

# Seriously Pro

SP Racing H7 ZERO Flight Controller

## About

The SPRacingH7ZERO flight controller features a 400Mhz H7 CPU that runs twice as fast as the previous generation F7 boards. A fast control-loop is what you need for perfect flight performance, the H7 at 400Mhz gives you all the processing power you need.

The SPRacingH7ZERO has integrated OSD (on-screen-display), BMP388 barometer, BEC, 8 motor outputs, SD card and on-board 128MB flash for logging.

Analyze your race and flight telemetry/blackbox logs using the built-in 128MB flash or MicroSD card socket.

The SPRacingH7ZERO gives you all the essential features combined with the latest in CPU performance and sensor technology that you need for the heart of your aircraft, perfect for FPV racing and freestyle acrobatic flying!

## Software

The SPRacingH7ZERO runs the open-source Betaflight flight control (FC) software which is based on Cleanflight. It has an ever-growing community of friendly developers and users. Being open-source means that you too can contribute to the system.

For latest and detailed software setup refer to the Betaflight wiki.

## History

The hardware was designed by the lead developer of Cleanflight to be more capable than the previous-generation STM32F7/4/3-based boards and to set the benchmark for a standard STM32H750 based board with OSD. It has other features not seen on any F1/F3/F4/F7 FCs, other than the blisteringly fast 400Mhz H7 CPU, including 8 motor outputs, 6 serial ports and new high-performance interfaces for SD card and flash logging.

The SPRacingH7ZERO is the third H7-based flight controller that runs Betaflight.

## Features

- Next-generation STM32 H7 processor with hardware floating point unit for efficient flight calculations and faster ARM-Cortex M7 core running at 400Mhz.
- 128MB External Flash.
- Features the latest 32khz capable Accelerometer, Gyro sensor device connected via a fast SPI bus.
- New high-accuracy Baro/Altitude sensor with less drift than previous sensors.
- Configurable On Screen Display (OSD) system gives you all the information you need when flying and a menu system to allow you to configure the FC.
- MicroSD-Card socket for black box flight log recorder - optimize your tuning and see the results of your setup without guesswork.
- Solder-from-top design makes installation and maintenance simple.
- 8 Motor outputs. DSHOT/OneShot/PWM for ESCs and Servos. When using external MAG for GPS only 6 motor outputs are usable.
- Supports direct connection of SBus, SumH, SumD, Spektrum1024/2048, CRSF, FPort, SRXL/XBus receivers. No external inverters required (built-in). Legacy PWM 1 wire per channel receivers are not supported.
- Supports direct connection of 3.3v Spektrum Satellite receivers - use 3v3 pad for Satellite RX.
- 6 Serial Ports - NOT shared with the USB socket.
- Micro USB socket.
- Dedicated output for programmable LEDs - great for orientation, racing and night flying.
- I2C pads for connection of OLED display or MAG.
- On-board battery monitoring for voltage, and input for external current sensor.
- Analog RSSI monitoring.
- Buzzer port for audible warnings and notifications.
- Developer friendly debugging pads (SWD) and boot mode selection, unbrickable bootloader.
- Side-press boot button for CPU DFU mode.
- Side-press settings/bind button for easy receiver binding, VTX control and SPRacing bootloader control.
- Symmetrical design elements for super tidy wiring.
- Pads for all IO - optionally 7 connectors can be fitted for IO (Motors1-4/Motors5-8/UARTs/RX/Camera/VTX/SWD).
- Firmware upgradable via USB and MicroSD card.
- Standard 30.5mm mounting hole pattern with 4mm holes and grommets for 3mm screws.
- LEDs for 3v, 5v and Status for easy diagnostics.
- Cleanflight, Betaflight and SP Racing logos.

## WARNINGS

Failure to adhere to these warnings will void your warranty and destroy your flight controller.

- Observe polarity at ALL TIMES. **Check** and **DOUBLE CHECK** before applying power. Do not rely on wire color-coding alone.
- **POWER OFF** before unplugging, plugging in or making any connections.
- Do not connect SOURCES of power to the pins marked with **5v**. They are **OUTPUTS** for supplying power to other devices.
- The **3.3v** supply is for low-current use only. 20mA MAX.
- Do not connect GND, **5v**, **VBAT** or **3.3v** to each other (short circuit).
- Do not connect GND, **5v**, **VBAT** or **3.3v** to any inputs or outputs unless specifically stated.
- Do not connect any input or output to any other input or output unless specifically stated.
- Do not connect all three pads of the 3 pin solder bridges, connect the center pad to one other pad **ONLY**.
- Do not allow dirt/dust/glue/liquid/etc into the pressure sensor (barometer) and microphone.
- Keep magnets away from the flight controller.
- Keep all conductive liquids away from the flight controller.
- Do not attempt to clean using an ultra-sonic cleaner - all the sensors be damaged.
- Do not use excessive force when inserting or removing MicroSD cards.
- Always align USB plug and socket when inserting/removing USB cables to prevent damage to the USB socket.
- Never power up any VTX without an antenna connected otherwise you will **DESTROY** the VTX.
- Do **NOT** rely on cable color-coding due to manufacturer variations.

