



User Manual Multi-Rotor Brushless ESC

BLHeli

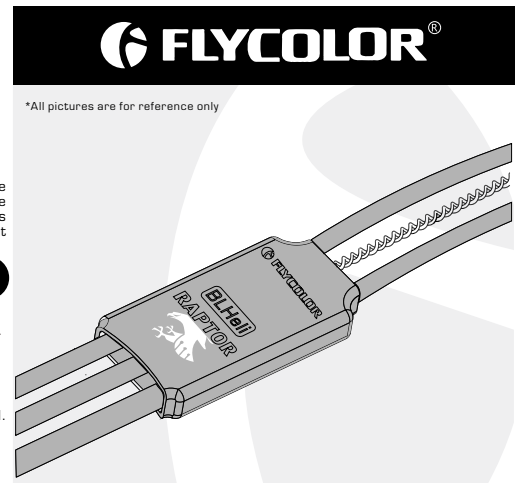
Raptor /Raptor 390



Thank you for purchasing our brushless electronic speed controller (ESC) . Any improper operation may cause personal injury damage to the product and related equipments. This high power system for RC model can be dangerous, we strongly recommend reading the user manual carefully and completely. We will not assume any responsibility for any losses caused by unauthorized modifications to our product. We have the right to change the design, appearance, performance and usage requirements of the product without notice.

01 Main features

- High performance MCU.
- Mini size, lighter in weight.
- Optimized firmware is specialized for disc motor, excellent compatibility.
- ESC compatible with "regular" signal-receiving mode and "Oneshot125" signal-receiving mode (throttle signals range from 125µs ~ 250µs).
- Use BLHeli open-source firmware, can update the firmware or write setup via signal cable; Using "Damped light" mode, it improves the throttle response, when reducing the throttle amount, the Motors slow down rapidly. It strengthens the stability and flexibility of multi-rotors, quite suitable for GAVs.
- The twisted-pair of the throttle signal cable effectively reduces the crosstalk caused by signal transmission, and makes flight more stable.
- In "regular" signal-receiving mode, ESC supports frequency of throttle signal to 500Hz max., compatible with various kinds of flight control.
- **Raptor 390** series ESC compatible with Multishot (5µs ~ 25µs) when remote control opens S-BUS, It's about 10x faster than Oneshot125 (125µs ~ 250µs).
- **Raptor 390** series ESC greatly increased maximum rpm limiting at 400k erpm.



*All pictures are for reference only

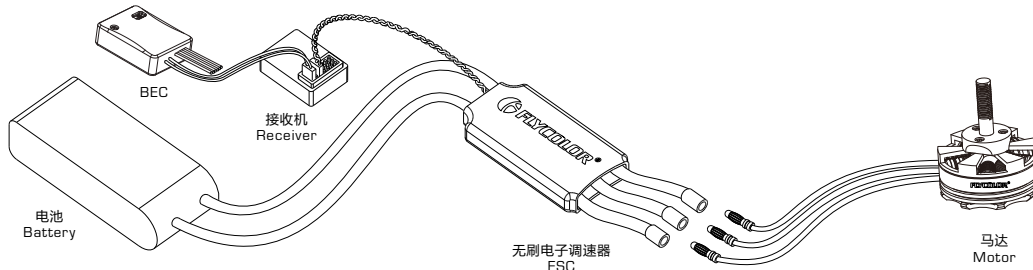
02 Specification

Model	Manufacture Model	Con. Current	Burst Current (10S)	BEC	LiPo cells	Weight (For reference)	Size (For reference)	Typical Applications (For reference)
Raptor-12A	W-FW012004	12A	15A	No	2-4S	8.3g	27x12x5mm	170-250 Multi
Raptor-15A	W-FW015004	15A	20A	No	2-4S	8.8g	27x12x5mm	170-280 Multi
Raptor-20A	W-FW020004	20A	30A	No	2-4S	9.6g	27x12x5mm	170-330 Multi
Raptor-30A	W-FW030004	30A	40A	NO	2-4S	9.6g	27x12x5mm	170-450 Multi
Raptor390-20A	W-FW020004-B	20A	30A	No	2-4S	7g	29x12x5mm	170-330 Multi
Raptor390-30A	W-FW030004-B	30A	40A	NO	2-4S	7g	29x12x5mm	170-450 Multi

* The weight and size are for reference only, Please connect us for more details.

03 Wiring diagram

Please ensure all solder joints are insulated with heat shrink where necessary.



