ELECTRICKERY

…by Richard Neve

Welcome to the third in a series of articles where I will attempt to pass on some of the things I have learned about flying electrically powered aircraft over the past couple of years.

Last time we covered batteries, speed controllers, motors and chargers. This time, I want to look at the connecting up the powertrain from battery to motor but first, let's talk about tools…

Wattmeter

I suspect that most people don't worry too much about what their i.c. engine is up to under the skin. Perhaps the most we do is check the rpm when using a new prop for the first time, especially in view of our Club requirement to stay under 10,000rpm! Unfortunately, electric flight is a bit different and you simply **must** be able to measure the volts, amps and watts involved. You might be able to get away with it provided you stick rigidly to a manufacturer's recommended set up but sooner or later it will go horribly wrong and the result is likely to be a written off battery or speed controller.

Fortunately, there's only one bit of kit you need and that is an Astro Flight Wattmeter or one of the many copies there are on the market now. As an example, Al's Hobbies do a Whattmeter clone by Jamara which retails at £33 so there's no reason not to get one of these vital measuring tools.

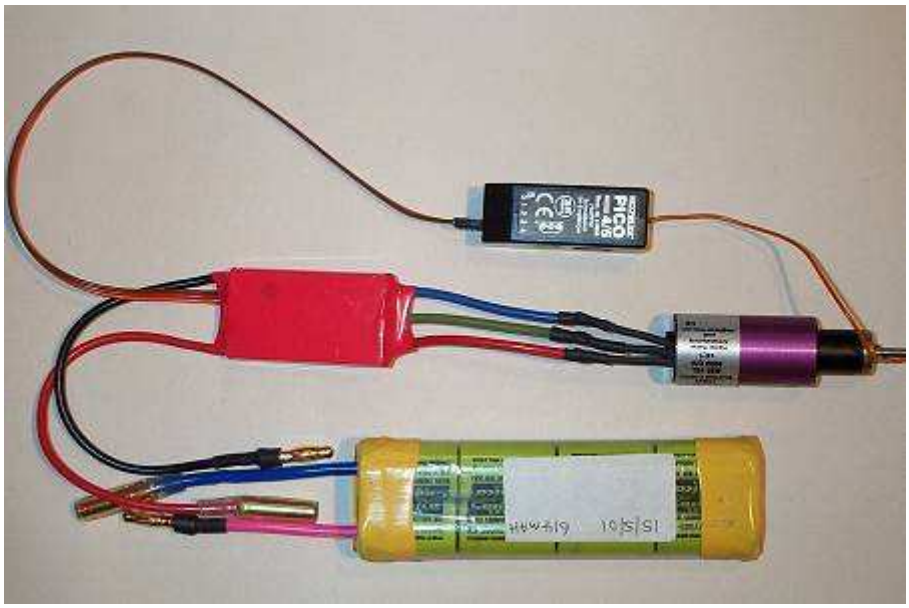
As you can see from the picture, the meter has an input (from the battery) and an output (to the speed controller) and it measures everything we need for electric flight.
The display shows battery voltage, the current being drawn, the power (in watts) and the total capacity drawn from the battery in milliamp hours.

Soldering Iron

At the moment, there is a sad lack of standardisation among manufacturers as regards connectors for the various bits of kit we use. Batteries are typically sold either with Tamiya connectors (see later) or are unterminated and speed controllers are almost always unterminated on the battery side. For this reason, it feels like a large part of my life is spent soldering on new connectors and for this job you will need is a soldering iron of at least 150 watts. The picture shows a typical example from Axminster Power Tools and it retails at around £15. Ordinary electronics soldering irons in the 15 to 35 watt range simply don't have the grunt to ensure a good joint on the typical 4mm connector.

Powertrain

OK, let's look now at the whole electric powertrain. The picture shows an example of a complete setup with battery, speed controller, motor and receiver.



The battery (yellow) is connected to the electronic speed controller or ESC (red) and the ESC is connected to the motor (purple).

The smaller cable running from the ESC to the receiver is the throttle cable and plugs into channel 3 on the receiver as usual.

There is no separate battery for the receiver as the power for this is usually taken from the flight battery via a battery eliminator circuit in the ESC.

