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Introduction

SmartAP AutoPilot is the next generation flight control system capable of fully autonomous flight. It has a powerful microcontroller, accelerometers, gyroscopes, magnetometer, pressure sensor and more. Additionally, GPS and wireless telemetry modules can be connected. Multilayer PCB design makes the board very compact having the size of only 60x40mm. Complex missions including take off and landing can be created with the help of ground control station.

Description

Specifications of the autopilot are listed below:

- PCB size 60x40mm
- Weight 16g
- 168MHz STM32 ARM Cortex M4 microcontroller
- Input power 5V@0.2A
- USB Firmware update
- FPU (Floating Point Unit)
- 6 PWM inputs, 6 PWM outputs
- IMU - Invensense MPU-6050 / MPU-9150
- Magnetometer - HMC5883L
- Pressure sensor - MS5611-01BA03
- UART port for wireless telemetry connection (e.g. Xbee)
- MicroSD card slot for flight data logging
- GPS port
- Buzzer
- External bright statusLED port
- Sonar port
- External magnetometer port
- Airspeed sensor port

Flight Modes Overview

- Stabilization
- Altitude Hold
- GPS Position Hold
- Loiter
- Return to Home
- Autonomous Waypoints Flight
- Guided / Follow me
- Take off
- Landing
Parts

The parts listed below are included in the kit:

- SmartAP AutoPilot Flight Control System
- MicroSD Card
- External bright LED
- Electromagnetic Sounder

The parts listed below are NOT included in the kit and can be purchased separately:

- USB Mini-B Cable for FW update / configuration
- STM32 ST-Link for code debugging / programming
- GPS Module* for Autonomous Flights
- Wireless Telemetry Module** for GCS control

* GPS Module – Ublox LEA6-H, available from:
  https://store.3drobotics.com/products/3dr-gps-ublox-with-compass

** Wireless telemetry module HM-TRP, available from:
http://hobbyking.com/hobbyking/store/__42846__fpv_radio_telemetry_kit_915mhz.htm
https://store.3drobotics.com/products/3dr-radio
Transmitter Commands

ARM
0.5 second
Performs all calibrations before take off and unlock motors. Long beep followed by a short beep means that the system is ARMED and ready to fly. Continuous beeping – something went wrong and the system requires reboot.

DISARM
0.5 second
Locks motors.
Two short beeps mean that the system is DISARMED and safe.
If you hear continuous beeping – something went wrong and the system requires reboot.

SAVE parameters to SD card
2 seconds
Short positive tone means that the parameters have been successfully saved.
Short negative tone means that the system was unable to save parameters.

Magnetometer calibration start / stop
3 seconds
Long beep means that the system is performing temperature calibration, after short beep the system is ready for dynamic calibration.
Do the same action when you want to stop the calibration and save parameters.

Accelerometer calibration start
3 seconds
Accelerometer calibration process starts after a long beep. Short positive tone means that the calibration was done successfully and save to SD card.
Getting Started

Mounting the board
Mount your board to your copter frame. It’s highly recommended to mount the board as close to the geometrical center of the copter as possible. Mounting should be done with four 3mm nylon screws. Add rubber spacers to reduce motors vibration noise.

Note the “FRONT” arrow to install the board properly.

Connections

After mounting the board you need to connect cables to/from RC Receiver as shown on the diagram below. Connection pins are in the rear part of SmartAP board. Firstly, connect every individual PWM output from your receiver to every individual PWM input of SmartAP board. Use 2.54mm female jumper cable 6 pin to 6 pin to do this.

Input channel 1 – Roll
Input channel 2 – Pitch
Input channel 3 – Throttle
Input channel 4 – Yaw
Input channel 5 – Mode selection
Input channel 6 – Configuration tuner

Be sure NOT to mix up polarity. GND line (black) is near edge, +5V line (red) in the middle.
Motors ESC Outputs

SmartAP board gets power supply from one of the ESC’s BEC (generally 5V, 2A). Connect first motor’s ESC (front right) to OUTPUT 1 of SmartAP board. Remove +5V pin (middle pin, generally connected to RED wire) from every other than first ESC cable. Now connect other ESC cables to SmartAP outputs. Numbers of channels for corresponding motors are shown on the right.

Be sure to connect only one +5V pin to power rails of SmartAP, otherwise this may damage your ESCs or SmartAP board.

The last thing is to connect power supply from SmartAP board to RC receiver. This can be done with 2.54mm female jumper cable 2 pin to 2 pin.

