

SR *Electric Flight Techniques*[™]

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The ABC's of Electric Flight

By Larry Sribnick

As you already know, Electric Flight is a real alphabet soup of numbers and letters. Motors are 400's, 500's, 550's, 600's, 700's, 05's, 15's, 25's, etc., etc., etc.. As if that wasn't enough, we have BB motors, FAI motors, ferrite motors, cobalt motors, and neodymium motors. How can you possibly know which motor to use in a particular aircraft?

The cells we use in our battery packs are no better. We have AA cells, A cells, SubC cells, C cells, and D cells. Not only that, we have SC cells, SCR cells, SCE cells, Max cells, Magnum cells, and a whole bunch of other confusing identifiers.

Let's see if I can simplify some of this confusing information so that you will have a better idea of what's available and how you can put it to best use.

The 1-2-3's Of Motors...

Way back in the dark ages of Electric Flight, what a particular company called, or named, a particular Electric motor was fairly straight forward and simple. If an Electric motor produced power which was comparable to that of an .049 or .051 two stroke engine, they rounded it off and called the Electric motor an 05. If the Electric motor produced a power output similar to that of a .25 two stroke engine, the Electric motor was named a "25."

This was a simple system and it made a lot of sense. "Wet" flyers had no idea of how much power an Electric motor would produce. As a result they had no idea of which size Electric motor to use in a particular aircraft. If they were going to use a two stroke engine they did have enough experience to choose the right engine. However, when choosing the right size Electric motor, they were in the dark. By naming the motors in a similar fashion to that of a two stroke engine, the manufacturer was giving the modeler an idea of what he or she could expect from that particular motor.

Naturally, as time went on, Electric motors got bet-

ter and produced more power. But rather than rename the motors, the manufacturers kept the same old names. Eventually, it got to the point where we would assume that a Electric motor would produce the power of the next larger two stroke engine. In other words, an "05" Electric motor would produce the power of a ".15" two stroke engine. A "25" Electric motor would produce the power of a ".40" two stroke engine. This was still no problem as this "correction factor" worked pretty well. However, today all bets are off!

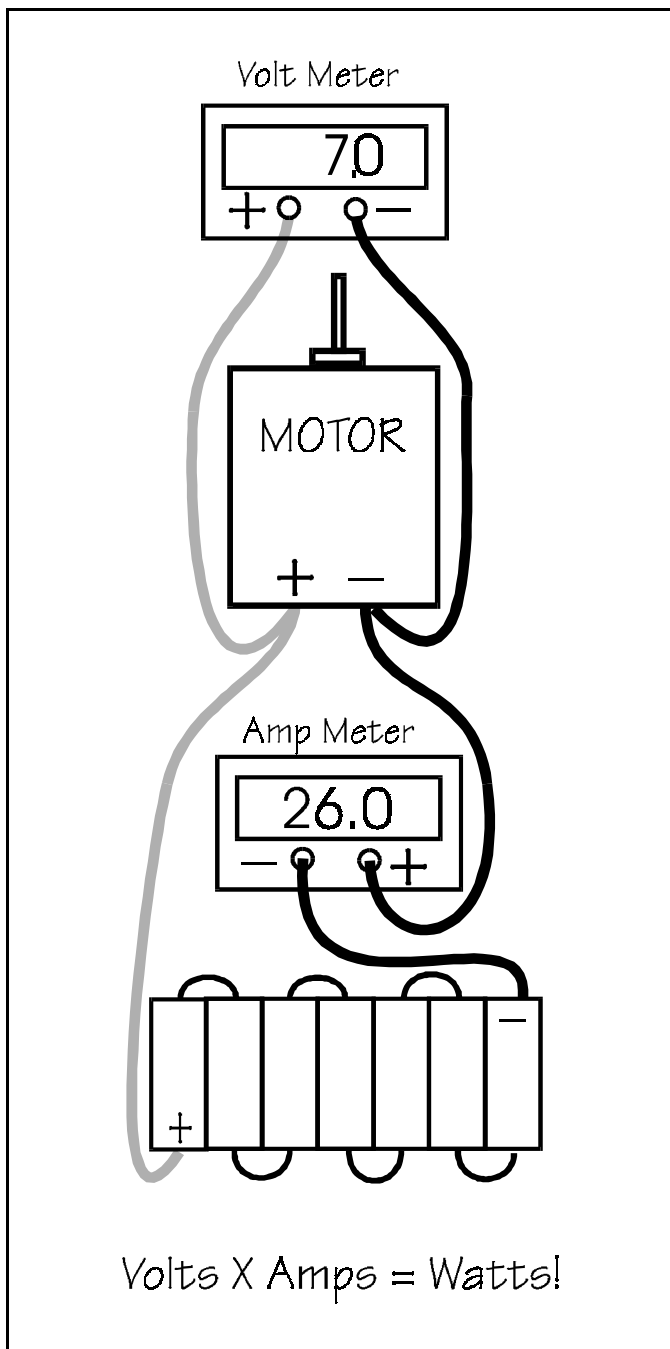
The power outputs of today's Electric motors are all over the place. We have motors which are called "05's." We have "FAI 05's." We have "Modified FAI 05's." We even have "ferrite," "cobalt," and "neodymium" motors. There was even a proposal that we calculate the volume of a motor's armature and name the motor accordingly!

