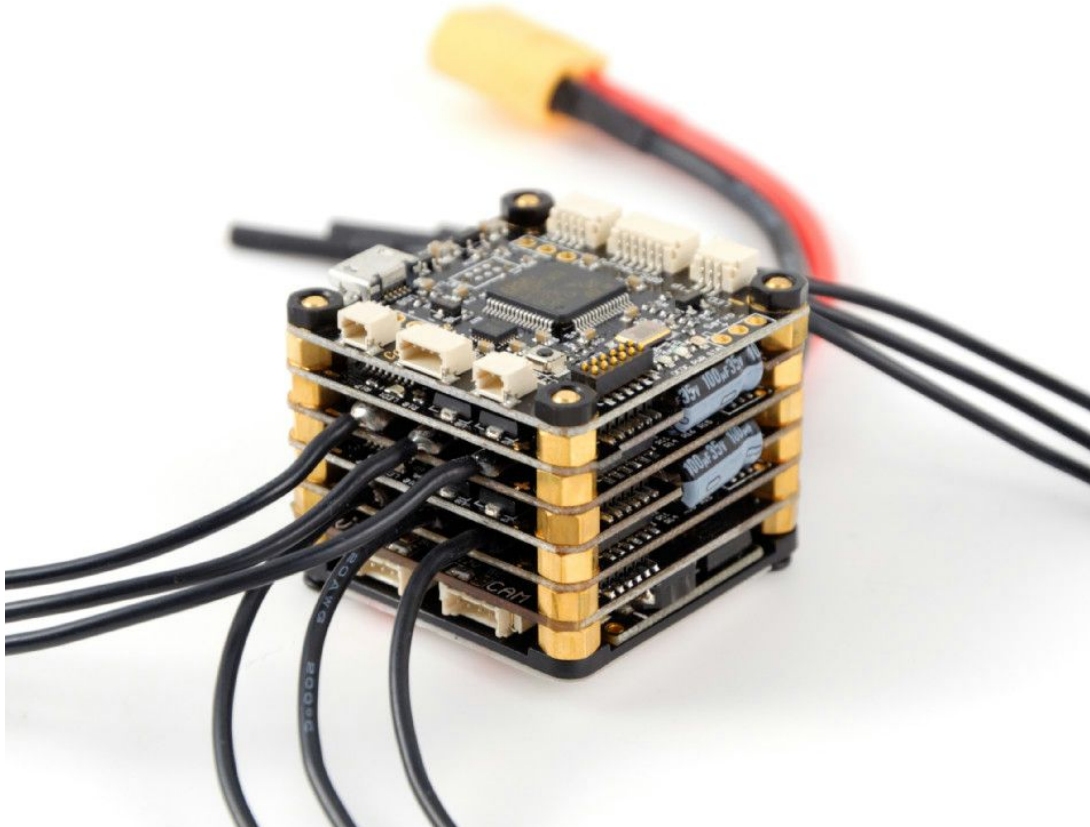# TBS POWERCUBE - Multirotor Stack *patented!*

All-in-one racing flight control, speed control and power distribution

Revision 2015-09-26

The next generation plug & play RACE system. Design optimized for ultimate performance and reliability. Compatible with any multi rotor frame.

Key features

- Ultra-lightweight and high-performance multirotor stack
- Designed to be bundled and sold with any 120 to 330mm size frame
- Stacked boards for extreme durability
- Based on fast STM32F3 flight controller
- Innovative patent-pending wire-free power distribution through stand-offs
- True plug & play, no soldering required
- Cost-efficient and field-repairable
- Tested, developed and flown by the world's leading pilots
- Highest quality aluminum screws, brass standoffs and electronic components
- Standard 36x36mm dimension, 70g incl. PDB, wires & connectors

TBS POWERCUBE
multi rotor stack

Specifications

TBS COLIBRI - Flight control layer

Hardware:	• STM32F303RCT6 72MHz 256kB MCU/FPU • MPU6500 3-axis Gyro • Motor PWM auto-connecting PWM/OneShot signals • Bootloader tactile switch for easy firmware update • 5V for receiver and FC over internal BUS System
Software:	Cleanflight V1.11 with BST and MultiFlash support Firmware: www.team-blacksheep.com/powercube/colibri-latest.zip
Compatibility:	Tri-, quad- and hexacopters
In/outputs:	• 1x Receiver port - PPM, SBUS or SPEKTRUM (PPM, UART2, 5V, 3.3V) • 1x RGB LED driver port with regulated 5V • 1x GPS/compass/altitude port (UART3, I2C, 5V) • 1x UART serial port (UART1) • 1x Piezo buzzer port for active driven buzzers • 1x IR LED timing system - *future support* • 1x Internal BUS system (6x PWM, 1x BST, 5V, 12V) • 1x Servo Output for tricopters • 2x VBatt (North-East & South-West corner) • 2x GND Batt (North-West & South-East corner) • 1x USB port (STM VCP) • 1x Push button - DFU boot mode
Connectors:	JST-SH 1.00mm with 2.54mm pin header

TBS BULLETPROOF 20A - Speed control layer(s)

Firmware:	BLHeli 14.2 , SimonK customized available	
Supports:	OneShot, active/regenerative braking, safety cut-off (simonk), lost-model alarm (simonk)	
Hardware:	• 1x Atmega8A MCU • Electrolytic capacitors - crash resistance! • Efficient high-performance FET drivers	
Maximums:	**Current draw** 20A constant - with 5mph airflow 30A constant - with good airflow 45A burst, 10 seconds	**Supply voltage** 2S, 3S, 4S, 5S, 6S compatible
In/outputs:	• 2x VBatt (North-East & South-West corner) • 2x GND batt (North-West & South-East corner) • 1x Internal BUS-system (6x PWM, BST, 5V, 12V)	

TBS POWERCUBE
multi rotor stack

	• 1x PWM-pads for custom installations • 3-phase brushless motor output

TBS PDB and TBS DCDC - Power distribution and power supply layer

Power distribution:	100A max. continuous current, 150A burst
Current sensor:	100A, 0.1A accuracy, BST-compatible (e.g for TBS CORE PRO)
Inputs:	• 1x Battery V+ and GND, 150A max • 1x Internal BUS system (6x PWM, BST, 5V, 12V)
Ports:	• CAM - FPV camera port, 5V/12V selectable on PCB (factory set to 12V) • VTX - FPV video transmitter port, 5V/12V/VBat selectable on PCB (factory set to 5V) • BST - BlackSheep Telemetry port, connects to TBS CORE PRO OSD
Power supply:	5V @ 2A, 12V @ 0.65A, combined max. draw
Connectors:	Molex Picoblade 1.25mm, 4-pin for VTX and CAM, 5-pin for BST

TBS POWERCUBE - Stack details

Working temperature:	0°C to 85°C
Dimensions:	36 x 36 x 30mm (with 4 ESCs)
Weight:	70g - brass standoff version 62g - aluminum-gold standoff version (available in PRO tuning kit)
Basic kit contents:	• 1x TBS COLIBRI flight control • 4x TBS BULLETPROOF speed control w/2mm female bullet connector • 1x TBS POWERCUBE DCDC and PDB w/ XT60 connector • 1x Plastic isolation layer • 1x PPM/SBUS cable • 1x Spektrum cable • 1x Piezo buzzer • 1x LED pigtail

TBS POWERCUBE
multi rotor stack

Attention

The TBS POWERCUBE, when installed, can easily damage property or extremities if not used properly. Always ensure that no propellers are installed when configuring, installing or tuning your multirotor. We also recommend to use the options "Spin motor when armed" and use stick commands to arm your multirotor, rather than switches.