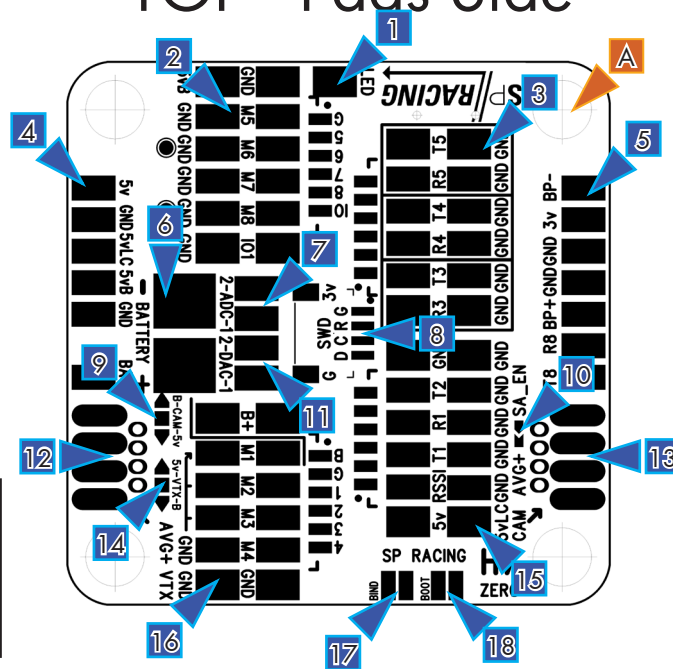
## GENERAL ADVICE

Follow the advice below for best performance and long-life of your flight controller:

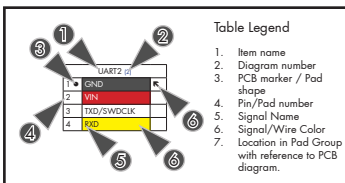
- Apply resin/glue to reinforce JST-SH connectors - helps if you crash your aircraft.
- To further protect the board from crashes you can add a some additional solder to the edges of the JST-SH and USB sockets to reinforce them.
- Support connector sockets when inserting cables.
- Install open-cell foam over the pressure sensor for more accurate readings.
- If the noise from motors is too loud you can also install open-cell foam over the microphone.
- Do not cover the hole in baro and microphone sensors (e.g. with glue, resin, etc) or allow foreign object to enter it.
- Using color-coded wires and connectors is recommended, especially for BATTERY connections.
- For optimum performance do everything you can to prevent vibrations reaching the accelerometer/gyro sensor. e.g. balance motors, props use rubber isolation grommets and secure everything. Do not allow any wires to vibrate against the FC.
- If any incorrect flight behaviour is observed check props, motor bearings and other sources of vibrations **BEFORE** adjusting any software filters or other settings.

# TOP - Pads Side

- LED Strip Pad.
- Motor 5-8 Pad Group.
- 3 UART3/4/5 Pad Group.
- Power Pad Group.
- Beeper, 3v3 and UART8 Pad Group.
- Battery Pads.
- ADC Pads.
- SWD Pads.
- Camera Voltage Selector.
- SmartAudio jumper.
- DAC Pads.
- VTX Pads.
- Camera Pads.
- VTX Voltage Selector.
- Receiver Pad Group.
- Motor 1-4 Pad Group.
- Bind Pads (Button on reverse).
- Boot Pads (Button on reverse).



A. 4mm Mounting Holes.



LED Strip Pad (1)	
1	LED Strip Data Out (DO)

## LED Strip Pad

Pad for connecting a to LED strip's "Data In" connection, Connect LED strip GND and Power to corresponding GND and 5VBEC pads on the FC. There are three pads in a row on the edge of the board suitable for 5VBEC and GND LED strip connections.

Note that some LED strips require a MAXIMUM voltage LESS than 5V. In this case connect a DIODE between the LED strip + and a 5V BEC pad to drop the voltage.

Motor 5-8 Pad Group (2)	
1	5vBEC (Left Column, Top Row)
2	Motor Signal Ground
3	Motor Signal Ground
4	Motor Signal Ground
5	Motor Signal Ground
6	GND (Left Column, Bottom Row)
7	GND (Right Column, Top Row)
8	Motor 5 Signal / I2C4_SCL
9	Motor 6 Signal / I2C4_SDA
10	Motor 7 Signal
11	Motor 8 Signal
12	IO1

## Motor 5-8 Pad Group

When using separate ESCs ensure each ESC has two wires, one for signal, one for signal ground. Use the GND pads next to the Motor X Signal connection. e.g. For Motor 5 use pins 8 and 2 of the group.

I2C4 is available on Motor Signal 5/6 pads.

External pull-up resistors (around 10k) may be required for some I2C devices, if needed connect pullup resistors between SCL and 3v3 and also SDA and 3v3. Use the IO remapping facility in the firmware to change the usage of the pins from "Motor" to "I2C4".

The IO1 signal can be used for PinIO functionality, e.g. to remotely turn on/off VTX or other devices that accept a 0/3.3v control signal. IO1 is connected to PB11/B11 on the CPU. The firmware can be used to remap this pin as required.

