TILT

RACING DRONE

CLEANFLIGHT MANUAL

Cleanflight Manual

This document aims at explaining and guiding you in setting up your tilting arms multicopter. The actual Cleanflight (CF) version works with Abusemark Naze32 and all its clones and assumes a single servo is used to rotate both arms. CC3D and other CF-compatible flight controllers have not been tested yet.

We will appreciate your feedback: what you like, what you don't, what you think can work/be done better, what is missing, etc. Please contact us for comments at info@tiltdrone.com and join us at the official page on facebook TILT drone racer and the Dynamic Tilting Arms users&help group.

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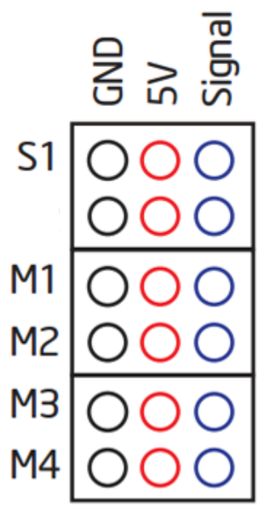
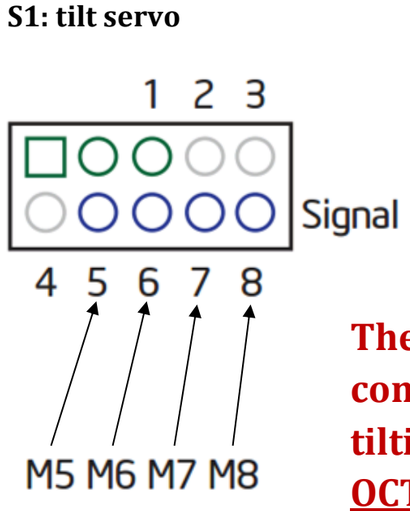
Hardware connections

From the connections point of view, the use of a servo for tilting arms only affects the motor outputs' connections: instead of connecting the motors 1-4 to motor outputs 1-4 respectively (as in classical fixed arms quadcopters) connect this way:

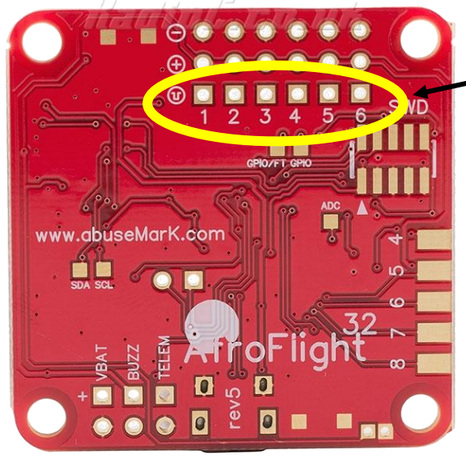
- The servo signal cable goes to motor output 1
- Motors M1 to M4 go to motors outputs 3-6 respectively
- For TILT X8 system, use the last four RC inputs for the motors M5 to M8