NEVER leave the platform powered on and unattended. Always check proper failsafe (power down) functionality, and try not to break too many laws while flying FPV (TBS can not be held responsible is what we are saying.)

Only disassemble/reassemble with proper tools! Take extra care to components that are situated around the standoffs. Check the maintenance section before attempting to open up the PowerCube!

Table of content

TBS POWERCUBE
multi rotor stack

TBS POWERCUBE Overview

Check out the POWERCUBE in all its glory. The following diagrams indicate the locations of each component and their purpose.

Top

Flight controller

Speed controller #1

Speed controller #2

Speed controller #3

Speed controller #4

Power distribution and power supply

Isolation bed

Battery lead with XT60 connector

Motor leads with bullet connectors 2mm

TBS POWERCUBE
multi rotor stack
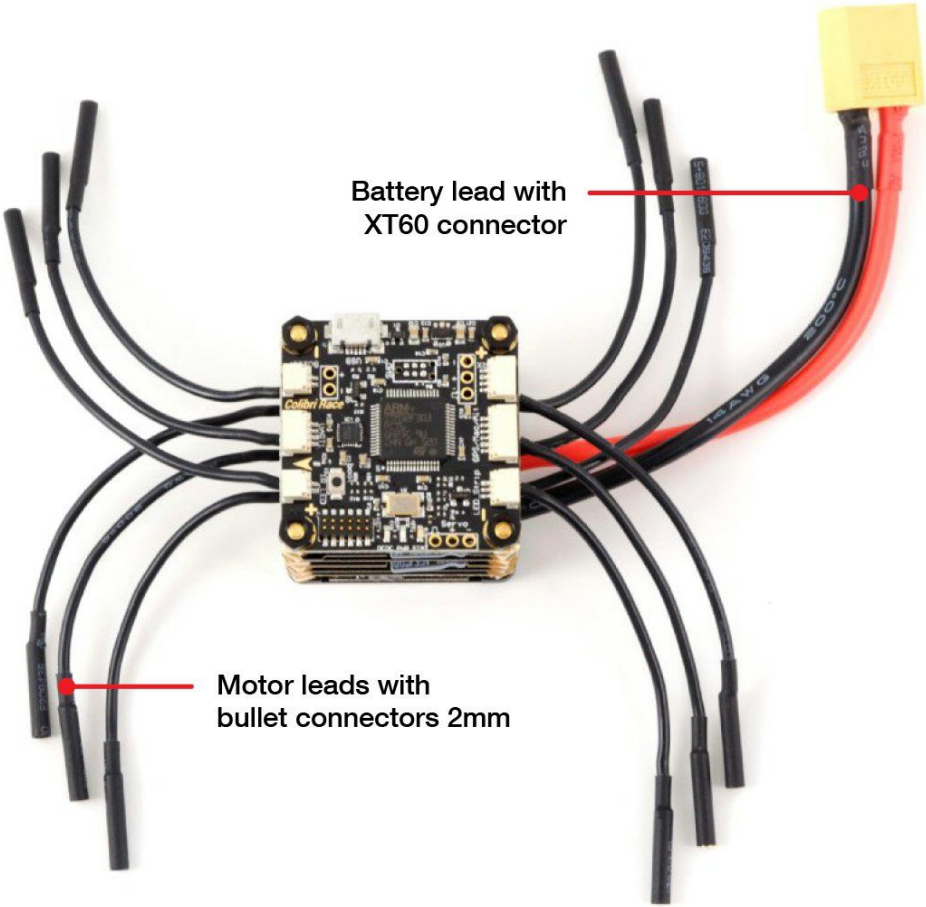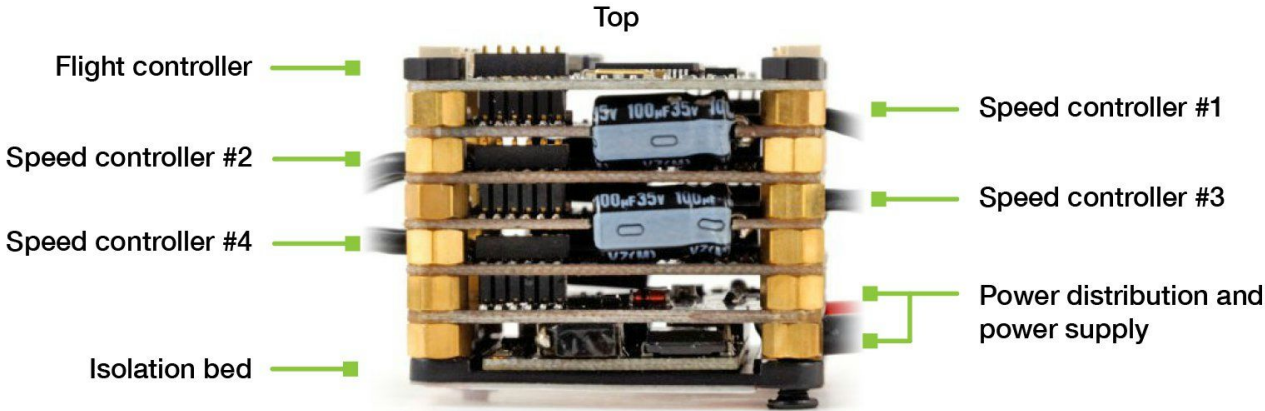
Installation

Mounting on your frame

The TBS POWERCUBE should be placed in the same spot where the flight controller is normally installed. The TBS POWERCUBE carries power (VBatt, GND) over the four standoffs in the corners, alternating between VBatt and GND. For this reason, the two screws carrying power (VBatt) are hidden underneath the double sided sticky tape on the bottom of the TBS POWERCUBE. The tape isolates them from the carbon fiber frame. The ground-carrying standoffs should be used to bolt the TBS POWERCUBE onto the frame. In combination with the tape, this creates a very solid mount.
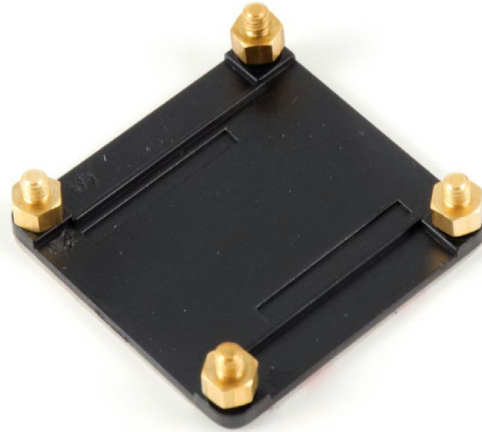
The corners on the top layer indicates the polarity of the power, i.e. "+" for VBatt and "-" for GND, as shown in the image below.

