TURNIGY Manual for Brushless Motor Speed Controller

Thank you for purchasing our Electronic Speed Controller (ESC). High power systems for RC model can be very dangerous; we strongly suggest you read this manual carefully. We have no control over the correct use, installation, application, or maintenance of our products, no liability shall be assumed nor accepted for any damages, losses or costs resulting from the use of the product. Any claims arising from the operating, failure or malfunctioning etc. will be denied. We assume no liability for personal injury, property damage or consequential loss resulting from our product or our workmanship. As far as is legally permitted, the obligation to compensation is limited to the invoice amount of the affected product.

Features:

- Extreme low output resistance, super current endurance.
- Multiple protection features: Low voltage cut-off protection / over-heat protection / throttle signal loss protection.
- 3 start modes: Normal / Soft / Super-Soft, compatible with fixed-wing aircraft and helicopter.
- Throttle range can be configured to be compatible with all transmitters currently available on market.
- Smooth, linear and precise throttle response.
- Separate voltage regulator IC for microprocessor (except Plush-6A and Plush-10A) with good anti-jamming capability.
- Supported motor speed (Maximum): 210000 RPM (2 poles), 70000 RPM (6 poles), 35000 RPM (12 poles).
- The pocket-sized **Program Card** can be purchased separately for easily programming the ESC at flying field.
- With a program card, user can activate the music playing function of the ESC, and totally there are 15 songs can be selected.

Specifications:

PLUSH Series										
Class	Model	Cont. Current	Burst Current (>10s)	BEC Mode	BEC Output	Battery Cell		User Programmable	Weight	Size
						Li-ion Li-poly	NiMH NiCd			L*W*H
6A	PLUSH-6A	6A	8A	Linear	5V/0.8A	2	5-6	Available	6g	32*12*4.5
10A	PLUSH-10A	10A	12A	Linear	5V/2A	2-4	5-12	Available	9g	38*18*6
12A	PLUSH-12AE	12A	15A	Linear	5V/2A	2-4	5-12	Available	10g	38*18*7
18A	PLUSH-18A	18A	22A	Linear	5V/2A	2-4	5-12	Available	21g	55*25*6
25A	PLUSH-25A	25A	35A	Linear	5V/2A	2-4	5-12	Available	25g	55*25*9
30A	PLUSH-30A	30A	40A	Linear	5V/2A	2-4	5-12	Available	25g	55*25*9
40A	PLUSH-40A	40A	55A	Switch	5V/3A	2-6	5-18	Available	39g	60*24*15
	PLUSH-40A-OPTO	40A	55A	N/A	N/A	2-6	5-18	Available	35g	60*28*12
60A	PLUSH-60A	60A	80A	Switch	5V/3A	2-6	5-18	Available	63g	83*31*16
	PLUSH-60A-OPTO	60A	80A	N/A	N/A	2-6	5-18	Available	60g	83*31*14
80A	PLUSH-80A	80A	100A	Switch	5V/3A	2-6	5-18	Available	72g	83*31*16
	PLUSH-80A-OPTO	80A	100A	N/A	N/A	2-6	5-18	Available	69g	83*31*14

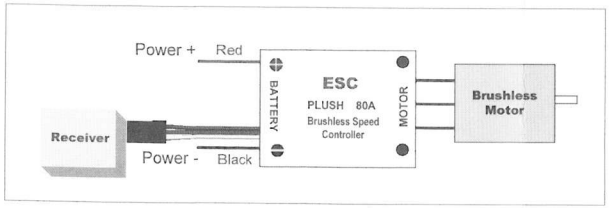
BASIC Series										
Class	Model	Cont. Current	Burst Current (>10s)	BEC Mode	BEC Output	Battery Cell		User Programmable	Weight	Size
						Li-ion Li-poly	NiMH NiCd			L*W*H
18A	BASIC-18A	18A	22A	Linear	5V/2A	2-4	5-12	Available	21g	55*25*6
25A	BASIC-25A	25A	35A	Linear	5V/2A	2-4	5-12	Available	25g	55*25*9

BEC Output Capability	Linear Mode BEC(5V/2A)				Switch Mode BEC(5V/3A)	
	2S Li-Poly	3S Li-Poly	4S Li-Poly	5S Li-Poly	2S — 4S Li-Poly	5S Li-Poly
Standard micro servos(Max.)	5	4	3	2	5	4

Note1: ***BEC means the "Battery Elimination Circuit". It is a DC-DC voltage regulator to supply the receiver and other equipments from the main battery pack. With the build-in BEC, the receiver needn't to be supplied with an additional battery pack.***

IMPORTANT! The ESC named "xxx-xxx-OPTO" hasn't a built-in BEC, so an UBEC (Ultimate-BEC) or an individual battery pack should be used to power the receiver. And an individual battery pack is needed to power the program card when setting the programmable value of ESC, please read the user manual of program card for reference.

