Seriously Pro

SP Racing H7 EXTREME Flight Controller

About

The Seriously Pro Racing H7 EXTREME Flight Controller (SPRacingH7EXTREME) was designed to give you all the CPU performance you need for a low-latency control-loop and dual simultaneous gyros for extreme flight performance.

This premium flight controller features many features not found elsewhere, such as PID-Audio and an on-board microphone which allows you to hear your quad as it flies.

It also features a race timing transponder system the SPRacingH7EXTREME is truly designed for racers. Analyze your race and flight telemetry/blackbox logs using the built-in 128MB flash or MicroSD card socket.

The SPRacingH7EXTREME features DUAL SIMULTANEOUS GYRO support. Having two gyros is better than one, and new for the H7EXTREME one of the gyros is rotated at a 45 degree angle so that the FC receives movement information from 3 gyro axes at the same time for pitch/roll movements. e.g. on a roll you get full roll from one gyro, and half pitch and half roll from the other gyro, which is then all combined and filtered to create a more precise sensor reading than a single gyro.

PID-Audio allows to you to hear how hard the PID controller is working and thus wether your tuning is optimal for your style of flight. You will learn to hear how your aircraft sounds, this is useful in many scenarios, such as detecting weather conditions, broken/damaged props, damaged arms, loose screws, etc. It's suprising what you can identify from audio feedback!

The SPRacingH7EXTREME gives you all the features you need for the heart of your aircraft, whether you're into FPV racing, freestyle acrobatic flying or stable and smooth aerial photography it's perfect!

Software

The SPRacingH7EXTREME 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 premium STM32H750 based board. It has other features not seen on most other FCs, other than the blisteringly fast 400Mhz H7 CPU, including an Dual Simultaneous Gyro, 12 motor outputs and simultaneous Transponder, LED Strip and Telemetry support along with the ability to stack with a VTX board.

The SPRacingH7EXTREME is the first 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 two of the latest 32khz capable Accelerometer, Gyro sensor devices connected via the fast SPI bus.
- New high-accuracy Baro/Altitude sensor with less drift than previous sensors.
- MEMS Microphone to allow you to hear the motors while flying.
- PID-Audio to let you hear what the flight-controller is doing in real-time as you fly. With practice you'll recognise when your FC is tuned how you like it by listening to the CPU generated audio-stream.
- 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.
- Race transponder built in - just turn up at a race and have your lap times recorded.
- MicroSD-Card socket for black box flight log recorder - optimize your tuning and see the results of your setup without guesswork.
- Audio mixer with balance control to adjust the balance between the PID-Audio and the microphone.
- Solder-from-top design makes installation and maintenance simple.
- 12 Motor outputs. DSHOT/OneShot/PWM for ESCs and Servos. When using VTX board with FX756-2-SPI only 8 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.
- 7 Serial Ports - NOT shared with the USB socket.
- Micro USB socket.
- Dedicated output for programmable LEDs - great for orientation, racing and night flying.
- Dedicated I2C port for connection of OLED display or MAG without needing flight battery.
- Battery monitoring for voltage and current.
- RSSI monitoring (analog or PWM).
- Buzzer port for audible warnings and notifications.
- Developer friendly debugging port (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 for a super tidy wiring.
- 3x JST-SH sockets for IO (I2C, UART3,UART4), SWD, UART5/Camera OSD control.
- 1x 6-way Picoblade socket for receiver connections, now with RSSI input on the receiver connector.
- Header pin pads for recevier connections (UART2), IR LED, UART1, 5V/GND and Buzzer
- Firmware upgradable via USB and MicroSD card.
- Stackable design - optional VTX board available.
- 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

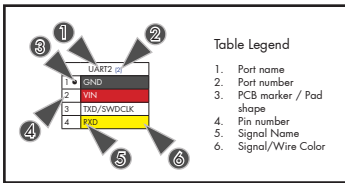Follow the advice below for best performance and long-life of your flight controller:

- 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.

