Seriously Pro

SP Racing™ Transponder BEC

About

The Seriously Pro Racing Transponder BEC (SPRacingTBEC) was designed specifically for multi-rotor racing based on the needs of racers and race organizers.

Features

- Built-in 5v regulator (BEC) - The built-in 5V 1 AMP regulator means you don't need a separate 5V regulator. Plenty of power for your FC, RX, LEDs, etc.
- Range - Works at distances up to 5m, even outdoors in sunlight. Use more track-side receivers to further increase sensitivity.
- Dual IR LEDs - Two LEDs allows you to position for greater intensity or for clockwise and anti-clockwise tracks.
- iLAP Compatible - Works with the most popular transponder receiver system currently in-use worldwide today.
- High-speed - Uses a high-speed transmission to eliminate interference.
- 7-Digit code - Longer codes, compared to other systems, means you won't have issues with duplicate codes.
- Flexible Form Factor - Mount using 30.5mm mount holes and stack above your FC. Or remove the tabs, heat-shrink it and use velcro to mount as appropriate.
- Flexible Power Options - Power using 2S-5S Lipo OR power from existing 5V supply, you choose.
- Suitable for racing clubs or pilot ownership - Flexible design allows racing club owners to fit them with standard 3 pin cable for use on race days.
- 32bit STM32 processor.
- JST-SH SWD debug port.
- JST-SH UART serial port.

WARNINGS
Failure to adhere to these warnings will void your warranty and destroy your transponder.

- 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.
- Only use 2S to 5S batteries via the BATTERY connection. 25V MAX.
- Connect only one 5.0v SOURCE of power. Either connect a battery OR a 5v supply. Not both.
- Do not use a 5.0v voltage source higher than 5.0v. Check your 5v supply is actually outputting 5.0 volts, check it before powering the transponder via VCC. - do not just assume it is 5v.
- Do not connect GND, 5v, BATTERY to each other (short circuit).
- Do not connect any input or output to any other input or output unless specifically stated.
- Do not draw more than 1A current from the 5V regulator via the 5.0v connected devices.
- When detaching break-off tabs support the main section of PCB and use grips on the edges of the parts that are to be removed - do NOT squash any components. Ensure you watch the instructional video BEFORE attempting to break off tabs. See website for video.

GENERAL ADVICE

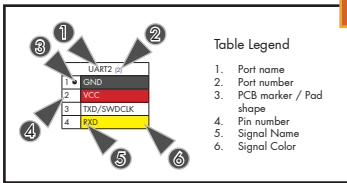Follow the advice below for best performance and long-life of your transponder:

- 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 sockets to reinforce them.
- Using colored pin headers to color-code connections is recommended (not supplied). Recommend ORANGE for BATTERY+, BLUE for BATTERY-, RED for 5V+, BLACK for GND. This will help when making connections.
- Read the 'Race Organizer' and 'Soldering' sections carefully for more advice and tips.

1. IR LED 1 headers.
2. Battery headers.
3. 5v IN/OUT headers.
4. BOOT Pads.
5. IR LED 2 headers.
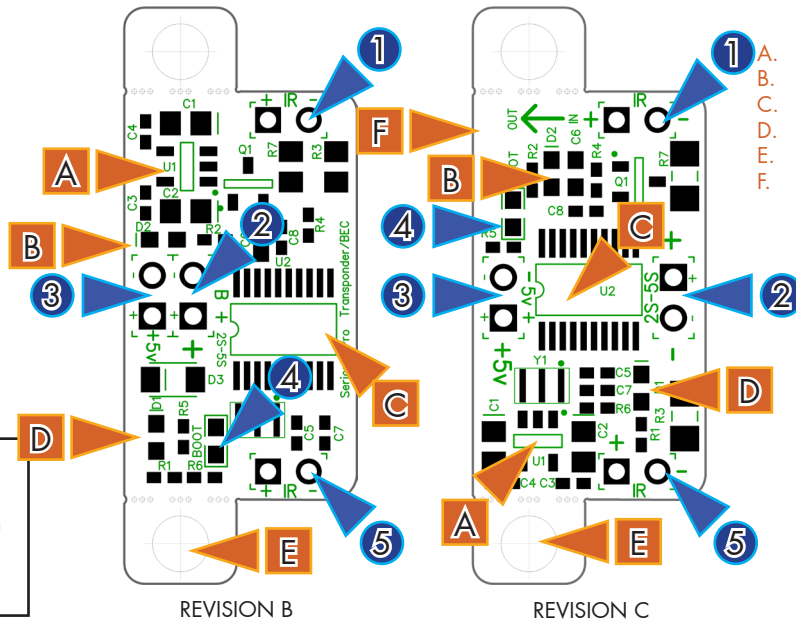
A. 3v3 Voltage Regulator
B. POWER OK LED.
C. STM32 processor.
D. STATUS LED.
E. M3 mounting holes.
F. Copper Etched SP Racing logo.

