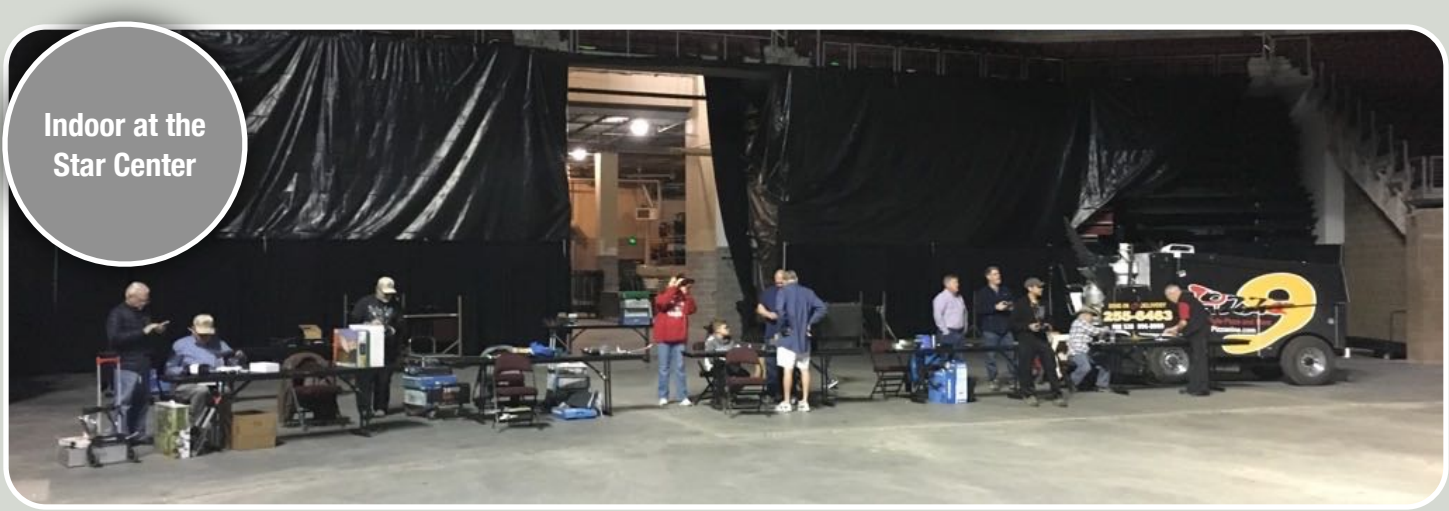
March 2018 Volume 29 Issue 3

TURBULATOR

Newsletter
of the Rio Rancho Radio Control Flying Club

AMA Club #2770

WATERMAN FIELD ELEVATION 5840 FEET 35° 17.2'N 106° 44.8'W



Indoor at the Star Center

PRESIDENTS CORNER

"Da Prez Sez"

It looks like winter is going to be around for a while longer. Now it is colder again and it looks like the wind will never stop. The holiday fly inn at the Star Center was fun as it gave the working members of the club a chance to get in some flying. We also got a chance to wish Vic happy Birthday, with Coffee and Donuts brought in by his wife, Natalie. March is the swap meet month.

Coming Events

1. Next Meeting 5 March 7pm @ Wallen Clubhouse
2. Indoor @ the Star Center 19 March 0900
3. SWAP Meet at the March Meeting