Wiring Diagram:



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Programmable Items:

1. **Brake Setting:** Enabled / Disabled, default is Disabled
2. **Battery Type:** Li-xx(Li-ion or Lipo) / Ni-xx(NiMH or NiCd), default is Li-xx.
3. **Low Voltage Protection Mode(Cut-Off Mode):** Soft Cut-Off (Gradually reduce the output power) or Cut-Off (Immediately stop the output power). Default is Soft Cut-Off.
4. **Low Voltage Protection Threshold(Cut-Off Threshold):** Low / Medium / High, default is Medium.
   1) For lithium batteries, the number of battery cells is calculated automatically. Low / medium / high cutoff voltage for each cell is: 2.85V/3.15V/3.3V. For example: For a 3 cells lithium pack, when "Medium" cutoff threshold is set, the cut-off voltage will be:3.15*3=9.45V.
   2) For nickel batteries, low / medium / high cutoff voltages are 0%/50%/65% of the startup voltage (i.e. the initial voltage of battery pack), and 0% means the low voltage cut-off function is disabled. For example: For a 10 cells NiMH battery, fully charged voltage is 1.44*10=14.4V, when "Medium" cut-off threshold is set, the cut-off voltage will be:14.4*50%=7.2V.
5. **Startup Mode:** Normal /Soft /Super-Soft, (300ms / 6s / 12s), default is Normal.
   Normal is preferred for fixed-wing aircraft. Soft or Super-soft are preferred for helicopters. The initial acceleration of the Soft and Super-Soft modes are slower in comparison, usually taking 6 seconds for Soft startup or 12 seconds for Super-Soft startup from initial throttle advance to full throttle. If the throttle is closed (throttle stick moved to bottom) and opened again (throttle stick moved to top) within 3 seconds of the initial startup, the restart-up will be temporarily changed to normal mode to get rid of the chances of a crash caused by slow throttle response. This special design is suitable for aerobatic flight when quick throttle response is needed.
6. **Timing:** Low / Medium / High,(3.75° /15° /26.25°),default is Low. *Note2*
   Usually, low timing or medium timing is suitable for most motors. In order to get higher speed and bigger output power, please choose **High** timing.
   Note2: ***After changing the timing setting, please test your RC model on ground before taking off!***

Begin To Use Your New ESC

Note3: ***In the following instructions, we use the words of "Top position" and "Bottom position" to describe the location of the throttle stick.***
Top Position: *The throttle value is 100% at this position.*
Bottom Position: *The throttle value is 0% at this position.*

Please start up the ESC in the following sequence:

1. Move throttle stick to the bottom position and then switch on the transmitter.
2. Connect battery pack to the ESC, the ESC begins self-test process, a special tone " ♪23" is emitted, which means the voltage of the battery pack is in normal range, and then N "beep" tones will be emitted, means the number of lithium battery cells. Finally a long "beep------" tone will be emitted, which means self-test is OK, the aircraft/helicopter is ready to go flying.
   - If nothing is happened, please check the battery pack and all the connections;
   - If a special tone " ♪ 56712" is emitted after 2 beep tones ("beep-beep-"), means the ESC has entered the program mode, it is because the throttle channel of your transmitter is reversed, please set it correctly;
   - If the very rapid "beep-beep-, beep-beep-" tones is emitted, means the input voltage is too low or too high, please check your battery's voltage.
3. "**VERY IMPORTANT!**" Because different transmitter has different throttle range, we strongly suggest calibrating throttle range before flying. Please read the instruction on page 3------"Throttle Range Setting"

Alert Tone

1. Input voltage is abnormal: The ESC begins to check the voltage when the battery pack is connected, if the voltage is not in the acceptable range, such an alert tone will be emitted: "beep-beep-, beep-beep-,beep-beep-" (Every "beep-beep-" has a time interval of about 1 second.)
2. Throttle signal is abnormal: When the ESC can't detect the normal throttle signal, such an alert tone will be emitted: "beep-, beep-, beep-". (Every "beep-" has a time interval of about 2 seconds)
3. Throttle stick is not in the bottom position: When the throttle stick is not in bottom (lowest) position, a very rapid alert tone will be emitted: "beep-, beep-, beep-". (Every "beep-" has a time interval of about 0.25 second.)

Protection Function

1. Start up failure protection: If the motor fails to start within 2 seconds of throttle application, the ESC will cut-off the output power. In this case, the throttle stick **MUST** be moved to the bottom again to restart the motor. (Such a situation happens in the following cases: The connection between ESC and motor is not reliable, the propeller or the motor is blocked, the gearbox is damaged, etc.)
2. Over-heat protection: When the temperature of the ESC is over 110 Celsius degrees, the ESC will reduce the output power.
3. Throttle signal loss protection: The ESC will reduce the output power if throttle signal is lost for 1 second, further loss for 2 seconds will cause its output to be cut-off completely.