Motor 5-8 Pad Group (3)	
1	TXD (T5)
2	RXD (R5)
3	TXD (T4)
4	RXD (R4)
5	TXD (T3)
6	RXD (R3)
7	GND (Right Column, Top Row)
8	GND
9	GND
10	GND
11	GND
12	GND (Right Column, Bottom Row)

## UART 3/4/5 Pad Group

For easy wiring the group is made of 3 sub groups containing 2 GND signals, a TX and an RX signal.

Use for connecting VTX/ESC Telemetry/OSD/GPS/BlueTooth/RX Telemetry/Etc.

5v RX/TX signals OK.

Power Pad Group (4)	
1	5V
2	GND
3	5VLC
4	5VBEC
5	GND
6	Battery +

## Power Pad Group

The power pad group is set of pads for accessory/peripheral power.

Note the difference between the 5V/5VLC/5VBEC power rails:

\* 5V = Always on, un-filtered, low current. (<200mA when all 5V pads combined)

\* 5VLC = Always on, LC-Filtered, low current (<200mA when all 5VLC pads combined).

\* 5VBEC = Only on when battery connected, high current. (< BEC rating when all 5VBEC pads combined)

Beeper, 3v3 and UART8 Pad Group (5)		
1	BUZZER- (B-)	↑
2	3.3v	
3	GND	
4	GND	
5	BUZZER+ (B+) / 5v	
6	RXD (R8)	
7	TXD (T8)	↓

### Beeper, 3v3 and UART8 Pad Group

Use BP+ and BP- to connect to an external **5V** buzzer. Note the pads are spaced so that the pins of a ~12-13mm buzzer with ~7-10mm pitch can be directly soldered flat against the pads on the FC so the buzzer faces sideways.

The 3v pad is for use when connecting to **3.3v** receiver, e.g. Spektrum Satellite receiver. **20mA MAX**

The R8/T8 pads can be used for VTX/ESC Telemetry/OSD/GPS/BlueTooth/RX Telemetry/Etc.

BATTERY Pads (6)		
1	Battery -	↑
2	Battery +	↓

### BATTERY - IMPORTANT: DOUBLE CHECK and TRIPLE CHECK POLARITY!

For connecting a 2-6S LiPo battery (26V MAX). Connect to a MALE connector, e.g. the XT60 with the pins. Your battery should have a female connector.

ADC Pads (7)		
1	ADC-2	↑
2	ADC-1	↓

### ADC Pads

The ADC pads accept **0 - 3.3v**. By default the ADC-2 pad is used for external current sensor connection. The firmware can be used to remap the ADC pad functions.

SWD Pads. (8)		
1	3.3v	↖
2	GND	↙
3	GND	↗
4	NRST	
5	SWDIO	
6	SWDCLK	↘

### SWD/DEBUG pads - Used for software development

Use a compatible SWD debugger. Black Magic Probe, ST-Link, Segger J-Link, etc.

IMPORTANT: Do not attempt to reflash the firmware on the H7 CPU via SWD. Firmware is stored on external flash.

A JST-SH 4pin connector can be soldered to the pads to allow easy debugger cable connections as required. ERRATA: The silk-screen on the PCB has D (DIO) and C (CLK) transposed.

Camera Voltage Selector (9)		
1	Battery +	↑
2	VTX Voltage	
3	5V BEC	↓

### Camera Voltage select bridge pads.

Create a solder bridge between **TWO PADS ONLY** to select the Camera voltage.

IMPORTANT: Check that no short-circuit exists between 5V and Battery+ before and after soldering!

a) bridge ▲ and ■ to set the camera voltage to **BATTERY** voltage.

b) bridge ■ and ▼ to set the camera voltage to **5V**.

SmartAudio Jumper (10)		
1	TXD (T4)	↑
2	Audio Out	↓

### SmartAudio jumper

When using a SmartAudio compatible VTX bridge this jumper to use UART4 for SmartAudio. UART4\_TX will then be connected to the AUDIO\_OUT signal on the VTX pads (12).

DAC Pads (11)		
1	DAC Channel-2	↑
2	DAC Channel-1	↓

### DAC Pads

The DAC pads are directly connected to the CPUs DAC output pins. These pins can generate voltages from 0 to 3.3v. Their use is dependent on the firmware. The firmware can be used to remap the DAC pad functions.

VTX Pads (12)		
1	Audio Out	↑
2	Video Out	
3	GND	
4	VTX Voltage	↓

### VTX

Connect an NTSC or PAL Video transmitter camera. Ensure your VTX uses the same video format as the camera. i.e. Use an NTSC camera for an NTSC video transmitter.

VTX voltage is configured by the VTX voltage selector (14). Set the voltage to either **BATTERY** or **5V**.

Camera Pads (13)		
1	Camera Voltage	↑
2	GND	
3	Video Out	
4	Audio In/Camera OSD Control	↓

### Camera

Connect an NTSC or PAL FPV camera.

Camera voltage is configured by the CAM voltage selector (9). Set the voltage to either **BATTERY** or **5V**.

Pin 4 (A) can be used for Audio In (from Camera/Microphone) or as Camera OSD Control, set the Audio In / Camera OSD Control selector on the reverse of the board.