You'll notice that in this particular setup, there are the expected two wires, positive and negative, running from the battery to the ESC but there are three wires running from there to the motor. That's because this is a *brushless* motor and they work on slightly different principles to a normal hobby electric motor. The ESC converts the DC supply from the battery into the three phase AC supply needed by a brushless motor. This type of current supply is very common in industrial electric motors and by arranging things this way, it allows the manufacturer to concentrate all the electronics needed to operate the motor in the ESC circuitry. If you ever look inside a typical brushless motor, you'll see it has very few parts – basically just a ring of magnets and a few coils of wire.

Connectors

As I mentioned earlier, there is no standardisation for electric flight connectors so it's down the individual which type they use. These are the main types you may come across:

Deans Connectors

Powerpole Connectors

Tamiya Connectors

Deans or Powerpole connectors are both very effective for currents up to about 50 amps and they are widely used in the USA, indeed kit bought from US suppliers will often have Deans connectors already fitted. These types are good quality and the way they're constructed means you are unlikely to get the polarity the wrong way round but they're not widely available in the UK. The only thing I would say about Tamiya connectors is that if your battery comes fitted with them, cut them off immediately and throw them away!

They're absolutely useless for electric flight as they have a high resistance to current flow and the pins inside them are physically very weak and will break if you so much as look at them! Just one point, when you do cut them off, cut one wire at a time because if you cut both at once, you will short circuit the battery as you cut.

So, what are we left with? Well, the most effective connector I've found is the 4mm round gold plated type.
These are good for currents up to about 80amps (which is a lot!), they give a positive, low resistance connection and most model shops now stock them. Generally they come with heatshrink insulation as shown. There's also a 2mm diameter version which is good for currents up to about 25amps and is physically much smaller and easier to fit into tight fuselage spaces.
Whichever connector type you choose, the important thing is to standardise so that you don't end up down at the field with a battery that doesn't fit the plane you've brought.

Wiring Everything Up

OK, so you collected together a battery and the speed controller and motor recommended on the box for your model, let's connect everything up.
If you've opted to use the 4mm connectors then the first thing to do is decide on which battery lead is going to have the male (plug) half of the connector pair and which is going to have the female (socket). I was always taught that you should insulate the positive wire when dealing with batteries so I've opted to put the exposed male connector on the black, or negative, wire on all my batteries and I remember this by the word "blackmail". Having said that, it doesn't make too much difference and in the picture of the complete drivetrain above, the owner has chosen the opposite convention. It doesn't matter as long as you stick to one or the other and carry it right through the powertrain so that the positive is always insulated or always not. Of course, if you choose the "blackmail" convention, we might be able to share batteries in an emergency – just a thought.
Just one other point, don't forget that the wires from the charger will have the connectors reversed, otherwise you wouldn't be able to plug in the battery!

I said earlier that soldering these connectors takes some grunt from the iron and this is because the connector and the heavy battery wire conduct heat away from the joint remarkably quickly meaning you need plenty of welly (Weller?) to get a good joint. Having soldered your connectors to the battery, the next job is to solder the opposite halves to the speed controller. Take care here because ESCs can be quite delicate and they object to a hefty dose of heat coming down the wire into their circuit boards. The answer is to make the joint quickly and this does take a bit of practice. The other thing you can do is run the joint under the cold tap immediately afterwards but take care not to run water into the battery or controller!

Lastly, we have to connect the ESC to the motor. Depending on your installation, you can opt to solder the controller wires directly to the motor wires as this forms the best possible joint and takes the least space but it does reduce flexibility if you ever need to take out the motor, for example to replace a shaft following an 'arrival'. I think the best way is to use the bullet connectors that are usually provided with the ESC. For some reason, these are almost always 3.5mm diameter – why not 4 or even 3mm I couldn't tell you – and they provide a robust, low loss, connection between the controller and the motor. These must be soldered on with the male half on the motor wire and the female on the controller so that the 'live' wire is always protected with a fully enclosing piece of heatshrink.

Next time
That's it for now but next time, I'll go into more depth on prop / motor / ESC / battery combinations which have worked well in my models, and those which haven't!