1. Motor 2 pads (4x pads).
2. 5V and GND headers.
3. UART4 headers.
4. Motor 1 pads (4x pads).
5. Motor 8/7 / UART6 signal pads.
6. Motor 5/6 signal pads.
7. 3.3v pad.
8. IR LED headers.
9. Battery pads.
10. Buzzer headers.
11. UART1/Receiver headers.
12. Analog/PWM RSSI selector
13. RSSI pad.
14. LED Strip pad.
15. Motor 4 pads (4x pads).
16. Motor 3 pads (4x pads).
17. Camera + Camera OSD pads.
18. VTX + Audio pads.
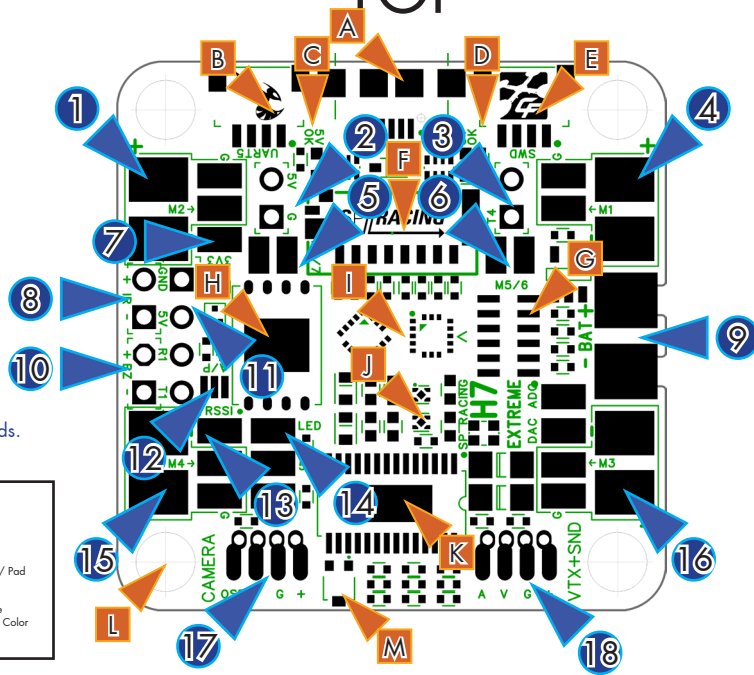
A. MicroUSB socket.
B. UART5/GPIO socket.
C. 5V OK LED (Green).
D. 3V OK LED (Blue).
E. SWD debug socket.
F. Micro SD socket.
G. Stacking connector.
H. 128MB Flash.
I. Dual Gyro and Accelerometer sensors.
J. 3v3 Voltage Regulators.
K. OSD.
L. 4mm Mounting Holes.
M. MIC/PID-Audio balance control.

Table Legend
1. Port name
2. Port number
3. PCB marker / Pad shape
4. Pin number
5. Signal Name
6. Signal/Wire Color

Motor Pads (1,4,15,16)	
1 -	Battery - -
2 +	Battery +
3 M	Motor Signal
4 G	Motor Signal Ground

RSSI (13)	
1 ■	RSSI

5V/GND (2)	
1 ■	GND
2 ●	5V

UART4 (3)	
1 ■	TXD (T4)
2 ●	RXD (R4)

Motor Pads (5)	
1 ■	Motor Signal 8 / UART6_TX (Left Pad)
2 ■	Motor Signal 7 / UART6_RX (Right Pad)

Motor Pads (6)	
1 ■	Motor Signal 5 (Left Pad)
2 ■	Motor Signal 6 (Right Pad)

IR LED (8)	
1 ■	IR -
2 ●	IR +

BATTERY (9)	
1 ●	Battery +
2 ●	Battery -

BUZZER (10)	
1 ■	BUZZER- (B-)
2 ●	BUZZER+ (B+) / 5v

UART1 RX/TLM (11)	
1 ■	GND
2 ●	5v
3 ●	RXD (R1)/PPM
4 ■	TXD (T1)/TLM

3.3v Pad (7)	
1 ■	3.3v

LED Strip Pads (14)	
1 ■	LED Strip Data Out (DO)
2 ●	5V BEC
3 ■	GND

Motor 1-4 Pads

4 pads per motor/ESC. Pads are inside the white border.
Connect Battery+/Battery - pads to ESC power pads/wires.
Connect Signal and GND to ESC signal and ground pads/wires.
When using 4in1 ESC do not use Battery+/- pads; Use 4in1 PADS instead (see Bottom).