At SR Batteries, I'm just as guilty as everyone else in thinking that I have a better way of naming our motors. I decided to name the motors according to the maximum number of cells which could normally be used with a particular motor. The SR Max⁷ motor is a five to seven cell motor so we named it Max⁷. The SR Max¹⁰ is a seven to ten cell motor so we named it Max¹⁰.

So where does all of this leave you in trying to choose a new motor? Well, I think the best thing a company can tell you about a motor is what they recommend as far as an "input wattage." Input wattage is a measure of how much energy is going "into" a motor. You calculate it by multiplying the voltage at the brushes by the current draw of the motor. A shortcut I usually take is to assume a voltage of 1.0 volt per cell in the pack. In other words, I assume a seven cell pack will give me 7.0 volts at the brushes. I don't use 1.2 volts per cell because at the current draws which we normally use, the effective voltage of a cell will drop to 1.0 volt per cell. Is 1.0 volt per cell dead on? No, but it's close enough so don't write me any letters!

To calculate the input wattage, I measure the current draw of the motor and multiply it by the number of cells in the pack. If the motor is drawing 26 amps

and I'm using a 7 cell pack, I multiply 26 x 7 and get 182 input watts. If the motor had been drawing 34 amps, the input wattage would have been 238 watts or 34 x 7.



In order to calculate input watts, you have to simultaneously read voltage and amperage.

OK, so what? Why would you want to know the maximum or typical input wattage of a motor? Simple, so you can choose a prop, gear ratio, or the number of

cells to be used in the battery pack!

Let's say a particular motor is listed as having a maximum input wattage of 200 watts. And, let's also say that I'm using a gearbox with a ratio of 3:1 and a 12x7 prop. I'm using a seven cell battery pack and the motor is drawing 34 amps. No good! 7 x 34 is 238 watts and the maximum input wattage for this motor is only 200 watts. This will burn out the motor!

What options do you have? First, you could switch from a 12x7 prop to an 11x7 prop. If you did, the current draw might drop to 28 amps and as a result the input wattage would drop to an acceptable 196 watts. Let's say that I don't want to change the prop. What else could I do? No problem, go from a 3:1 gear ratio to a 3.5:1 gear ratio. This would drop the current draw and as a result, the input wattage of the motor.

What if you don't want to change the prop or the gear ratio? No problem. Go to a six cell pack rather than a seven cell pack. In this case, the current draw of the motor could be as high as 33 amps without going over the limit of 200 input watts, 33 x 6 is 198 input watts.

In practical terms this is a very important point. Let's say you have an "05" motor that is rated at 200 input watts. Let's also say you're going to use it direct drive and want to use a 9" or 10" diameter prop. Normally, an 8x4.5 prop would be the largest you could use. In this case, by going to a six cell or even a five cell pack, rather than a seven cell pack, you can keep the input wattage in line. With a five cell pack you could draw as much as 40 amps and still not go over the 200 watt input rating! Got that?

Before I move on, let me mention one more thing about input wattage. There are really two different types of input wattage, maximum and constant. The Maximum input wattage is the highest possible input wattage that will not damage the motor during short motor run applications. By short motor runs, I mean the 30 or 45 second motor runs used in AMA Class A and B LMR (Limited Motor Run) Sailplane events. When bench running at the maximum input wattage, you should limit your motor runs to 10 seconds or so. The 30 to 45 second motor runs are OK in the air but on the bench, don't go beyond 10 seconds just to play safe.

The constant maximum input wattage of a motor is

just that. It is the highest input wattage that can be used with that particular motor. This is regardless of the duration of the motor run. Now, as they say, "Don't check your brains at the door!" We're still talking about a motor run of 5 to 12 minutes. Not 60 minutes! Also, we're assuming adequate cooling air to the motor. If the motor is completely enclosed, don't go running it at the maximum constant input wattage on the bench for 12 minutes. You may burn the motor up. For motor runs of 30 to 45 seconds, cooling to the motor is less important because it takes some time for the motor to heat up. However, for longer motor runs, it makes sense to feed some air to the motor. Try not to overdo bench running. It can really be hard on the system if you're not careful.

As a side note, notice that in all of the above, an Electric motor is a "motor" and an internal combustion engine is an "engine." Personally, I don't think it's a big deal but you might as well get it right as Electric Flyers will be continually correcting you if you get it wrong.

