



Builders guide – FlightClub PROton (Witchcraft)

Safety First

Please build, fly and configure your drone safely. Moving propellers and mishandled lithium batteries can cause serious damage to person and property. It is your responsibility to operate **safely when flying and handling your 'drone'!**

Some related external resources (by no means exhaustive!): -

- [The Home of British FPV Racing](#)
- [Dronesafe](#)



Why build this quad?

FPV FlightClub is a US store who also design frames (and sponsor racing Pilots). The attention to detail FlightClub invest in their frames is spectacular, their Tokio was the first frame I was aware of to use chamfered edges on the carbon, they tried many different types of carbon (a lot of manufacturers say this but in FlightClubs **case I was involved in some of the testing) and the “Buttermount” is just brilliant.**

The Proton is the latest frame from FlightClub and is a light frame which can be configured a number of ways, the version we are building here is the Skeleton, the lightest one and I have to say, having built it it flies spectacularly well.

The frame has all the usual features from FlightClub such as Buttermount for the flight controller, countersunk screws so you have a flat bottom – no screw head damage to the LiPo, mounts for a micro cam, VTX antenna and RX antennae, a mount point for the VTX and an innovative aluminium plate which removes the requirement for lock nuts.

Quite honestly this is the cleanest build I have, nothing is held in place with zip ties, nothing is attached to the top plate, it just fits. On top of this it flies superbly, my first **flight I referred to it as “Witchcraft” and honestly, I stick by it.**

Don't be deceived by the description as being “Racing Quad”, this thing makes an excellent acro quad, there are arms options that can be used to make it more suited to that. It is simply the best frame I have

Parts list

Frame: FlightClub PROton Ultralight Racing Quad

Flight Stack: Sunrise Siskin 4 in 1 30A ESC, F4 FC and OSD (2-4S)

Motors: BrotherHobby Returner R5 2306 2450kv (Deadpool are always popular but I prefer the RedHulks, the photos never do them justice, they are not flat scarlet but bright metallic red, see the photo at the front

VTX: TBS Unify Pro HV Race

Camera: Foxeer Arrow Micro (Runcam Swift Micro will fir just as well, but I prefer the Foxeer, it has proved more robust)

Receiver: FrSky XM+

VTX antenna: Lumenier Axii ufl

Ancillary Parts: XT60 connector, shorter standoffs (20mm) can be used

Tools: Soldering iron and solder, side trimmers, craft knife, hot glue gun, hex drivers, blue threadlock

Other useful stuff: files and wet-and-dry paper, hot air gun, tweezers.

Preparation and Dry Build

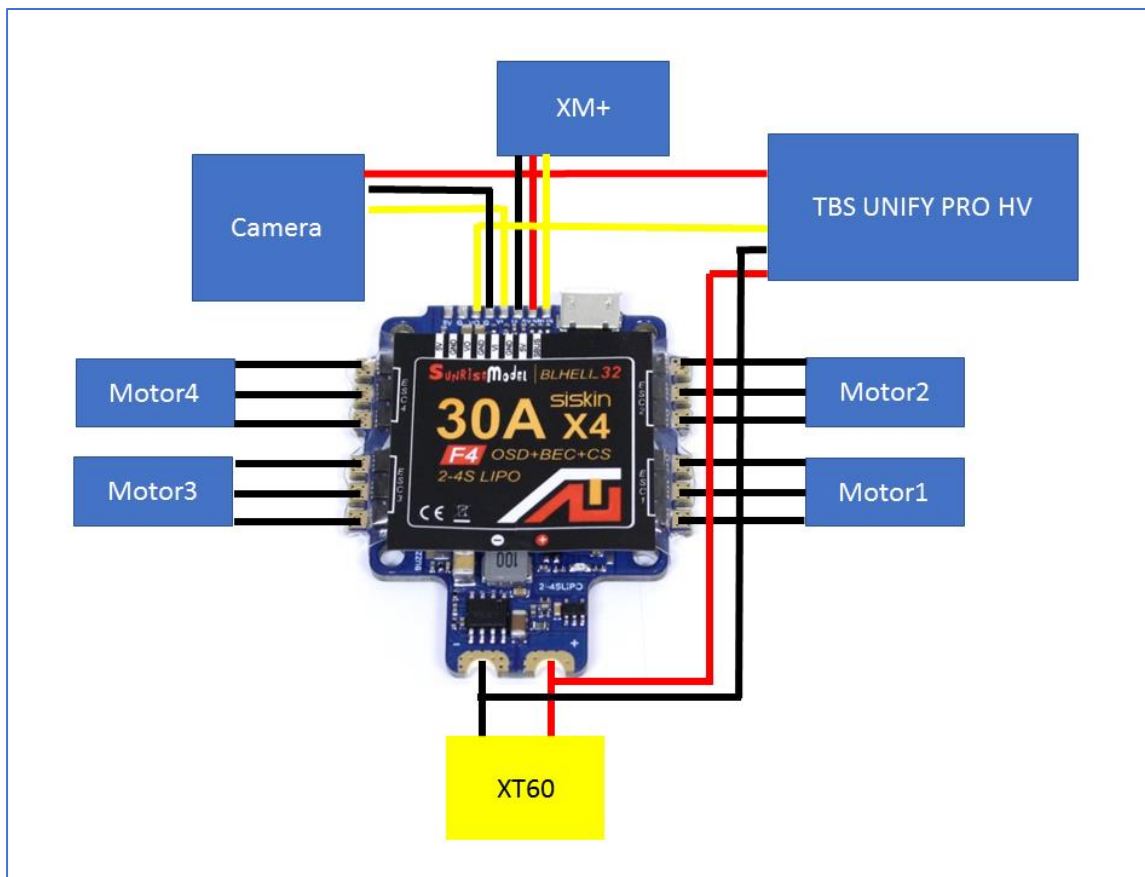
There is no prep work required on this quad, FlightClub are pretty good at making sure everything is right. Dry building the frame is always recommended to work out where everything fits. FlightClub have done a nice video that shows how to assemble the quad and in the interest of not reinventing the wheel it can be found here:

<https://www.youtube.com/watch?v=XuWfn1731PA&t=29s>

The xm+ sits below the flight controller with the bind button visible through the bottom of the frame (although the battery strap may need to be moved to access it). There is a carbon plate which sits above the flight controller and the VTX comes with double sided tape which can be used to stick it to the plate.

