode has the option to automatically activate during each system start (power up) when the transmitter's Autopilot mode switch is set to STAB. This option reduces pilot effort before each flight, but we strongly recommend confirming that the mode status on the OSD screen displays "**TAKE**" mode before each takeoff since inadvertent Autopilot mode switch changes will deactivate takeoff mode.

Note: When the system is powered up with the transmitter's Autopilot mode switch set to OFF or AUTO, takeoff mode will be activated the first time the pilot changes the mode to STAB if the airplane is still below the target cruise altitude (below the auto takeoff turn-off condition).

To activate this option open **OSD menu -> Take off support** and set **Take-off on startup** to **YES.**

Deactivation of takeoff mode

Takeoff functionality will be turned off (deactivated) automatically when the airplane reaches the pre-set cruise altitude set in the **OSD menu -> Take off support** submenu. This altitude can be set from 50 to 200 meters above the initial launch altitude (AGL) in 50m increments.

Also, any change in Autopilot mode from **STAB** to **AUTO** or **OFF** (and back to **STAB** if necessary) turns off this functionality. This allows takeoff mode to be exited at any time, e.g. in case of an emergency.

After deactivation the Autopilot changes to **STAB** mode. Full throttle will continue to be applied but the elevator will return to its neutral STAB position without any additional climb angle.

Ascending pitch angle

The Ascending pitch angle determines the desired climb slope during airplane launch. This angle can be set in the OSD from 4 to 20 degrees in 4 degree increments. This can be done in the **OSD menu ->Take off support** submenu. Higher pitch angles are suitable for airplanes with more powerful motors and smaller payloads (see safety notes). To avoid stalls, when flying heavily loaded or underpowered planes a smaller angle should be chosen.

Note: Depending on pitch stabilization and the overall ability of the airplane to climb, the actual climbing angle may vary from that set in the OSD menu.

The target pitch angle set in the OSD menu is calculated for full throttle when an airplane's climbing ability is greatest. When the actual throttle value is lower, the Autopilot calculates and sets a lower climbing pitch angle to help maintain airspeed and avoid a stall.

Throttle management

For safety reason autopilot may keep engine off before takeoff (on ground), or allow only slow motor/propeller spinning when pilot applies full throttle with transmitter stick. This engine lock or spinning limit is automatically removed when airplane is launched and certain criteria are met (launch acceleration and speed). User definable options for throttle limiting on ground, acceleration, speed and enable delay allows configurations for safe hand, catapult or bungee launching.

Throttle limiting/disabling feature is controlled by following parameters:

Throttle limit controls maximum throttle output level on ground/before takeoff when pilot applies throttle with transmitter stick. Value of 0% disables throttle before takeoff (e.g. for safety during hand or bungee launch). Higher limits may be used for catapult launch, when low spinning motor during takeoff may reduce time to reach maximum rotation speed and increase launch speed.
Acceleration threshold allows to properly indicate launch condition when airplane starts to accelerate, and ignore any shakings, or movements on the ground. Higher values are recommended for catapult or bungee launch.
Speed determines airplane speed (over ground) when autopilot releases throttle lock and allow full throttle.
Delay causes autopilot to wait some additional time before activating full throttle (after airplane

reaches launch speed threshold) to ensure that propeller is away from hands, catapult frame or bungee thread. Values under one second are suitable for hand/catapult launch, where longer delays are recommended for bungee launch.

Note: In case of "false" takeoff (when acceleration and speed criteria are accidentally met on ground, or airplane landed prematurely), autopilot deactivates throttle after 3 seconds.

Just before takeoff pilot should apply full throttle. Due to active throttle limit motor will stay off or spin with predefined, low rotation speed. After launch autopilot will detect acceleration and airplane speed and after specified delay turns motor to its full rotation speed (or speed determined by current throttle stick position), without need of any further pilot action.

Note: Setting throttle limit to 100% disables throttle management during takeoff. In this case pilot has full manual control over throttle and motor rotation speed.
Autopilot never applies throttle to motor when transmitter stick is down. AP only limits or disables throttle applied by pilot when airplane is on ground/before takeoff

Safety notes

To avoid stalls and crashes do some experiments with takeoff mode parameters. The plane's pitch can be displayed in the OSD (pitch angle field should be first activated in layout designer). High ascending angles may cause a stall, especially for airplanes with heavy payloads and relatively low powered engines.

Take care when launching airplanes in situations where the batteries are not able to produce maximum motor thrust for example when the battery is not fully charged or in low temperatures. In these situations the risk of stalling is increased since the reduced motor thrust may not be able to maintain the desired climbing angle.

Keep in mind that even with two condition used to control/disable throttle before takeoff it may happened to meet these criteria accidentally (especially when these values are set low) and start engine on ground. For safety reason apply throttle just before launch, and keep it low during pre-flight preparations.

Always be ready to quickly take over control of built-in functionality to avoid dangerous situations. Always keep the RC transmitter within quick and easy reach during takeoff.

We wish you many safe flights with our system,

Pitlab & Zbig