*** S1: tilt servo**



These are the connections for tilting arms OCTOCOPTERS in X8 configuration



Motor outputs 1 to 6

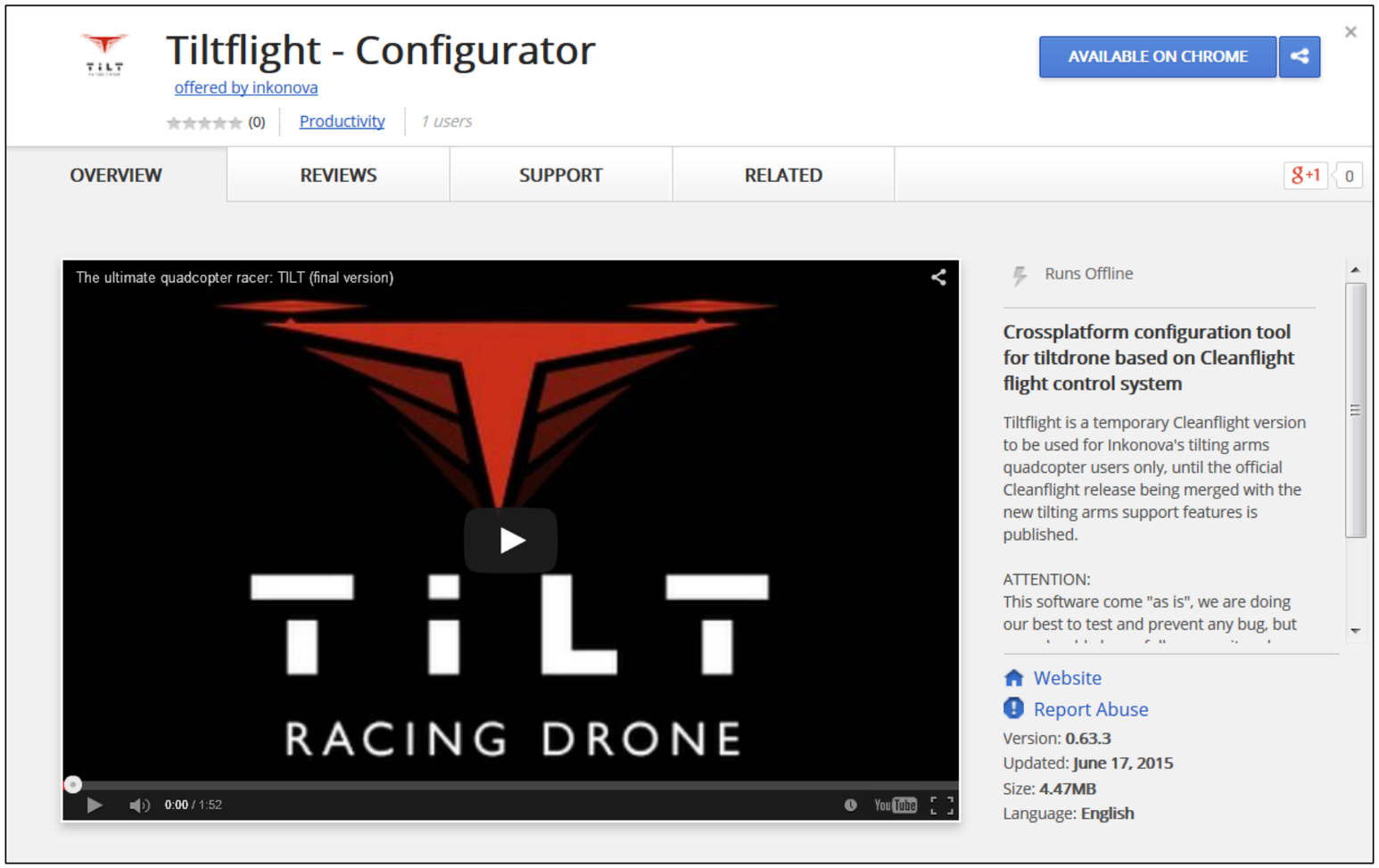
*** S1: tilt servo**

These are the connections for tilting arms QUADCOPTERS

For the rest of Naze32 hardware setup please use this PDF.

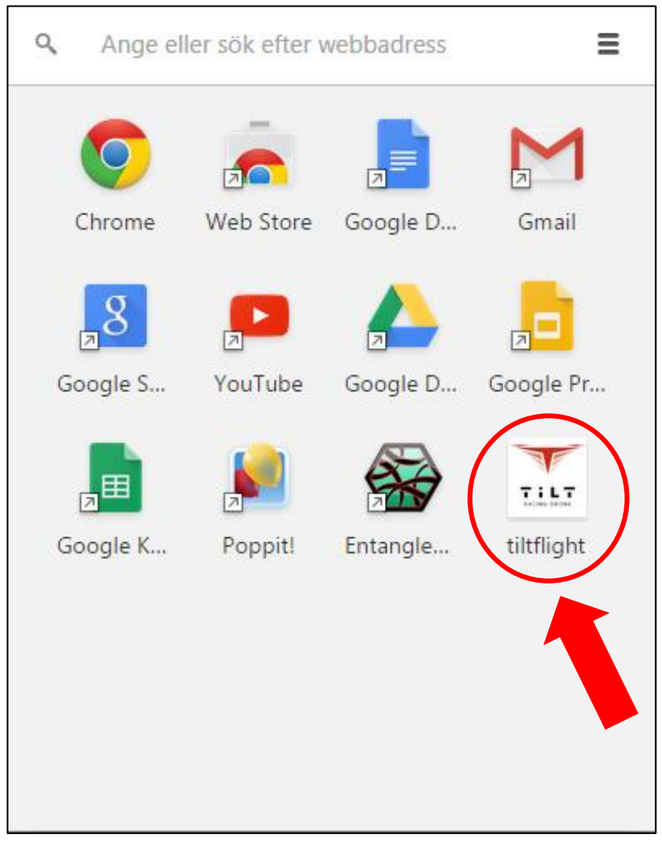
Cleanflight Configurator download

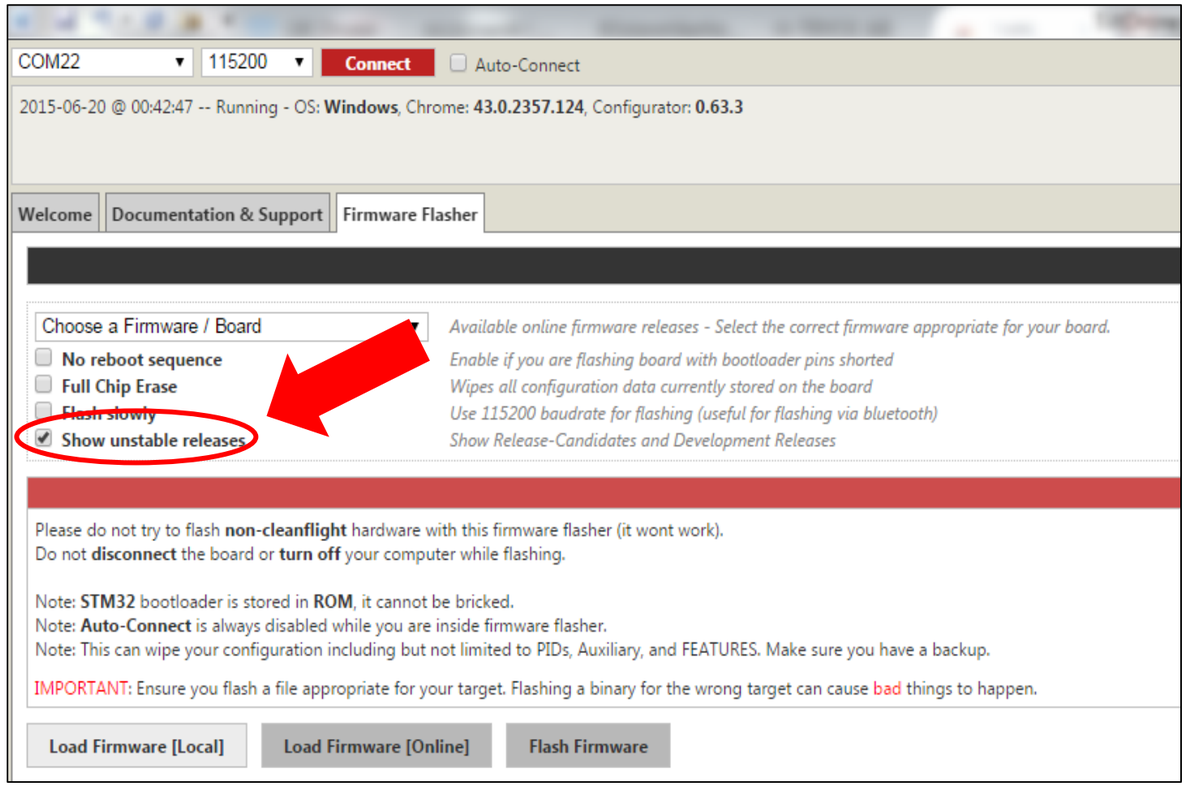
Our Cleanflight code with tilting arms support is now public on Google Chrome. When the next official CF version is released including our tilting arms features, you'll be notified and our 'Tiltflight' code will eventually be remove from the Chrome Store. To enjoy your TILT quadcopter, just dowload the Configurator from HERE.