Wiring Diagram

Below is the wiring diagram for the Quad:





The Build

It is important to check the flight controller can connect to Betaflight and the gyro is working correctly before soldering anything, once something is soldered to the board it will void any warranty.

Use of a flux pen and a small tip on the soldering iron is recommended as the pads on the flight controller are quite small.

I found it easiest to mount the flight controller and motors and then cut wires and solder. The order which is easiest is:

- XT60 connector
- Motors
- The rest

This approach means you will not be applying a lot of heat to the board to connect something like an XT60 ground when something has a much smaller connection and could get de-soldered by heat wicked from the XT60

It is generally good practice to use the following approaches:

- Use a smoke stopper during testing
- Use a multimeter to check the continuity (or lack of) before testing anything
- Do one component at a time and test before moving on to the next one

Configuration

There are three things to configure; the Flight controller, the ESCs and the FPV components, a couple of general rules:

1. PROPS -never ever ever plug the LiPo in with props on when you are working on your quad. Quite aside from any damage to your equipment, this is likely to cause a very angry, sharp and fast moving set of blades to make contact with your face or hands and result in very serious injury. Always remove the props when working on the quad, it is a pain in the bum but you do not want to learn the lesson the hard way. Make it a habit.
2. It is assumed the radio has been bound to the receiver, there are many guides available on how to do this as well as instructions that come with the receiver

Configuring the Flight controller – Butterflight?

First we are going to use Butterflight here. I have set the quad up using Betaflight and it worked fantastically. However there are builders guides already which explain how to flash and configure Betaflight and the can be used for this quad just fine. Butterflight is the new kid on the block so it is being used as an example.

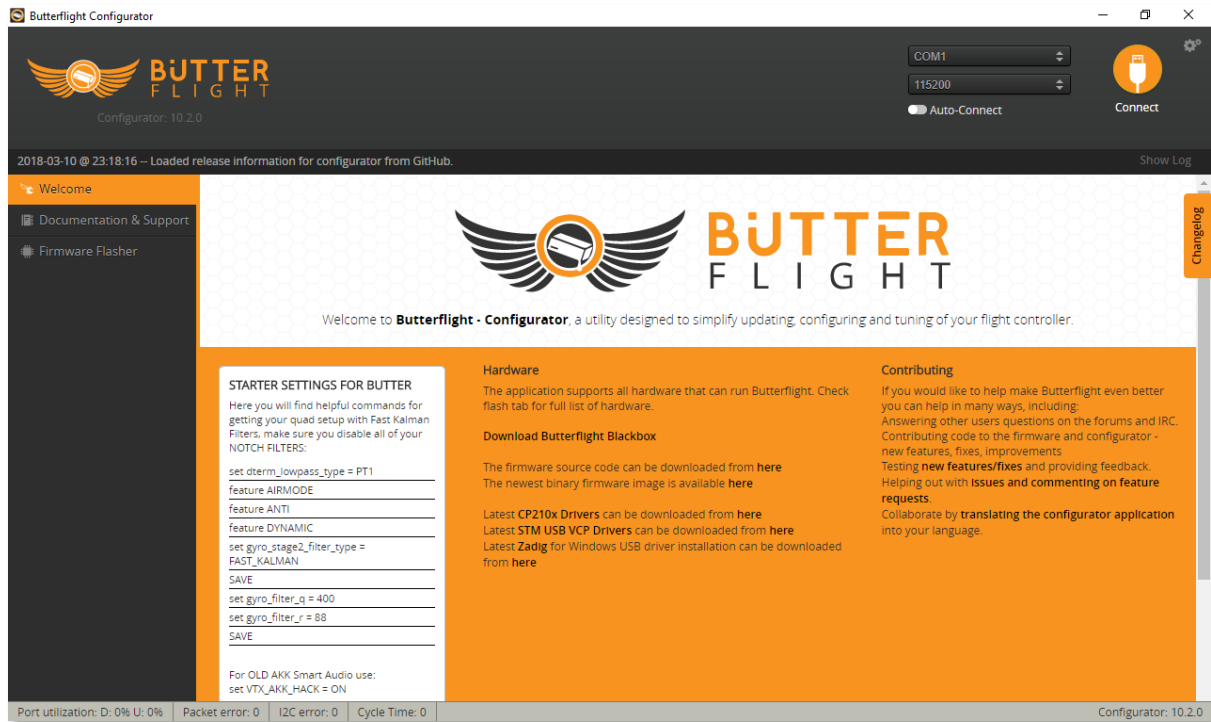
To install Butterflight you need to download the Butterflight configurator from here and install it



<http://butterflight.co/>

Go to the “get Butterflight Configurator” **button** and **click it then click on the version** of configurator for your operating system and it will download, then run the install program in the download and the configurator will install.