Linear BEC's versus Switching BEC's

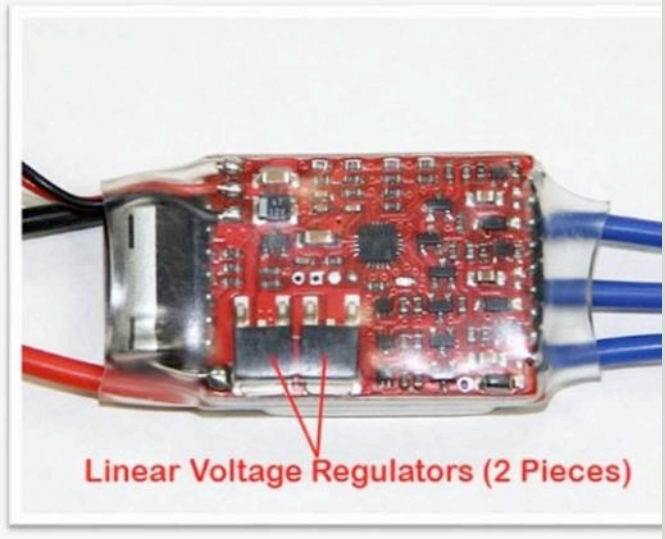
"What is the difference between a Linear BEC and a Switching BEC?" This is actually a pretty good questions, and knowing the difference between the two can really help in selecting the right speed controller for a model.

Well, the simple answer is that a Linear BEC throws away excess voltage by converting it to heat, while a Switching BEC does it by turning on and off really fast as needed to pass through the required voltage. Unfortunately, that does not tell you very much! Since I like to pass on educational information to fellow hobbyists whenever possible, the complete answer to this question is explained below.

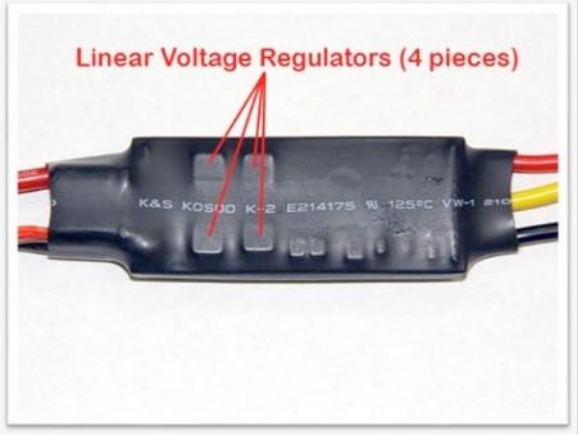
In all BEC's, the object is to step down the voltage level of the motor battery to a lower value, typically between 5 and 6 volts, so you can power the radio receiver and servos directly from the motor battery. This eliminates the need to carry a separate 4-cell or 5-cell, Ni-Cad or Ni-MH, battery pack in the plane to run the receiver and servos. This is where the BEC gets its name, since BEC stands for "Battery Eliminator Circuit". The BEC eliminates the need to have a separate battery on board to power the Receiver and Servos.

The batteries used to power RC aircraft are normally Li-Po type, and can be anywhere from 2 cells (7.4 volts) up to 12 cells (44.4 volts). The receiver and servos are typically designed to be operated from 5 to 6 volts, so the battery voltage from the motor needs to be dropped down to a lower level, so it can safely be used to power the receiver and servos. There are two different ways to drop down the voltage level from the battery pack to the correct level, Linear BEC circuits and Switching BEC circuits.

Linear BEC circuits simply use voltage regulator IC's to step the voltage down to a safe level. The photo below shows the back side of a speed controller showing the location of the voltage regulator IC's on the circuit board. These parts are normally about 3/8" or 10mm square. These devices typically drop the battery voltage down to 5.0 volts, and dissipate the excess voltage out as heat into the part, and into the surrounding PC board that they are attached to.



This next photo shows how the Linear BEC chips look on an ESC that has a black heat-shrink cover, so you know what to look for.



The benefit of Linear BEC circuits is that they are cheap, and require no other additional components to work properly. Everything is contained within the part itself. The down side is that they are limited to use on smaller batteries, such as 2-cell and 3-cell Li-Po packs, because of the amount of heat that they generate. In most cases, each voltage regulator chip can handle 1 amp of current, so a 2-amp BEC will have 2 of these IC chips working together, as seen on the ESC with the clear heat shrink above, and a speed controller with a 4-amp BEC will have 4 of these IC's working together, as seen in the speed controller above with the black heat shrink cover.