Use the Camera OSD Control and GND connections to control your camera's OSD with the transmitter sticks. See Betaflight wiki for details of connections and supported cameras. The FC uses a 1uF capacitor to ground and 470ohm resistor in series with the data signal on PE5/E05.

VTX Voltage Selector (14)		
1	5V BEC	↑
2	VTX Voltage	
3	Battery +	↓

### VTX Voltage select bridge pads

Create a solder bridge between **TWO PADS ONLY** to select VTX voltage.

IMPORTANT: Check that no short-circuit exists between 5V and Battery+ before and after soldering!

a) bridge ▲ and ■ to set the VTX voltage to **5V**.

b) bridge ■ and ▼ to set the VTX voltage to **BATTERY** voltage.

Receiver Pad Group (15)		
1	GND	↖
2	TXD (T2)	
3	RXD (R1)/PPM	
4	TXD (T1)	
5	RSSI	
6	5VLC	↙
7	GND	↗
8	GND	
9	GND	
10	GND	
11	GND	
12	5VLC	↘

### Receiver Pad Group

Connect to a receiver. Examples:

FrSky XSR - UART1 for Serial RX, UART2 for SmartPort. Use R1 for TX and T2 for SmartPort.

CRSF RX - UART1 for Serial RX. Use R1 for CRSF TX and T1 for CRSF RX.

FrSky FPort - UART2 for Serial RX. Use T2 for FPort (SmartPort pin on Receiver).

Other Serial RX - UART1 for Serial RX, T2 for Telemetry (Hott/Smartport/etc).

PPM RX - "RXD (R1)/PPM" for PPM, "TXD (T1)" or "TXD (T2)" for Telemetry.

IMPORTANT: RSSI is Analog with **0-3.3v** range **ONLY**.

LC-Filtered **5.0v** via 5VLC is also supplied when powering via USB.

Motor 1-4 Pad Group (16)		
1	Battery +	↖
2	Motor Signal Ground	
3	Motor Signal Ground	
4	Motor Signal Ground	
5	Motor Signal Ground	
6	GND (Left Column, Bottom Row)	↙
7	Battery +	↗
8	Motor 1 Signal	
9	Motor 2 Signal	
10	Motor 3 Signal	
11	Motor 4 Signal	
12	GND (Right Column, Bottom Row)	↘

### Motor 1-4 Pad Group

When using separate ESCs ensure each ESC has two wires, one for signal, one for signal ground. Use the GND pads next to the Motor X Signal connection. e.g. For Motor 1 use pins 8 and 2 of the group.

Bind Pads (17)		
1	BIND	←
2	3.3v	→

### Bind pads

The bind pads have the same function as pressing the Bind button on the reverse of the board. They can be connected to an external push-to-make momentary switch if required.

Boot Pads (18)		
1	3.3v	←
2	BIND	→

### Boot pads

The boot pads have the same function as pressing the Boot button on the reverse of the board. They can be connected to an external push-to-make momentary switch if required.

**IMPORTANT:** For developer use ONLY. The H750 CPU's ROM DFU bootloader is NOT for normal firmware upgrades; the SPRacing Bootloader should be used instead, see the bootloader section of this manual.

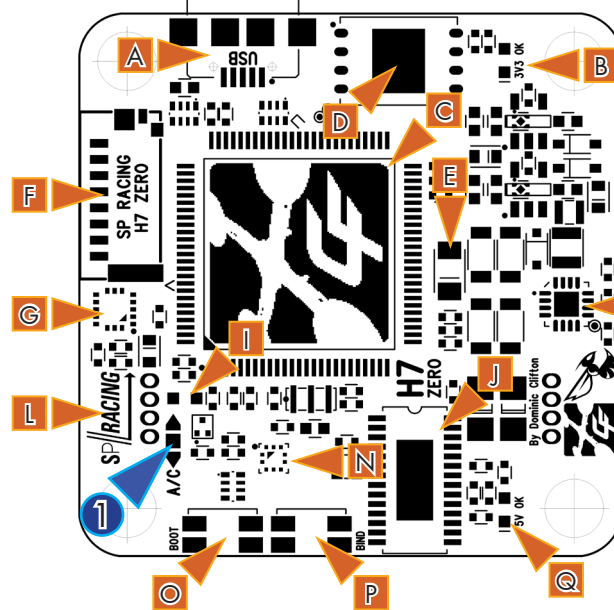
### NOTE:

When bridging select pads with solder, put a small blob of solder on two pads, let the solder cool, then bridge them together with a little more solder.

**VERY IMPORTANT:** For selectors ensure that you **DO NOT CONNECT ALL THREE PADS TOGETHER!** Check for shorts before and after soldering.

# BOTTOM - Component Side

1. Audio In / Camera OSD Control selector.



- A. USB Socket.
- B. 3v3 OK LED, Blue.
- C. H7 400Mhz CPU.
- D. 128MB Flash
- E. TVS Protection Diode.
- F. SD Card Socket.
- G. ICM20602 Gyro/Acc.
- H. 5V BEC.
- I. Status LED, Red.
- J. OSD controller.
- K. Betaflight Logo.
- L. SP Racing Logo.
- M. Cleanflight Logo.
- N. BMP388 Barometer.
- O. Boot Button.
- P. Bind Button.
- Q. 5V OK LED, Green.