GPS Receiver

Connect GPS receiver cable into GPS port of SmartAP:
GND <> GND, 5V <> 5V, TX <> RX, RX <> TX

Telemetry module

Connect Telemetry module cable into UART port of SmartAP:
GND <> GND, 5V <> 5V, TX <> RX, RX <> TX

External Bright LED

Connect Bright LED to LED port of SmartAP.

Electromagnetic sounder

Connect Electromagnetic sounder to ZZZ port of SmartAP.

Firmware

Getting the Firmware

The latest firmware for the flight control system including all required drivers and utilities can be found in the download section at Sky-Drones website: www.sky-drones.com

Notice: Purchased board comes with the latest firmware and you don’t need to update it.
After the first power up the board you will have to download and install Virtual COM Port driver.

### Downloads

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
<th>Version</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SmartAP 1.0 AutoPilot Firmware</td>
<td>download</td>
<td>0.9.1</td>
<td>219KB</td>
</tr>
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### Utilities

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
<th>Version</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32 ST-LINK utility</td>
<td>download</td>
<td>2.4</td>
<td>2386KB</td>
</tr>
<tr>
<td>STM32 DfuSe USB utility</td>
<td>download</td>
<td>3.0.3</td>
<td>17200KB</td>
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### Drivers

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
<th>Version</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-LINK/V2 USB driver for Windows 7, Vista and XP</td>
<td>download</td>
<td>1.0.4</td>
<td>10182KB</td>
</tr>
<tr>
<td>STM32F4 Virtual COM Port Driver</td>
<td>download</td>
<td>1.1.1</td>
<td>11200KB</td>
</tr>
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</table>

### Firmware update

**Using ST-Link Programmer / Debugger**

To upload firmware you need JTAG programmer / debugger. It's recommended to upload firmware with ST Link v2 programmer.

ST Link v2 and JTAG functions table is shown below:  

<table>
<thead>
<tr>
<th>Pin no.</th>
<th>ST-LINK/V2 connector (CNS)</th>
<th>ST-LINK/V2 function</th>
<th>Target connection (JTAG)</th>
<th>Target connection (SWD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VAPP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>TRST</td>
<td>JTAG TRST</td>
<td>JNTRST</td>
<td>GND(3)</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>4</td>
<td>TDI</td>
<td>JTAG TDO</td>
<td>JTDI</td>
<td>GND(2)</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>6</td>
<td>TM3_SWDIQ</td>
<td>JTAG TMS, SW IO</td>
<td>JTIMS</td>
<td>SWDIQ</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>8</td>
<td>TCK_SWCLK</td>
<td>JTAG TCK, SW CLK</td>
<td>JTCK</td>
<td>SWCLK</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>10</td>
<td>NC</td>
<td>Not connected</td>
<td>Not connected</td>
<td>Not connected</td>
</tr>
<tr>
<td>11</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>12</td>
<td>TDO_SWO</td>
<td>JTAG TDI, SWO</td>
<td>JTD0</td>
<td>TRACESWO(4)</td>
</tr>
<tr>
<td>13</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>14</td>
<td>NRST</td>
<td>NRST</td>
<td>NRST</td>
<td>GND(3)</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>16</td>
<td>NC</td>
<td>Not connected</td>
<td>Not connected</td>
<td>Not connected</td>
</tr>
<tr>
<td>17</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
<tr>
<td>18</td>
<td>VDD</td>
<td>VDD (3.3V)(5)</td>
<td>Not connected</td>
<td>Not connected</td>
</tr>
<tr>
<td>19</td>
<td>GND</td>
<td></td>
<td>GND(3)</td>
<td>GND(3)</td>
</tr>
</tbody>
</table>
Connect corresponding pins of ST Link v2 programmer to corresponding pins of SmartAP:

<table>
<thead>
<tr>
<th>ST Link v2</th>
<th>SmartAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3V3</td>
</tr>
<tr>
<td>3</td>
<td>TRST</td>
</tr>
<tr>
<td>5</td>
<td>TDI</td>
</tr>
<tr>
<td>7</td>
<td>TMS</td>
</tr>
<tr>
<td>9</td>
<td>TCK</td>
</tr>
<tr>
<td>13</td>
<td>TDO</td>
</tr>
<tr>
<td>15</td>
<td>RST</td>
</tr>
<tr>
<td>20</td>
<td>GND</td>
</tr>
</tbody>
</table>

After connection is done connect power supply via USB to both ST Link v2 and SmartAP board. Download ST Link Utility from sky-drones.com website or from the STMicroElectronics official website. Also, you may need ST-LINK/V2 USB driver for Windows 8 / 7, Vista and XP which you can download from sky-drones.com or from the official STMicroElectronics website.