Program example

Setting "Start Mode" to "Super-Soft", i.e. value #3 in the programmable item #5

1. Enter Program Mode Switch on transmitter, move throttle stick to top position, connect battery pack to ESC, wait for 2 seconds, "beep-beep" tone should be emitted. Then wait for another 5 seconds, special tone like "♪ 56712" should be emitted, which means program mode is entered.
2. Select Programmable Items Now you'll hear 8 tones in a loop. When a long "beep------" tone is emitted, move throttle stick to bottom to enter the "Start Mode"
3. Set Item Value (Programmable Value) "Beep-", wait for 3 seconds; "Beep-beep-", wait for another 3 seconds; then you'll hear "beep-beep-beep", move throttle stick to top position, then a special tone " ♪1515" is emitted, now you have set the "Start Mode" item to the value of "Super-Soft"
4. Exit Program Mode After the special tone " ♪1515", move throttle stick to bottom within 2 seconds.

Trouble Shooting

Trouble	Possible Reason	Action
After power on, motor can't work, no sound is emitted	The connection between battery pack and ESC is not OK	Check the power connection. Replace the connector.
After power on, motor can't work, such an alert tone is emitted: "beep-beep-, beep-beep-,beep-beep-" (Every "beep-beep-" has a time interval about 1 second)	Input voltage is abnormal, too high or too low	Check the voltage of battery pack
After power on, motor can't work, such an alert tone is emitted: "beep-, beep-, beep- "(Every "beep-" has a time interval about 2 seconds)	Throttle signal is abnormal	Check the receiver and transmitter Check the cable of throttle channel
After power on, motor can't work, such a alert tone is emitted: "beep-, beep-, beep-" (Every "beep-" has a time interval about 0.25 second)	Throttle stick is not in bottom(lowest) position	Move the throttle stick to bottom
After power on, motor can't work, a special tone "♪ 5671̇2̇" is emitted after 2 beep tone (beep-beep-)	The direction of throttle channel is reversed, so the ESC has entered the program mode	Set the direction of throttle channel correctly
The motor runs in opposite direction	The connection between ESC and the motor need to be changed.	Swap any two wire connections between ESC and motor
The motor stop running while in working state	Throttle signal is lost	Check the receiver and transmitter Check the cable of throttle channel
	ESC has entered Low Voltage Protection mode	Land RC model as soon as possible, and then replace the battery pack
	Some Connections are not reliable	Check all the connections: battery pack connection, throttle signal cable, motor connections, etc.

Normal startup procedure:

Move throttle stick to bottom and then switch on transmitter.	Connect battery pack to ESC, special tone like "♪123" means power supply is OK	Several "beep-" tones should be emitted, presenting the number of lithium battery cells	When self-test is finished, a long "beep-----"tone should be emitted	Move throttle stick upwards to go flying

Throttle range setting: (Throttle range should be reset when a new transmitter is being used)

Switch on transmitter, move throttle stick to top	Connect battery pack to ESC, and wait for about 2 seconds	"Beep-Beep-" tone should be emitted, means throttle range highest point has been correctly confirmed	Move throttle stick to the bottom, several "beep-" tones should be emitted, presenting the number of battery cells	A long "Beep-" tone should be emitted, means throttle range lowest point has been correctly confirmed

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Program ESC with transmitter (4 Steps):

1. Enter program mode
2. Select programmable items
3. Set item value (Programmable value)
4. Exit program mode

1. Enter program mode

1) Switch on transmitter, move throttle stick to top position, connect the battery pack to ESC
2) Wait for 2 seconds, the motor should emit special tone like "beep-beep-"
3) Wait for another 5 seconds, special tone like "♪ 5671̇2̇" should be emitted, which means program mode is entered

2. Select programmable items:

After entering program mode, you can hear 8 tones in a loop in the following sequence. If you move the throttle stick to bottom within 3 seconds after one kind of tones, then this item will be selected.

1.	"beep"	brake	(1 short tone)
2.	"beep-beep-"	battery type	(2 short tone)
3.	"beep-beep-beep-"	cutoff mode	(3 short tone)
4.	"beep-beep-beep-beep-"	cutoff threshold	(4 short tone)
5.	"beep-----"	startup mode	(1 long tone)
6.	"beep-----beep-"	timing	(1 long 1 short)
7.	"beep-----beep-beep-"	set all to default	(1 long 2 short)
8.	"beep-----beep-----"	exit	(2 long tone)

Remark: 1 long "beep-----" = 5 short "beep-"

3. Set item value (Programmable value):

You will hear several tones in loop. Set the value matching to a tone by moving throttle stick to top when you hear the tone, then a special tone "ɪsɪs" emits, means the value is set and saved. (Keeping the throttle stick at top position, you will go back to step 2 and select other items; Moving the stick to bottom within 2 seconds, you will exit the program mode directly)

Tones / Items	"beep-" 1 short tone	"beep-beep-" 2 short tones	"beep-beep-beep" 3 short tones
Brake	Off	On	
Battery type	Li-ion / Li-poly	NiMh / Nicd	
Cutoff mode	Reduce power	Shut down	
Cutoff threshold	Low	Medium	High
Startup mode	Normal	Soft	Super soft
Timing	Low	Medium	High

4. Exit program mode

There are 2 ways to exit program mode:

1. In step 3, after special tone "ɪsɪs" , move throttle stick to bottom within 2 seconds.
2. In step 2, after tone "beep-----beep-----"(ie. The item #8), move throttle stick to bottom within 3 seconds.