When you open the configurator it will look very familiar:

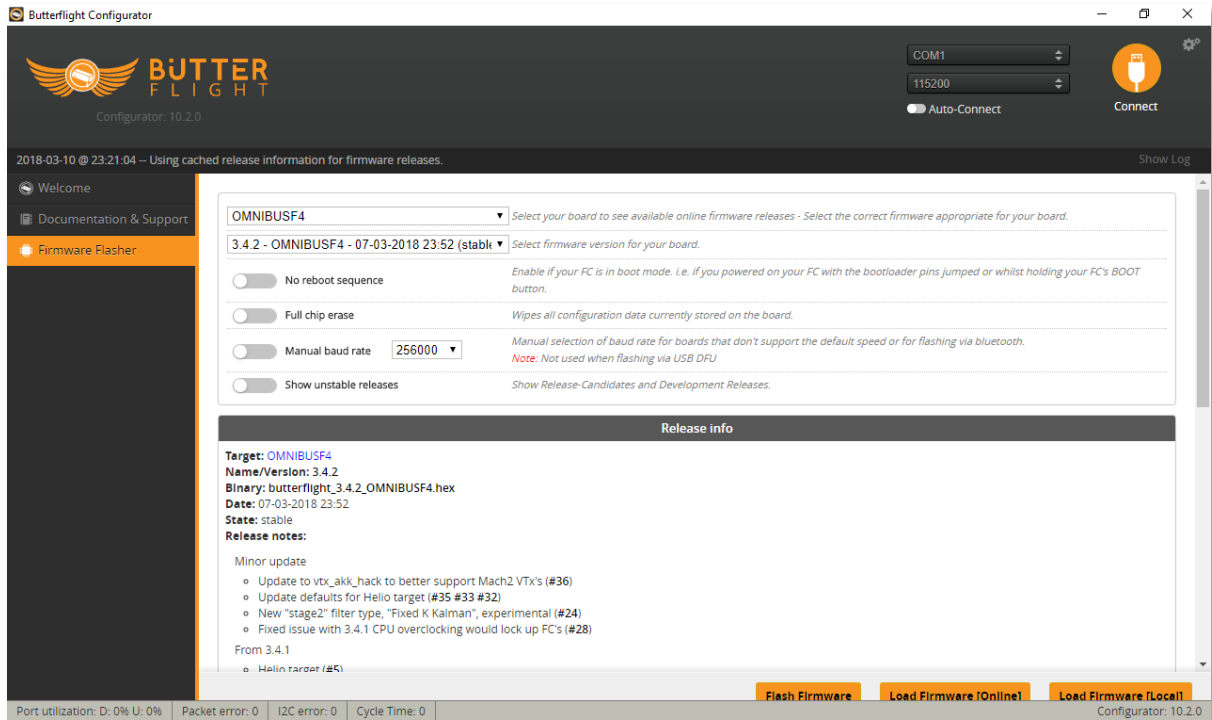


Notice the white panel on the left side entitled “**Starter settings for Butter**”, it is worth taking a copy of these, although we are going to adjust them slightly.

Plug the flight controller into the PC **go to the “Flash Firmware” tab.**

From the top drop down select OMNIBUS F4

From the second drop down select the latest stable version, then click on Load Firmware (online) at the bottom and once the firmware has loaded click on Flash Firmware



The firmware should flash but if it is the first time Butterflight has been flashed the board may not go into DFU mode (because it does not match the existing firmware), this can be fixed by either using the boot button when you plug the USB in or by using Betaflight configurator and using the DFU command then switching to the Butterflight configurator.

The latest version of Butterflight will then flash to the board.

Make use the com port is shown at the top and then click on Connect

Go to the ports tab and set UART1 to Serial rx and click Save and Reboot



The screenshot shows the Butterflight Configurator software interface. The top bar includes the Butterflight logo, version information (Configurator: 10.2.0, Firmware: BTR 3.4.2), and various sensor status icons (Gyro, Accel, Mag, Baro, GPS, Connet). A 'No dataflash chip found' warning is present. The main content area is titled 'Ports' and contains a table with columns for Identifier, Configuration/MSP, Serial Rx, Telemetry Output, Sensor Input, and Peripherals. The table lists four ports: USB VCP, UART1, UART3, and UART6. Each port has a toggle for Configuration/MSP (set to 115200), a Serial Rx toggle, and dropdown menus for Telemetry Output and Sensor Input. A 'Save and Reboot' button is at the bottom right. The status bar at the very bottom shows port utilization, packet error, I2C error, cycle time, CPU load, and firmware information.

Identifier	Configuration/MSP	Serial Rx	Telemetry Output	Sensor Input	Peripherals
USB VCP	<input checked="" type="checkbox"/> 115200	<input type="checkbox"/>	Disabled AUTO	Disabled AUTO	Disabled AUTO
UART1	<input type="checkbox"/> 115200	<input checked="" type="checkbox"/>	Disabled AUTO	Disabled AUTO	Disabled AUTO
UART3	<input type="checkbox"/> 115200	<input type="checkbox"/>	Disabled AUTO	Disabled AUTO	Disabled AUTO
UART6	<input type="checkbox"/> 115200	<input type="checkbox"/>	Disabled AUTO	Disabled AUTO	Disabled AUTO

Once the board has rebooted, reconnect and go to the Configuration tab

In the mixer pane, enable “Motor Direction is Reversed”

In the ESX/Motor Features select DShot1200 from the drop down.

I also enable motor stop because I prefer to use Air Mode on a switch so I can disable it for landing, this stops the infamous Air Mode bounce landings and allows me to stop the motors by dropping the throttle when I land.