When the installation is done run ST Link Utility.

Then go to Target -> Connect

You will see Device Memory and information about microcontroller:
After that go to File -> Open and select .HEX file with SmartAP firmware which you can get in downloads section and click Open.

Then ST Link Utility will ask you permission to upload firmware. Click OK and then Program.
Firmware will be uploaded and verified

Finally, you will see the message Verification... OK in status box. Then go to Target -> Disconnect. This means that firmware upload was successfully completed.
Using USB Firmware Update tool

Upgrading firmware via USB requires DFU image generation. First of all download and open DFU File Manager Utility. Then select “I want to generate a DFU file from S19, HEX or BIN file” and press OK.

Then press “S19 or HEX” and select the hex file of the firmware you would like to convert to DFU and press “Generate”.

After that you will get the message that DFU image was successfully generated.
Then take your SmartAP board and remove the jumper. It will allow SmartAP running in USB firmware update mode.

Connect the board to your computer with USB cable and run DfuSe utility. Press “Choose” in “Upgrade of Verify” section and select the .dfu file you would like to load. Then press “Upgrade”.

Wait 40-60 seconds until you get the message that the firmware was successfully updated.

Do not forget to place the jumper back.
Configuration

Command Line Interface

By default, SmartAP Autopilot can be configured using simple Command Line Interface (CLI). First of all you need to download Putty – terminal client, which will help you to configure SmartAP. It’s available from downloads section at sky-drones.com.

Open Putty, set Serial and select the right COM port (make sure that the board is connected to your computer), set Speed to 115200 and press Open.

You will see the black window opened and press Enter. Available commands list will be presented.

Type “help”, press Enter and you will get the list of available commands with the description.
First power-up

Make sure that microSD card is inserted in SmartAP.

Connect the board to your computer via USB. You will hear continuing beeping. Then open Putty and connect to the board. First of all, you need to save the default parameters to microSD card. Type `params save` and hit Enter. You will get `>/app/params: Params file saved.` Reconnect the board. You will hear short tones, confirming that the system has successfully completed self-check.

After performing some calibration steps the system will be ready to fly.

Airframe configuration

Type `motors scheme show` to see the list of available airframe configurations. Type `motors scheme set n`, where `n` is the id of scheme you would to use and press enter.

After that you will get the confirmation that the scheme was successfully set.

Flight modes configuration

SmartAP allows you to configure 3 different flight modes accessible with the 3-position switch on your transmitter. Type `modes list` and press enter to see the list of available flight modes. Type `modes preset n m`, where `n` is the mode position on your transmitter’s switch (1, 2 or 3) and `m` is the id of the mode you would like to select.

It’s recommended to have #2 STABILIZE mode set as the primary mode for the switch.

Calibrations

DANGEROUS! REMOVE ALL PROPS BEFORE ANY CALIBRATION!!!

Hold the throttle stick down during all calibration procedures except some steps in Radio Calibration.

Radio Calibration

Make sure that you have powered on transmitter / receiver. Open Putty terminal.

Notice: Receiver is powered on only when the main LiPo battery is connected.

Set all transmitter sticks and switches to the middle positions, type `radio cal center` and press enter. In a few seconds you will see the message `/app/radio: radio center calibration done!`

Type `radio cal ep`, hit enter and move all the sticks and switches to their extreme positions. When it’s done – type `radio cal stop` and hit enter.

If you see some of the channels reversed – then you can do channel reverse by entering `radio reverse n`, where `n` is a number of a channel to be reversed. Radio show command will give calibration info.
**IMU calibration**

IMU calibration is very important for flight performance.

Place your copter as parallel to the surface as possible with zero pitch and roll. Power on transmitter and the system and move the right stick to top-left for 3 seconds until you hear a beep. Release the stick. Wait 3 seconds until you hear two short beeps. Calibration is done successfully and saved. If you hear continuous beeping, then something went wrong reboot.

**Magnetometer calibration**

Perform magnetometer calibration only outdoors, far from any magnetic materials (keys, belts) or RF emitting devices (mobile phones) on a fully equipped vehicle.