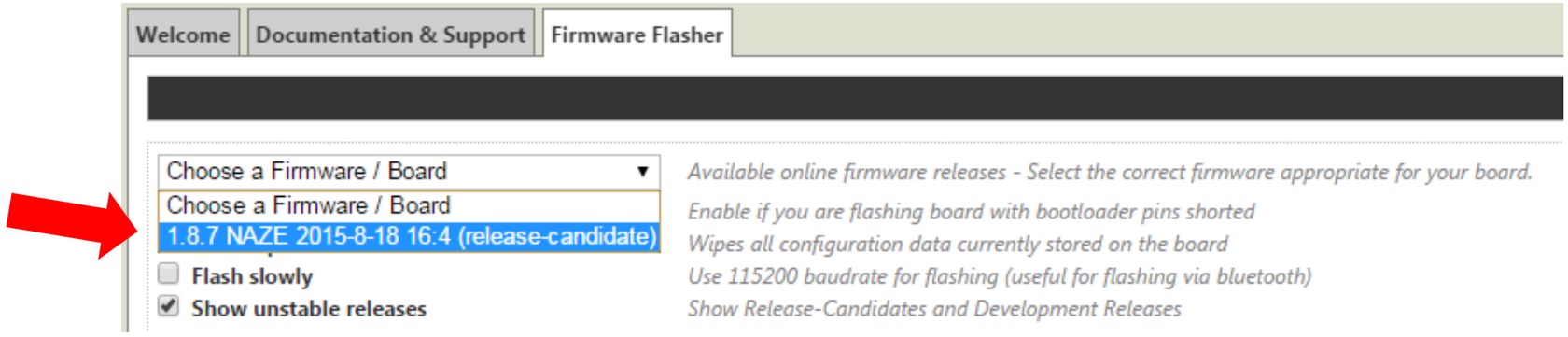
Flashing the Cleanflight firmware

After installing our Cleanflight Configurator (we call it TiltFlight in Google's webstore just to distinguish it from the oficial Cleanflight Configurator. We'll notify you when the tilt features will be available in the new official CF), click it and go to the Firmware Flasher tab and tick on '**Show unstable releases'**.

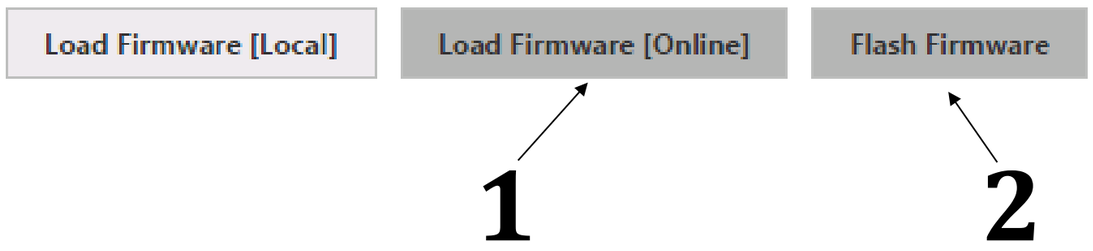




Then select the latest firmware version you'll see in the unfolded menu. Select '**Full chip erase**' if you want to erase all previous settings (even if you don't tick this option, we recommend you to always revise your settings prior to fly with a new flashed firmware).

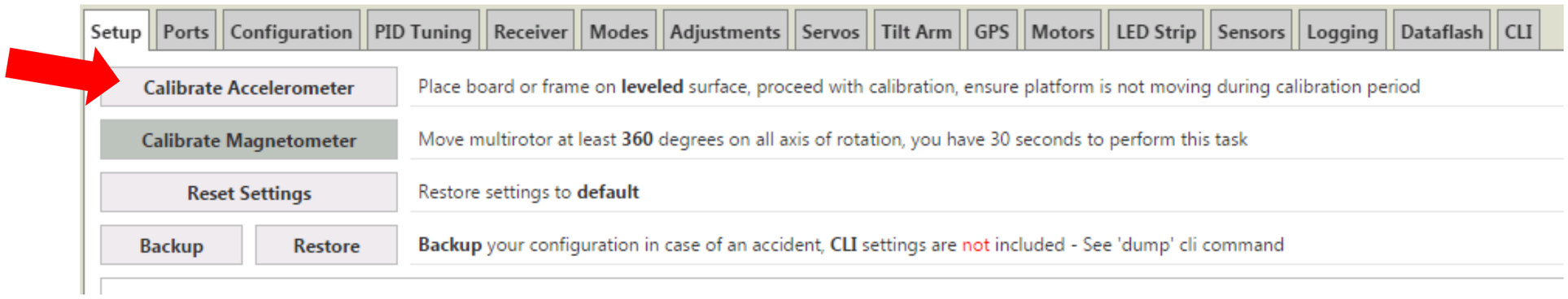


Then clic on 'Load Firmware (Online)' and finally click on 'Flash Firmware'. Done!! You are ready to 'Connect' to the board and start setting up the firmware parameters.



Setup tab

After flashing the firmware click on 'Connect'. Place the **quadcopter on a flat and stable surface and calibrate the accelerometer** (if you are using the Naze Full version, calibrate also the magnetometer doing the 'compass dance' explained in a number of videos on Youtube (we will assume you are using the Naze Acro version (no magnetometer or barometer).

