Manual of Sensorless Brushless Motor Speed Controller

Thank you for purchasing our Electronic Speed Controller (ESC). High power system for RC model can be very dangerous; we strongly suggest you read this manual carefully. In that 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 damages 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:

◆ Great innovation of **Lithium battery Balance Discharge Monitoring and Protecting Design**, real time monitors the discharge voltage of each lithium (Li-ion/Li-poly) cell in a battery pack. Don't worry about the over discharge problem again, your lithium battery pack will have a much longer life. **(Remark: This function is ONLY available for "Guard" series ESC)**
◆ Extreme low resistance, super current endurance.
◆ Full protection features: Low-voltage cutoff protection / over-heat protection / throttle signal lost protection
◆ 3 startup modes: Normal / Soft / Super-Soft, can be used for both fixed-wing aircraft or helicopter models
◆ Throttle range can be configured, fully compatible with all market available transmitters.
◆ Smooth and accurate speed control, excellent throttle linearity.
◆ Microprocessor uses separate voltage regulator IC (except Pentium-6A and Pentium-10A), with good anti-jamming capability.
◆ Supported highest motor speed: 210000 RPM (2 poles), 70000 RPM (6 poles), 35000 RPM (12 poles).
◆ Program Card in a very small size can be purchased additionally for easily programming the ESC on field.
◆ With a program card, you can activate the music playing function of ESC, and there are 15 songs can be selected.

Specifications:

Pentium Series										
Class	Model	Cont. Current	Burst Current (>10s)	BEC Mode	BEC Output	Battery Cell Li-ion Li-poly	NiMH NiCd	User Programmable	Balance Discharge Protection	Weight	Size L*W*H
6A	Pentium-6	6A	8A	Linear	5V/0.8	2	5-9	Available	N/A	6g	24*12*6
10A	Pentium-10	10A	12A	Linear	5V/1A	2-4	5-12	Available	N/A	9g	27*17*6
12A	Pentium-12	12A	15A	Linear	5V/1A	2-4	5-12	Available	N/A	12g	32*24*8
	Pentium-12E	12A	15A	Linear	5V/2A	2-4	5-12	Available	N/A	13g	32*24*10
18A	Pentium-18	18A	22A	Linear	5V/2A	2-4	5-12	Available	N/A	19g	45*24*11
25A	Pentium-25	25A	35A	Linear	5V/2A	2-4	5-12	Available	N/A	22g	45*24*11
	Pentium-25-OPTO	25A	35A	N/A	N/A	2-4	5-12	Available	N/A	21g	45*24*11
30A	Pentium-30	30A	40A	Linear	5V/2A	2-4	5-12	Available	N/A	25g	45*24*11
40A	Pentium-40	40A	55A	Linear	5V/3A	2-5	5-15	Available	N/A	33g	55*28*12
	Pentium-40-OPTO	40A	55A	N/A	N/A	2-6	5-18	Available	N/A	32g	55*28*11
60A	Pentium-60	60A	80A	Switch	5V/3A	2-5	5-15	Available	N/A	60g	70*31*14
	Pentium-60-OPTO	60A	80A	N/A	N/A	2-6	5-18	Available	N/A	56g	70*31*13
80A	Pentium-80	80A	100A	Switch	5V/3A	2-5	5-15	Available	N/A	62g	70*31*14
	Pentium-80-OPTO	80A	100A	N/A	N/A	2-6	5-18	Available	N/A	58g	70*31*13
100A	Pentium-100	100A	120A	N/A	N/A	2-6	5-18	Available	N/A	125g	78*55*15

Guard Series										
Class	Model	Cont. Current	Burst Current (>10s)	BEC Mode	BEC Output	Battery Cell Li-ion Li-poly	NiMH NiCd	User Programmable	Balance Discharge Protection	Weight	Size L*W*H
18A	Guard-18	18A	22A	Linear	5V/2A	2-4	5-12	Available	Available	24g	45*26*11
25A	Guard-25	25A	35A	Linear	5V/2A	2-4	5-12	Available	Available	27g	45*26*12
30A	Guard-30	30A	40A	Linear	5V/2A	2-4	5-12	Available	Available	29g	45*26*12
40A	Guard-40	40A	55A	Switch	5V/3A	2-5	5-15	Available	Available	40g	55*28*15
60A	Guard-60	60A	80A	Switch	5V/3A	2-5	5-15	Available	Available	65g	70*31*14
80A	Guard-80	80A	100A	Switch	5V/3A	2-5	5-15	Available	Available	67g	70*31*14

