Simple Brushless Gimbal Controller tuning manual

Firmware version: 1.2
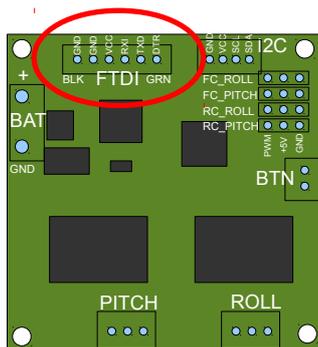*GUI version: 1.2*
Board version: 1.0

Connecting to computer

To connect controller to PC, you need FTDI adapter with installed drivers (see manufacturer guide how to install drivers). In case of proper installation, additional COM-port will appear in the system. You should know its number and specify it in the GUI.

1. Connect FTDI adapter to controller board, preserving polarity. See picture below to define write connector orientation. In case of FTDI cable from SparkFun, black wire means ground and green wire means DTR.


2. Run GUI for your operating system (Windows, Limux or Mac) and choose FTDI COM-port from list of available ports. *Note: GUI version should match firmware version!*

3. Just after connection, current settings will be read from board and real-time data communication starts. You may press **READ** any time to load settings from board.

4. When you finished editing, press **WRITE** to write parameters to device memory (EEPROM) and apply it. To return to factory default settings, press **USE_DEFAULTS**.

GUI window structure

1. Settings. To change value in field, move cursor inside field, press mouse button and drag left or right.

2. Input signal from receiver and external flight controller, in range of 900-2100 microseconds.

3. Current IMU sensor orientation. Numbers mean angles in degrees

4. Sensors raw data and debug variables. To turn it on/off click on color rectangle[1].

5. Sensors raw data graph and error description, if present.

6. Graph zooming factor. Drag left or right to change it.

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1   MAG (magnetometer) is not supported in version 1.xx
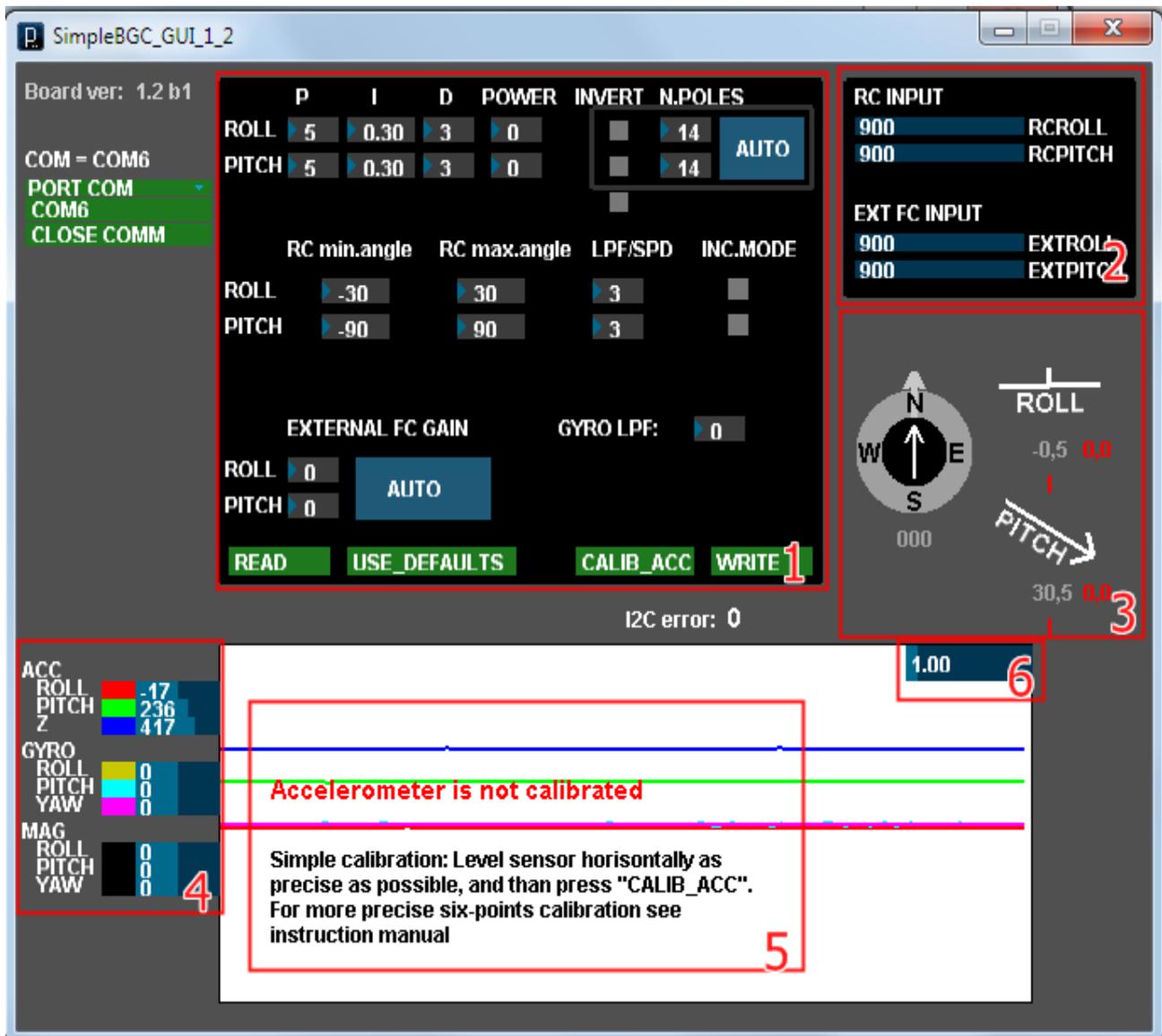
Parameters description