RSSI

RSSI is for 0 - 5v PWM RSSI or 0 - 3.3v Analog RSSI - Disabled until RSSI select pads are set.

5V/GND

Primarily used for Stacking VTX board. May be used to power other 5V devices.

UART4

Use for connecting VTX/ESC Telemetry/OSD/GPS/BlueTooth/RX Telemetry/Etc. 5v signals OK.

Motor 7-8/UART6 Pads

1 pad per motor/ESC. Ensure each ESC is also connected to a Motor Signal Ground pad. e.g. from M1-4 pads. These pads can also be used for UART6. In the firmware unassign resources from motors and re-assign to UART6.

Motor 5-6 Pads

1 pad per motor/ESC.Ensure each ESC is also connected to a Motor Signal Ground pad. e.g. from M1-4 pads.

IR LED

IR headers are used to a connect single IR LED - either direct-solder the LED or attach the LED via a cable. The LONG leg of the LED goes in the ROUND hole. The SHORT leg of the LED goes in the SQUARE hole.

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. The FC also measures current when using these pads.

BUZZER

Use 5V and BUZZER- to connect to an external buzzer.
5.0v is also supplied when powering via USB.

UART1/PPM - Serial RX or PPM RX + Telememetry

For receiver connections.
Note: Some receivers like the FrSky XSR/X8R require the use of two serial ports for RX and Telemetry in this case use UART1 (for RX) and UART2 (for Telemetry) - See also the receiver connector on the bottom of the PCB.

5v signals OK

3.3v Pad.

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

LED Strip Pads

Pads for connecting an LED strip. Note that some LED strips require a MAXIMUM voltage LESS than 5V. In this case connect a DIODE between the LED strip + and the 5V BEC pad to drop the voltage. The LED Strip signal pad is marked "LED" and closest to the middle of the board.

Camera (17)

1 C	Camera OSD Control	
2 V	Video Signal	
3 G	GND	
4 +	CAM Voltage	

Camera

Connect an NTSC or PAL FPV camera.

CAM voltage is configured by the CAM bridge on the bottom of the board. Set the voltage to either BATTERY or 5V.

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 (18)

1 A	Audio Signal	
2 V	Video Signal	
3 G	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 bridge on the bottom of the board. Set the voltage to either BATTERY or 5V.
IMPORTANT: Ensure your VTX supports with AUDIO IN otherwise you will not be able to use PID-Audio and MIC.

SWD/DEBUG socket (E)

1 ●	GND
2 R	NRST
3 D	SWDIO
4 C	SWDCLK

SWD/DEBUG connector - 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.

UART5/OSD socket (B)

1 ●	GND
2	GPIO Pin (TIM15_CH2/PE6/E06)
3	TXD (T5)
4	RXD (R5)

UART5

Use for connecting VTX/ESC Telemetry/OSD/GPS/BlueTooth/RX Telemetry/Etc. 5v signals OK.

The GPIO pin can be used for PINIO purposes, see Betaflight wiki/manual.