TBS POWERCUBE
multi rotor stack
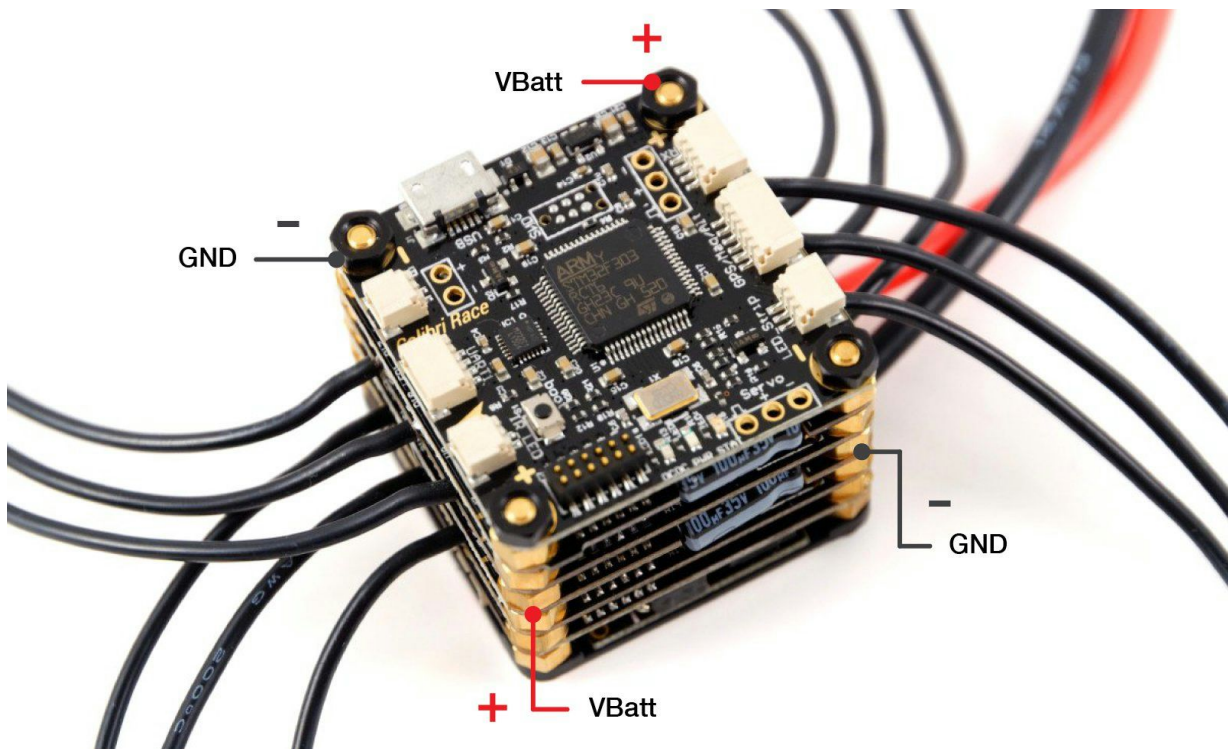
Installed from the factory are super-lightweight M3 aluminum screws. They are anodized to protect against short circuits. The provided mounting screws are made for frames up to 2mm thickness. If your frame is thicker, please use below table to find the correct screw length:

Frame thickness:	Recommended mounting screw length:
1.6mm	M3x6 (included in kit)
2mm	M3x6 (included in kit)
2.5mm	M3x7
3mm	M3x7
4mm	M3x8
5mm	M3x9

Carbon fiber frames

Carbon fiber frames can conduct electricity, therefore the lower plastic isolator bed must be used. If you are mounting the stack onto power distribution boards or G10 frames, you can use smaller nylon washers or stand-offs (3mm shorter) instead of the plastic isolation bed.

Frame type:	Mounting options:
G10, other glass fiber materials	No plastic bed, mounting screws on all four corners
Carbon Fiber, FR4 with copper	Plastic bed required, mounting screws only on GND "-" corners

When using carbon fiber plates, make sure that you only screw the mounting (GND) screws through the frame, the power-carrying screws (VBatt) remain isolated inside the plastic bed.

Make sure that no power carrying elements can get in touch with the carbon frame except ground (Powercube GND, VTX antenna socket etc.).
Pay special attention to motor phases, also make sure the screws are not too long to push up into the motor windings.

TBS POWERCUBE
multi rotor stack

Finalizing your installation

If you have a multimeter handy, make a quick test if V+ and GND don't short. You do this with the "sound" or "ohm" setting on your multimeter, and then probing on the 2 pins inside the XT60 connector. If there is no short, connect a battery and a receiver. If you have a TBS CORE PRO, you can now simply turn on your FPV display or goggles and run the calibration wizard. After this, all your channels are mapped correctly. If you're not using the CORE PRO, you will need to ensure that the channels are correctly mapped using the Cleanflight Configurator software and your R/C.
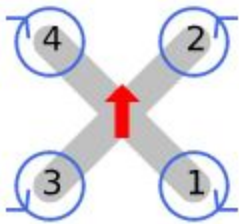
Then, start your motors and ensure they are spinning in the right direction. The arm command is Yaw Left, Throttle at zero. The motors will spin in idle. Verify that the motor directions matches the left diagram. If they do not match, you may need to flip two of the 3 connector cables. Also, now is a good time to double-and-triple check that motor 1, 2, 3 and 4 are wired up to the correct layer in the TBS PowerCube stack.

The first flight

When preparing for the first flight, there are a couple of things to consider.

1) Do not move the model while plugging in the battery and during the first 4 to 5 seconds after powering up. During initialization the gyro must remain idle, otherwise the self-calibration will be wrong. If you have installed LEDs or a Buzzer, they will indicate when the model is ready to take off by 3 distinct beeps and solid LED color on all LEDs using the "Warnings" LED setting.

2) If the model immediately flips or rolls during take-off, verify that the TBS POWERCUBE flight controller is oriented in the correct way and that all motors are plugged into the correct position of the TBS PowerCube stack. The arrow on the board must face flight forward. Also, verify that the motor spin directions are correct
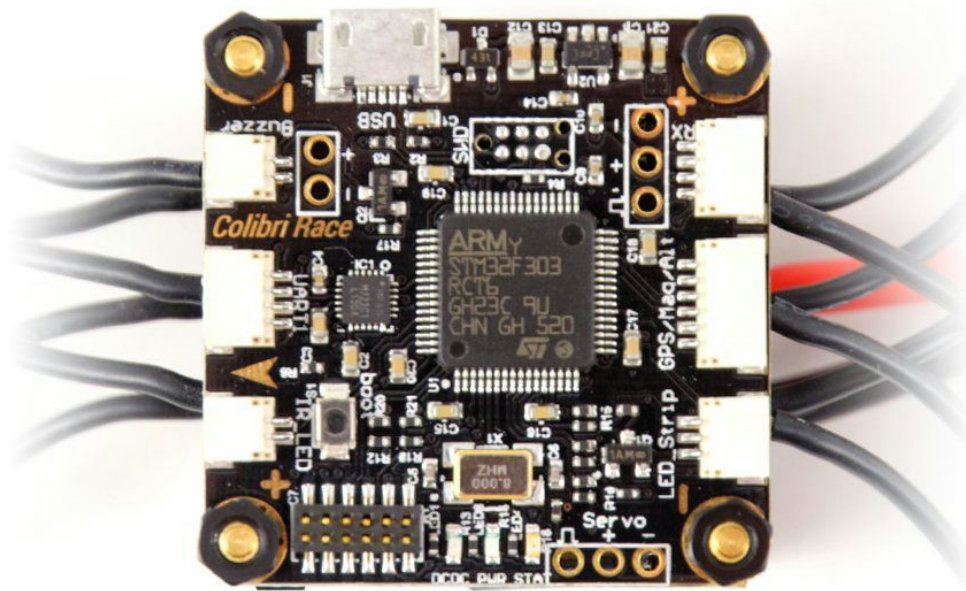
TBS COLIBRI - Flight control