Audio In / Camera OSD Control selector (1)		
1	▲ Camera OSD Control Out	↑
2	■ Audio In/Camera OSD Control	
3	▼ Audio In	↓

### Audio In / Camera OSD Control selector

The A/C selector allows the "Audio In/Camera OSD Control" pad on the Camera pads to be either Camera OSD Control or Audio In.

**IMPORTANT:** Check that no short-circuit exists between Audio In and Camera OSD Control pads (1 and 3) before and after soldering!

- a) bridge ▲ and ■ select Camera OSD Control.
- b) bridge ■ and ▼ select Audio-In to Audio-Out.

## Receiver Connections

The H7ZERO supports many different receiver connection methods, refer to the 'Receiver Pad Group', above, for some examples and refer to the betaflight wiki/manual for an up-to-date list of current supported protocols.

## Camera/VTX/LED-Strip 5V BEC Connections.

The H7ZERO supports **5V** or **BATTERY** voltage Cameras and VTXs, the on-board **5V** regulator components are rated for 1.5Amps, but other devices, such as the FC itself and any receivers or LED strip connected to it will use the regulator. To be on the safe side do not use more than 1A at **5V**. Suggest measuring the current usage of each connected device, one at a time prior to using them all at the same time.

If you run more than a few LED-STRIP LEDs it is better to have a separate BEC for the LEDs to ensure that LED operation doesn't interfere with flight behavior. When checking current draw of LEDs set them to WHITE as this will use the most current.

Cameras and VTXs that support LiPo battery voltages are recommended, more flexible and can be connected to either **5V** or **BATTERY** and thus allow you to spread the load. Cameras and VTXs that support **BATTERY** input often also have additional signal filtering for a clearer picture.

## Camera Connection.

Connect your Camera via the Camera pads. There are also holes to allow a 4-pin PicoBlade connector to be installed as required.

Set the Camera voltage selector to either **5V** or **BATTERY** voltages, refer to your Camera manual for support voltage range.

If your FPV camera has it's own OSD and allows control via buttons it may also be supported by the firmware to allow the transmitter sticks to be used to control the camera's OSD, refer to the betaflight wiki for configuration. See the "Camera Pads" above for details of the components used in the circuit which you will need to know to configure it correctly.

**IMPORTANT: Remember to set/reset the Audio In/Camera OSD Control and Camera Voltage selectors before connecting new/different camera!**

## Separate ESC Connections.

If you are using separate ESCs, one ESC per motor, proceed as follows.

1. Connect FC battery wire to FC's Battery +/- pads. Use a MALE connector on the FC battery lead as the battery itself should have a FEMALE connector.
2. Connect each ESC to the large +/- pads in each corner of the FC.
3. Connect a GND and a Motor signal wire from the FC to each ESC.

There should be 4 wires to each ESC and 2 to the battery, 18 total.

This allows the FC to measure current used by all the ESCs and supplies the FC with power.

The large 4in1 ESC pads on the bottom of the FC should not be used for ESCs or Battery.

## 4in1 ESC Connection.

If you are using a 4in1 ESC, one ESC for 4 motors, then proceed as follows:



1. Connect FC battery wire to FC's Battery +/- pads. Use a MALE connector on the FC battery lead as the battery itself should have a FEMALE connector.
2. Connect 4in1 pads on the bottom of the board to ESC.
3. Connect Motor signal pads from FC to motor signal pads/wires on 4in1 ESC.

This allows the FC to measure the current used by the 4in1 ESC board and supplies the FC with power.

Alternatively, if your 4in1 ESC has a current sensor then you can connect the 4in1 ESC's current sensor ADC output signal to the External ADC pad on the top of the board. You still need to provide the FC with battery voltage using the Battery +/- pads.

## VTX Connection

Connect your VTX via the VTX pads. There are also holes to allow a 4-pin PicoBlade connector to be installed as required.

If your VTX supports audio input or SmartAudio then connect the Audio Out from the FC to the Audio In on the VTX.

If your VTX accepts 0/3.3v control signals for PIT Mode then connect IO1 from the FC to this, and ensure PB11/B11 is configured for PinIO usage in the firmware so you can turn on/off your VTX from a transmitter switch.

**IMPORTANT:** Remember to set/reset the Audio In/Camera OSD Control and Camera Voltage selectors before connecting new/different camera!

## Cables

If you purchased cables for your flight controller then do **NOT** rely on cable color-coding due to manufacturer variations. Always check before applying power.

**IMPORTANT:** Ensure that you leave some slack in your cable routing as this will help if you crash your aircraft.

## MicroSD Card

The MicroSD socket allows MicroSD/SDHC/SDXC to be inserted.

HOWEVER, Currently only **MicroSD** and **MicroSDHC** are supported. **MicroSDXC** is **NOT** currently supported by Betaflight.

For full details on how to enable logging, SD card speed requirements and how to view logs please see the Betaflight software manual.