RSSI PWM / ANALOG SELECT (12)

1 A	ANALOG RSSI	
2 ■	INPUT	
3 P	PWM RSSI	

RSSI PWM / ANALOG selector

Create a solder bridge between TWO PADS ONLY to select the function of the INPUT pad.
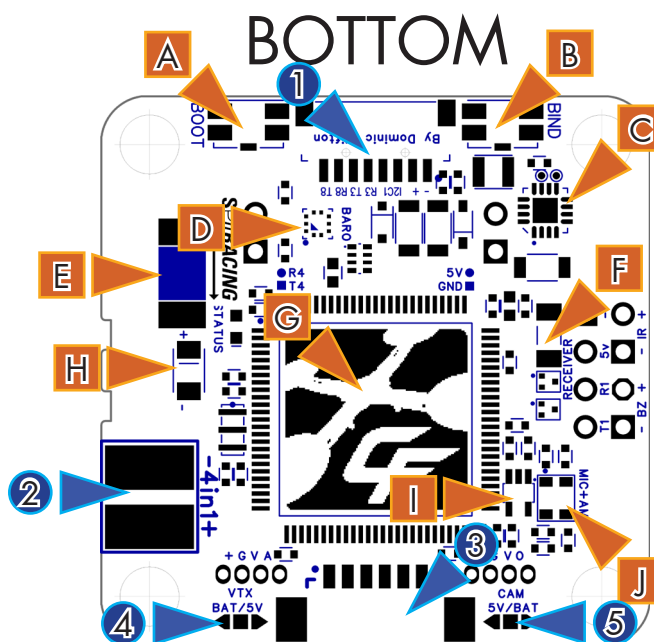a) bridge A and ■ to use the "RSSI" pad for ANALOG RSSI - for 0 - 3.3v Analog Signals.
b) bridge ■ and P to use the "RSSI" pad for PWM RSSI - for 0 - 5v PWM signals.

Stacking connector (G)

1 ●	RXD (R8) (Next to ADC pad)
2	TXD (T8)
3	Motor Signal 9 (PA6)
4	Motor Signal 10 (PA7)
5	Motor Signal 11 (PB0)
6	Motor Signal 12 (PB1)
7	GND (Next to Micro SD socket)
8	SPI3_MISO
9	SPI3_MOSI
10	SPI3_CLK
11	3.3v
12	5v

Stacking connector

Use for connecting the optional Stacking VTX board. See manual section below.

BOTTOM

1. IO socket.
2. 4in1 ESC pads.
3. Receiver socket.
4. VTX voltage select bridge.
5. Camera voltage select bridge.

A. Boot Button.
B. BIND Button.
C. 5V BEC.
D. Air pressure (Baro) sensor.
E. Current sensor.
F. IR Transponder circuit.
G. STM32H750 CPU.
H. TVS Protection Diode.
I. Audio Mixer.
J. MEMS Microphone.

VTX Voltage (4)	
1 ◄	Battery +
2 ■	VTX Voltage
3 ►	5V BEC

VTX Voltage select bridge pads

Create a solder bridge between TWO PADS ONLY to select VTX voltage.
a) bridge ◄ and ■ to set the VTX voltage to BATTERY voltage.
b) bridge ■ and ► to set the VTX voltage to 5V.

Camera Voltage (5)	
1 ◄	5V BEC
2 ■	CAM Voltage
3 ►	Battery +

Camera Voltage select bridge pads

Create a solder bridge between TWO PADS ONLY to select the Camera voltage.
a) bridge ◄ and ■ to set the camera voltage to 5V.
b) bridge ■ and ► to set the camera voltage to BATTERY voltage.

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.

IMPORTANT: DO NOT CONNECT ALL THREE PADS TOGETHER.

IO socket (1)	
1 ●	GND
2	5v
3	SCL
4	SDA
5	RXD (R3)
6	TXD (T3)
7	RXD (R8)
8	TXD (T8)

IO socket for I2C/UART3/UART8

Use this socket to connect a GPS receiver with I2C MAG sensors to use GPS features.

IMPORTANT: The SCL and SDA are 3.3v signals

5.0v is also supplied when powering via USB.

IMPORTANT: 5.0v to 3.3v logic level converters are REQUIRED for SCL/SDA if your sensors use 5.0v signals.

UART3 R3/T3 and UART8 R8/T8 can use 5.0v signals.