The amount of heat generated by the IC's is dependent on the amount of current that the BEC circuit produces, multiplied by the voltage drop of the part. When running one of these parts on a 2-cell Li-Po battery, the battery voltage starts at 8.4 volts when the battery is fully charged, and drains down to about 7.2 volts at the end of the charge, so the average voltage is around 8 volts. If you drop 8 volts from the battery down to 5 volts for the servos, the drop is 3 volts. If the BEC puts out the full rated current of 1 amp, then the IC chip must dissipate 3 volts x 1 amp or 3 watts of power. In a 2-amp BEC, each IC would carry 1 amp, so the total heat output would be double or 6 watts of heat energy.

When you step up to a 3-cell battery, now average voltage of the pack is closer to 12 volts. This means that when you step 12 volts down to 5 volts, you have 7 volts left over. At the full current of 1 amp, each IC chip would need to get rid of 7 watts of heat energy. Unfortunately, the D2PAK type of case that these IC chips normally come packed in, can only safely dissipate about 4 watts of power without overheating. In this case, running the BEC at full power of 7 watts per chip would overheat the BEC. This is why Linear BEC circuits are only good for their full rating when run from a 2-cell battery pack. If you run them from a 3-cell battery pack, you have to "De-Rate" the output of them to only 50% of the rated value. This means that an ESC that has a 3-amp BEC can only put out the full 3 amps on a 2-cell battery. On a 3-cell battery you can only expect to get 1.5 amps from it without overheating.

If you do go up to a 4-cell battery pack, then the battery voltage goes up to 16 volts, and you have to get rid of 11 volts to get down to 5 volts for the receiver and servos. This limits the maximum current to about 1/4th of actual rating, which is typically not enough to drive even 1 servo. This is why most ESC manufacturers recommend not using the internal BEC, and using an external BEC circuit for this type of ESC when it is run on 4 Li-Po cells.

To "disable" the on-board BEC, there are a couple of options. The most common way is to lift up on the little tab that holds the contacts into the black connector shell, and slide the contact for the red wire out of the connector. This is then folded over and covered with electrical tape or a piece if heat shrink to keep the bare contact from touching anything. This prevents the voltage from the BEC to go out and power the receiver when the ESC is plugged into the throttle channel. Some people will actually cut out a small piece of the red wire to disable the BEC. I do not recommend this, because it is not easily

reversible if you want to use the BEC later on in a different application.

Another easy way of disabling the BEC is to install a short 4″ servo extension onto the control lead of the ESC, that has had the red wire cut out. This makes it easy to unplug the extension later and keep the BEC intact in the speed controller.

In short, the Linear type BEC is cheap, and works well for low voltage 2-cell and 3-cell operation. Unfortunately, they are not very efficient. When run on 2 cells, the efficiency is only 62% and when run on 3 cells it is only 42%. This is because all of the extra voltage is simply converted to waste heat and not used. In fact, in many cases, the BEC circuit actually heats up the ESC more than the transistors do when controlling the motor speed!

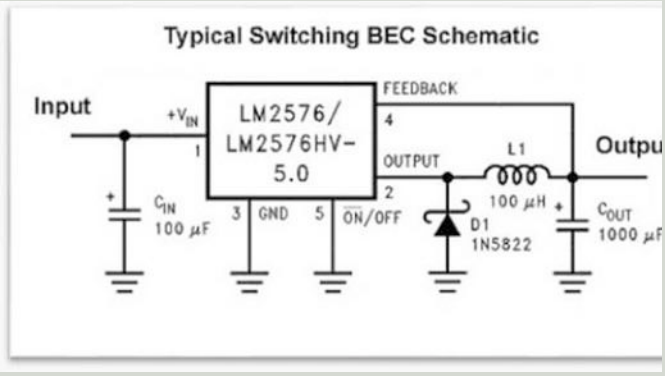
The other common type of BEC is the Switching BEC. This type uses a small FET transistor to switch the voltage from the battery pack on and off very quickly, around 150,000 times per second, and then filter this output through an inductor and capacitor to smooth out the ripple to produce a steady DC voltage. By varying how long the transistor stays turned on during each switching cycle, the device controls itself to maintain a constant voltage, regardless of the load.