Now, I can hear some of you saying, "Bah humbug," It's not the input watts that count, it's the output watts! Well, you're right. If you want to know how powerful a motor is, it's the power that comes out that counts, not the power that goes in. Each motor has an efficiency rating. This measurement of efficiency tells you how well the motor is able to convert the electrical energy going into the motor, into mechanical energy coming out of the motor. The problem is that you and I have no easy way to measure the mechanical energy being produced by a motor. Sure you could set up a test stand and make all of the important measurements. However, most of us would rather spend the day at the field flying rather than down in the basement testing motors. For the most part, the spread in efficiency is between 60% and 80%. Although this 20% spread is significant, most of us will gain more by watching input wattage rather than spending our time measuring output wattage. If you're at a point in your Electric Flying where you are set up to take all the necessary measurements, do it but don't fall into the trap of spending all of your time testing rather than flying.

This whole area of motor naming or identifying has some very important implications for the Electric competition flyer. The various classes used for internal combustion competition are simple to identify because

all you have to do is measure the bore and stroke of the engine to get its displacement. With Electric motors it isn't all that simple and repeatable. The present system of limiting the maximum number of cells used in a particular class is probably the fairest system we're going to come up with. At the very least, it encourages everyone to get the most out of what they have. Electric competition is still in its infancy so it probably would be a mistake to put all kinds of restrictions in place because it would stifle the evolution of the motors and cells we are using.

The ABC's Of Cells...

If naming motors is confusing, naming the cells we use is even more confusing. When it comes to cells, there are standard ways of describing the physical size of a cell. We're all familiar with "Double A" or "AA" cells, "C" cells, and "D" cells. When you got into Electric Flight, you discovered that there was something called a "SubC" cell and even a "2/3 SubC" and a "1/2 SubC." Technically, these are the official sizes of the cells but it is not the way the manufacturers name the cells. Sanyo for instance, has a N-1300SC, N-1400SCR, 1700-SCRC, and a KR-1700SCE. Are these all different size cells? Nope, they all look exactly the same.

At SR, we're just as bad. We have a 1500 Series, 2000 Series, 1500 Max Series, 1800 Magnum Series, and our new 1800 Max Series cell. Again, they are all the same size and look the same.

So how can you know what you can expect from a particular cell? In the case of Sanyo, the number indicates the capacity of the cell in milliamp hours. A "1400" cell has a capacity of 1400 mah. The letters "SC" after the number mean that the "diameter" of the cell is the same as the diameter of a "SubC" cell. Get it? SC, SubC. Notice that there is no mention of the length of the cell, only its diameter. The "R" after the "SC" is a designation Sanyo uses for their low internal impedance cells. No letter after the "SC" would be one of their standard series cells and an "E" after the "SC" would mean that the cell is a high internal impedance cell. These two designations, the SC and the R are totally independent of one another. Sanyo's low internal impedance "C" cell is a CR. Their low internal impedance "D" cell is a DR. I have seen time and time again articles printed in the magazines that call all Sanyo

cells, regardless of size, SCR cells. There's no such thing as a "AA" size SCR cell. If Sanyo made a low internal impedance "AA" cell, which they don't, it would be called an "AAR."

In the case of SR cells, a receiver or transmitter cell is identified by a Series such as 900 Series or 1800 Series. The number indicates the lowest capacity, in mah, you can expect from the cell. These cells are optimized for capacity and charge retention but are generally higher in internal impedance. In a receiver or transmitter cell the first priority is to get the most flying time in the smallest size and lightest weight cell.

The second priority is charge retention. In other words, after taking a pack off of charge, how long will it hold its charge. This is important because, although you should always charge before going flying, there are times when you won't be able to fly until the next day. In these cases, charge retention is very important. Low internal impedance is much less important in receiver and transmitter cells because they aren't called upon to deliver a continuous 30 amps or be charged in less than 15 minutes.

For Electric Flight applications, we have Max and Magnum cells. All Max Series cells have an extremely low internal impedance while Magnum cells have a slightly higher internal impedance, but at the same time a higher capacity for a given size and weight. Max cells should be used in very high current draw applications. Magnum cells should be used in applications where the longest possible motor run times are the pri-

ority rather than being able to deliver 45 amps to the motor.

When it comes to internal impedance and cell capacity, there's no free lunch in nickel cadmium cells. All cell manufacturers are continually trying to come up with designs that will give you the highest capacity at the lowest internal impedance but it is always a compromise. Capacity is a result of plate area. The cell with more plate area has more capacity.

Internal impedance is the result of the internal resistance of the cell. Just as small diameter wire can't carry high current loads and large diameter wire can, thinner plates and smaller internal connections can't carry high current loads and thicker plates and heavier connections can. The problem is, if I make the plates thicker and the connections bigger, they won't fit into a particular size cell. The volume of a particular cell is always the limiting factor. The design problem is always, how can you lower the internal impedance of a cell while increasing its capacity and without increasing the size of the cell. Hey, if it was easy, everyone would want to do it!

I hope I've cleared up some of the confusion you may have had regarding motor and cell designations. At the very least, you'll now be able to catch all of the misnamed cells that appear in the Electric magazine articles. You'll also be able to do some intelligent cell count and prop choice experimenting without blowing up your motor.