An Owl cannot fly without …

Volume 6, Issue 5
May 2015

Flight Feathers

The official publication of OneWingLowSquadron.org

INSIDE THIS ISSUE:

NEXT MEETING

JUNE 6TH
@ 11:00 AM

DON'T FORGET

OUR ANNUAL ELECTRIC FLY-IN MAY 23RD

WISE OWLS

MIKE FLICK
PRESIDENT
~
JERRY FLICK
VICE PRES.
~
RON SANDERS
SEC./TREAS.
~
ROB GRANT
SAFETY OFFICER
~
GALE MOORE
CONTEST DIRECTOR

ESCs – Electric Speed Controllers for Brushed Motors

Early speed controllers consisted of nothing more than a hefty variable resistor, the wiper of which was moved by a servo. This had the advantage of being simple, but was very inefficient at partial throttle settings. Such a control works by reducing the voltage to the motor, but this means that any voltage that does not appear across the motor terminals must appear across the speed control. For example, at half throttle, a resistor speed control that is controlling a motor drawing 10A from a 6-cell pack will have 3.6V across it, and 10A flowing through it. Thatôs 36W, which all becomes useless heat. This would be like running a 40W light bulb in the radio compartment of your plane. Furthermore, half the power being produced by the battery is being wasted. A resistor speed control is only efficient at zero throttle (when no current is flowing), and at full throttle (when there is no voltage drop across the speed control).

An electronic speed control works by applying full voltage to the motor, but turning it on and off rapidly. By varying the ratio of ñonò time to ñoffò time, the ESC varies the average voltage that the motor sees. Since at any given instant, the control is either fully ñoffò or fully ñonò, this kind of control is theoretically 100% efficient.

In reality, ESCs are not 100% efficient. Ignoring the factors introduced by switching rate, the loss in efficiency is due to the fact that the components doing the actual switching are not perfect. They are not mechanical switches, and therefore have significant resistance. Whenever there is current flowing through a resistance, there is power loss.

Some early electronic speed controls used ordinary (bipolar) transistors to switch the motor current. These generally have a 0.7V drop, *regardless of the current* flowing through them.

Modern ESCs use MOSFETs (Metal Oxide Semiconductor Field Effect Transistors). Rather than having a fixed voltage drop like a bipolar transistor, a MOSFET has a fixed resistance when turned on. Therefore, the voltage drop *depends on the current flow*. A typical MOSFET used in inexpensive ESCs has 0.028 Ohms resistance resulting in a 0.56V drop at 20A.

Theoretically, the ESC will be equally efficient at all throttle settings. (One could argue that it is more efficient at lower settings, because it spends more of its time in the 100% efficient ñoffò state.)

The rate at which an ESC turns the motor on and off is also rather important. Early speed controls, including some still made today, were **low-rate** ESCs. These turn the motor on and off at the same rate that your radio sends pulses to the servos (usually 50 to 60 times per second). The simple theory presented above breaks down at these low rates, and such speed controls are very inefficient at partial throttle settings. There are many technical reasons for this, involving factors like motor coil inductance, impedance, and so on. There is also one simple reason, and that is bad timing.

Consider a typical low-cost motor with a three slot armature. As this motor rotates, each of the three commutator segments passes each brush three times per revolution. Each armature winding is energized in a given direction once per revolution. Now suppose that the speed control is being operated at 1/3 throttle (so it is on 1/3 of the time and off 2/3 of the time), and that this results in the motor turning at 60 revolutions per second (3,600 RPM). If the speed control is pulsing the motor 60 times per second, then each pulse corresponds exactly to the beginning of one revolution. Since the power is on only 1/3 of the time, only one armature winding is energized in each revolution, and it will always be the same one. Therefore, this one winding is doing all the work, and will get much hotter than if the work were shared by all three windings. The rotation will also not be smooth, as the motor accelerates and decelerates with each revolution.

Modern ESCs turn the motor on and off at a much **higher rate** (typically 1,000 to 4,000 times per second, with 2,500 being typical). Even at 1,000 cycles per second, the problem described above would not happen until the motor reached 60,000 RPM, which is beyond the reach of most motors. This results in much smoother operation and, due to a better match of the switching frequency to armature winding characteristics, results in less heat loss within both the motor and the ESC.