In the case of a 3-cell battery, you need to step the voltage down from 12 to 5. An output of 5 volts is 42% of the 12 volts, so if the transistor turns on for 42% of each cycle, and off for 58% of each cycle, and this amount of voltage is averaged out and filtered, you end up with 5 volts DC.

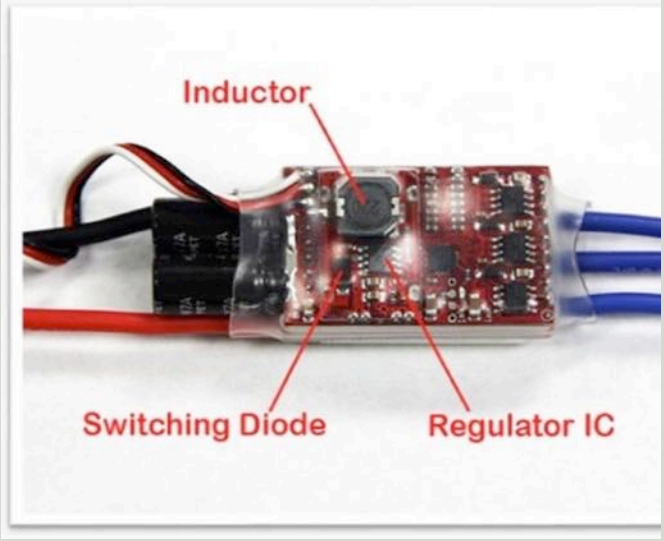
In the case of a 4-cell battery, to go from 16 volts to 5 volts, the output needs to be on for 31% of the time and off for 69% of the time and you still get 5 volts out. As the input voltage increases, the duty cycle simply reduces so that you always have 5 volts out.

The beauty of this type of BEC is that there is no waste heat energy generated to speak of. Instead of throwing away the excess voltage as waste heat, as is the case with a Linear type BEC, the Switching type BEC simply turns off when it gets enough power for each cycle. There is a small amount of heat lost in the switching transistor, the controller IC and the Inductor in the circuit, but this is typically only 4 to 6% of the total amount of energy. Because of this, the overall efficiency of a Switching type BEC is around 95%, regardless of the input voltage.

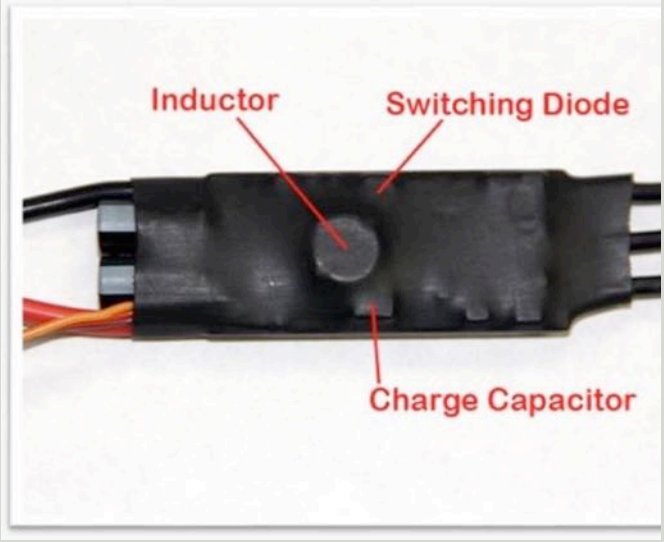
The down side to a Switching type BEC is that it has more parts, is more complex, and costs more to implement. Below is a schematic diagram of a typical BEC circuit as used in an R/C ESC. There is a small IC chip that is normally in a 5 to 6 pin package that contains the switching transistor and the control circuitry. In addition to this part you typically have an input capacitor, and output capacitor (often called a Charge Capacitor), an inductor and a diode.