RECEIVER (3)	
1 ●	RXD (R1) / PPM
2	TXD (T1) / FrSky TLM
3	TXD (T2 / SmartPort/Hott TLM)
4	RSSI (Analog or PWM)
5	5v
6	GND

RECEIVER port - Molex Picoblade 1.25mm pitch connector

Connect to a receiver using optional cables. Examples:

FrSky XSR - UART1 for Serial RX, UART2 for SmartPort.
Other Serial RX - UART1 for Serial RX, T2/UART2 for Telemetry (Hott/Smartport/etc).
PPM RX - Use dupont cable. RXD/R1/PPM for PPM, TXD/T1/UART1 for Telemetry.

NOTE: RSSI selector pads must be set when using RSSI input.

NOTE: There are also header pins and holes for receivers.

5.0v is also supplied when powering via USB.

4in1 ESC pads (2)	
1 +	Battery +
2 -	Battery -

4in1 ESC pads - IMPORTANT: DOUBLE CHECK and TRIPLE CHECK POLARITY!

For connecting to a 4in1 ESC. See Connections section below.

Receiver Connections

The H7EXTREME has many methods to allow receiver connections, the main ones are as follows (listed in order of popularity):

1) Serial RX on UART1 + Telemetry on UART2 via Picoblade connector (e.g. FrSky XSR).
2) Serial RX on UART1 via Headers Pins + 3v3 PAD (Spektram Satellelite)
3) Serial RX on UART4 via Stacking Header Pins when stacking with VTX board (e.g. FrSky XM+).
4) PPM + Telemetry via UART1 on Header Pins (e.g. FrSky D4R-II)

When using the FrSky XM+ on the Stacking VTX board use the group of 4 header pins marked "T1/R1/5v/-" and solder the very-low-profile stacking sockets to the 5v/G and R4/T4 either side of the MicroSD card socket. Solder the very-low-profile stacking pins to the bottom of the Stacking VTX board. Use UART4 for Serial RX in Betaflight.

Camera/VTX/LED-Strip BEC Connections.

The H7EXTREME 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 seperate 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.

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

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

When using the stacking VTX board do NOT install the supplied 4 PIN Picoblade socket, instead use the 4 pin stacking socket supplied with the stacking VTX board. Solder stacking socket in the FC, solder stacking pins in Stacking VTX board.

Set the VTX voltage bridge on the bottom of the board to 5V if using the Stacking VTX board with the FX758-2-SPI module.

For other VTXs use set the VTX voltage bridge to either 5V or BATTERY voltages, refer to your VTX manual.

Cables

The flight controller is supplied with camera and VTX cables and sockets for them.

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

Spare or replacement cables are available from your retailer.

Do NOT rely on cable color-coding due to manufacturer variations. Always check before applying power.

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.

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.

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 "SPRACINGH7EXTREME" 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 EXTREME 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 EXTREME 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_SPRACINGH7EXTREME_EXST.exst -s 0x97CE0000:leave
dfu-util -D obj/betaflight_4.1.0_SPRACINGH7EXTREME.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 Chome 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: Transponder code not recognised by receiver.
A: Check transponder enable bridge. Check IR LED orientation and light beam exit path. Ensure transponder feature enabled in software. Ensure transponder code correctly configured.

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 SPRacingH7EXTREME and Stacking VTX board are supplied with grommets. Install the grommets in each corner of each board. Then use appropriate spacers between your frame and between each board.

The SP Racing H7 EXTREME has a directional arrow on it indicating the front of the board. The USB socket should be on the RIGHT when the quad is facing FORWARDS.

When using the Stacking VTX board ensure the gap between the FC and the Stacking VTX board is the same on all sides and that all stacking connectors are properly mated and connected.

Ensure that all wires soldered to the FC do NOT touch the bottom of the Stacking VTX board. Use appropriate guage cable and solder neatly! Especially for the Battery and ESC power cables.

Transponder

The SPRacingH7EXTREME features a IR LED transponder system. For optimum performance ensure you read the following section.

Mounting - Ensure that the IR LED can shine light from its installed location onto the track-side receiver, unobstructed. e.g. ensure that props, motors, arms, etc, are not in the way of the light shining from the LED.