The TBS COLIBRI RACE edition is a barebone version of the TBS COLIBRI (debuted in the TBS GEMINI), built specifically for the TBS POWERCUBE. Flashed by default with Cleanflight to allow maximum tuning capabilities for racers, with multiple innovative features such as built-in IR port, MPU6500 with serial support (insanely low looptimes!!), USB VCP, JST-SH plug&play ports, as well as solder sockets for the most critical input and outputs for seasoned builders.

- STM32F303 based chipset for ultimate performance
- PPM, SBUS, DSM, DSMX input (5V and 3.3V provided over internal BUS)
- 6 PWM ESC output channels (autoconnect, internal BUS)
- Choose between plug&play sockets or solder pads for R/C and buzzer
- 36x36mm standard size (30.5mm grid)
- RGB LED strip support incl. power management
- Extension port for GPS/external compass/pressure sensor
- UART serial port for peripherals (Blackbox, FrSky telemetry etc.)
- 5V buzzer output
- MPU6500 new generation accelerometer/gyro sensors
- Runs Cleanflight software
- 3x status LED (DCDC Pwr/3.3V Pwr/Status)
- Weight only 4.4g

Overview and connections

An overview of all the ports provided by the COLIBRI RACE flight controller is shown in the illustration below. Connect your peripherals according to your requirements.

North

- **Buzzer** - Accepts any active driven buzzer on 5V, alarms can be set in Cleanflight GUI
    - ○ Pinout from left: GND / 5V Signal
    - ○ Additional soldering pads for direct soldering (first batch has reverse signed + and - pads!)
- **UART1** - Serial communication port
    - ○ Pinout from left: UART1 TX / UART1 RX / GND / 5V
- **IR_LED** - Lap-timing using IR LED - for future use
- **Boot button** - Boot button for flashing new firmware
    - ○ Button must be pressed to get into the DFU firmware loader mode

East
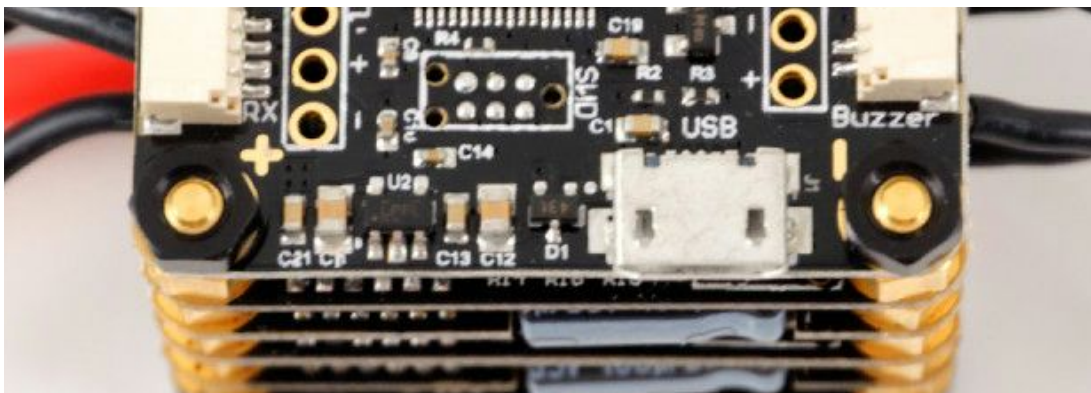
- **Micro-USB** - Connect via USB for configuration via Cleanflight and firmware upgrades
- **SWD header** - Used for direct microcontroller programming

TBS POWERCUBE
multi rotor stack

South

- **LED_Strip** - For directly connecting WS2812B, WS2812, and WS2811 based RGB LED strips
  - Regulated 5V PWR provided to connector over internal BUS, no additional voltage regulator required!
  - Any WS2812B LED boards with up to 32 LEDs should work
  - Pinout from left: Signal / 5V / GND
  - Signal-pin connects to DIN on WS28xx pads
- **GPS / MAG / Alt** - GPS connector for external GPS, Magnet sensor, Altitude sensor
  - Pinout from left: 5V / GND / UART3 TX / UART3 RX / SDA / SCL
- **RC_RX** - Receiver connector, supports: PPM, S.BUS, DSM, DSMX
  - Pinout from left: PPM, UART2 / 3.3V / GND / 5V
  - Additional soldering pads for direct soldering receiver PPM signal

West
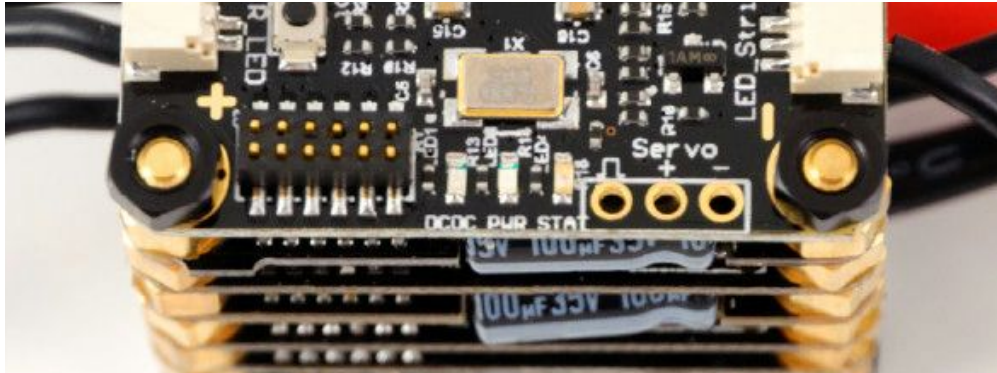
- **LEDs** - Status indicator
    - ⭕ DCDC LED, lights up once 12V is available over internal BUS
    - ⭕ PWR control LED, controlled via CleanFlight
    - ⭕ STAT LED, controlled via CleanFlight
- **Servo** - One Servo output (for tricopters) with 3-pins for PWM / 5V / GND
    - ⭕ 5V is provided from internal BUS

TBS POWERCUBE
multi rotor stack

Driver Installation

The COLIBRI RACE is one of the first flight controllers that natively supports USB. In newer operating systems (Windows 10, Mac OS X 10.10) there are no drivers required to enable configuration. However, for the most users a new driver has to be installed manually. Download and install the following driver.