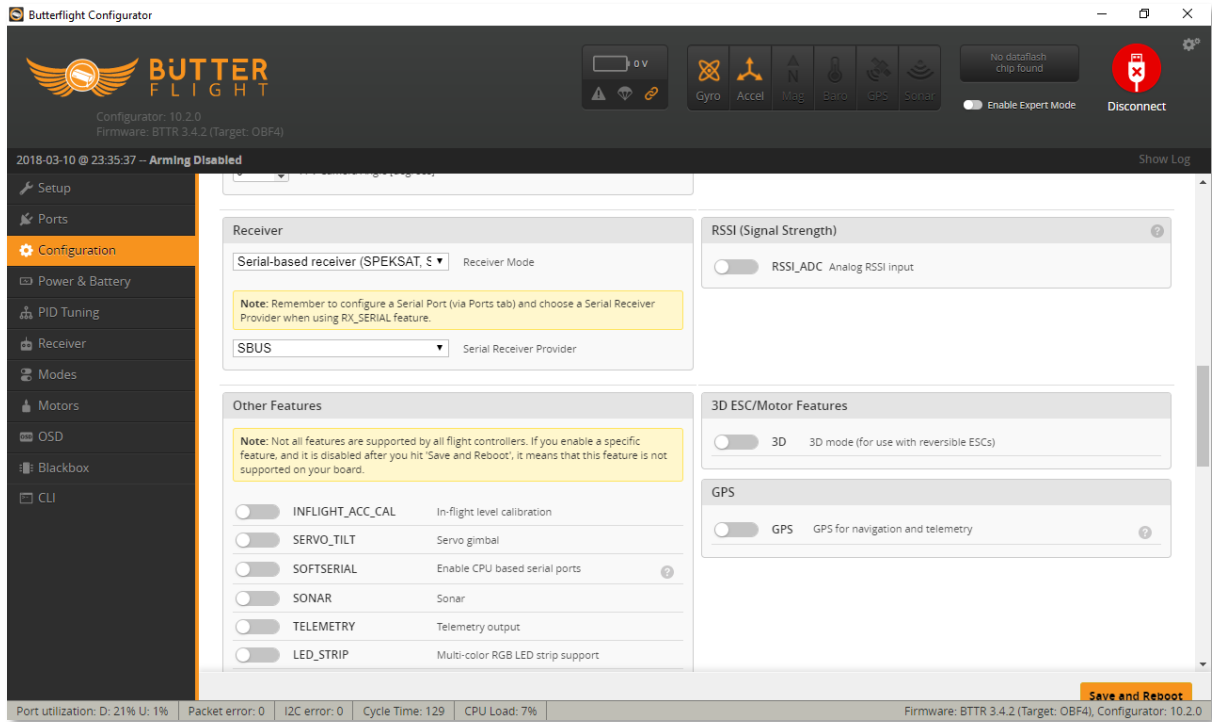
The screenshot shows the Butterflight Configurator interface. The left sidebar has 'Configuration' selected. The main panel is titled 'Configuration' and contains several sections: 'Mixer' with a 'Quad X' dropdown and a diagram of a quadcopter with motors 1-4 and a 'reversed' label; 'ESC/Motor Features' with 'DSHOT1200' selected and 'MOTOR_STOP' checked; and 'Board and Sensor Alignment' with 'Roll Degrees', 'Pitch Degrees', 'GYRO Alignment', 'ACCEL Alignment', and 'MAG Alignment' all set to 'Default'. A 'Save and Reboot' button is at the bottom right. The status bar at the bottom shows 'Port utilization: D: 21% U: 1%', 'Packet error: 0', 'I2C error: 0', 'Cycle Time: 125', 'CPU Load: 7%', and 'Firmware: BTR 3.4.2 (Target: OBF4), Configurator: 10.2.0'.

Scroll down, in the System Configuration panel set the PID loop Frequency to 8Khz and disable the Barometer and Magnetometer

In the personalisation Panel enter the Quad or Pilot name

The screenshot shows the Butterflight Configurator interface with the 'System configuration' panel selected. A yellow note reads: 'Note: Make sure your FC is able to operate at these speeds! Check CPU and cyclotime stability. Changing this may require PID re-tuning. TIP: Disable Accelerometer and other sensors to gain more performance.' The 'Gyro update frequency' and 'PID loop frequency' are both set to '8 kHz'. The 'Accelerometer', 'Barometer (if supported)', and 'Magnetometer (if supported)' are all disabled. The 'Personalization' section has 'Adam' entered as the 'Craft name'. The 'Arming' section has 'Maximum ARM Angle [degrees]' set to '25'. A 'Save and Reboot' button is at the bottom right. The status bar at the bottom shows 'Port utilization: D: 21% U: 1%', 'Packet error: 0', 'I2C error: 0', 'Cycle Time: 125', 'CPU Load: 7%', and 'Firmware: BTR 3.4.2 (Target: OBF4), Configurator: 10.2.0'.

Scroll down, in the Receiver Panel set the Serial Receiver Provider to SBus



Scroll down and in the Other Features Panel, ensure the follow are the features that are enabled:

OSD

Anti_Gravity

Dynamic_Filter

I also disable all beeper settings (**because there isn't a beeper on the quad**)

Then click on Save and Reboot



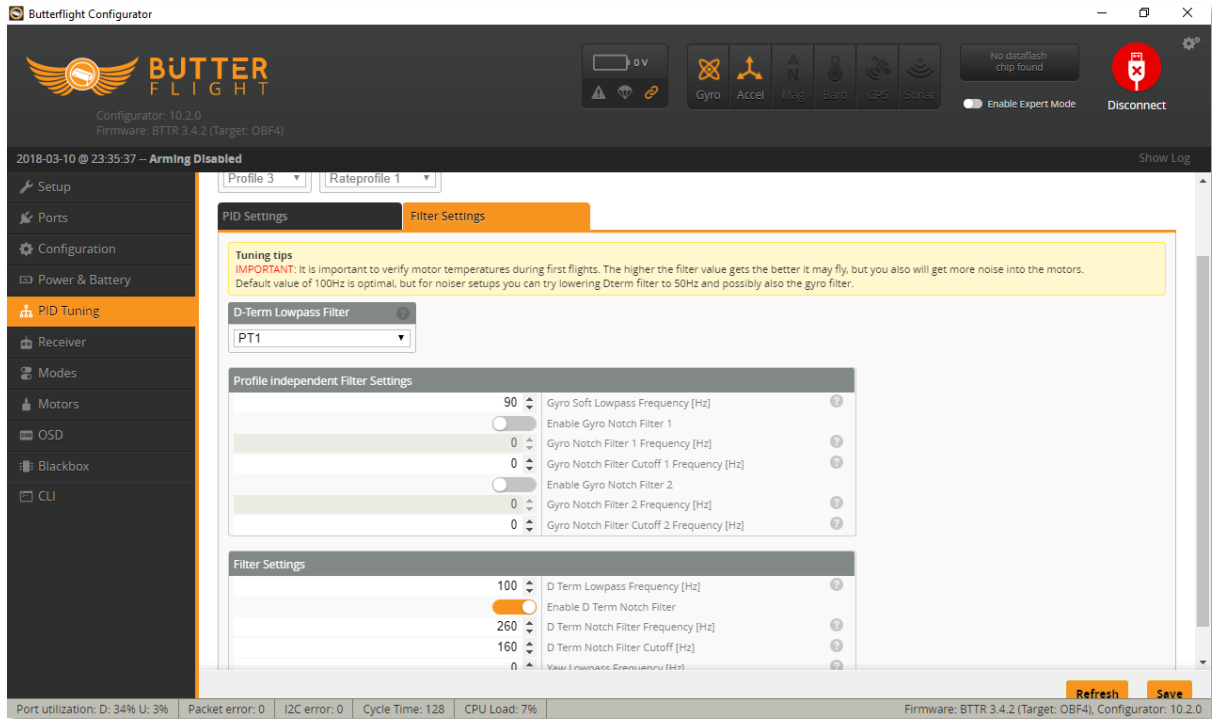
When the Flight Controller has rebooted, reconnect.