Orientation - Ensure the LED points outwards from the aircraft towards the track-side receivers. The more receivers you use the better the code reception will be.

Verifying operation - Ensure that the TRANSPONDER feature is enabled in Betaflight. Ensure that the TRAN-SPONDER code has been configured via the Race Transponder configuration section in the Betaflight Configurator. Once this is done you can use a CMOS/CCD camera without IR block pointed directly at the IR LEDs and you should see them pulsing. A mobile phone camera works well for this, your FPV camera and screen/goggles may be OK if it doesn't block IR light.

Once you have verified that the IR LED pulses IR light then you can scan your SPRacingH7EXTREME past one of the iLAP receivers. The iLAP receiver just needs power, no software configuration is required to verify that the code is working.

The first time the iLAP receiver can read the transponder code the LAP light will pulse once, while the iLAP receiver can read the code then the activity light (ACT) will be flashing.

Each time the LAP light flashes the receiver transmits transponder code and timing information via it's COM port to the computer it is attached to.

By default the iLAP receivers will not transmit the transponder code to the PC twice in a row unless the transponder code has not been received for over one second.

For further iLAP receiver configuration and setup advice refer to the iLAP documentation.

NOTE:

You can check the transponder LED is working by using a mobile phone camera pointed straight at the LED when the transponder is enabled via the board and in the software. The LED will pulse an infrared signal which usually shows up purple via a mobile phone camera.
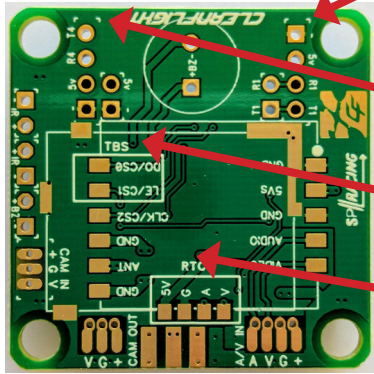
Stacking VTX board

Install the 4-pin male very low profile stacking connectors into the BOTTOM of the Stacking VTX board and solder them from the TOP of the board. Install the female connector into the TOP of the FC. Always install the 5v/GND and R1/R2 stacking connectors. They are needed for electrical connectivity, mechanical support and alignment.

Connect the camera to the FC (for Camera OSD and OSD support)

VERY IMPORTANT: The Stacking VTX board is supplied with two peices of yellow Polyimide/Kapton insulating tape.
You MUST installed ONE peice of tape under the VTX on the UNUSED connections so that your VTX module does not contact them, as follows:

FC UART 4 = Stacking VTX UART1 - configure UART4 for RX and use the UART1 pads for the FrSky XM+ or Crossfire NANO RX.

FC UART 8 = Stacking VTX UART4 - configure UART8 for SmartAudio and connect the TBS Unify to the pads for it. Leave the large 2.54mm pitch UART4 pads un-conected when using TBS Unify Pro.

TBS Unify Pro: Install ONE peice of Polyimide tape over the 2 pads in the box labelled `TBS`.

FX758-2-SPI / RTC 6705 module: Install ONE peice of Polyimide tape over the 4 pads in the box labelled `RTC`.

TBS Unify Pro option

- Install Poliyimide tape over box labelled 'TBS' as illustrated.
- Install the TBS Unify, line up the board with the 4 signal pads and the box, then solder the 'V' pad first. Check alignment after soldering one pad, then solder remaining pads.
- Set 'VTX BAT/5V' bridge on FC to 5V.
- Enable 3 bridges on the bottom of the Stacking VTX board.
    1. 'VTX+ 5V ONLY'
    2. 'SA_EN'
    3. 'AU_EN'
    All three jumpers are located near the 'AV/IN' pin holes.
- Enable SmartAudio on UART8 (Labelled R4/T4 on stacking VTX board).