- STM32 VCP Driver Download (Windows only)

Some computers may not immediately recognize the new STM32 VCP drice after installing the driver. You may need to go into your Device Manager and updating the driver directly. Find a yellow icon next to the USB device, right-click it and select "Update Driver". Navigate to the following folder to locate the correct driver:

```
C:\Program Files (x86)\STMicroelectronics\Software\Virtual comport driver\
```

Configuration

The COLIBRI RACE runs Cleanflight by default. Cleanflight comes with a great and easy to use Chrome Application that you can download here:

- Cleanflight Configurator

There are several very detailed Cleanflight guides available, which teaches you how to tune, configure and calibrate your model. It would be impractical for this manual to regurgitate all of this.

- FliteTest: Naze32 Tutorial
- PID Tuning Explained

However, please do ensure that the parameter values specified in the following section are set in the configurator for proper control of the ESCs and aircraft.

Default Values

The ideal parameter values for COLIBRI to work with the BULLETPROOF 20A ESCs are shown in the following screen capture. Open Cleanflight and make sure all the fields are set to the corresponding values. The ESCs come pre-calibrated out of the box, there is no need to calibrate the servo range or do any other setup.

TBS POWERCUBE
multi rotor stack

Additionally, if you are planning to install LEDs on your frame, you can enable "LED Strip" support in Cleanflight. It allows you to directly connecting WS2812B, WS2812, and WS2811 based RGB LEDs to the Colibri RACE flight control and configure their color.

Firmware

The TBS Colibri runs with a slightly customized Cleanflight, which you can always grab here:

● www.team-blacksheep.com/powercube/colibri-latest.zip

If you don't need features such as BST or Multiflash, or until these features are merged into the Cleanflight project, you can use the standard Cleanflight builds directly from the Cleanflight Configurator.

Upgrade via Cleanflight

The latest version of Cleanflight Configurator supports flashing firmware for the TBS ColibriRACE. However, the code for BST (communication with TBS Core PRO) and the MultiFlasher technology has not yet merged into the Cleanflight project. If you are happy with stock Cleanflight you can flash firmware using the Cleanflight configurator. You need to start the Colibri in "DFU" mode. To do this, connect the USB with the "boot" button pressed. Then go to the firmware tab, select "Colibri RACE", select "Load Firmware (online)" and then scroll down to program.

Upgrade via DFU

Use the following procedure to update the COLIBRI firmware using DFuSE, a free tool from ST Microelectronics.

1. Download STM DFU loader (Windows required)
2. Install and execute the DFU loader
3. Press the boot button on COLIBRI RACE while connecting USB - with no other power connected
4. Your COLIBRI should now show up as a DFU device inside the tool (see right)
5. Download the latest COLIBRI firmware
6. Select "Choose" and select downloaded DFU file
7. Click "Upgrade" and wait for the software to finish uploading
8. Re-plug your USB cable to start using the new firmware.

TBS POWERCUBE
multi rotor stack
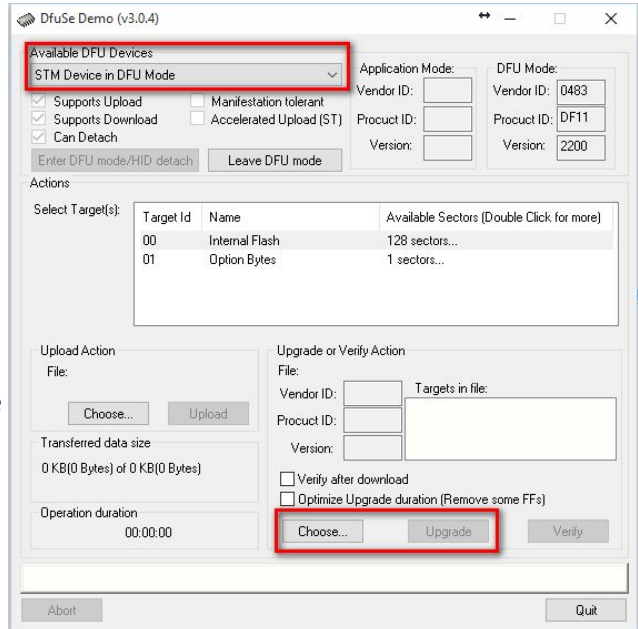
TBS BULLETPROOF 20A - Speed control

The next in line of the most innovative, reliable and powerful ESC for multirotors. The first 2S to 6S capable TBS BULLETPROOF ESC, forged and optimized for racing. The best thing about those ESCs - no soldering and a very short manual. There is nothing to set up, configure, or solder. Simply plug your motors into the provided 2mm bullet connector sockets, check motor spin direction and you are all set. More seasoned builders and pilots may wish to directly solder motor cables to the ESC, for greater reliability.
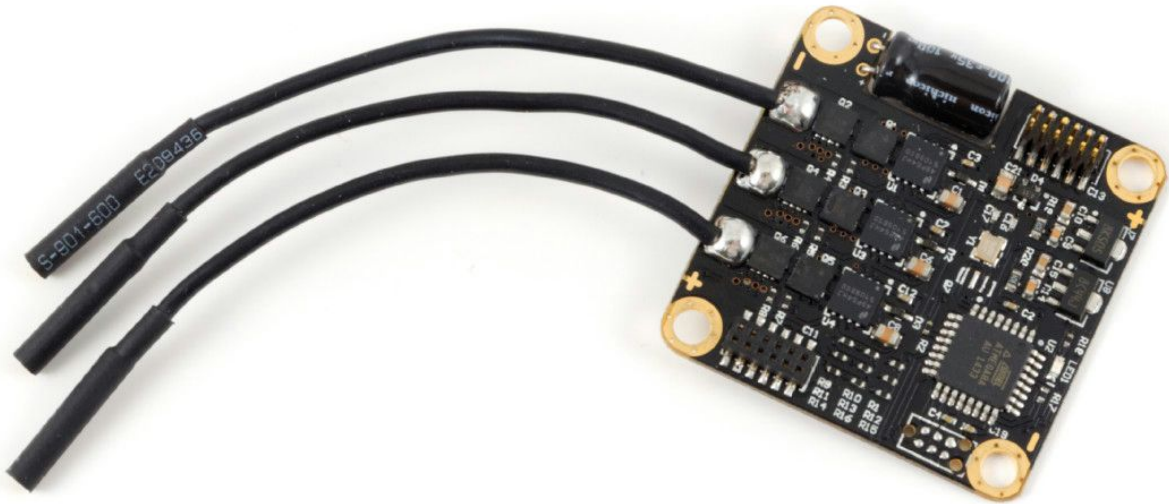
The ESCs stack into the TBS POWERCUBE in alternating fashion. The location in the stack determines which motor they are assigned to - assignment starts closes to the flight controller (from #1) and downward.