Go to the PID tuning tab, the PIDs show below are ballpark, it will vary depending on what props you are using as well as if you use different arms, different lipos, etc:

The rates are what I use for general flying, you should put your own rates in



Then go to the Filter Settings section and ensure it is set up as shown below and click on Save



Go to the Receiver Tab

From the Channel map drop down select Spktrum / Graupner / JR

From the RSSI channel drop down select Aux 12

Click on Save



The screenshot shows the Butterflight Configurator interface. The 'Receiver' tab is active, displaying various configuration options. The left sidebar shows navigation options: Setup, Ports, Configuration, Power & Battery, PID Tuning, Receiver (selected), Modes, Motors, OSD, Blackbox, and CLI. The main content area includes a warning box, a list of channels (Roll [A], Pitch [E], Yaw [R], Throttle [T], and AUX 1-14) with their corresponding pulse widths, and a 'Channel Map' section with dropdown menus for 'TAER1234' and 'RSSI Channel' set to 'AUX 12'. Below this are sections for 'Stick Low' Threshold (1050), 'Stick Center' (1500), 'Stick High' Threshold (1900), 'RC Deadband' (3), 'Yaw Deadband' (3), and '3D Throttle Deadband' (50). The 'RC Interpolation' is set to 'Auto'. At the bottom, there are 'Refresh' and 'Save' buttons. The status bar at the very bottom shows system metrics like port utilization, packet error, I2C error, cycle time, CPU load, and firmware version.

Go to the Modes Tab

Set up the modes as required, in the screen shot below I am using:

A three position switch on Aux 1 to give Disarmed / Armed / Armed and Air Mode

A three position switch on Aux 2 to give Rate mode / Horizon Mode / Angle mode

A momentary switch on Aux 3 to give Pre Arm

Click Save when done



Butterflight Configurator

BUTTERFLIGHT
Configurator: 10.2.0
Firmware: BTTR 3.4.2 (Target: OBF4)

2018-03-11 @ 00:00:26 -- EEPROM saved

Setup
Ports
Configuration
Power & Battery
PID Tuning
Receiver
Modes
Motors
OSD
Blackbox
CLI

Modes

Use ranges to define the switches on your transmitter and corresponding mode assignments. A receiver channel that gives a reading between a range min/max will activate the mode. Remember to save your settings using the Save button.

ARM AUX 1
Min: 900 Max: 1700

ANGLE AUX 2
Min: 900 Max: 1300

HORIZON AUX 2
Min: 1300 Max: 1700

HEADFREE
Add Range

FAILSAFE
Add Range

Port utilization: D: 27% U: 2% Packet error: 0 I2C error: 0 Cycle Time: 128 CPU Load: 7%

Firmware: BTTR 3.4.2 (Target: OBF4), Configurator: 10.2.0

Butterflight Configurator

BUTTERFLIGHT
Configurator: 10.2.0
Firmware: BTTR 3.4.2 (Target: OBF4)

2018-03-11 @ 00:00:26 -- EEPROM saved

Setup
Ports
Configuration
Power & Battery
PID Tuning
Receiver
Modes
Motors
OSD
Blackbox
CLI