FX758-2-SPI Option

- Install Poliyimide tape over box labelled 'RTC' as illustrated.
- Install the FX758-2-SPI module, ensure the orientation is correct. Use the pins marked 'ANT' on both the VTX module and the Stacking VTX board for orientation reference. Solder a corner pin first, CS1 or VIN pads are best. Check alignment, solder opposite corner pin. Check alignment again. Solder remaining pins.
- Set 'VTX BAT/5V' bridge on FC to 5V.
- Enable 'VTX+ 5V ONLY' bridge.
- Do NOT bridge 'SA_EN' or 'AU_EN'.

IMPORTANT: Do NOT attempt to remove either VTX module from the board once you have soldered it in place unless you have specialist equipment - they are very hard to remove, removal will likely destroy both the VTX module and the stacking VTX board itself.

NOTE: SmartAudio and PID-Audio can be used at the same time.

Hardware Specifications

- STM32H750 CPU, 400MHz inc FPU
- 128MByte 1GBit NAND flash via QuadSPI
- 2x Low-noise ICM20602 accelerometer/gyro with dedicated VREG (connected via SPI)
- BMP388 Barometer - bottom mounted for wind isolation (I2C + interrupt)
- OSD with customisable layout, profiles and configuration menu system
- On-board MEMS microphone
- PID-Audio with CPU audio out and audio mixer
- MicroSD card slot (SD/SDHC, upto 32GB) connected via 4-Bit SDIO
- Durable 1.6mm thick 6-layer copper gold-plated PCB with cutouts for battery wires
- Current sensor/Amperage meter (110A)
- 2-6S BEC 5V Switching regulator, 1A
- TVS protection diode
- Dedicated 500mA VREG for gyros with extra filter capacitors
- Second 500mA VREG for CPU, and other peripherals
- Transponder circuitry (LED and code available separately)
- Buzzer circuitry
- RSSI Analog and PWM circuit
- 12 motor outputs (4 by motor pads, 4 in the middle, and 4 on stacking connector)
- 1x SPI breakout onto stacking connector
- 7 Serial Ports (6x 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
- FPV stack weight of FC/PDB + OSD/VTX ~16 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)
- Optionally supplied with 2x Audio/Video PicoBlade connectors. (for Camera Input, for VTX Output)
- Optional receiver cables for FrSky XSR receivers and 3-pin style receivers available
- 4x pairs of solder pads for ESC Signal/GND connections (Bi-Directional DSHOT compatible)
- 4x pairs of solder pads for ESC Power/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 PWM RSSI
- 1x solder pad for LED Strip
- 1x solder pad for DAC out
- 1x solder pad for ADC in (for 4in1 current sensor output, etc)
- 2x solder pads for 5V/GND power
- 2x large solder pads with cut-outs for battery wires
- 2x large solder pads for 4in1 ESC power connection
- 1x 2pin though-holes for pin headers for UART4 RX/TX
- 1x 2pin though-holes for pin headers for BUZZER
- 1x 2pin though-holes for pin headers for 5V/GND
- 1x 2pin though-holes for pin headers for IR Transponder LED
- 1x 4pin though-holes for pin headers for Receiver (GND/5V/UART1 RX+TX)
- 1x 8pin bottom mounted, JST-SH socket for GND/5V/I2C/UART3/UART8 (IO port, e.g. for external GPS module)
- 1x 6pin bottom mounted, PicoBlade receiver socket for UART1(PPM/SerialRX)/UART2 TX(Telemetry)/RSSI/GND/5V
- 1x 4pin top mounted JST-SH socket for SWD debugging
- 1x 4pin top mounted JST-SH socket for UART5 RX+TX/GPIO/GND
- 1x 12pin stacking connector (SPI, UART8, DSHOT/PWM 9-12/TIM3-CH1-4, 5V BEC, 3.3V, etc)
- 1x Side-press BOOT button (top mounted)
- 1x Side-press VTX/Settings button (top mounted)
- 1x Mixer control (top mounted, near Camera input/output)
- 2x 5V/BATTERY voltage selectors for Camera and VTX outputs
- 1x Analog/Digital RSSI selector
- Cleanflight and Betaflight logos - they're on there, you just have to find them
- SP Racing logo
- 2x Additional easter eggs!

Credits and acknowledgements

Community