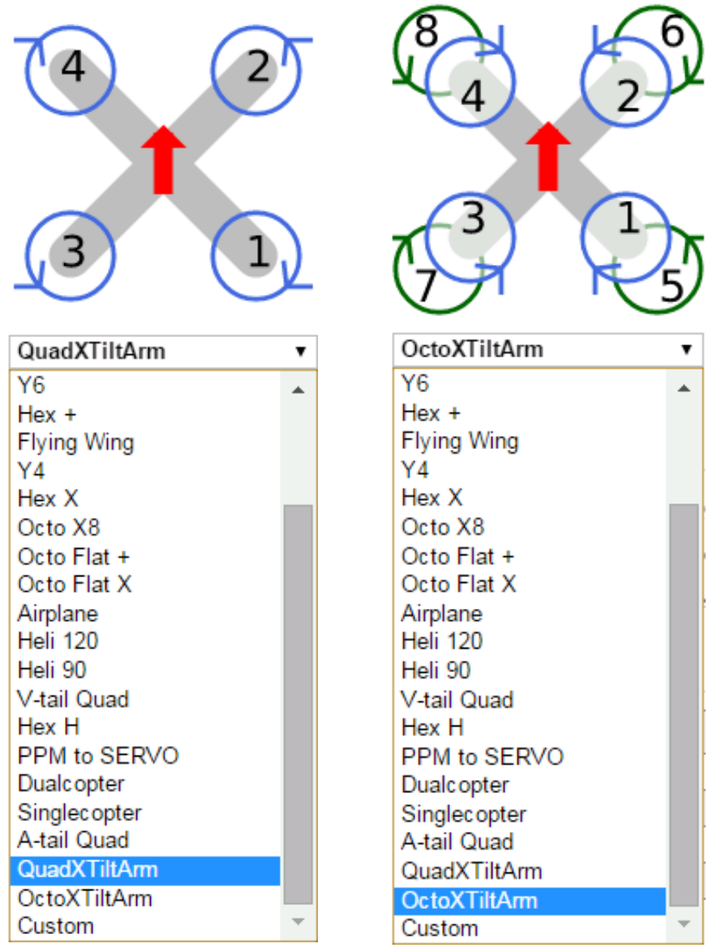


Configuration tab

In the Configuration tab:

1. Choose the **QuadXTiltArm** or **OctoXTiltArm** (for X8 multicopters)
2. Write the proper rotation angle for 'Board alignment' (TIP: we like the USB port of Naze pointing to the right of the quad, in that case you must write '−90' in the field 'Yaw adjustment')
3. Tick the options 'Motor stop' and 'Oneshot125' if you like and your ESCs support oneshot125
4. Select RX_PPM if you use PPM to communicate from Recevier to Naze or select the option that matches your configuration

   Change the rest of parameters according to your liking (general manual HERE) and click 'Save and reboot' on the bottom of the page.



Receiver Mode

Enabled	Feature	Description
◉	RX_PPM	PPM RX input
○	RX_SERIAL	Serial-based receiver (SPEKSAT, SBUS, SUMD)
○	RX_PARALLEL_PWM	PWM RX input
○	RX_MSP	MSP RX input

PID setup and CLI tab

We have field tested the code with ‘multiwii’ (PID_controller = 0) and ‘luxfloat’ (PID_controller = 2). Other PID controllers should also work but right now their use is under your responsability. We recommend you to change the following parameters in the CLI tab (if you use other ESCs, you can use any other looptime, we use 2000 for the Rctimer ESCs):

- set looptime = 2000
- acc_lpf_factor = 100
- save

Choose looptime according to your ESC max frequency:

3500 - 286Hz

3000 - 333Hz

2500 - 400Hz

2000 - 500Hz (Rctimer 30A mini ESC)

1600 - 600Hz

In the **<u>Annex A</u>** at the end of this document you’ll find screenshots of the latest settings where TILT starts getting in shape from the tuning perspective.

Receiver and Modes tabs

Use the regular Naze manuals (as the ones linked above) for setting these tabs up.