CAMERA CONTROL 1
Add Range

CAMERA CONTROL 2
Add Range

CAMERA CONTROL 3
Add Range

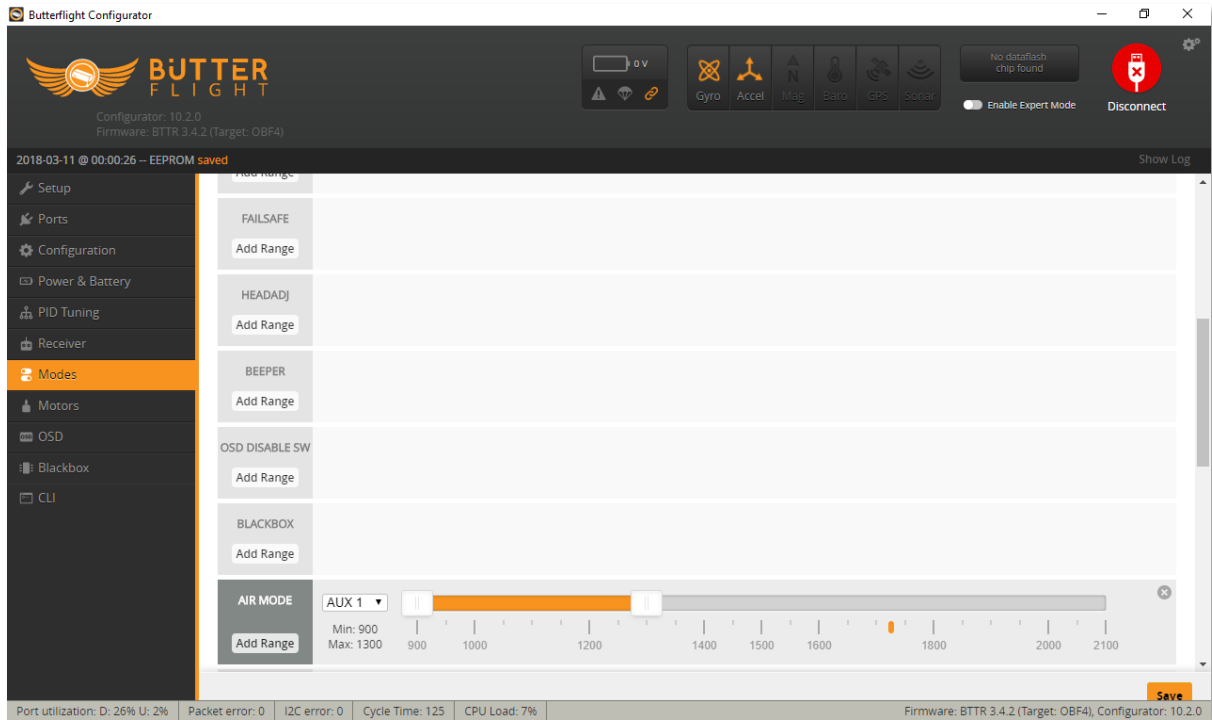
FLIP OVER AFTER CRASH
Add Range

PREARM AUX 3
Min: 1500 Max: 2100

VTX PIT MODE
Add Range

Port utilization: D: 23% U: 2% Packet error: 0 I2C error: 0 Cycle Time: 128 CPU Load: 7%

Firmware: BTTR 3.4.2 (Target: OBF4), Configurator: 10.2.0



Go to the Motor Tab

Here we are going to check the direction of rotation of the motors

Make sure you have removed your props

Click the I understand the risks switch in the bottom right quarter of the window,

Plug the lipo in.

One motor at a time, slowly raise the slider, until the motor starts to turn smoothly

Compare the direction the motor turns in to the corresponding arrow in the diagram at the top left,

Take a note of any motors that are spinning in the wrong direction

Stop that motor and go on to the next one

When all four motors are done disconnect the lipo



The screenshot shows the Butterflight Configurator interface with the 'Motors' tab selected. The top left features the Butterflight logo and version information (Configurator: 10.2.0, Firmware: BTR 3.4.2). The top right shows a battery level of 0V and various sensor status icons (Gyro, Accel, Mag, Baro, GPS, Sonar). A 'No dataflash chip found' warning is present. The main area displays a graph for motor RPM, a 'reversed' motor diagram, and a table of motor parameters. A 'Motor Test Mode / Arming Notice' is shown at the bottom right. The status bar at the bottom indicates 'Runaway Takeoff Prevention temporarily Disabled' and shows system metrics like CPU load and cycle time.

Go to the OSD tab and set up the OSD as required (features are enabled on the left and then can be drag and dropped on the screen).

Click Save when done

The screenshot shows the Butterflight Configurator interface with the 'OSD' tab selected. The top left features the Butterflight logo and version information. The top right shows the same sensor status icons. A 'No dataflash chip found' warning is present. The main area displays a 'Note' about OSD preview, a list of 'Elements' to be added to the OSD, a 'Preview' window showing a flight scene with 'BETA FLIGHT' and 'LOW VOLTAGE' text, and 'Video Format' and 'Timers' settings. The status bar at the bottom indicates 'EEPROM saved' and shows system metrics like CPU load and cycle time.



Go to the CLI tab.

It is possible to copy and paste the recommended settings from the front screen before connecting here, however we are going to change a little:

This is the current recommended settings:

Set `dterm_lowpass_type = PT1` We have already set this on the filter tab, but by all means do it again if you want

Feature AIRMODE This sets AirMode to be always on, as discussed above, this makes landing very difficult, instead we have set it up on a switch

Feature ANTI We have set this up already

Feature DYNAMIC Again we have already set this up

Set `gyro__stage2_filter_type = FAST_KALMAN` type this in and press return

Set `gyro_filter_q = 400`

Set `gyro_filter_r = 88` these are the recommended filter settings, however I have had quads where these produce heat in the motors, I strongly recommend `q = 300` and `r=80`, type the two lines in and hit return after each.

(note you can choose to use the recommended settings from butter flight, in the majority of quads these have been fine, but do keep an eye on motor temp)