- **P,I,D** – PID controller settings, separate for each axis[1].

  - **P** – defines response to disturbance. The bigger it is, the faster is reaction. Can be also explained as a "gain" of sensor signal before it will be passed to motors.

    How to tune: slowly increase this value from zero until quality of stabilization becomes good. Too high values may lead to system self-excitation (visible as increasing oscillations).

    IMPORTANT!!! If vibrations from the main frame are passed to camera platform, they may lead to easy self-excitation and unbalance.   It is very important to prevent vibrations, using high-quality vibration dumpers in gimbal mount!

    In case of low-frequency oscillations, they may be suppressed by increasing D parameter. Increase D by 1..2 units and if oscillations will stop - you may increase P further.

  - **D** – defines inhibition of reaction. It helps to prevent low-frequency oscillations, but too high values may introduce high-frequency noise in system, that may be increased in case of vibrations. Try to keep it as close to zero as possible.

  - **I** – defines the speed of reaction to control commands from receiver. The low values give very slow and smooth reaction to operator control, but also very slow movement to proper horizon position in case of big error. The high values let the fast movement of camera and fast return to

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1   In version 1.XX YAW axis is not supported

horizon if inclined.

- **Power** – defines output power for each motor. Set it from 0 to 255, where 255 – is the maximum available power. The base rules how to set this parameter:

  - MOTOR SHOULD NOT OVERHEAT! Too high temperature (above 80C) will lead to permanently loose of magnetic properties

  - Low power means low torque - gimbal may suddenly loose its position and fail to recover.

  - If you have tuned PID controller, and decided to increase power – you should decrease PID controller values, because power is proportional to gain.

- **Invert** – defines the direction of motor rotation. It is very important to choose right setting for it. There is auto-detection possible. To start detection, set P,I,D=0, set POWER according to recommendations above (or set 100 as general value). Level camera plate horizontally (may be not precise because magnetic field vector is in random position) and press the **AUTO** button (located near **Invert** setting). Camera will tilt on small angles during calibration.

- **N.POLES** - defines number of poles (magnets) of each motor. This value is roughly detected in auto calibration procedure described above. If it detected wrong, set it manually: count the number of magnets in your motor (generally it is 14 poles)

- **RC min.angle, RC max.angle** – defines the range from minimal to maximal angle of camera inclination, controlled from receiver. To inverse control, just set first value bigger than second. For example, if you want to tilt camera from horizon (0 degree) to straight down (90 degree), set min.angle=0, max.angle=90 (or 90..0 for inverse).

- INC.MODE – RC control mode switch. If not set, it is *absolute mode* - camera will follow stick position. If stick not moved, camera will stop, too. If set, it is *incremental mode* - camera will rotate with speed, proportional to stick declination from center position.
  In both cases, view angle is limited by **RC min.angle, RC max.angle** parameters, and reverse of control is possible.

- **LPF/SPD** – in case of *absolute mode*, it set *low-pass filter* applied for receiver signal. The bigger it is, the smoother is control (but more delayed response). In case of *incremental mode*, it set the angular speed of camera rotation. The bigger it is, the faster rotation.