*All pictures are for reference only

04 Programming parameter value

Programming parameters below in table that can be accessed from the remote control or configuration software (BLHeliSuite):

Function	1	2	3	4	5	6	7	8	9	10	11	12	13
1 - Closed loop P gain	0.13	0.17	0.25	0.38	0.50	0.75	1.00	1.5	2.0	3.0	4.0	6.0	8.0
2 - Closed loop I gain	0.13	0.17	0.25	0.38	0.50	0.75	1.00	1.5	2.0	3.0	4.0	6.0	8.0
3 - Closed loop mode	HiRange	MidRange	LoRange	Off	/	/	/	/	/	/	/	/	/
4 - Multi gain	0.75	0.88	1.00	1.12	1.25	/	/	/	/	/	/	/	/
5 - Startup power**	0.031	0.047	0.063	0.094	0.125	0.188	0.25	0.38	0.50	0.75	1.00	1.25	1.50
6 - Commutation timing	Low	MediumLow	Medium	MediumHigh	High	/	/	/	/	/	/	/	/
7 - Pwm frequency	High	Low	*DampedLight	/	/	/	/	/	/	/	/	/	/
8 - Pwm dither***	Off	3	7	15	31	/	/	/	/	/	/	/	/
9 - Demag compensation	Off	Low	High	/	/	/	/	/	/	/	/	/	/
10 - Rotation direction	Normal	Reversed	Bidirectional	/	/	/	/	/	/	/	/	/	/
11 - Input pwm polarity	Positive	Negative	/	/	/	/	/	/	/	/	/	/	/

Default values are marked in dark gray.

*:Only enabled for some ESCs. From code rev 14.4, damped light is default on the ESCs that support it. For prior code revisions, high is default.

** : Default startup power varies by ESC. Generally the default power is lower for larger ESCs.

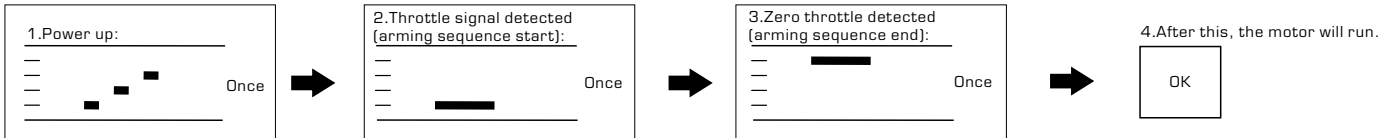
***:For code revs 14.4 and before, dither range was 7/15/31/63.

- Closed loop P gain sets the proportional gain for the rpm control loop. This setting controls the gain from speed error to motor power.
- Closed loop I gain sets the integral gain for the rpm control loop. This setting controls the gain from integrated speed error (summed over time) to motor power.
- Closed loop mode sets the range of speeds that the control loop can operate on.
 - For the high range, throttle values from 0% to 100% linearly correspond to rpm targets from 0 to 200000 electrical rpm
 - For the middle range, throttle values from 0% to 100% linearly correspond to rpm targets from 0 to 100000 electrical rpm
 - For the low range, throttle values from 0% to 100% linearly correspond to rpm targets from 0 to 50000 electrical rpm
 - When closed loop mode is set to off, the control loop is disabled.
- Multi gain scales the power applied to the motor for a given input. Note that this is only for PWM input, for PPM input it has no effect. Beware that a low multi gain will also limit the maximum power to the motor.
- Startup is always done with the direct startup method, which runs the motor using back emf detection from the very start. In this mode power is given by the throttle used, but limited to a maximum level. This maximum level can be controlled with the startup power parameter. Beware that setting startup power too high can cause excessive loading on ESC or motor!
- Commutation timing can be adjusted in three steps. Low is about 0°, mediumlow 8°, medium 15°, mediumhigh 23° and high 30°. Typically a medium setting will work fine, but if the motor stutters it can be beneficial to change timing.
- Pwm frequency:
 - High: High pwm frequency is around 20KHz.
 - Low: Low pwm frequency is around 8KHz.
 - Damped light : This mode adds loss to the motor for faster retardation. Damped light mode always uses high pwm frequency. This mode is only supported on some ESCs (where fet switching is sufficiently fast).
- Pwm dither is a parameter that adds some variation to the motor pwm off cycle length. This can reduce problems (like throttle steps or vibration) in rpm regions where the pwm frequency is equal to harmonics of the motor commutation frequency, and it can reduce the step to full throttle. It is primarily beneficial when running damped light mode. Dither is not applied in closed loop mode.
- Demag compensation is a feature to protect from motor stalls caused by long winding demagnetization time after commutation. The typical symptom is motor stop or stutter upon quick throttle increase, particularly when running at a low rpm. As described earlier, setting high commutation timing normally helps, but at the cost of efficiency. Generally, a higher value of the compensation parameter gives better protection. If demag compensation is set too high, maximum power can be somewhat reduced.
- The rotation direction setting can be used to reverse motor rotation.
- The input pwm polarity setting can be used to invert the throttle behaviour. This is intended to be used with receivers that provide negative pwm. When using PPM input it must be set to positive.

