1. Hovering mode

In the following, we describe a typical flight in hovering mode.

* 1. Flight phases

The uav can be in the three following flight phases

* Take-off
* In-flight
* Auto-land

Independently of the flight mode (manual/stabilized/GPS), the flight phase is determined as follows.

The altitude sensors provide reliable measurements above a minimal height over ground (say 20cm). Once the quadplane reaches this altitude, the state switches from take-off to in-flight. Once the state is in-flight, the yaw stabilization is activated. Also, all the integral term of the PID controller are enabled.

Only in stabilized mode :

the auto-land state is activated if the uav is in the in-flight state, and that the uav is below the reliable measurement altitude. In auto-land, the uav is close to the ground and does not rely on the altitude sensors. It lands by progressively reducing the throttle.

* 1. Engine throttle depending on flight mode
     1. Manual mode

The engine power (averaged value of the four engines) is determined by the Tx throttle stick. Roll and pitch stabilization are active even in manual mode. To avoid the engines to start as soon as the battery is connected, the roll and pitch stabilization are activated only if the throttle stick value exceeds 20%.

Take-off is obtained by increasing throttle stick value. The altitude sensors provide reliable measurements above a minimal height over ground (say 20cm). Once the quadplane reaches this altitude and that the altitude measurements are detected as reliable, the state switches from take-off to in-flight.

Once the state is in-flight, the yaw stabilization is activated.

* + 1. Stabilized mode

1. Manual throttle take-off, maintain the uav at an altitude between 0.95m and 2m
2. After a few seconds, the automatic altitude control gradually replaces the manual throttle
3. In case of abnormal functioning of the automatic altitude control, the pilot should be able to engage manual throttle control. The procedure is as following :

* Set thottle stick to zero
* Then, as soon as the throttle stick is pushed forward, the throttle is manually controlled

To summarize, the take-off procedure is :

* Take-off in manual throttle, set UAV altitude between 1,1m and 2m
* After 10s, set throttle stick to zero

In case of abnormal functioning of the automatic altitude control, the pilot can take manual throttle control with the throttle stick.

* + 1. Failsafe modes
       1. Emergency landing

An emergency landing will be triggered in the following cases :

* + Low battery. If voltage is below a given threshold or used mAh above a given threshold
  + Radio signal lost (while GPS is locked)
  + Altitude is above the maximal allowed altitude

As emergency landing is activated, the altitude control switches to automatic control and an emergency landing mode is activated. Target altitude is decreased from the current value at a rate of 1m/s.

* + - 1. Failure of altitude sensors

In this case, we cannot rely on altitude control to perform an emergency landing. We choose to set the throttle to a constant value which is calculated to roughly compensate the weight, so that no brutal upward or downward motion should occur. The uav would also waggle to warn the user that the altitude sensors are not working.

* 1. GPS positioning control