Your aircraft will fly better if you analyze your logs and tune accordingly.

## Soldering

VERY IMPORTANT! - Do NOT solder your flight controller until you have plugged in a USB cable and checked that the GREEN, BLUE and RED lights operate! Red will flash, GREEN and BLUE must be ALWAYS ON. Once you have checked the FC is OK then unplug it and solder your wires.

### IMPORTANT:

- Use a high quality soldering iron and good solder.
- Tin/Lead solder is MUCH easier to use than other Lead-free solder.
- Use solder with flux and remove any flux residue after soldering. AVOID CORROSIVE FLUX!
- Check for and remove solder balls you may have created after soldering - use a magnifying glass.
- Ensure you have sufficient fume extraction when soldering.
- Pin headers that connect to the GND signal and large battery/esc pads will be more difficult to solder because the PCB will sink the heat from your soldering iron. Solder the signal pins, then the VIN pins, then the GND pin or large pads - by the time you get to the GND pins or large pads you will have heated the board and it will be easier to solder them.
- If you have never soldered before then DO NOT attempt to solder the flight controller, practice on something else first.
- Position your soldering iron tip so that you do not accidentally de-solder other components on the board.

The flight controller may be supplied with some pin-headers and connectors. Choose very carefully which ones you want to use. You can solder headers to top or the bottom of the board.

Once you have soldered pin headers or connectors in place **DO NOT** attempt to remove them unless you are highly skilled in de-soldering and have the correct tools. Overheating the board or components will destroy it.

## Getting started

Verify flight controller operation via the configuration software.

- Disconnect the flight controller from your computer.
- Disconnect ALL connectors and headers from the flight controller.
- Install latest STM32 Virtual COM Port Driver  
<http://www.st.com/web/en/catalog/tools/PF257938>
- Install and launch the Betaflight Configurator tool  
<https://github.com/betaflight/betaflight-configurator>
- Connect flight controller to computer via USB cable.
- Select the correct COM port if it is not automatically detected.
- Verify all sensors on your board are giving correct readings.
- Disconnect and **upgrade the firmware** if new firmware is available.

For further software configuration see the getting started guide in the Betaflight wiki or manual.

The basic steps, after firmware upgrade, are as follows.

- Choose board alignment - you can mount it in any orientation, not just with the arrow facing forwards.
- Calibrate sensors.
- Configure serial ports.
- Choose model/mixer (default is Quad X)
- Enable features.
- Configure receiver, set channel mapping.
- Configure channel mid and endpoints (1000-2000) and trim channels on transmitter.
- Configure voltage/current monitoring.
- Configure outputs (servos/ESCs)
- Ensure ESC calibration matches ESC configuration, recalibrate ESCs if needed.
- Learn about flight modes and configure channels/switches to activate them as required.
- Learn how to arm/disarm.
- Bench-test failsafe without props attached.
- Read safety notes.
- Learn how to download and view your flight logs to help tune your aircraft.
- Enable blackbox logging before your first flight (so you have a log).
- Learn how to recognise un-tuned flight characteristics and the effects of a PID controller. (Watch some videos).
- First flight should be in Acro/Rate mode (the default mode when no other modes are active).
- Tune PIDs.
- Backup settings.
- Contribute to the Betaflight project with feedback, suggestions, code, etc.

## Firmware Upgrade

### VERY IMPORTANT:

It is **REQUIRED** that you immediately upgrade the firmware of the flight controller so that you have the latest features and bug fixes. **DO NOT ATTEMPT TO FLY** until you have installed the **latest firmware**. Due to the fast-paced development cycle of Betaflight and manufacturing lead-times the firmware installed in the factory may not have all features enabled and issues may have been fixed.

On Windows USB DFU drivers must be installed.

1. Click the Firmware Flasher tab.
2. Select the correct COM port and speed, use the default speed unless you have changed it on the FC.
3. Select the latest "SPRACINGH7ZERO" stable release. (Do **not** use other targets). If no firmware is currently available or the target is not listed do **NOT** attempt to flash and refer to the betaflight wiki/issue tracker for firmware availability. **NOTE: Flashing the wrong firmware can cause the FC to be permanently damaged.**
4. Click 'Load firmware [Online]' and wait for firmware to download and read release notes before flashing.
5. Click 'Flash Firmware'. At this point the FC should reboot into DFU mode. DFU will appear in the list of ports and flashing via DFU will proceed. After flashing the virtual COM port will re-appear.

**IMPORTANT: Verify operation using latest official firmware before attempting to use alternative firmware. Not all features may be supported by alternative firmware.**

**NOTE: Do not use the configurator versions that do not have support H7 EXST flashing. Configurators released after BF4.1 should have this, until then refer to the links below for flashing via dfu-util. Attempts to flash using the incorrect configurator version will not work.**

Official firmware:

<https://github.com/spracing/betaflight/issues/1>

Official source:

<https://github.com/spracing/betaflight/issues/2>

## Bootloader

The SP Racing H7 ZERO is unlike any other Cleanflight/Betaflight FC before it as the Betaflight/Cleanflight software is NOT stored on the CPU itself, instead the software is stored on the external flash or SD card and loaded into the CPU's RAM when the FC is powered on.