September 30, 1997 for Sailplane & Electric Modeler Magazine

Editor's Note: This article is dated and was intended for brushed motors (2-wire). It may contain vintage information. Always follow the manufacturerôs recommendations for your model when choosing an ESC and motor.

WARNING!
To prevent brain overload from just too much damn information … the Editor recommends taking a coffee break (or whatever drink of choice you prefer) before proceeding to the next page.

The OWLS are International! Mike Elmore sent my *In the Hangar* interview of him and Shaun to friends in New Zealand, and they somehow got it published in Model Flying World magazine (page 33). I'm honored, Mike.

onewinglowsquadron.org/spotlight

Sorting It All Out

After one of my more "enthusiastic" landings with my Tempo … enthusiastic enough to bend the motor shaft … I purchased a new shaft from Lee's Hobby, installed it, and set about hooking everything back up.

Plugged in the battery and the Rx light lit. The surface servos worked, but there was no response from the ESC or motor. After a quick trip to Rob's Hobby where Rob let me substitute a new ESC and motor … still no response.

What's left? I ordered a new Rx from Horizon Hobby and voila, the original ESC gave me the proper tones, but the repaired motor only wiggled and waggled back and forth. Tried an old motor I had on hand, and it spun its little heart out.

Conclusion? I guess the damage to the motor (though not visible) extended beyond the bent shaft. Installed a new Cheetah motor from BP Hobby and the Tempo is ready to take-to-the-air once again.

More ESC Info

An ESC does several things. First, if it is labeled BEC or UBEC (Universal) Battery Elimination Circuit, it converts part of your battery voltage down to 5v for the Rx. Second, it converts the DC power from your battery to AC current which is required by a *brushless* motor (3-wire).

ESCs have one very key feature: the **amperage rating**. Every motor takes a different amount of amps. A motor that pulls 10 amps requires an ESC that is rated for 15 or 18 amps. Why? HEAT! The higher the amp-rating, the less heat generated.

ESCs can get very warm at times and should be placed in such a manner that they get sufficient airflow to keep them cool.

Rocket to be Reused via Helicopter Rescue …from the Editor's Desk

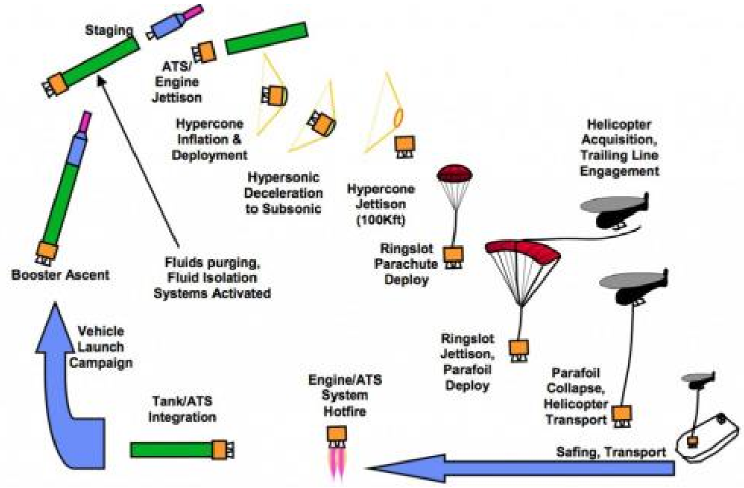
One primary reason space travel is so expensive: rockets are single-use. Imagine if you had to buy a new car every time you took a road trip.

Now **United Launch Alliance** is building a more affordable way to get to space and back by catching the rocket engine with a helicopter as it falls back to Earth after the launch. The ñSensible, Modular, Autonomous Return Technologyò (SMART) initiative will allow ULA ñto reuse the most expensive portion of the first stage ï the boosterôs main engines ï via mid-air capture.ò

The ***Vulcan*** will ñprovide the countryôs most reliable, affordable, and accessible launch service,ò ULA claims, and ñtransform the future of space.ò Itôs ña game-changer in terms of creating endless possibilities in space.ò

Why the name: Vulcan? It was chosen by more than one million online votes.