Combo Products										
Class	Model	Cont. Current	Burst Current (>10s)	BEC Mode	BEC Output	Battery Cell Li-ion Li-poly	NiMH NiCd	User Programmable	Balance Discharge Protection	Weight	Size L*W*H
25A	Pentium-25A + UBEC	25A	35A	Switch	5V/2A	2-4	5-12	Available	N/A	29g	45*24*11(ESC)
30A	Pentium-30A + UBEC	30A	40A	Switch	5V/2A	2-4	5-12	Available	N/A	32g	45*24*11(ESC)

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

IMPORTANT! For ESC named "xxx-xxx-OPTO" or without a built-in BEC, 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.

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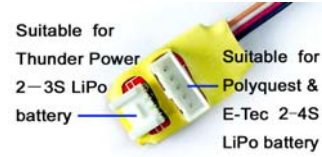
Wiring Diagram:
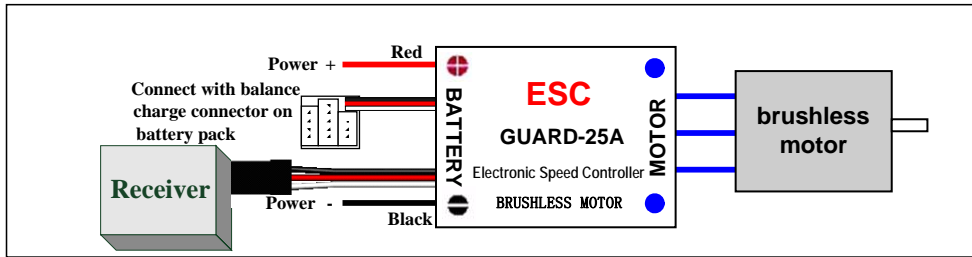
Lithium Battery Balance Discharge Monitoring and Protecting Adapter For "Guard" Series ESC:

We provide 3 kinds of Lithium Battery Balance Discharge Monitoring and Protecting Adapters for user to choose.

Adapter #1   Adapter #2   Adapter #3

VERY IMPORTANT!   You MUST connect the adapter with the balance charge connector on battery pack BEFORE connecting the main power to ESC.

Feature Explanation:

1. **Brake Settings**：Brake Enabled / Brake Disabled, default is Brake Disabled
2. **Battery Type**：Li-xx(Li-ion or Li-poly) / Ni-xx(NiMh or Nicd)，default is Li-xx.
3. **Low Voltage Protection Mode(Cutoff Mode)**：   Reduce / Cutoff Output Power, default is Reduce the output power gradually.
4. **Low Voltage Protection Threshold(Cutoff Threshold)**：Low / Medium / High, default is Medium.
   - ◆ **When NOT using balance discharge monitoring and protecting function** (i.e. **Do Not** plug the balance charge connector into the balance discharge protecting socket on ESC, in this case , the ESC only monitors the voltage of whole battery pack)
      1) For Li-xx battery，number of battery cells are calculated automatically，low / medium / high cutoff voltage for each cell are: 2.6V/2.85V/3.1V. For example: 3 cells Li-Poly, when medium cutoff voltage is set, the cutoff voltage is: 2.85*3=8.55V.
      2) For Ni-xx battery, low / medium / high cutoff voltages are 0%/45%/60% of the startup voltage (i.e. the initial voltage of battery pack), and 0% means low voltage cutoff function is disabled. For example: 10 cells NiMH battery, fully charged voltage is 1.44*10=14.4V, when "medium" cutoff voltage is set, the cutoff voltage is : 14.4*45%=6.5V。
   - ◆ **When using balance discharge monitoring and protecting function** (i.e. Plug the balance charge connector on battery pack into the balance discharge protecting socket on ESC, in this case , the ESC monitors not only the voltage of whole battery pack but also the voltage of each cell). For Li-xx battery，low / medium / high cut off voltage for each cell are: 2.6V/2.85V/3.1V. When the voltage of any cell in battery pack is lower than the cutoff threshold, the protecting program is activated.
5. **Startup Mode**：Normal /Soft /Super-soft, default is Normal startup.
   Normal is good for fixed-wing aircraft. Soft and Super-soft are good for helicopters. The initial speed of soft / super-soft mode is very slow, 1 second (soft startup) / 2 seconds (super-soft startup) from startup to full speed. But if throttle is closed (throttle stick is moved to bottom) and opened again (throttle stick is moved upwards) within 3 seconds after the first startup, the restart will be temporarily changed to normal mode to get rid of the chances of crash caused by slow throttle response in aerobatic fly.
6. **Timing**：Low / Medium / High, default is Low.
   In normal cases, low timing can be used for most motors. But for high efficiency, we recommend the **Low** timing for 2 poles motor and **Medium** timing for 6 poles and above. For higher speed, **High** timing can be chosen.
   Important!   After you changing the timing setting, please test your RC model on ground firstly!