REVISION B

REVISION C

Table Legend

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

UART2 (2)	
1	GND
2	VCC
3	TXD/SWDCLK
4	RXD

BATTERY (2)	
1 ■	+V (Battery Positive)
2 ●	GND

BATTERY - WARNING: DOUBLE CHECK and TRIPLE CHECK POLARITY

For connecting a 2-5S LiPo battery (6.6V MIN / 25V MAX). Use to power the board and accessories. Supplies power to the 5V regulator and 5v PINS.

SQUARE PAD IS BATTERY POSITIVE.

NOTE: On older revision A/B boards the battery pads are near the 5v pads. Ensure that you do NOT get them mixed up!

NOTE: On revision C boards an arrow is present to indicate IN and OUT.

5v IN / OUT (3)	
1 ■	5v
2 ●	GND

5v IN / OUT - WARNING: DOUBLE CHECK and TRIPLE CHECK POLARITY

5v OUTPUT when the battery header is connected to a battery.
5v INPUT when the battery header is NOT used.

SQUARE PAD IS +5v

IR LED (1 and 5)	
1 ■	IR +
2 ●	IR -

IR LED

Used to connect two IR LEDs when using transponder feature. One LED per pair of holes. One LED each side. Do NOT connect two LEDs to one pair of holes.

The LONG leg of the LED goes in the SQUARE hole. The SHORT leg of the LED goes in the ROUND hole.

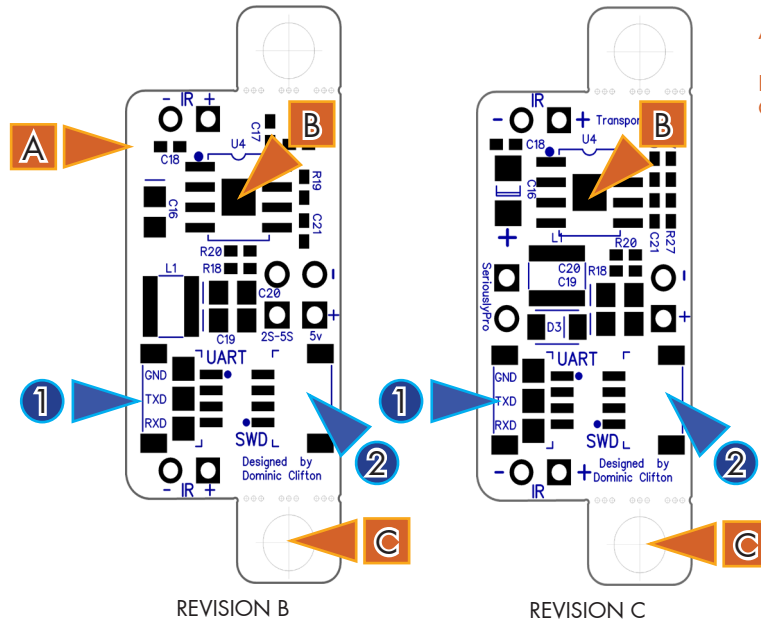| BOOT (4)	
1 ■	3.3v
2 ●	BOOT

Boot Headers - Used for recovering firmware

No connection = Boot Normally
Bridged = STM32 Bootloader

BOTTOM

1. UART socket.
2. SWD socket.

A. Copper Etched SP Racing logo.
B. 5V 1A Voltage Regulator.
C. M3 mounting holes.

REVISION B

REVISION C

UART (1)	
1 ●	GND
2	5v
3	TXD
4	RXD

UART connector - Used for Serial IO.

5.0v is always supplied via the on-board voltage regulators, even when powering via USB.

For developers only.

SWD/DEBUG (2)	
1 ●	GND
2 R	NRST
3 D	SWDIO
4 C	SWDCLK

SWD/DEBUG connector - Used for software development or flashing via SWD

Use an ST-Link debugger with OpenOCD or a J-Link debugger.

For developers only.

Soldering

The transponder is supplied with a bag of pin-headers. Some are straight, some are right-angled. Choose very carefully which ones you want to use. You can solder headers to top or the bottom of the board.

Read the entire manual BEFORE soldering.

Once you have soldered pin headers 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.

Cables

The transponder is not supplied with any cables as none are required for normal operation. There are sockets for two 4-pin JST-SH plugs/cables.

JST-SH cables are available from your retailer.

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

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

Transponder

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

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

Orientation - Ensure the LEDs point outwards from the aircraft towards the track-side receivers. The more receivers you use the better the code reception will be. You can mount the transponder so that the LEDs are on the same side or one on each side.

When mounting LEDs on the same side mount them in a V pattern so they point slightly outwards from each other and do not shine light at the same point. You can mount them in a vertical V pattern; so the light shines on multiple receivers, or in a horizontal V pattern; so that one LED light shines on a receiver as the aircraft approaches and the other LED shines on the same receiver as the aircraft passes. Race organizers should test what works best for their track and advise pilots before racing. Pilots in doubt should ask their race organizer.