On an actual speed controller, these parts look like the one shown in the photo below. Three of the main parts are labeled, the Inductor, the Diode and the IC chip. The output capacitor can just barely be seen behind the inductor, and the input capacitor is the small part just below the IC chip.

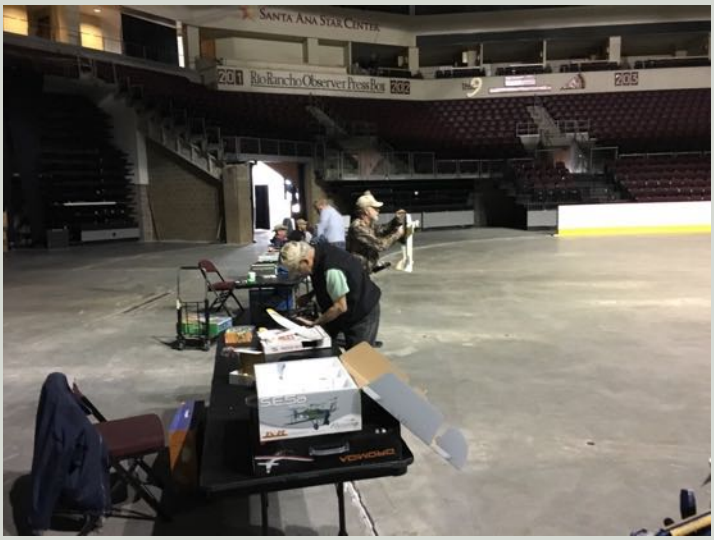


On a speed controller with black heat shrink, the switching type ESC can be identified by the large inductor, with is about ½" or 12mm square, as seen in the next photo.



The nice thing about the Switching BEC is that it puts or full current, regardless of the input voltage. This is much better than the Linear type BEC, which must be de-rated or disabled as the voltage goes up. If you have a Switching BEC that is rated for 5 amps, it will deliver the full 5 amps whether you run it on a 3-cell, 4-cell 5-cell or even a 6-cell battery.

So now you REALLY know the difference between a Linear BEC and a Switching BEC.



Indoor at the Star 19 Feb

Dan Sellers with his electric powered 30cc Valiant

MEETING MINUTES

Minutes from the February 2018 Club Meeting

The Meeting was called to order @8:05pm with 12 Members Present

Minutes: Accepted as Published

Treasurers Report: Accepted as Presented

Membership Report: 37 2018 Members

Field Report: Most of the month there has been inclement weather and high winds. Some members have flown.

Safety: No Issues Noted.

Unfinished Business: 1. Bill contacted Tom at the Events Center where we had our Christmas Party to see about booking for 2018. Tom has promised to call back, Bill is waiting on the call. The decision was made that if the room was available and reasonable that Bill should book the facility for the 2018 Party.

2. There will be a club Swap Meet at the March Meeting.

New Business: 1. There may be a Drone Demo team booked at the Star Center. If more information becomes available it will be passed on to the club members.

2. It was brought up that linking to the HeadsUpRC page from our club website would be beneficial to the club. Don will investigate and if beneficial make the changes to our website and report back at the next meeting.

3. Garry has opened his lake house up for the club to have a lake fly weekend. Don will email the club to get suggestions on dates/times.

The meeting adjourned at 7:45

Vic Newton gave an interesting presentation on Electronic Speed Controllers and Battery Eliminators. Vic had a business where he designed and sold his own line of speed controllers for both Brushed and Brushless motors. His presentation covered the different types of speed controllers, design characteristics and choosing the best speed controller for your aircraft. The presentation was very good and lasted approximately 25 minutes.

Turbulator:
Editor Don McClelland
We are always looking for articles, pictures and your input!

For comments, or suggestions
Please Email Don at
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Next Club Meeting
March 5th 7:00pm at the Wallen Club House. 5545 Lilac Pl.