SpeedMax-40

Programmable 40 Amp Electronic Speed Controller

Introduction

SpeedMax-40 is an advanced, compact and light-weight 40 Amp Electronic Speed Controller (ESC) driven by a powerful RISC microprocessor and employing the latest MOSFET driving techniques, including variable frequency PWM and reverse exponential power curve using real-time polynomial solving. These features make SpeedMax-40 one of the most efficient ESCs across the full power range and provide the user with linear power output with respect to throttle stick position. The programming feature allows the BEC cut-off voltage to be set and the propeller brake to be enabled or disabled. Setting the cut-off voltage is critical in preventing over-discharge of the battery pack for Li-Po and Ni-Cd or Ni-MH packs.

Features

Programmable brake	Enabling the brake will stop the propeller wind-milling when throttle is set to zero.
Reduced RF interference	Passive interference counter-measures means no servo jitter!
Programmable BEC cut-off voltage	The cut-off voltage is used to cut power to the motor while still providing power to the servos and receiver. Programming the correct cut-off voltage protects expensive battery packs against over-discharging which damages cells.
Programmable end-points	During the programming procedure, the end points of the RC signal is detected and stored to memory allowing the throttle stick range to be correctly mapped to the power setting from start-up.
Reverse exponential power curve	A smooth reverse exponential power curve is calculated in real-time to map propeller thrust linearly over the throttle range.
Variable frequency PWM	The PWM switching frequency is dynamically varied which significantly increases brush and winding life of the motor, as well as improve efficiency which results in increased running time.
Battery Elimination Circuit (BEC)	Power is supplied to the receiver from the ESC via the servo lead, which eliminates the need for a separate receiver battery pack.
False start protection	On power-up, the ESC waits for zero throttle to be applied before arming itself.
Lost model protection	Power output to the motor will be disabled if the receiver is out of range of the transmitter, or if the transmitter is switched off.
Noise and "glitch" immunity	Multiple algorithms have been implemented to reject noise and "glitches", protecting against erroneous or unexpected behaviour.

Technical Information

Continuous current rating[1]	40 A	**Typical on resistance**	2.3 mΩ
LiPo cells	2 – 3	**PWM Frequency (variable)**	1.25 kHz to 2.5 kHz
Ni-Cd cells	5 – 10	**PWM Resolution**	160 steps
Operating voltage	5.0 V – 12.0 V	**Current consumption**	13.2mA @ 12V
BEC	1A : 5V	**Module size**	25.6 x 17.6 x 6mm
Programmable cut-off	5, 6, 7, 8, 9, 10V	**Weight with/out power leads**	17g / 8g

Installation

Connect SpeedMax-40 to the motor using the red (Positive +) and blue (Negative -) power leads, marked as M+ and M- respectively. Make sure the motor has RF interference suppression capacitors. If there are no suppression capacitors on the motor, it is highly recommended that two 47nF (± $47x10^{-9}$ Farad) ceramic capacitors be installed, one between the positive terminal of motor and the metal motor casing and the other between the same point on the casing and the negative terminal of the motor.

Next, connect the ESC to the battery using the red (Positive +) and black (Negative -) power leads, trimming them to the minimum possible length (do not exceed 4.7in / 120mm) and paying careful attention to the polarity. If the distance between the battery and motor is large, rather increase the cable length between the ESC and motor, not the ESC and battery!

WARNING: SpeedMax-40 does not have reverse battery protection. Reversing the polarity of the battery may result in permanent damage to the ESC and the battery. ALWAYS follow the correct connection procedure and use polarised connectors, which cannot be connected the wrong way around.

[1] Requires airflow cooling above 35A continuous.

Operation

Make sure your frequency is not in use by someone else before turning on the transmitter. Connect the battery or turn on the ESC (if a switch is installed). Move the throttle stick to minimum position (zero throttle) for a half second to arm the ESC (*false start protection feature*). The LED will flash in rapid succession until the ESC is armed. When armed and at zero throttle, the LED will flash the programmed cut-off voltage, which is represented in Table 1 below. Move the throttle stick forward to apply power to the motor. At full throttle the LED will turn on – this may be useful for troubleshooting. If the RC signal to the ESC is lost, power to the motor will be cut (*lost model protection feature*). If the battery voltage falls below the programmed cut-off voltage, power to the motor will be cut. The cut-out condition can be (temporarily) reset by briefly moving the throttle stick back to minimum throttle.