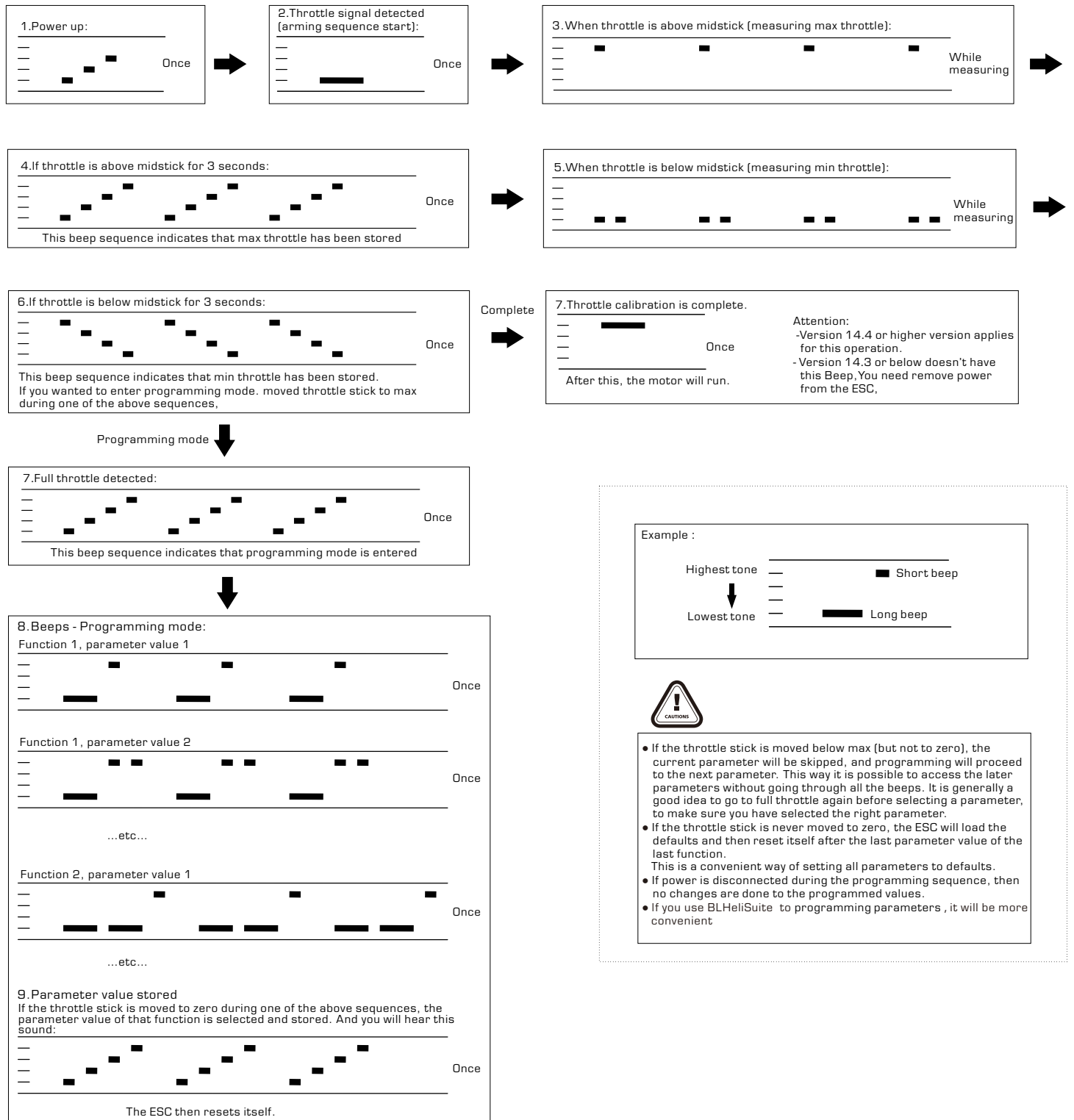
Programming parameters that can only be accessed from configuration software (BLHeliSuite):

- Throttle minimum and maximum values for PPM input (will also be changed by doing a throttle calibration).
- Throttle center value for bidirectional operation with PPM.
- Beep strength, beacon strength and beacon delay.
- Programming by TX. If disabled, the TX can not be used to change parameter values (default is enabled).
- Thermal protection can be enabled or disabled (default is enabled).
- Temperature is above 140°C, motor power is limited to 75%; Above 145°C, motor power is limited to 50%; Above 150°C, motor power is limited to 25%. Above 155°C, motor power is limited to 0%.
- PPM input can be enabled or disabled (default is disabled). If disabled, only 1-2ms PPM and 125-250µs OneShot125 are accepted as valid input signals.
- Power limiting for low RPMs can be enabled or disabled (default is enabled). Disabling it can be necessary in order to achieve full power on some low kV motors running on a low supply voltage. However, disabling it increases the risk of toasting motor or ESC.
- Brake on stop can be enabled or disabled (from rev14.5, default is disabled). When enabled, brake will be applied when throttle is zero. For nonzero throttle, this setting has no effect.

05 Beeps-Normal operation



06 Beeps - Throttle calibration and entering programming mode



07 Attention

- After the ESC connected to the flight system, it will automatically detect the input throttle signals every time it powered on, and then execute the corresponding signal-receiving mode.
- User need to calibrate the throttle range when starting to use a new ESC or another transmitter.
- BLHeli open-source firmware, when some abnormality occurs in ESC driving the motor or need the motor to reach a higher RPM, user can try to change the timing.
- User also can update the firmware or change the setup via signal cable.
- Please contact Flycolor sales or technical support for more information.