- **EXTERNAL FC GAIN** – this setting is required, if you were made optional connection to flight controller.   This connection helps to improve stabilization quality. Many flight controllers have output to camera gimbal servos for ROLL and PITCH axis. You should configure this outputs to about +-30 degrees range and connect to SimleBGC according to connection diagram. Then follow the next steps:

  - Activate cam stab mode in you flight controller (read its manual how to configure and activate it)

  - Disable all filtering and compensation, if present, to make linear response.

  - Connect SimpleBGC to PC, run GUI and press **START** button. If all connected properly, you will see response from flight controller in EXT_FC_INPUT box. Check if it reacts to frame tilting.

  - Controller should be tuned and powered on. Camera stabilization should work. Press **AUTO** button and slowly tilt copter frame by each axis forth and back about 20~30 degree. Repeat this 5-10 times for each axis (all takes about 30 seconds).

  - Press **AUTO** again. Calibration stops and estimated settings will be read from controller.

- **GYRO LPF** – gyro sensor low-pass filtering. Use this only in case of high vibrations interfering sensor. Generally, should be set to zero.

Tuning algorithm

Balancing camera

It is very important to perfectly balance the camera for each 3 axis. To check balance, take gimbal in hands (powered off) and rapidly move it forth and back, or left and right. Try to catch resonance where camera begin to swing. If swing is weak or not noticed at all – camera is balanced well.

Don't let wires to resist rotation. Take as thin and flexible wires, as possible.

Hint: perfect balance and easy rotation lets you greatly decrease POWER needed for stabilization.

Gyro calibration

This is made on every power-on after 3-4 second delay. It is VERY IMPORTANT to keep whole system at rest for few seconds after power-on, preventing even small moving or disturbance. Signal LED will flash slowly about 3-4 second and then light on when calibration is done.

Accelerometer calibration

This is generally done one time at the beginning of the system tuning.   But It is better to re-calibrate accelerometer after a long time, or when the temperature was considerably changed since last calibration.

To calibrate accelerometer, you don't need to connect main power. Just connect FTDI cable.

Simple mode: level the sensor board strictly horizontally (this is "base position"), fix it in this position by hands, and press **CALIB_ACC** button (or menu button). Signal LED will flash about 2-3 seconds. Don't move sensor board while calibrating.

Extended mode (preferred): first of all, make calibration in simple mode. Then, rotate sensor board by 90 degree, to make every of 5 faces "looking up" (total 5 positions excluding "base"). Fix sensor in every position, press **CALIBRATE_ACC** and wait about 3 second. Repeat this step 5 times (the sequence of rotation is no matter).   Remember, that calibration in simple mode will cancel results of extended calibration, so make it first.

> **Hint:** Precise ACC calibration is very important to keep horizon stable in case of aggressive flight

Tuning parameters

- Reset parameters to factory defaults pressing **USE_DEFAULTS** button.

- Connect main power.

- Set POWER according to this manual.

- Run auto-detection for INVERT and N.POLES. Check N.POLES and correct it if necessary.

- Tune PID controller. To check quality of stabilization, you may refer to peak-meter (red strokes and numbers beside axis drawing). They show the maximum fluctuations of camera angle.   Try to decline frame by small angles (10-20 degree, moderate speed) and tune PID to minimize this values. For beginning, 1.0 is good result.

- Connect external flight controller and make auto calibration of EXT_FC_GAIN as described above. After calibration, you may get camera angle fluctuations less than 0.2 degree even in case of fast and big frame disturbances.

Test gimbal in real conditions

Leave board connected to GUI, start main frame motors and give throttle to hover (WARNING: take frame firmly in your hands ABOVE your head! Be very carefully!). See graph in GUI to check ACC and GYRO raw data. This graph lets you to estimate the level of vibrations presented in gimbal. Remember that too big vibrations will highly impact overall stabilization quality. Try to balance props and motors, and use vibration dampers in the gimbal mount.

You may need to slightly adjust PID settings and take vibrations into account, to make it stable.

Menu button

If you have connected menu button, you can get quick access to number of functions:

- **Single-press** — runs accelerometer calibration (like **CALIB_ACC** button in GUI)

- **Double-press** — temporarily switching input from receiver's PITCH axis to ROLL axis. This is useful if you connect only one receiver channel to RC_PITCH, and want to adjust ROLL axis before flight. When finished, double-press menu button again and ROLL position will be saved to memory.

- **Press and hold for 3 seconds** – reset system

Signal LED states

- **LED is off** – small delay before calibration to let you take your hands off
- **LED slow flashing** – run calibration procedure
- **LED fast flashing** – system error. Connect GUI to see error description
- **LED is on** – all ok, stabilization performed