Power on your transmitter and the system. Move the right stick to right-top position for 3 seconds until you hear a beep. After hearing another beep start moving the copter around all axis in different directions until you hear beeps. When you continue rotating the copter, but don’t hear any beeps – then the calibration is well done and you can save it. Do this by moving the right stick to top-right position again and hold it for 3 second until you hear a beep. Calibration is done successfully and saved. If you hear continuous beeping, then something went wrong and the system needs reboot.

**Setting Magnetic Declination**

If you are going to fly in position hold / autonomous modes using GPS, then you need to configure your magnetic declination.

Magnetic declination or variation is the angle on the horizontal plane between magnetic north and true north.

Correct magnetic declination is very important for precise position hold.

Magnetic declination value for your region can be found here: [http://magnetic-declination.com/](http://magnetic-declination.com/)

Type `params set IMU_MAG_DECL dec`, where `dec` is the declination value. Then type `params save` to save it.

Example: Magnetic declination: -7° 3’ WEST  
`IMU_MAGDECL=-7.05`

Example: Magnetic declination: +13° 9’ EAST  
`IMU_MAGDECL=13.15`
GPS Configuration

GPS receiver must be connected to GPS port of SmartAP.

GPS configuration can be done using U-Blox U-Center software and FTDI cable connected to GPS receiver.

Configure GPS receiver with the following parameters:

- Baud rate: 38400
- Protocol: NMEA
- Update rate: 5 Hz, 200 ms or higher

To check the GPS receiver you can type `gps print` in SmartAP command line interface. If you are able to see correct information about your position, number of satellites and etc. then you have successfully configured your GPS receiver.

Configure GPS Receiver using U-Blox U-Center

Download U-Blox U-Center configuration utility either from the [www.sky-drones.com](http://www.sky-drones.com) website or from U-Blox official website. Also you will need FTDI cable.

1. Connect FTDI cable to the GPS receiver as follows:
   - GND <-> GND
   - 5V <-> Power
   - TX <-> RX
   - RX <-> TX
2. Connect FTDI cable to your computer and start U-Center.
3. Select your FTDI cable COM port and Baud rate. (By default, baud rate is 9600, some modules are configured for 38400).

4. Go to “View” – “Configuration view”

5. Go to tab “Navigation” and change “Dynamic model” to “3 - Pedestrian”. Click “Send” in the left bottom corner of the window.
6. Go to tab “PRT (Ports)” and change “Protocol out” to “1 - NMEA” and “Baudrate” to “38400”. Click “Send” in the left bottom corner of the window.

7. Go to tab “RATE (Rates)” and change “Measurement period” to “200”. Click “Send” in the left bottom corner of the window.

8. After this, you will need to reconnect again. Select baud rate as “38400” and press connect again. Now you need to save this configuration to EEPROM. Go to “CFG (Configuration)” tab and select all devices from “0 – BBR” to “4 – SPI FLASH” in the “Devices window”. Click “Send” in the left bottom corner of the window.
9. Finally, close the “Configuration View”. If you’re able to see the signal from satellites, then you have successfully configured your GPS module.
Your First Flight

The following steps will you help you to make your first flight with SmartAP.

Before take off

Always power on the transmitter before powering on the copter!

<table>
<thead>
<tr>
<th>Double blinking – system</th>
<th>DISARMED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single blinking – system</td>
<td>ARMED</td>
</tr>
</tbody>
</table>

1. Set your throttle stick down.
2. Power on the transmitter.
3. Power on the copter.
   - If you hear short tone – self test OK
   - If you hear continuous beeping – system reboot required.
4. Make sure you’re in stabilize mode.
5. When you’re ready to fly – ARM the system by turning left stick right-down for a second.
6. Release the stick after hearing the short beep:
   - If you hear long beep – the system is ARMED and ready for take off.
   - If you hear continuous beeping – system reboot required.

The Flight

1. Slowly raise your throttle stick until the copter takes off from the ground.
2. Use the right stick to control the lean angles / position of the copter.
3. Use mode switch if you want to switch to Loiter / Auto / RTL etc. mode.

After landing

1. Disarm the system after landing by turning let stick left-down for a second.
2. Two short beeps mean that the system has been successfully disarmed.
3. Power off the copter.
4. Power off the transmitter.
Parameters Tuning

SmartAP provides good stability and navigation precision even “out of the box”, but additional tuning will improve the flight performance of your vehicle.

Default parameters allow flying almost any type of multirotor.