Firmware upgrades

The TBS PowerCube comes with a Multiflash technology. The TBS Agent will connect to the TBS PowerCube and give you the ability to change between BLHeli and SimonK, and upgrade them to their latest versions.

This feature is currently in experimental stage and not available to the public.

● Download the TBS Agent

TBS POWERCUBE
multi rotor stack

TBS POWERCUBE PDB - Power distribution

This board measures current and controls power distribution across the entire TBS POWERCUBE, provides regulated and filtered power for the ESCs, flight controller and FPV system.

Selecting VTX/CAM voltage

The output voltage for the VTX and CAM ports can be selectable on the PCB. By default is the CAM port set to 5V and the VTX set to 12V. If your equipment requires a different voltage (normally printed on the device or in the specifications), you have to switch the solder jumper bridge to the right voltage (5V or 12V.) You can even change the voltage for the VTX to VBatt if your video transmitter has an on-board regulator or requires more power than the TBS DCDC board can provide.

TBS POWERCUBE
multi rotor stack

If your are experienced with soldering you can make the change without disassembling the stack, but it is recommended to disassemble the PDB layer to get direct access to the solder bridge.

To change the output voltage, perform the following steps:

1. Disassemble the stack to get access to the top of the PDB layer (remove flight controller and all the ESC layers)
2. Desolder the bridge resistor and clean off any excess solder
3. Apply a small amount of solder to the center pad and the pad of the voltage you want to select.
4. Sweep across until the blobs join

Connecting FPV camera and transmitter

There are two ports on the PDB board which are for the FPV camera and video transmitter. Any TBS camera and transmitter is directly supported and plugs into the connector (Molex Picoblade) - be sure the output voltage is right for the equipment you are going to connect.

TBS POWERCUBE
multi rotor stack
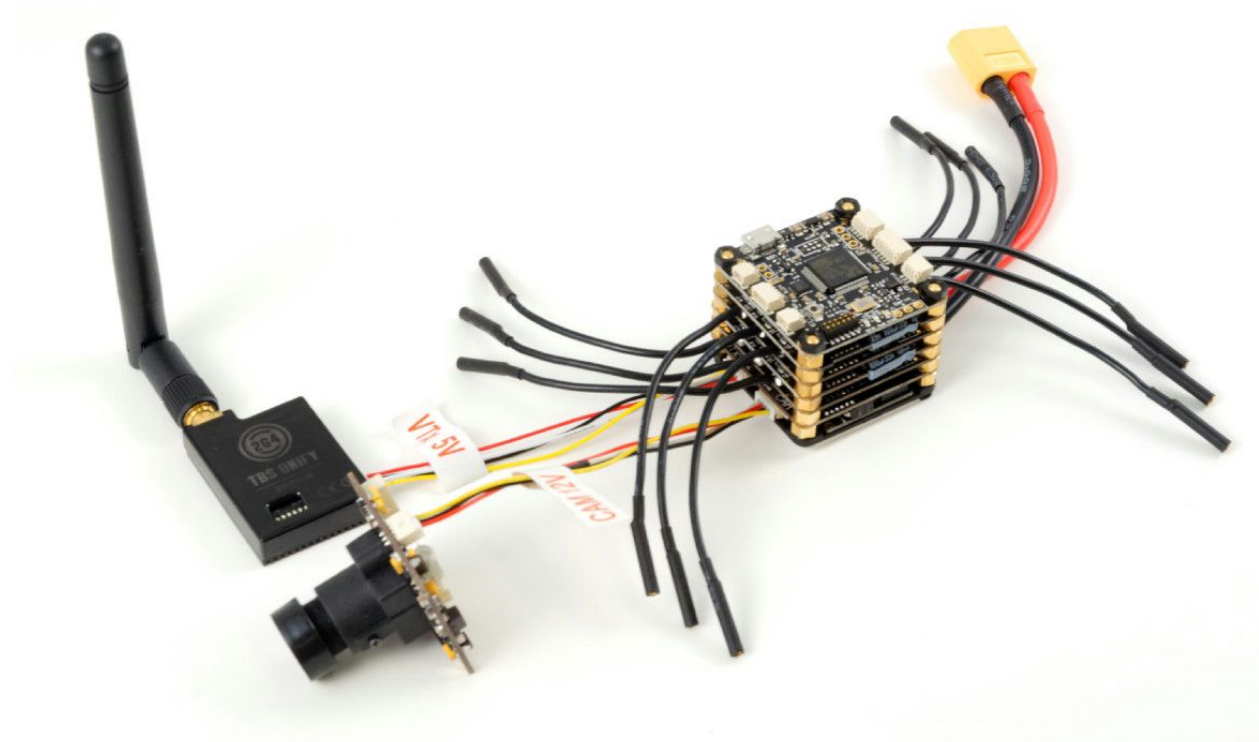
By looking at the side of the PDB layer, you can see "VTX" and "CAM" marked on the other side of the board. Plug the FPV transmitter and camera into their corresponding port.
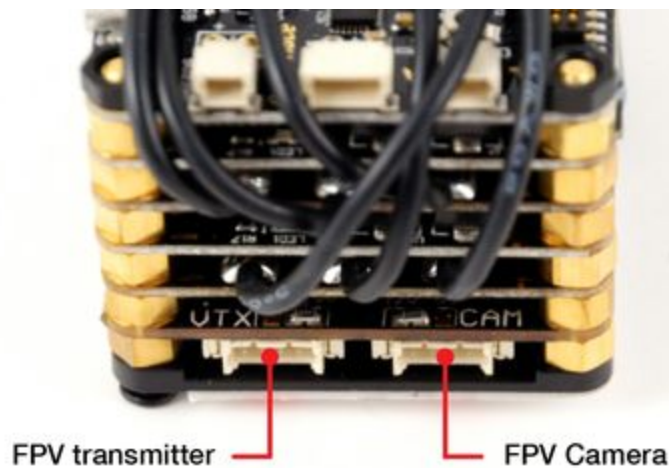
Troubleshooting FPV Transmitter / Camera

● **Only static on receiver, or no video**
Verify that you have a working 5V and 12V supply by using a multimeter and measuring on the dedicated 5V/12V/GND pads near the BST connector.
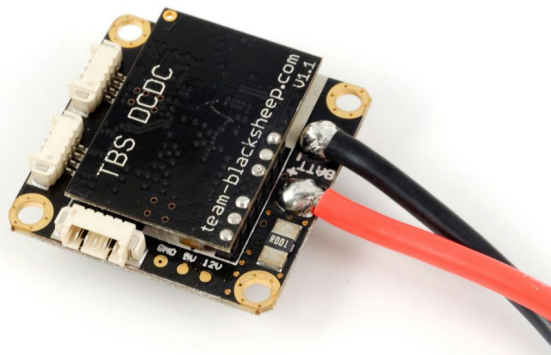
In case the 5V and 12V supply line is interrupted, you can try to fix it by soldering the 6 pin headers that connect the power distribution board with the TBS DCDC, especially on the TBS DCDCD side.