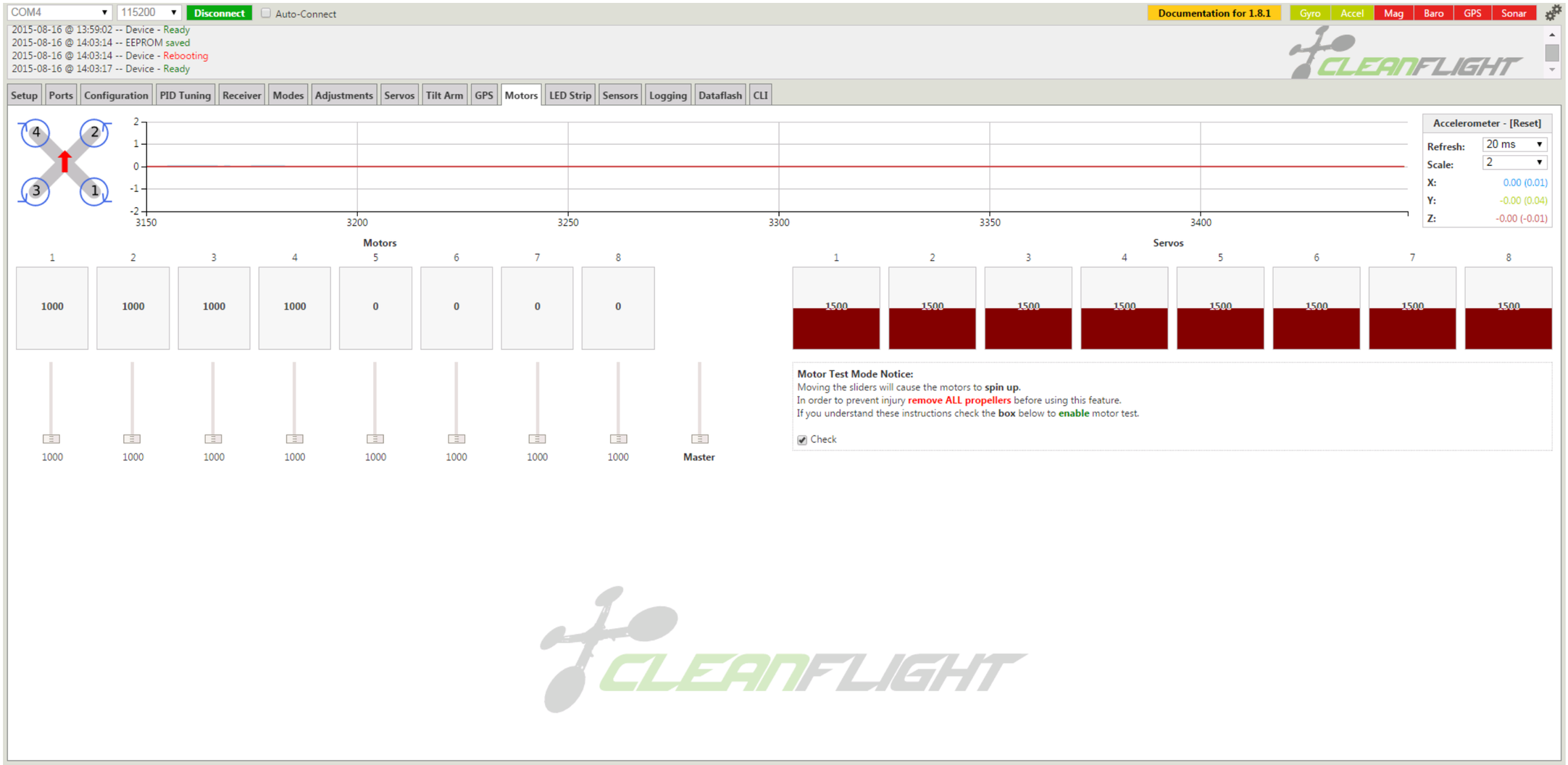
Motors tab

First of all: do NOT power up any ESC if it doesn't have a motor soldered on it: the motor inductance is necessary for the correct operation of the ESC, otherwise the ESC can get damaged.

Check the spin directions of the motors in this tab: with the PDB, ESCs and motors soldered and the ESC's signal cables connected to the Naze, connect a battery to the system (**ensure you don't have any propeller in the motors!!**). Tick on the 'Check' box and spin each motor a bit (**it is not good to spin the motors at high speed and/or long time with no load**) to check:

a) Each ESC is connected to the correct Naze motor ouptut by checking the diagram of motor numbering
b) Spin directions by checking the diagram of motor numbering

If you have any motor spinning the wrong way, just switch ANY two of the three cable connections that go from the ESC to motor.


COM4
115200
Disconnect
Auto-Connect
Documentation for 1.8.1
Gyro
Accel
Mag
Baro
GPS
Sonar
2015-08-16 @ 13:59:02 -- Device - Ready
2015-08-16 @ 14:03:14 -- EEPROM saved
2015-08-16 @ 14:03:14 -- Device - Rebooting
2015-08-16 @ 14:03:17 -- Device - Ready
CLEANFLIGHT
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Tilt Arm
GPS
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Sensors
Logging
Dataflash
CLI
Accelerometer - [Reset]
Refresh:
20 ms
Scale:
2
X:
0.00 (0.01)
Y:
-0.00 (0.04)
Z:
-0.00 (-0.01)
Motors
Servos
1000
0
1500
Master
Motor Test Mode Notice:
Moving the sliders will cause the motors to spin up.
In order to prevent injury remove ALL propellers before using this feature.
If you understand these instructions check the box below to enable motor test.
Check

Servos tab

For our supplied Emax ES-09xx servos the PWM values you should set are shown in the picture below. Check the Belt Tensioning Video before setting up this tab.

Once those values are set, you can then chose the desired forward ('MAX limit deg') and backwards ('MIN limit deg') maximum angle with respect to the vertical direction of the motors. Do not use negative values here: they are taken into consideration internally.

						Change Direction in TX To Match
Name	0deg PWM	90deg PWM	180deg PWM	MIN limit deg	MAX limit deg	CH1
Pitch Servo	600	1500	2400	70	70	☐

NOTE: During our tests of several servo brands we found out that servos come calibrated in different ways, and some can't even do a real full 180° (even forcing the PWM out of the recommended specs, especially digital ones, which are limited by firmware, at least all those we tested). If you use other servos than the EMAX ES-09xx, it is very important to properly set up the 'MIN limit deg' and 'MAX limit deg':

1. Find a way to be able to measure any angle in the for- and backwards direction (e.g. a square sheet of paper folded in the diagonal will give you a good 45 degrees measuring tool (we'll use this value as example now).
2. Write '45' degress on both 'MIN limit deg' and 'MAX limit deg'.
3. Go full elevator up/down and change the '180deg PWM' / '0deg PWM' values to those that give you the 45 degrees motor angle.

Tilt arm tab

This setup is very important to make the firmware math work correctly, please check your servo before every flight.

	If at any time you hear the Servo forcing its position and getting hot to the touch, turn the sistem off and let him cool down. Possible causes of overheating are physical limitation reached (decrease min/max limit in servo tab) or something is preventing the servo to move, like too much tension on the belt or high friction on the polymer bearings or motor cables too short