ULA is a joint venture of Lockheed Martin and Boeing, formed in 2006. It is also partnered with Amazon founder Jeff Bezosô Blue Origin.



http://spectrum.ieee.org/tech-talk/aerospace/space-flight/ulas-new-vulcan-rocket-comes-back-to-earth-via-helicopter

ESC Features

Brake: A brake forces the motor to stop turning once the ESC stops delivering power. Electric motors become generators when being driven by their output shaft (for example, by a wind-milling propeller). The more load you put on a generator, the harder it is to turn. A speed control brake simply places a load (a low resistance) across the motor terminals, making it difficult for the motor to turn. This is generally sufficient to stop it completely. If a folding propeller is being used, this will allow it to fold. If a fixed propeller is being used, it will produce less drag than if it were spinning.

Soft Start: This term describes both ESCs and a special kind of on/off-only motor switch. In both cases, it indicates that the control will go from off to full-throttle slowly (for example, over the course of one second) instead of instantly. This is very important if using a gearbox or folding propeller, since an instant start can strip gear teeth, or shear propeller hinge pins. Some speed controls let you adjust the soft start time interval.

Digital or Microprocessor: Until fairly recently, the majority of ESCs were analog, meaning they worked with voltages and pulse widths, and had dedicated circuitry to perform each of their functions. Most modern ESCs are digital. These controls use a microprocessor to measure the incoming pulse width from the radio, and to generate the pulses to the MOSFETs. Digital designs have the advantage of being adjustment free, and of being able to provide sophisticated safety features. For example, most digital controls will refuse to turn on until the throttle stick has been moved completely to the ñoffò position first.

Battery Eliminator Circuit (BEC): In small planes, it is advantageous to eliminate the weight of a receiver battery. Many ESCs have a BEC feature that provides power to the receiver and servos from the motor battery. There is still a great deal of debate as to whether this is safe, primarily due to the danger of electrical noise getting into the receiver and causing reduced radio range. The other danger of course is that the motor battery could run down to the point that the BEC cannot provide power to the receiver. BEC is very popular with the electric pylon racing crowd, where the planes never get very far away and land immediately after the race.

Automatic Cut-Off: This feature is generally used with a BEC, so that the motor will shut down before the battery is depleted, thus reserving some power for the radio.

Optical Isolation: To reduce the possibility of the ESC interfering with the radio receiver, some controls use an optoisolator chip. This is basically an LED (light emitting diode) and phototransistor encased in plastic. The signal from the receiver drives the LED, which optically transfers the signal to the rest of the speed control. There is no electrical connection between the receiver and the main part of the ESC. Obviously, this eliminates the possibility of providing a BEC.

Don't miss out! There are some interesting links on our website at onewinglowsquadron.org/info.

The OWLS Nest Gallery… See all the videos at https://vimeo.com/groups/onewinglow

The Pompano Hill Flyers had picture perfect weather for their sail plane contest.

17 pilots, representing a half-dozen or more clubs, participated in the two-day event.

Watch the video at:

https://vimeo.com/126710971

Ouch…that's gonna leave a mark.

Check out the entrance to KennyWorld the next time you visit the field. Kenny's daughter, Deb, did a wonderful job of sprucing it up for an eye-appealing welcome for our visitors.

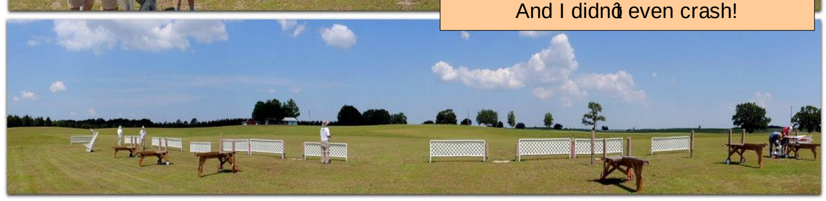
OPERATION PURPLE

On June 18th 10am-2pm, the Florida Sheriff's Caruth Camp is hosting *Operation Purple* for children 10-15 years of age from deployed military families. I have arranged for the OWLS to sponsor a space (amidst military & 1st responders) to bedazzle the kids with a display of various models and just perhaps plant the seed to grow a future R/C pilot.