Programming the Cut-off Voltage and Brake

To get into programming mode, disconnect the battery and turn on the transmitter, then do one of the following:
Method 1 (the easy way): Insert the jumper and connect the battery. Skip *Method 2* and go to "*Programming Mode:*".
Method 2: SpeedMax conveniently provides an alternative method to enter programming mode if the jumper pins have been removed or if a jumper cannot be found while at the field. It is a long-winded procedure to enter programming mode this way but is necessary to prevent accidental reprogramming of the cut-off voltage and brake. There are 4 phases to enter setup. The first phase starts when power is applied to the ESC if and only if the transmitter is on with the throttle stick centred (as required by Phase 1 in table 1). For the duration of each phase (grey columns in table 1), the ESC checks that the throttle stick is in the *Required Stick Position* and if not, programming mode entering terminates and normal operation is resumed (see section *Operation*). Each phase lasts 2 seconds during which time the LED remains on if and only if the throttle stick is in the *Required Stick Position* (as indicated in Table 1). When the LED turns off, immediately move the stick to the next *Required Stick Position* (there are 2 seconds to do this) and wait for the LED to turn on and then off before moving to the next *Required Stick Position*. At the end of phase 4 (stick will be centred), programming mode has successfully been entered.

Table 1: Illustration of programming mode procedure

Phase	1	*interval*	2	*interval*	3	*interval*	4
LED	ON	OFF	ON	OFF	ON	OFF	ON
Required Stick Position	Centre	-	Top	-	Bottom	-	Centre

Programming Mode:
Programming mode commences by flashing the LED in a sequence between 1 and 6 times with a brief pause between sequences. Start by moving the throttle stick back and forth 2 or 3 times. This allows the controller to detect the end points. The number of flashes is related to the cut-off voltage and is represented in **Error! Reference source not found.**. While selecting the cut-off voltage, the throttle range (between zero and full throttle) is equally divided into 6 (imaginary) regions with zero throttle being the start of region 1 and full throttle being the end of region 6 with regions 2 to 5 spaced between. The region number corresponds to the number of flashes, so for example, full throttle is in region 6 which will result in the LED flashing 6 times, indicating a cut-off of 10V. When the desired cut-off voltage has been selected (indicated by the number of flashes) and the throttle stick has not moved for 10 seconds, the ESC will store the setting to memory and move onto the brake enable/disable mode, indicated by a 2 second pause in the LED flashing (watch carefully!!). While selecting the brake mode, the throttle range is divided into 2 imaginary regions. Region 1 is between zero and half-throttle and region 2 the remainder. The region corresponds to the number of flashes. A single flash (region 1) enables the brake while a double flash (region 2) disables the brake. The ESC will store the setting when no region change (throttle movement) has been detected for 10 seconds then exit programming mode. The LED will flash rapidly waiting to be armed. These settings will be saved until the programming mode procedure is carried out as and when required.

Table 2: Flash count to cut-off voltage relationship

No. of flashes	1	2	3	4	5	6
Cut-off voltage	5V	6V	7V	8V	9V	10V

Cut-off Voltage Guideline

Please use the following guidelines for programming the cut-off voltage. Pay particular attention to the Li-Po cut-off voltage as over-discharging these cells may cause them to explode or catch fire.

Table 3: Cut-off voltage guideline

Cell chemistry	Li-Po		Ni-Cd / Ni-MH					
No. of cells	2	3	5	6	7	8	9	10
Cut-off voltage	6V	9V	5V	6V	7V	8V	9V	10V
Number of flashes	2	5	1	2	3	4	5	6

Contact

This product is designed and manufactured by FirmTronics. Visit us at www.firmtronics.com for more information, including troubleshooting, updated user manuals and other product information. If you have any suggestions, comments or general feedback, please email us at info@firmtronics.com.

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