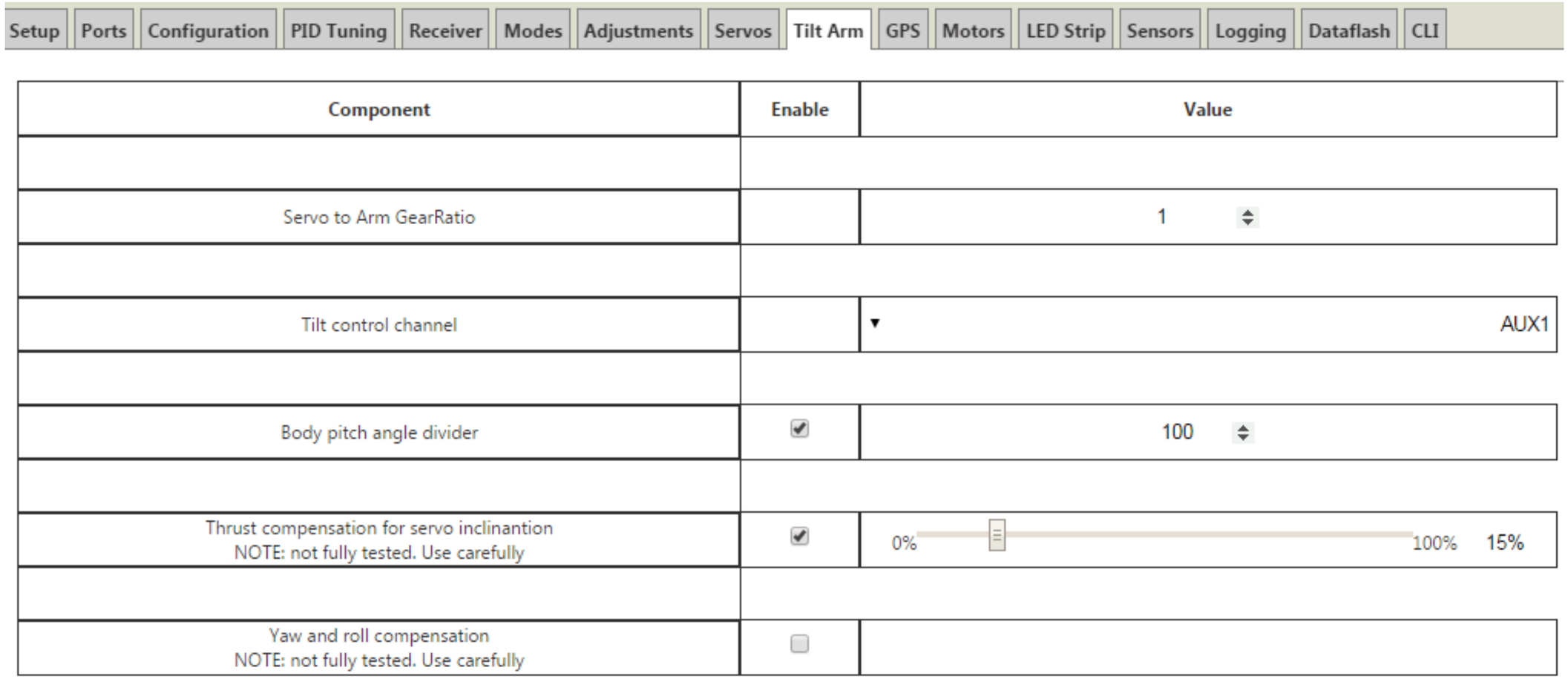
1. Select the proper '*Servo Arm Gear Ratio*' (=1 for TILT v1.x). That is simply the value resultant from dividing:

$$Gear\ ratio = \frac{servo\ pulley\ number\ of\ teeth}{arm\ pulley\ number\ of\ teeth}$$

2. Select the receiver '*Tilt control channel*' that you will use to change between dynamic tilting and fixed tilt: any value there below 1500 µs will activate dynamic tilting. However, above 1500 µs, this channel will fix the motors inclination to the corresponding PWM value (only forward). Therefore, if this channel is a potentiometer, the upper half pot travel allows you to set any fixed motor angle up to the value 'MAX limit deg' from the Servos tab. Or, you can just use a two-position switch here and set one position to

a value under 1500 µs and the other to a pre-determined motor inclination from 0° and forward. If you don't want to use any fixed tilt arm, just chose an AUX channel that is always kept at under 1500 PWM value.

3. '*Body pitch angle divider*': if enabled, the smaller the value there, the less body inclination the TILT Drone will have. For instance, with 1 the body will picth normally, with 10 it will pitch 10 times less, etc. We found out **30 is a good starting value** to have a bit of visual feedback in LOS or from the FPV camera to know what the quad is doing but still having the camera facing forward in fast forward velocity.
4. '*Thrust compensation for servo inclination*': as the motors tilt you will loose altitude. This feature tries to help you keep an horizontal fly path adding thrust when needed so that you have to work less on the throttle stick to keep a leveled flight. The slider rapresents the throttle stick position in hovering. This is very important to set correctly since, a too high value will make your quad compensate too much and fly away without control: **start with a low value ALWAYS (for instance 10%). Please be careful while setting this parameter, and be prepared to disarm your engine using a switch (DON'T USE ARM/DISARM USING TROTTLE/YAW STICK).**
5. '*Yaw and roll compensation*': the more the motors tilt forward or backward from the vertical orientation, the more mixed are the yaw and roll axis, i.e. that a yaw input has a roll component on the craft and viceversa. In the limit, when the motors are 90° forward or backwards (i.e. horizontal) yaw will became roll viceversa. This setting tries to mix the yaw and roll results from the PIDs to minimize unwanted effects, especially in banked/coordinated turns.


Setup
Ports
Configuration
PID Tuning
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Modes
Adjustments
Servos
Tilt Arm
GPS
Motors
LED Strip
Sensors
Logging
Dataflash
CLI
Component
Enable
Value
Servo to Arm GearRatio
1
Tilt control channel
AUX1
Body pitch angle divider
100
Thrust compensation for servo inclinantion
NOTE: not fully tested. Use carefully
0%
100%
15%
Yaw and roll compensation
NOTE: not fully tested. Use carefully