If any OWL is interested in participating or loaning his plane for the event, please contact me at *keukadiver@gmail.com*.

Sean's VTO plane

Karl's Hangar 9 Funtana with Richard helping



Can a day be more perfect than this? And I didn't even crash!

Got Photos? Catch me at a meeting or send a copy to: keukadiver@gmail.com

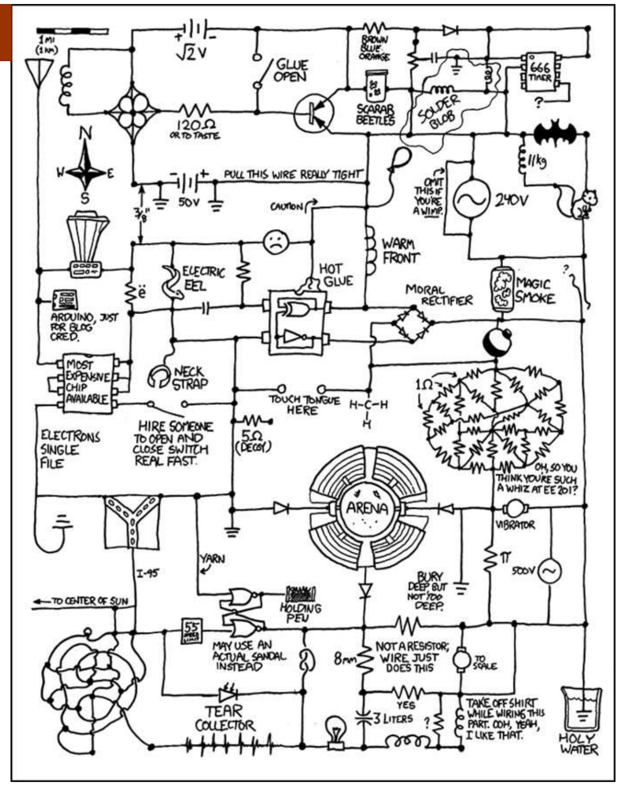
KennyWorld R/C Field **CR 464 west of SR 41, 17150 SE 60th Street, Morriston, FL 32668, 352-528-3744**
We're on the Web! Onewinglowsquadron.org and Facebook! Https://m.facebook.com/profile.php?id=857602174259072

Name This Plane for a Chance to be Revered by Your Fellow OWLS.

Rare ESC Schematic Discovered

After doing some deep research (and hacking) on the Internet, I found a top-secret schematic for a rare ESC made in Elbonia.

It certainly makes sense to me as nobody really knows how they work anyway.



The QUAD(rant)…

ESCs in Drones

Electronic Speed Controllers are an essential component of modern Quadcopter "drones" (one ESC per motor). These craft depend entirely on the variable speed of the motors driving the controlling rotors (usually four, but sometimes more) and, in turn, driving the propellers. **Altitude** is determined by the amount of power to all four motors. **Forward motion** is achieved by driving the aft props faster than the forward props. **Sideways motion** (yaw) is achieved by varying the speed of the left or right props. **'Rudder' movements** are again achieved by slowing or speeding individual motors - and this control is reliant on the fact that two of the motors rotate 'clockwise' while the other two are 'widdershins' so that, again, slowing or speeding individual motors (and props) will produce a change in attitude of the craft.

REST IN PIECES

Casualties from 2014 to Present

I've been doing the newsletter for a year now and thought it might be interesting to see the casualties that have piled up during that time.

Okay…I can take credit for four of these, and I'm sure there have been several others that have escaped my attention. Thank goodness all where not total losses.

But, as it was explained to me from the start, "It's not a matter of IF you'll crash but WHEN."


5/7/15

4/25/15


10/24/14

12/18/14

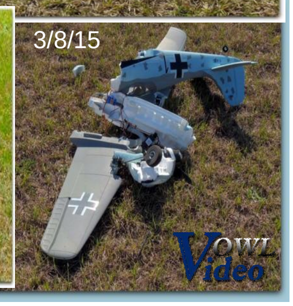

2/11/15

9/19/14
1st Crash


1/17/15
3rd Crash

3/8/15


5/10/14



3/8/15