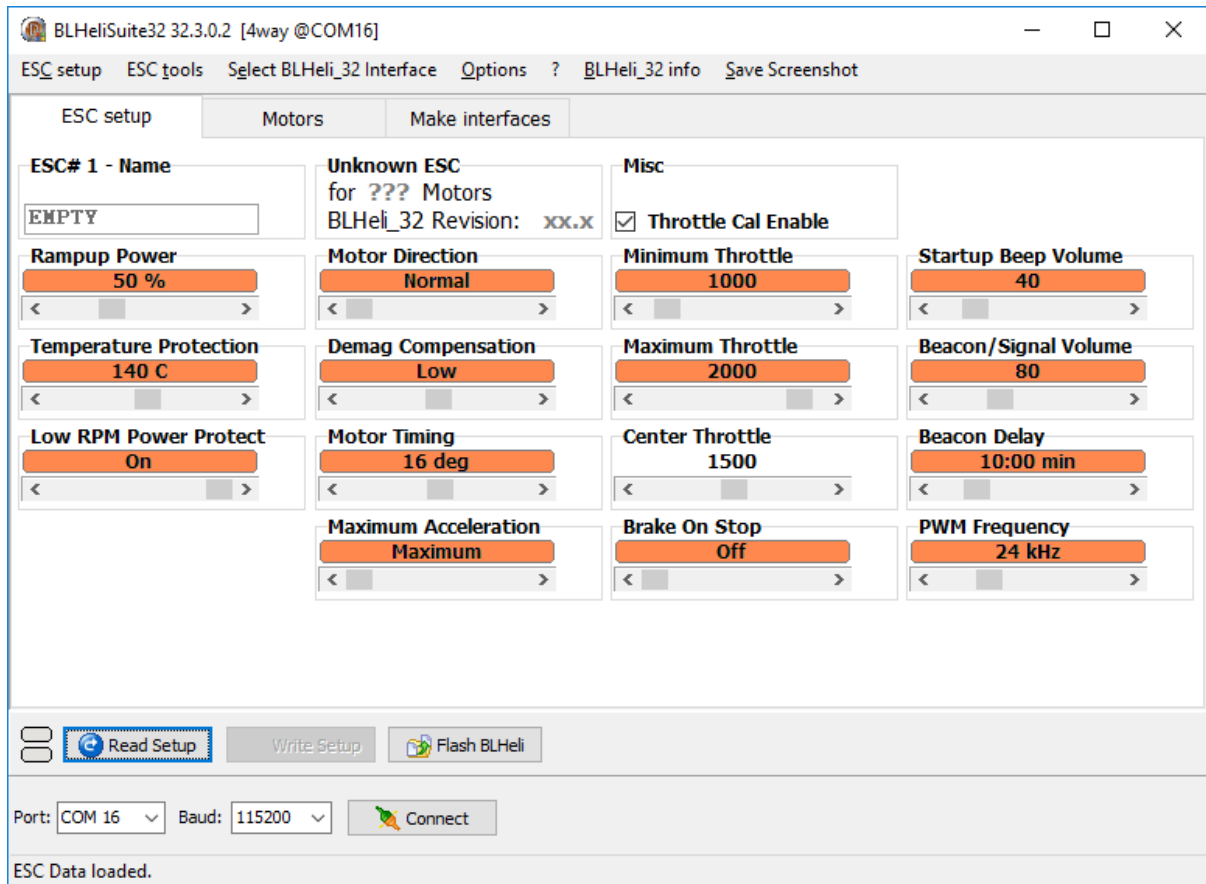
Type Save and hit return

Configuring ESCs – BLHeli32

To configure the ESCS we are going to use BLHeliSuite32. This is not the same software as BLHeliSuite used for BLHeli or BLHeli_S. It can be downloaded from here:

<https://www.mediafire.com/folder/dx6kfaasyo24l/BLHeliSuite>

Download it, unzip it and run the BLHeliSuite32.exe.



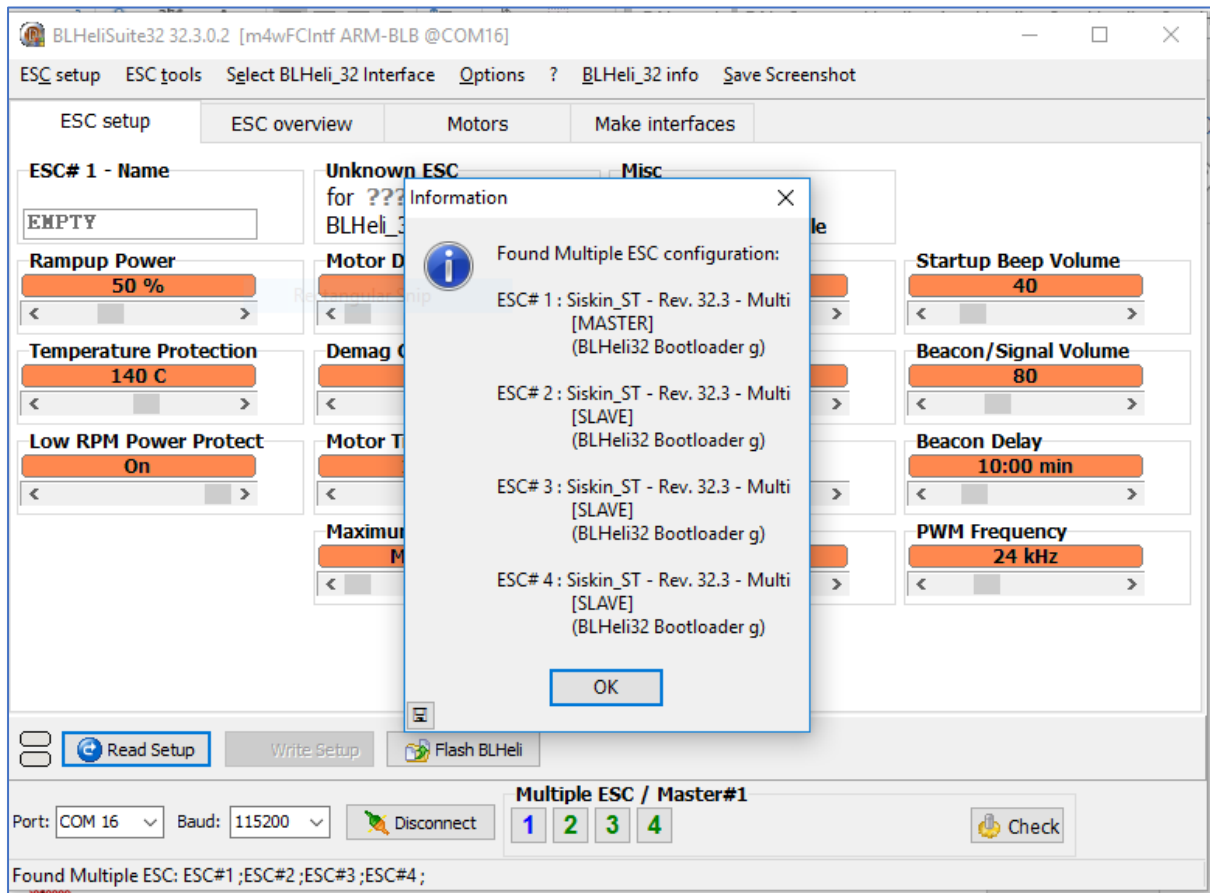
Click on Select BLHeli_32 Interface and from the drop down select BLHeli32 Bootloader (Cleanflight/Betaflight)