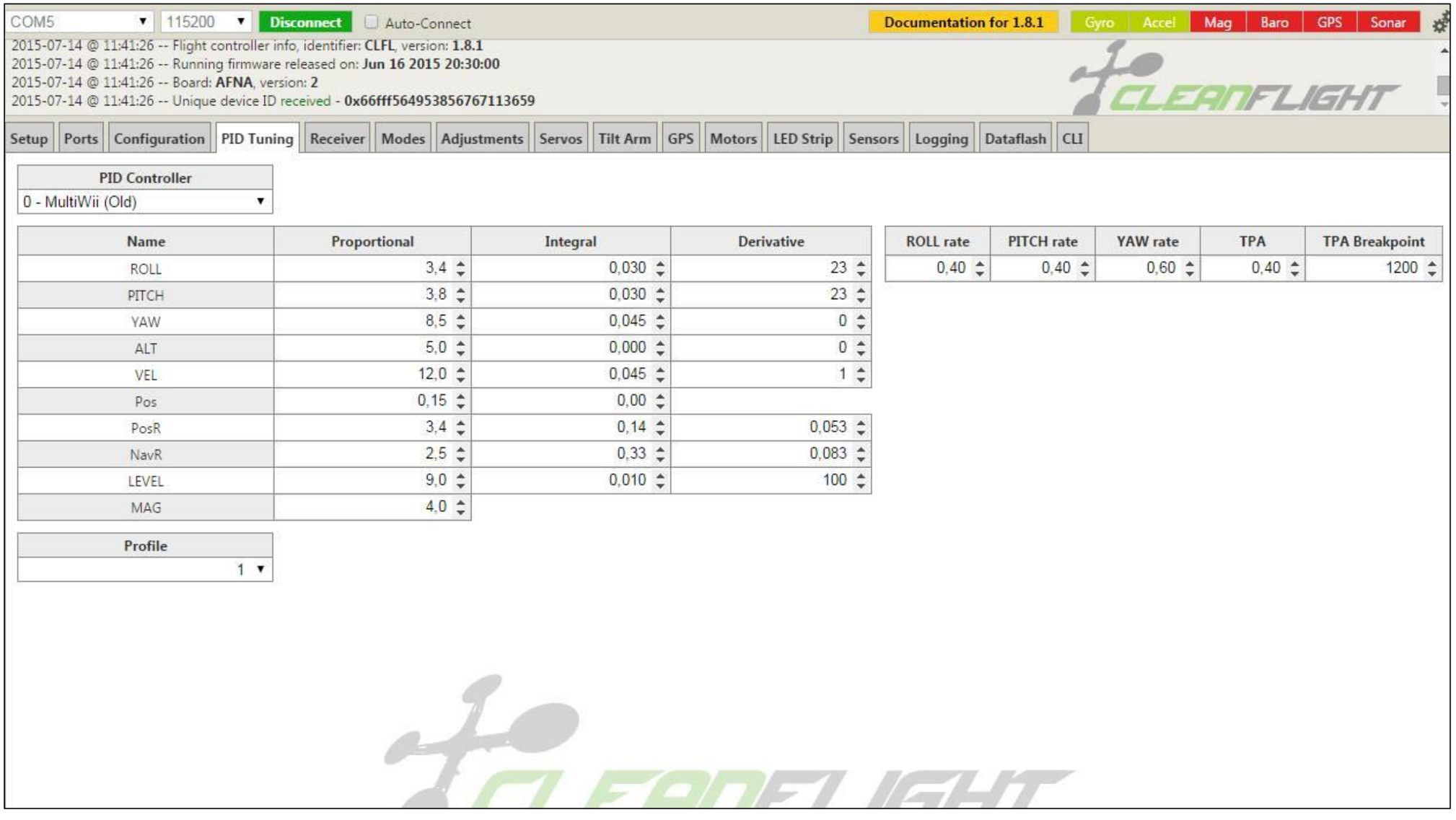
Annex A: Cleanflight settings

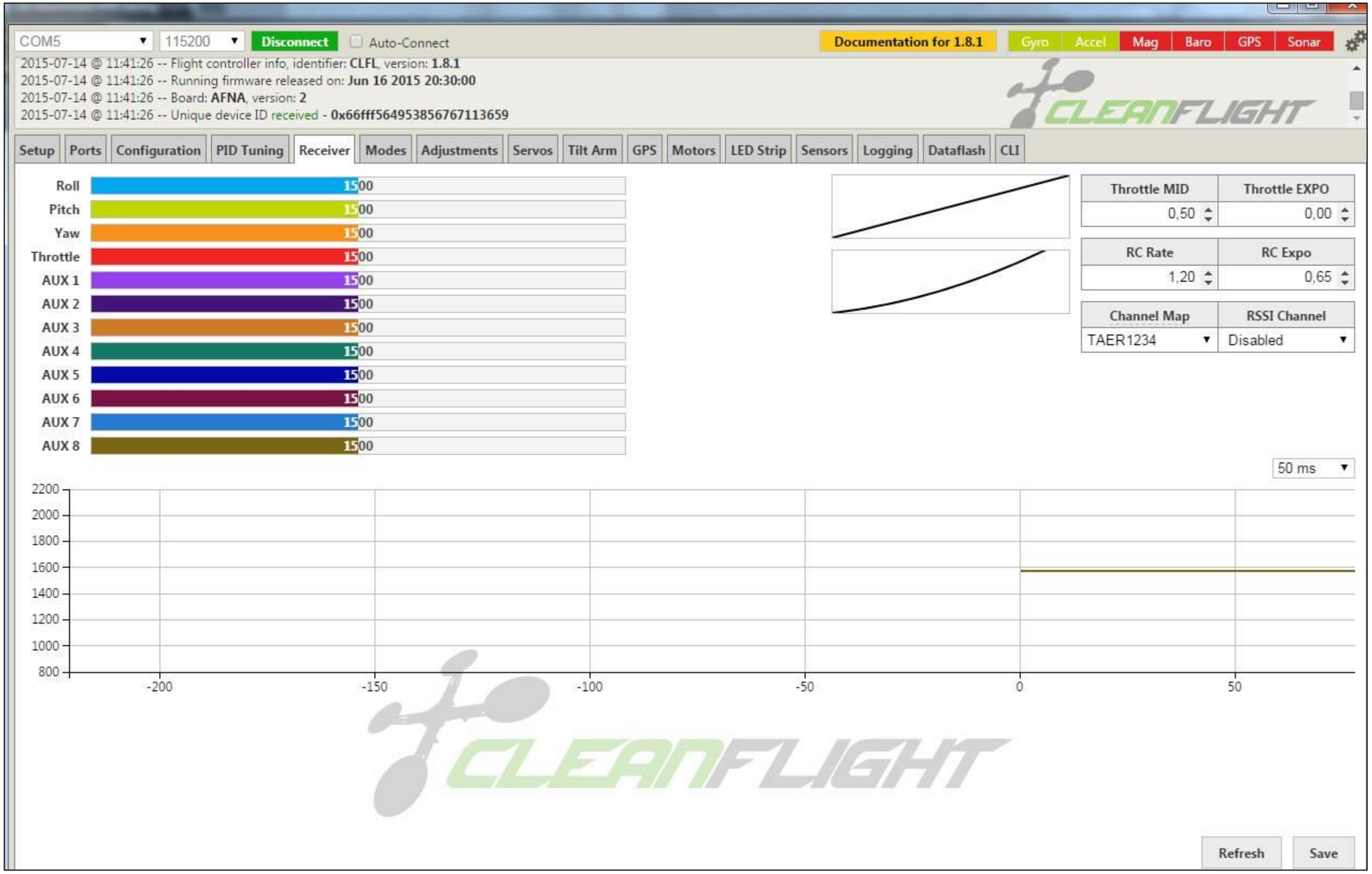
Here you'll find the latest settings and, when possible, videos flying with such values.