Special Hint

Some high KV out-runner motors have very special configuration, the space between each alnico is very large, and lots of ESCs can't drive these motors. After updating the program, our ESCs have very good compatibility with them. But some RC fans still have several questions about the programmable value for some special motors. So we just give some suggestions as follows:

Programmable Value Suggestion Motor	Timing	Startup Mode
General in-runner motor	Low	Usually, aircraft uses "normal" startup mode
General out-runner motor	Low or Medium	helicopter uses "super-soft" startup mode
Align 420LF (Made in TAIWAN, out-runner)	High (MUST)	
450TH (Made in TAIWAN, out-runner)	Low	Soft (MUST)

Begin To Use Your New ESC

Please start up the ESC in the following sequence:
1. Move the throttle stick to bottom position and then switch on the transmitter.
2. Connect battery pack to ESC, the ESC begins the self-test process, a special tone " ♪ 123" is emitted, which means the voltage of battery pack is in normal range, and then N "beep" tones will be emitted, means the quantity 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, i.e. the throttle channel of your transmitter is reversed, please set it correctly;
   - ◆ If a very rapid "beep-beep-, beep-beep-" tone is emitted, means the input voltage is too low or too high, please check your battery's voltage.

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3. "**VERY IMPORTANT!**" Because different transmitter has different throttle range, we strongly suggest you using the "Throttle Range Setting Function" to calibrate throttle range. Please read the instruction on page 4------"Throttle Range Setting".

Alert Tone
1. Input voltage abnormal alert tone: The ESC begins to check the voltage of battery pack when power on, if the voltage is not in acceptable range, such an alert tone will be emitted: "beep-beep-, beep-beep-,beep-beep-"(every "beep-beep-" has a time interval about 1 second.)
2. Throttle signal abnormal alert tone: 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 about 2 seconds)
3. Throttle stick not at bottom position alert tone: 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 about 0.25 second.)

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

Program example
Setting startup mode to "super-soft", i.e. value #3 in program item #5

1. Enter Program Mode Switch on transmitter, move throttle stick to top, connect battery pack to ESC, wait for 2 seconds, "beep-beep" tone should be emitted. Then wait another 5 seconds, special tone like "5671̇2̇" should be emitted, means program mode is entered.
2. Select Programmable Items Now you'll hear 8 tones in loop. When a long "beep------" tone is emitted, move throttle stick to bottom to enter the "Startup 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, then a special tone "1̇51̇5" is emitted, now you have set the "Startup Mode" item to the value of "Super-soft Startup"
4. Exit Program Mode After the special tone "1̇51̇5", 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.
Stochastic restart or abnormal work state	There is strong Electro - Magnetic interference in flying field.	The normal function of the ESC may be disturbed by strong Electro - Magnetic interference. If so, simply reset the ESC to resume normal operation by following the instruction manual. In case the function could not be resumed, please use the ESC in other places.

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Normal startup procedure:

Switch on transmitter, move throttle stick to bottom	Connect battery pack to ESC, special tone like "♪123" means power supply is OK	Several "beep-" tones should be emitted, presenting the quantity of lithium battery cells	When self-test is finished, a long "beep-----"tone should be emitted	Ready to go flying now

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 quantity of battery cells	A long "Beep-" tone should be emitted, means throttle range lowest point has been correctly confirmed

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 " 56712" 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-"
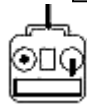
3. Set item value (Programmable value):

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 "i5i5" 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)

Items \ Tones	"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 " i5i5 ", 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.