MAKE SURE THE PROPS ARE REMOVED

Plug in the lipo

Click on Connect

Click on Read Setup



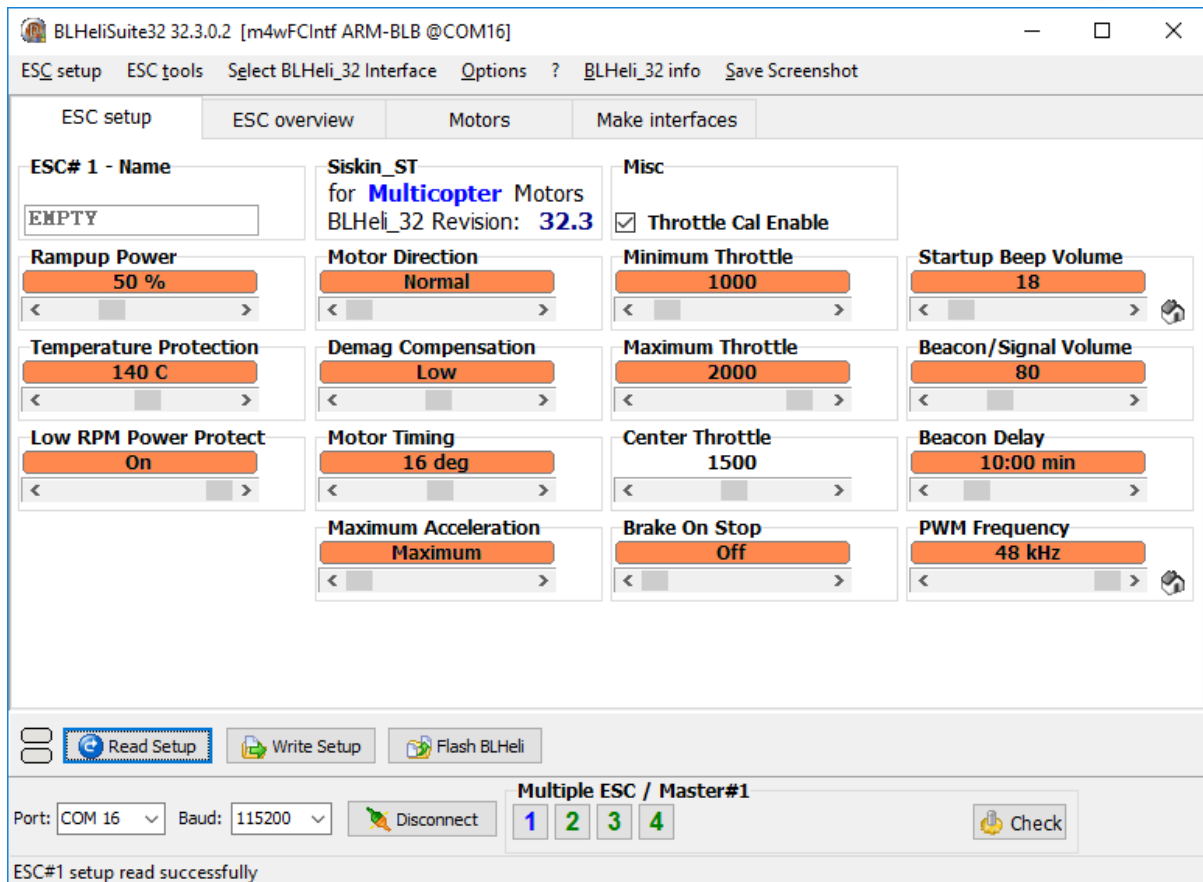
Click on OK on the popup.

The latest Version of BLHELI32 can be installed by using the Flash BLHeli button

However, what we really want to change here is the PWM Frequency on the bottom right which by default is 24khz, move the slider to the right so it is increased to 48khz

Click Write setup

IF any of your motors were spinning in the wrong direction this is the time to correct that. The four boxes at the bottom numbered 1 to 4 represent the four motors, by clicking on them you can deselect motors. Deselect all the motors apart from the one you want to change, use reverse motor direction to set the direction to reversed and click write setup then move on to the next motor



When done click Disconnect and unplug the LiPo. If you changed any motor directions pop back into ButterFlight and retest them.

Configuring the FPV components

NOTE: Never power a video transmitter without an antenna attached, it will burn out the transmitter.

Set up your goggles and receiver on the channel and band you want to use. Following the instructions that came with the VTX, WITHOUT PROPS ON, plug the LiPo in and use the button on the the VTX to set the band and channel on the transmitter, the image will appear in the goggles when correct. (note that the image may appear when you are on the wrong band and channel because the frequency is close, this will be fine on the bench but will have dramatically less range. Use the LED on the VTX and whatever mechanism is on your goggles to confirm they are on the same band and channel with the image in the goggles as confirmation.

On the camera connect the OSD cable, and switch off the OSD components (you don't want two OSDs and the Flight controller OSD is more useful)

Final things

Before flying for the first time (and regularly thereafter) test your failsafe (if you don't you will have what is termed a "Flyaway" at some point where your quad departs like some homesick Mary Poppins and is never seen again.

To do this, WITH PROPS OFF, turn on your radio, power up the quad, arm it and give it a little throttle so the motors start spinning, then turn the radio off. Within a second or so the motors should stop dead.

Test Hover your quad somewhere safe. Do it Line of Sight, I usually do it in Angle mode and from a safe distance before taking it to the field to fly for the first time.

Once you have tested failsafe and test hovered. Make sure everything is screwed down tightly, use blue threadlock on the motor mount screws and the four screws holding the standoffs to the bottom plate.

You are now good to fly, please do it safely and legally and ensure you have appropriate insurance such as that provided by BMFA membership.