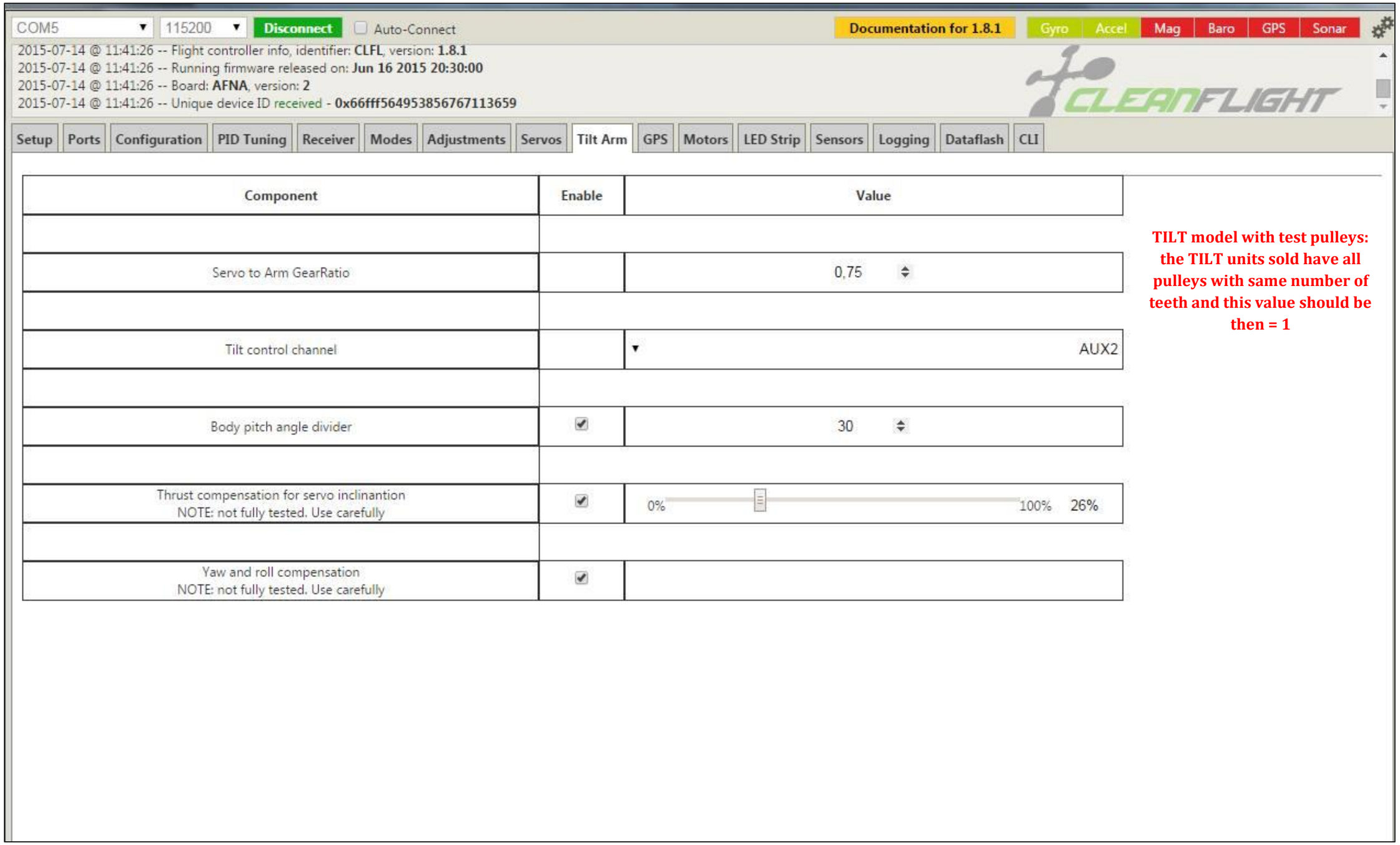
Tuning session #2 (15-07-2015)

If attempting to roll please increase the rates from those shown in the following screenshots!

VIDEO: https://youtu.be/rpzbqyvrSlI




COM5
115200
Disconnect
Auto-Connect
Documentation for 1.8.1
Gyro
Accel
Mag
Baro
GPS
Sonar
2015-07-14 @ 11:41:26 -- Flight controller info, identifier: CLFL, version: 1.8.1
2015-07-14 @ 11:41:26 -- Running firmware released on: Jun 16 2015 20:30:00
2015-07-14 @ 11:41:26 -- Board: AFNA, version: 2
2015-07-14 @ 11:41:26 -- Unique device ID received - 0x66fff564953856767113659
Setup
Ports
Configuration
PID Tuning
Receiver
Modes
Adjustments
Servos
Tilt Arm
GPS
Motors
LED Strip
Sensors
Logging
Dataflash
CLI
Roll
Pitch
Yaw
Throttle
AUX 1
AUX 2
AUX 3
AUX 4
AUX 5
AUX 6
AUX 7
AUX 8
1500
Throttle MID
0,50
Throttle EXPO
0,00
RC Rate
1,20
RC Expo
0,65
Channel Map
TAER1234
RSSI Channel
Disabled
50 ms
2200
2000
1800
1600
1400
1200
1000
800
-200
-150
-100
-50
0
50
Refresh
Save



TILT model with test pulleys: the TILT units sold have all pulleys with same number of teeth and this value should be then = 1

Code Number: MD04001-00-0810 v1.0

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