Control Algorithm Outline

SmartAP AutoPilot is based on P-PID control algorithm. It means that the stabilization (the ability to stay in the air) and navigation (the ability to follow desired trajectory) control algorithms include two loops:

Tuning importance of the values

- **HIGH IMPORTANCE** – affects much on the flight performance, depends on airframe
- **MEDIUM IMPORTANCE** – can be tuned, but doesn’t depend on airframe a lot
- **LOW IMPORTANCE** – tuning is not required in most cases

Parameters List & Description

Stabilization

- **Rate control (PID)**
  - **Roll & Pitch**
    - Controls the amount of power to the motors to achieve the desired angular rate:
      - **P**: STAB_ROL_RAT_P / STAB_PIT_RAT_P
        - Main tuning parameter.
        - Too small value: *Bad response to user’s control, no reaction on control*
        - Too big value: *High-frequency oscillations, instability*
        - Default value: 6.00, range: 3.00 – 20.00
      - **I**: STAB_ROL_RAT_I / STAB_PIT_RAT_I
        - Helps to compensate steady-state error (e.g. unbalanced airframe)
        - Too small value: *Compensation takes too much time, no effect at all*
        - Too big value: *Oscillations, instability*
        - Default value: 0.01, range: 0.00 – 0.05
      - **D**: STAB_ROL_RAT_D / STAB_PIT_RAT_D
        - Helps to dampen oscillations (e.g. too many oscillations on step response)
        - Too small value: *Low dampening, no effect*
        - Too big value: *High-frequency self-oscillations, instability*
        - Default value: 10, range: 0.00 – 25.00

- **Yaw**
  - Controls the amount of power to the motors to achieve the desired angular rate:
    - **P**: STAB_YAW_RAT_P
Too small value: *Bad response to user’s control, no reaction on control*
Too big value: *High-frequency oscillations, instability*
Default value: 12.00, range: 5.00 – 20.00

**I: STAB_YAW_RAT_I**
Helps to compensate steady-state error (e.g. unbalanced airframe)
Too small value: *Compensation takes too much time, no effect at all*
Too big value: *Oscillations, instability*
Default value: 0.005, range: 0.00 – 0.02

**D: STAB_YAW_RAT_D**
Helps to dampen oscillations (e.g. too many oscillations on step response)
Too small value: *Low dampening, no effect*
Too big value: *High-frequency self-oscillations, instability*
Default value: 0, range: 0.00 – 10.00

### Attitude control (P)
Controls the required angular rate to compensate current angle error:

**Roll & Pitch**

**P: STAB_ROL_ANG_P / STAB_PIT_ANG_P**
Too small value: *Doesn’t achieve the desired angle, reaction is slow*
Too big value: *Low-frequency oscillations, light instability, too control sensitive*
Default value: 3.00, range: 1.00 – 5.00 **Roll & Pitch**

**Yaw**

**P: STAB_YAW_ANG_P**
Too small value: *Doesn’t achieve the desired angle, reaction is slow*
Too big value: *Low-frequency oscillations, light instability, too control sensitive*
Default value: 3.00, range: 1.00 – 5.00

### Navigation

#### Velocity control (PID)
**Position (LAT / LON)**
Controls the lean angle to achieve the desired velocity:

**P: NAV_POS_RAT_P:**
Main tuning parameter
Too small value: *Doesn’t hold position, blown with the wind*
Too big value: *Flies around the desired position*
Default value: 0.10, range: 0.05 – 0.15

**I: NAV_POS_RAT_I:**
Helps to compensate steady-state error (e.g. wind)
Too small value: *Compensation takes too much time, blown with the wind*
Too big value: *Flies around the desired position*
Default value: 0.001, range: 0.00 – 0.01

**D**: NAV_POS_RAT_D:
- Helps to fight against the sudden disturbances (e.g. gust wind)
- Too small value: Low dampening, no effect
- Too big value: Self-oscillations, instability
- Default value: 0, range: 0.00 – 1.00

**Altitude**

Controls the power for motors angle to achieve the desired vertical speed:

**P**: NAV_ALT_RAT_P:
- Main tuning parameter
- Too small value: Doesn’t hold altitude, goes up or down
- Too big value: Oscillations around desired altitude
- Default value: 12.00, range: 8.00 – 18.00

**I**: NAV_ALT_RAT_I:
- Helps to compensate steady-state error (e.g. battery discharge, variable weight)
- Too small value: Compensation takes too much time, doesn’t hold altitude
- Too big value: Slow oscillations around desired altitude
- Default value: 0.015, range: 0.00 – 0.01