The SP Racing H7 ZERO has a small program, called a bootloader, which handles this task.

The bootloader will start as soon as the CPU powers on, and it will look for firmware and attempt to load it immediately, without interfaction.

If you need to enter the bootload you can do it from the configurator tool or by keeping the bind button pressed when powering on the FC. When the bind button is pressed on boot the status led will blink very fast until the bind button is released. When the button is released the bootloader software will flash the status led slowly and the FC will be in Bootloader DFU mode.

When the bind button is held during SP Racing bootloader mode the LED will flash once every 2 seconds, each LED flash indicates a different function. keep the bind button pressed until the LED has flashed the amount of times that correspond to the function number below, then release the bind button to start the function.

Bootloader functions:

- 1 Load firmware (looks for valid firmware on SD card for CFEXSTFW.BIN first, then external flash at 0x97CE0000)
- 2 Launch loaded firmware in RAM (for developers).
- 3 Clear firmware in RAM.
- 4 Enter CPU ROM DFU bootloader.
- 5 Reboot.
- 6 Erase config on external flash.
- 7 Erase firmware on external flash.
- 8 Erase entire external flash.
- 10 Flash firmware from file on SD card.
- 15 Erase CPU bootloader (**DO NOT DO THIS - You will have to return the FC to the factory for reprogramming**).
- 16 Erase external flash reserved area. (Do NOT do this unless instructed by Seriously Pro / SP Racing)

**IMPORTANT:** The bootloader is non-user-upgradable. If you erase it you will not be able to use the FC until a bootloader is restored to it by the factory, at your cost! If you are a developer you can erase it and write your own if you like; the bootloader has a function (15) which allows you to erase it for this purpose only.

Failure patterns:

When the bootloader can't do something, it will give a failure pattern. The patterns starts with a few quick flashes, then some slow flashes. Count the slow flashes and use the table below.

- 2 = Firmware verification failed. Corruption, hash mismatch.
- 3 = Firmware load failed. No valid firmware found.
- 4 = Firmware write failed (e.g. when flashing).
- 5 = External flash write failed.
- 6 = External flash read failed.
- 7 = SD write failed.
- 8 = SD read failed.

There are other codes, if you experience them contact SP Racing support with your symptoms.

Note: The betaflight failure patterns start with fewer and slower 'fast' flashes than the bootloader failure patterns which begin with much faster 'fast' flashes.

## Firmware flashing for developers

Manual flashing can be performed when the SP Racing bootloader is in DFU mode. The SP Racing bootloader allows full access to the external flash. You can also download Blackbox logs from the external flash via DFU! - very fast!

### Firmware Program

```
dfu-util -D obj/betaflight_4.0.0_SPRACINGH7ZERO_EXST.exst -s 0x97CE0000:leave  
dfu-util -D obj/betaflight_4.1.0_SPRACINGH7ZERO.bin -s 0x97CE0000:leave
```

### Firmware Erase

```
dd if=/dev/zero ibs=1k count=448 of=ZERO_448K.bin  
dfu-util -D ZERO_448K.bin -s 0x97CE0000:0x70000
```

### Firmware Read

```
dfu-util -U fw_448K.bin -s 0x97CE0000:0x70000
```

### Blackbox Log Read

```
dfu-util -U bb_log.bin -s 0x90000000:0x7CC0000
```

### Config Erase

```
dd if=/dev/zero ibs=1k count=128 of=ZERO_128K.bin  
dfu-util -D ZERO_128K.bin -s 0x97CC0000:0x20000
```

### Config Read

```
dfu-util -U config.bin -s 0x97CC0000:0x20000
```

The SP Racing bootloader firmware supports SWD debugging of the betaflight software code, just set breakpoints in the Betaflight code as you would normally. Refer to the BF source for BL address space usage.

## Troubleshooting

Q: Unable to flash firmware via DFU.

A: Likely the correct DFU drivers are not installed. Put the FC in SP Racing BOOTLOADER mode by holding BIND and connecting the USB cable. Release BIND when the status LED flashes fast repeatedly. Then update DFU drivers. See USB Flashing section of Betaflight manual for details.

Q: The COM port does not show up.

A: Ensure latest USB STM VCP (Virtual Com Port) drivers are installed.

Q: DFU does not appear in the port list when flashing.

A: Try disconnecting the FC. Hold BIND button to enter the SP Racing bootloader. Connect the USB cable. Release BIND, retry flashing.

Q: I have no LEDs on at all.

A: Check 5v supply. (Battery Charged?, USB cable damaged?)

Q: The status LED never lights or is always on.

A: Follow recovery procedure in the configurator. Likely caused by flashing wrong firmware. Could also be caused by stuck-down BOOT switch - check button for dirt, etc. You can also use the SP Racing Bootloader to erase/reset the FC configuration to defaults which may also help.

Q: Unable to connect and a repeating light sequence occurs on the activity LED.

A: Check the Betaflight manual for how to interpret the error code (count the long flashes).

Q: Unable to connect to the board (and status LED shows non-repeating pattern at boot-up).