● **Lines in video**
In some instances high-draw R/C receivers or telemetry devices are able to introduce interference into the video feed. In this case, it is recommended to place a LC filter in line with the FPV transmitter line.
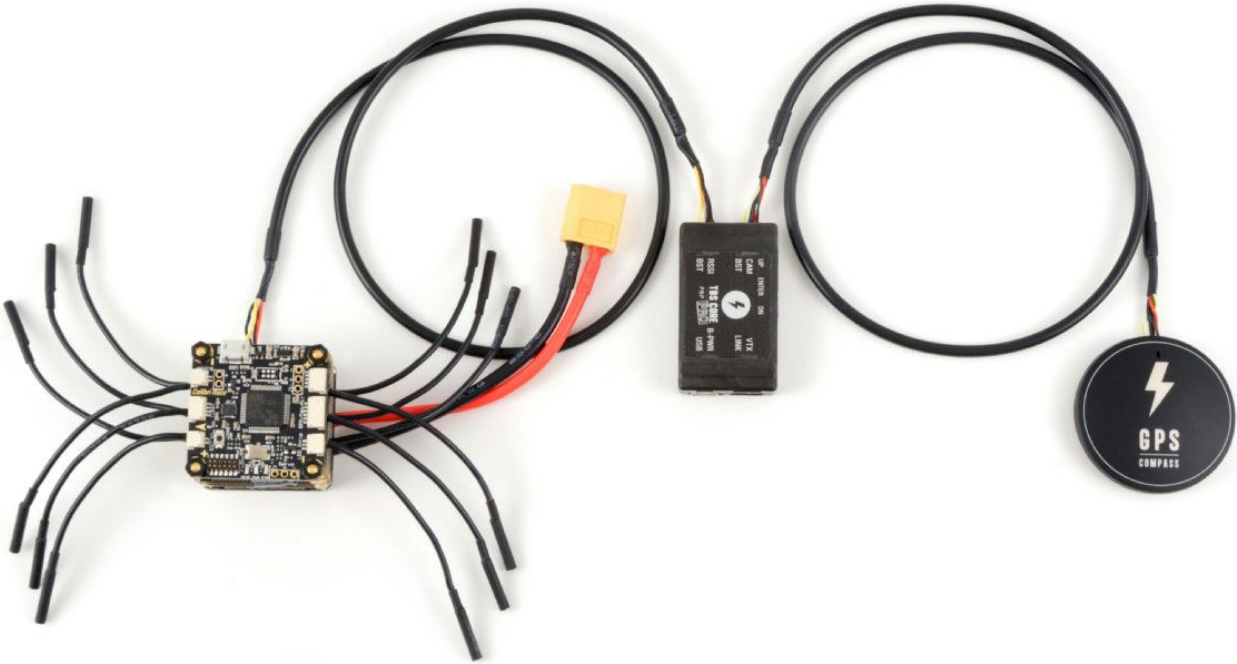
TBS POWERCUBE
multi rotor stack

Connectivity with TBS CORE PRO

One of the biggest advancements with the TBS POWERCUBE is the connectivity to the TBS CORE PRO, a next-generation OSD system. The software update that we released together with the TBS POWERCUBE enables the CORE PRO (V1.24 and later) to access and modify Cleanflight settings on the CORE OSD, as well as other handy features.

TBS CORE PRO connection

The POWERCUBE has a BST connector on the PDB layer which allows a connection to the CORE PRO. This connection provides battery power and current sensor data for the OSD on the CORE PRO. The FPV transmitter and camera must be connected to the CORE PRO not the POWERCUBE for the OSD to work. See the TBS CORE PRO manual for further details on selecting output voltage and configuring the OSD.

Connect a suitable length cable between the CORE PRO and POWERCUBE. Connect a GPS to the CORE PRO if you require position data. If you run out of BST ports, you can use a TBS 4-way BST splitter to get more ports.

RC calibration

coming soon

TBS POWERCUBE
multi rotor stack

Flight controller configuration

coming soon

TBS POWERCUBE
multi rotor stack
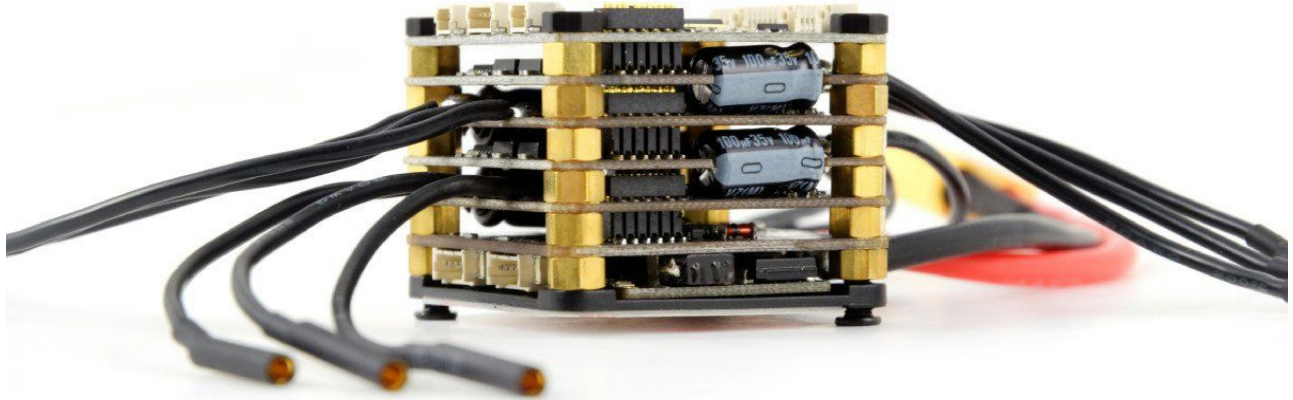
Maintenance

Replacing components

The TBS POWERCUBE comes pre-assembled out of the box. The stand-offs and nuts require a 5mm hex driver. TBS has some specialized tools available for super-fast and safe assembly. Without specialized tools, please take extra care when opening nuts that are close to the internal BUS-port (black pin header socket) and look out for small SMD components close to the stand-offs. The torque used in the assembly is 0.4Nm, if you have adjustable torque tools we suggest to use the same setting.