**D**: NAV_ALT_RAT_D:
- Helps to fight against the sudden disturbances (e.g. gust wind)
- Too small value: Low dampening, no effect
- Too big value: Self-oscillations, instability
- Default value: 25.00, range: 0.00 – 30.00

- **Position control (P)**

**Position (LAT / LON)**

Controls the desired speed to compensate current distance error:

**P**: NAV_POS_DST_P:
- Too small value: Doesn’t hold position, blown with the wind
- Too big value: Very low-frequency oscillations around desired position
- Default value: 0.35, range: 0.25 – 0.5

**Altitude**

Controls the desired vertical speed to compensate current altitude error:

**P**: NAV_ALT_DST_P:
- Too small value: Doesn’t hold altitude, goes up or down slowly
- Too big value: Low-frequency oscillations around desired position
- Default value: 0.3, range: 0.2 – 0.5
Changing and Saving Parameters

You can see parameters list by typing `params show` and pressing Enter.

To change the parameters value type `params set [id] [value]` or `params set [name] [value]`, where `id` – parameter id or `name` – parameter name and `value` – desired value to be set.

You can also tune parameter with CH6 using your transmitter. To select tuning parameter type `params tune [id] [min value] [max value]` or `params tune [name] [min value] [max value]`, where `id` – parameter id or `name` – parameter name and `min value` – minimum value or the range, `max value` – maximum value of the range.

Do not forget to save the parameters after tuning. Type `params save` and press Enter.
LED & Sound Meanings

- System DISARMED
- System ARMED
- System ERROR
- Mission loaded
Safety

Operating a powered vehicle of any kind can be a lot of fun, but it carries certain inherent risks. Regulations governing the use of powered vehicles, including aircraft, vary from locale to locale, even within the same country or district. It is your responsibility to ensure that you understand and comply with all local laws and regulations.

Safety basics:
• Never operate the vehicle or software in a way that could be dangerous to you, other people, or property.
• Always keep propeller arcs free of objects and body parts while the vehicle is live.
• Keep in mind that software and hardware failures happen. Although we design our products to minimize such issues, you should always operate with the understanding that a failure could occur at any time and without warning. Accordingly, you should take the appropriate precautions to minimize danger in case of product failure.
• Never use the software or hardware for manned vehicles.
• Always operate within local laws and regulations.
• Do not operate the aircraft if you are under the age of 16.

Additional safety information:
• Be sure to maintain safe distances between people and your aircraft.
• Never operate your aircraft if your ability to do so with the utmost attention to safety is impaired in any way. Do not operate your aircraft while tired, under the influence of drugs or alcohol, or otherwise unable to operate it with the highest attention to safety.
• Environment conditions can change rapidly and can make operation difficult. If this occurs, land your aircraft and discontinue use immediately. Do not operate your aircraft if operating conditions are not ideal. This includes, but is not limited to, rain, snow or excessive wind.
• Always ensure the battery cable is disconnected from the aircraft until you are ready to fly, and ensure that your batteries are fully charged prior to use.
• Always turn on the transmitter and ensure the throttle stick is all the way down before connecting the battery.
• After landing, disarm your vehicle immediately and disconnect the battery cable.
• Do not turn off the transmitter until after you have disconnected the battery.
• Always remove the propellers while testing the motors.
• When the battery is connected, always assume the vehicle is live and the motors are armed.
• Do not attempt to fly longer than the battery’s safe capacity.
• Do not operate the vehicle with excess weight attached.
• Ensure that all vehicle components are well maintained before each flight. Ensure that components are firmly attached and operating properly.
• Replace any worn or damaged components before each flight. Never operate with any damaged or worn components.
Support

For more information about SmartAP AutoPilot, please, visit www.sky-drones.com website.

If you have any questions, please, feel free to contact us at http://sky-drones.com/contacts.php

Disclaimer

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## Revision History

<table>
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<tr>
<th>#</th>
<th>Date</th>
<th>Ver.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>29.08.2014</td>
<td>1.0</td>
<td>Initial release of the Guide</td>
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<tr>
<td>2</td>
<td>28.09.2014</td>
<td>1.1</td>
<td>Added <em>Parameters Tuning</em> and <em>GPS Configuration</em> sections</td>
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<tr>
<td>3</td>
<td>14.10.2014</td>
<td>1.2</td>
<td>Added <em>Magnetic Declination</em> section</td>
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<tr>
<td>4</td>
<td>17.11.2014</td>
<td>1.3</td>
<td>Added <em>GPS configuration</em> section</td>
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