A: Close all Chrome browsers and Chrome apps, retry. COM Port drivers not installed? Try connecting via different UART OR Reset the board to defaults using buttons OR reflash firmware using 'full chip erase'. (Likely caused by mis-configuration of ports).

Q: The COM port does not show up after flashing firmware.

A: Wrong firmware was flashed; Use SP Racing bootloader to erase the firmware and config, reflash correct firmware.

Q: The receiver tab does not show any activity.

A: Check configuration tab - receiver mode. Center sticks, configure endpoints and trim on transmitter. Check ports tab if using Serial RX. Check wiring.

Q: You have a problem not listed here.

A: Reset and/or upgrade the firmware, try again, report issues via the forums - links are in the configurator on the 'Documentation & Support' tab. Before contacting your retailer reflash with latest Betaflight, reset FC to default setting and double check your issue - perhaps the firmware you are using is old or incorrect?

Q: Only 5V LED lights up, No BLUE 3V LED or RED STATUS LED.

A: Most common cause is misconnection or short of power/battery wires - FC will probably be destroyed! Check for short in Spektrum Satellite cable if using Spektrum Satellite RX. Normally only caused by destroyed CPU or overloaded/shorted voltage regulator.

## Mounting

The SPRacingH7ZERO is supplied with grommets. Install the grommets in each corner of each board; they should **always** be installed as they have two primary functions: 1) vibration isolation, 2) excessive shock to the gyro in a crash.

The SP Racing H7 ZERO is designed to be installed in most frames with pads facing upwards, components downwards.

The camera pads are designed to be at the front, vtx and battery pads at the rear, and BMP388 sensor downwards for wind isolation. However you are free to install it however you like just remember to set the board orientation in the firmware to match how you have installed it in your frame.

Ensure that all wires soldered to the FC do **NOT** rub against anything in a way that would cause them to be damaged and short something out.

**Use appropriate guage cable and solder neatly!** Especially for the Battery and ESC power cables.



## Hardware Specifications

- STM32H750 CPU, 400MHz inc FPU
- 128MByte Flash (for firmware, config and Blackbox logging, 4-bit QuadSPI not 1-bit SPI)
- Single ICM20602 Gyro (SPI, with interrupt signals, 32khz capable)
- BMP388 Barometer - bottom facing for wind isolation (I2C + interrupt)
- OSD with customisable layout, profiles and configuration menu system
- MicroSD card slot (SD/SDHC, upto 32GB) connected via 4-Bit SDIO
- Lightweight 1.2mm thick 4-layer copper gold-plated PCB
- Easy wiring of 4in1 or separate ESCs
- 2-6S BEC 5V Switching regulator, 1A
- TVS protection diode
- Dedicated 500mA VREG for sensors and SD card with extra filter capacitors
- Second 500mA VREG for CPU and other peripherals
- Buzzer circuitry
- RSSI analog input
- Current sensor input
- 8 motor outputs
- 6 Serial Ports (5x TX+RX + 1x TX only bi-directional)
- 3 LEDs for 5V, 3V and STATUS (Green, Blue, Red)
- 37x37mm PCB with 30.5mm mounting hole pattern
- 4mm mounting holes for soft-mount grommets and M3 bolts
- Weight of FC ~4 grams
- MicroUSB socket for configuration and ESC programming
- Bootable from SD Card or External flash.
- Supplied with 4x soft-mount grommets.
- Optionally supplied with 2x Audio/Video cables. (Camera Input, VTX Output)
- 8x pairs of solder pads for bi-directional ESC signals/GND connections
- 4x special solder pads with through-holes for Camera In + Camera OSD
- 4x special solder pads with through-holes for Audio+Video Out (VTX)
- 1x solder pad for analog RSSI
- 1x solder pad for LED Strip
- 2x solder pad for DAC outputs
- 2x solder pad for ADC in (for 4in1 current sensor, etc)
- 2x solder pads for un-filtered 5V BEC output.
- 4x solder pads for LC-filtered 5V output.
- 2x large solder pads for battery wires
- 3x sets of 3 solder pads for UART RX/TX/GND connections for UART3/4/5
- 2x solder pads for UART8 RX/TX
- 2x solder pads for BUZZER output
- 1x group of 6 solder pads for receiver (GND/5V-LC/UART1 RX+TX, UART2 TX)
- 1x set of pads for 4pin JST-SH socket for SWD debugging (\*socket available separately)
- 1x Side-press BOOT button
- 1x Side-press BIND/Settings button
- 2x 5V/BATTERY voltage selectors for Camera and VTX outputs
- 1x camera OSD control/audio-in selector
- 1x SmartAudio to VTX jumper
- PCB also allows for 6 pin-picoblade connectors to be installed on 4 groups of pads (\*connectors and cables available separately).
- Cleanflight and Betaflight logos
- SP Racing logo
- Additional easter egg!

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<https://www.youtube.com/user/Painless360/playlists>

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<https://github.com/cleanflight/cleanflight/graphs/contributors>

## Community

Thanks to everyone from the AWESOME Cleanflight/Betaflight/iNAV communities for code, artwork, support, ideas, feedback, and everything else. Without you all this product would not exist.