The flight control and power distribution boards are "terminating layers" - meaning they are the head and the tail of the cube. In between are the ESCs, which are stacked on top of each other with 180 degree offset, this means the motor wires exit left and right in alternating fashion. The ESCs know their spot in the TBS POWERCUBE, so starting from the top down they are tied to motor #1 to #6 according to their position in the stack from the flight control layer. Take extra care when putting the TBS POWERCUBE back together - the pin header socket sits down on the pins from the layer below. Make sure the headers line line up before applying pressure to avoid bending the pins.
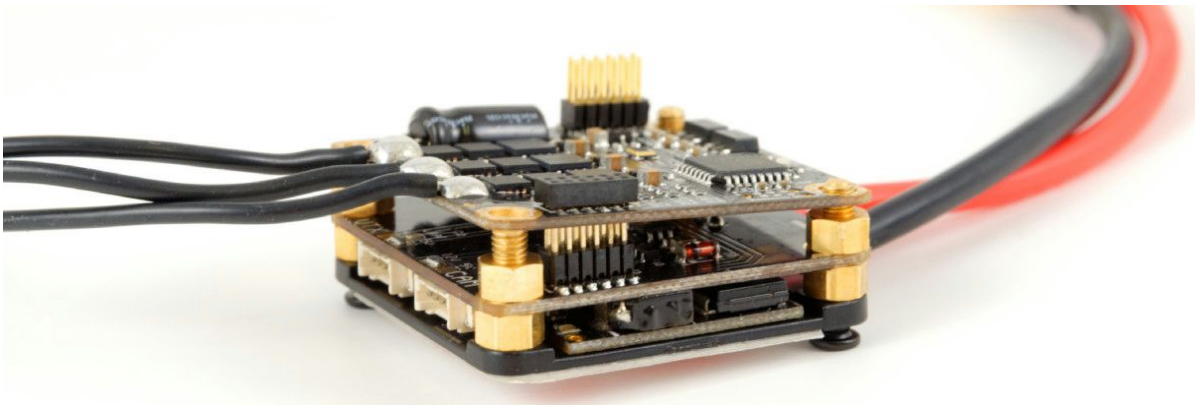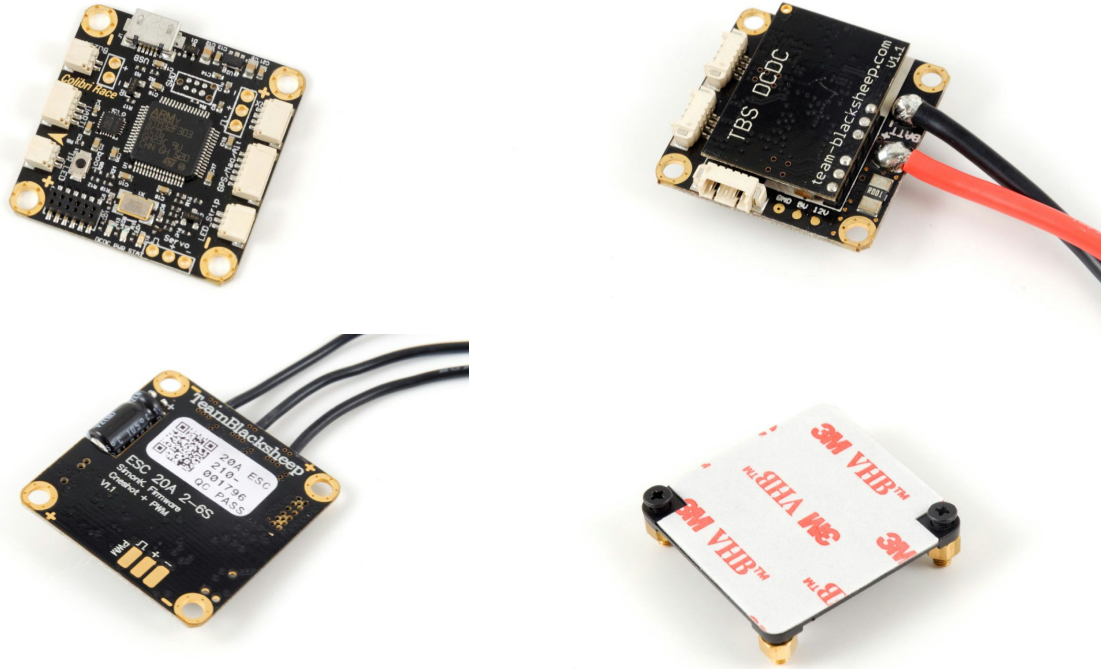
Tuning

The stock standoffs are made from brass to keep money in your pockets or rainy day funds. For the serious weight aficionado, aluminum-gold based standoffs are available. They will shed around 12g off the total AUW, while improving conductivity and thus the maximum power throughput.

Further optimization can be done by using conformal coating on the PCB surface, to protect your ESCs against the elements. Be sure to add tape to all parts that need to remain exposed, such as the standoff holes, any sockets, pin headers or connectors. Weatherproofing your setup can substantially increase its life-time, especially in winter or when flying over wet grass or in industrial areas with metallic trash lying around that could short out components.

Troubleshooting

- **Carbon burnt**

  Check for electrical short, specially the motor phases shorted to Frame. Motor mounting screws too long so that they screwed up into the motor windings?

TBS POWERCUBE
multi rotor stack

Good practices

We have compiled a list of all of practices which have been tried and tested in countless environments and situations by the TBS crew and other experienced FPV pilots.

Follow these simple rules, even if rumors on the internet suggest otherwise, and you will have success in FPV.

- Start with the bare essentials and add equipment one step at a time, after each new equipment was added to proper range- and stress tests.
- Do not fly with a video system that is capable of outperforming your R/C system in terms of range.
- Do not fly with a R/C frequency higher than the video frequency (e.g. 2.4GHz R/C, 900MHz video).
- Monitor the vitals of your plane (R/C link and battery). Flying with a digital R/C link without RSSI is dangerous.
- Do not use 2.4GHz R/C unless you fly well within its range limits, in noise-free environments and always within LOS. Since this is most likely never the case, it is recommended to not use 2.4GHz R/C systems for longer range FPV.
- Do not fly at the limits of video, if you see noise in your picture, turn around and buy a higher-gain receiver antenna before going out further.
- Shielded wires or twisted cables only, anything else picks up RF noise and can cause problems.
- When using powerful R/C transmitters, make sure your groundstation equipment is properly shielded.
- Adding Return-To-Home (RTH) to an unreliable system does not increase the chances of getting your plane back. Work on making your system reliable without RTH first, then add RTH as an additional safety measure if you must.
- Avoid powering the VTx directly from battery, step-up or step-down the voltage and provide a constant level of power to your VTx. Make sure your VTx runs until your battery dies.
- Do not power your camera directly unless it works along the complete voltage range of your battery. Step-up or step-down the voltage and provide a constant level of power to your camera. Make sure your camera runs until your battery dies.
- A single battery system is safer than using two dedicated batteries for R/C and FPV. Two batteries in parallel even further mitigate sources of failure.
- For maximum video range and "law compatibility", use 2.4GHz video with high-gain antennas.
- When flying with R/C buddies that fly on 2.4GHz, or when flying in cities, it is perfectly possible to use 2.4GHz video provided you stick to the channels that do not lie in their band (CH5 to CH8 for Lawmate systems, available from TBS).
- Do not use diversity video receivers as a replacement for pointing your antennas, diversity should be

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used to mitigate polarization issues.

- Improving the antenna gain on the receiver end is better than increasing the output power (except in RF-noisy areas). More tx power causes more issues with RF on your plane. 500mW is plenty of power!

- Try to achieve as much separation of the VTx and R/C receiver as possible to lower the RF noise floor and EMI interference.

- Do not buy the cheapest equipment unless it is proven to work reliably (e.g. parts falling off, multitudes of bug fix firmware updates, community hacks and mods are a good indicator of poor quality and something you do NOT want to buy for a safe system). Do due diligence and some research before sending your aircraft skyward.

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