Verifying operation - Ensure that the transponder has power (via battery OR 5v IN) and that the power led is continually lit. Ensure that the status LED blinks about once per second.

Once this is done you can use a CMOS/CCD camera, without IR-block filter, 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 LEDs pulse IR light then you can scan your SPRacingTBEC 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 receives 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 and the activity light on the bridge unit(s) receiving the signal will also 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.

Race Organizer Tips

When using transponders for turn-up-and-fly users take precautionary steps to prevent damage to the transponders.

- Mount LED as close to the edges of the PCB.
- Apply glue (e.g hot glue) to the rear of the LED and PCB edge.
- Solder wires to transponder.
- Use color coded wires. (Suggested color coding: ORANGE = Battery +, BLUE = Battery -, RED = 5v, BLACK = GND).
- Use POLARIZED connectors.
- Verify connections are correct at race-control before the pilot connects their battery.
- Heat-shrink the entire transponder, ensure ends of the LEDs are not covered by heat-shrink.
- Waterproof the transponder. (e.g. apply plasti-dip or similar) Ensure LED is not covered.
- If soldering pin headers to the board cut small pieces of colored heat-shrink and slide up the pin BEFORE soldering pin header to the board so users can identify which pin is which. (Use color coding as above). Note: Heat-shrink can be applied to header pins after soldering by carefully removing the plastic part the holds the pins together, sliding heat-shrink up the pin and then replacing the plastic part.
- Take deposits from pilots that cover the cost of a replacement should they damage it.
- Ensure pilots are briefed on how to install the transponder.
- Check IR LED line-of-sight from aircraft. Advise user to relocate as required.
- Transponder work even in bright sunlight. For indoor use and for better outdoor reception mount receivers so that light reflections are avoided.
- As with any timing system placing receivers on a slower part of a track will give the timing system more time to read the transponders. e.g. place receivers after a tight turn but positioned at a point where the aircraft are level. Avoid mounting receivers at the end of a main straight.

Troubleshooting

Q: No pulses from IR leds when viewed with a camera.
A: Check IR LED orientation (connected backwards?). IR LEDs only work when installed the correct way round.
Remove camera IR block. Use a different camera.

Q: Lap time not recorded.
A: Position IR LEDs so the light shines out from the aircraft, unobstructed. Clean IR LEDs if dirty/dusty. Clean track-side receivers if dirty/dusty. iLAP system not working correctly. Faulty/worn iLAP receiver cables (kinked/squashed?). Intermittent track-side receiver cable connection. Receiver cables not fully inserted. Timing software mis-configured. Pilot not registered with race control.

Q: I have no LED lights at all.
A: Check Battery, check 5v supply. (Battery Charged?, cables damaged?)

Q: Power light flashes - disconnect immediately.
A: Check battery (Charged?). Check regulator is not overloaded.

Q: I plugged the battery or 5v supply in backwards.
A: The device may now be damaged and need replacing (non-warranty).

Q: The IR LED pulses but the iLAP receiver ACT light does not flash and the iLAP system has been verified with a known-working transponder.
A: The transponder may be running a factory test code. Contact support.

Q: The status LED blinks very slowly (less than once a second).

A: Contact support.

Q: I have a problem not listed here.
A: Contact support.

Hardware Specifications

- Measures 36x13.5mm with 2 x 30.5mm mounting hole tabs
- Measures 26x13.5mm with tabs removed
- Weight ~3 grams
- 5V regulator, 1 AMP
- Power LED
- Activity LED
- 1x 2pin though-holes for pin headers for battery.
- 1x 2pin though-holes for pin headers for 5V in/out.
- 1x 4pin bottom mounted, JST-SH socket for SWD debugging
- 1x 4pin bottom mounted, JST-SH socket for UART
- 2x 2pin through-holes for IR LEDs (supplied).
- Comes with right-angled and straight pin headers
- STM32 CPU.
- 5V 1A Regulator for powering FC, receiver and small servos
- 2 IR LEDs and unique code for race transponder
- Copper-etched SP Racing logos

Hardware Revisions

Revision A - For testers. Firmware v1.0.0, API 1.0.0.
Revision B - First publicly available version. Firmware v1.0.0, API 1.0.0.
Revision C - Battery connector moved to opposite edge of board. STM32 processor can also be flashed via UART1 port when bootloader mode enabled.   Firmware v1.1.0, API 1.0.0.

Credits and acknowledgements

Hardware design by Dominic Clifton.
Manual by Dominic Clifton.
Firmware by Dominic Clifton.
Seriously Pro website by Dominic Clifton.
iLAP compatibility by Dominic Clifton.

Thanks to everyone who provided testing and feedback on the SPRacingTBEC boards.

Thanks to RCLapCounter / iLAP for creating a great timing system.

iLAP receivers are available to purchase from http://www.rclapcounter.com.

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