

Data logging for electric boats – why bother?

We all enjoy running our boats and increasingly more people are choosing electric boats. They're great fun when they go well, but not so great when components fail, solder melts, the unforgettable smell of a burnt out ESC fills the air, and so on – they're usually very expensive outcomes! Nevertheless, for maximum "fun" the power trains of most electric boats tend to be run near, at, or well beyond, their safe limits, so it's no wonder there can be a few problems.

So data logging might provide a way of avoiding potential pitfalls.

So what might we realistically aim to achieve when considering data logging? May be it is just that you have confidence that your boat is operating within safe limits, so there is little chance of damaging the motor or electronic speed controller, or it is to optimise your boat's performance.

In the simplest case, you'll know someone who has run a particular boat like yours without any issues – so if you copy their set up you'll have a very good starting point. If, however, you want more speed, you will need to proceed step by step to achieve this aim without problems. Unlike petrol engines, electric motors don't provide quite the same feedback. Initially, it's usually a case of running the boat and then checking to see if the motor/ESC/batteries are cool/warm/hot/red hot, etc. But again, you may well find some one who has gone to the next level and you can learn from their experiences without the need for additional instrumentation.

Next, it's a good idea to get an estimate of the safe running time of your set up. LiPos do not like to be flattened completely, about 20-25% capacity left "in the tank" is a good limit to aim for. If you run the boat with a fully charged battery for a fixed time and then either use a battery capacity meter (not great, but better than nothing) or recharge the battery and note how much capacity you need to add to return the battery to full charge. From this you can decide how long to run the boat without reducing the lifetime of the batteries. Additionally, most ESCs can be set to shut the motor down when the battery voltage has reached a set level – somewhere around 3.1 volts, so this is your longstop.

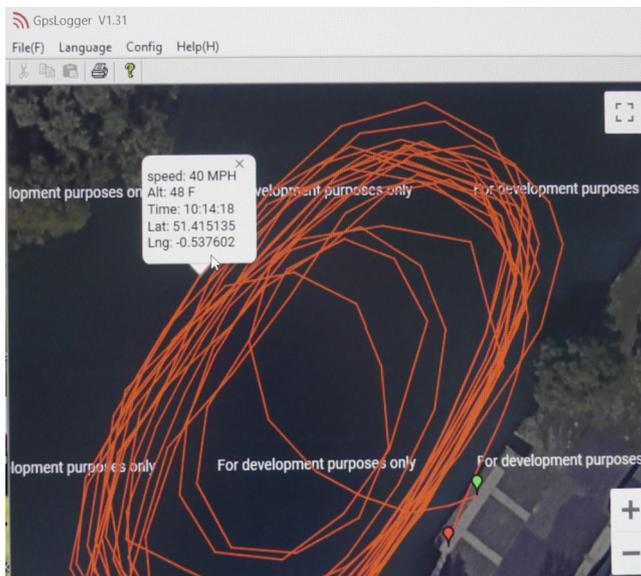
In the case of optimising a set up for racing, the idea is to aim for specific performance levels which are determined by the racing rules. Then modify your driving to get ahead of the field within a fixed time without running out of battery energy! In this case it is a question of being able to measure the effects of changing propeller size, motor kV, motor timing, your driving style, and so on. In practice even a small increase in prop diameter and/or pitch, for example, can have a very significant effect on current draw.

There are two schools of thought on how to collect the data needed to make adjustments to the boat's set up. First, by collecting data from the motor and battery, such as ESC temperature, voltage, current and revs, then storing it on-board and subsequently downloading the data to analyse it after a run. Several ESCs have data-logging capabilities and using one of these is probably the simplest approach, the additional cost is relatively modest. Often a value of maximum current can be obtained immediately from a programming box, with the possibility of more detailed data to be studied at your leisure.

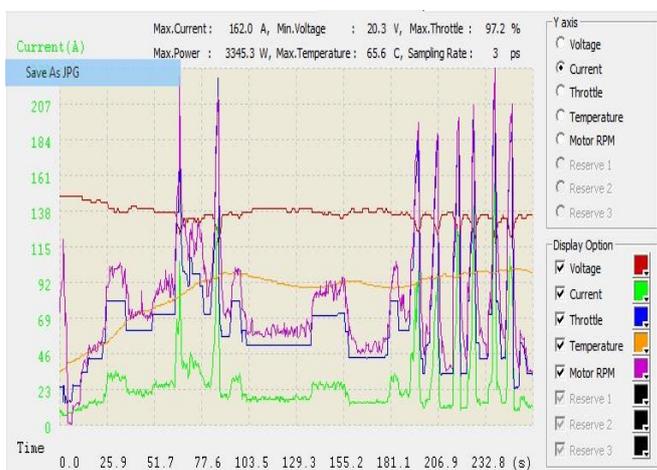
The second approach is more complex, it entails collecting the data from the motor/batteries and sending it back in real time to the transmitter for display and storage. Of course, it is almost impossible to drive a boat and look at the data. However, it is possible to set alarms to indicate when certain thresholds have been crossed, such as the remaining energy in the battery, or flagging up excessive current draw from the battery, etc. Some transmitters even allow an audible indication of the data in real time as well.

As well as monitoring the battery/motor characteristics, it is possible to track speed against the boat's location with a relatively cheap (£70) stand-alone unit. However this does not allow you to compare speed with other parameters in real time, but it can provide very useful data. The data rate is often about 3 data points per second for such units. For some GPS units that just record a maximum speed their data collection rate is often 10 per second. The advantage of the slower data rate is that you can see how the speed varies with location on the lake. The advantage of the units that just record maximum speed indication is that boat speed during periods high acceleration can be recorded, data which would be missed by units with slower data collection rates. Nevertheless, one rogue maximum speed data point could give a false impression of a boat's performance. Such a rogue point would stand out from the points around it when more data is available for study. Of course, the more expensive systems record all data at 10 points per second or more – but are not simple!

Most systems produce data in the form of a spreadsheet – this is easy to scan by eye to highlight any problems and to get a feel for what is happening. As you can see from the figure below looking at each point could be a bit time consuming without a spreadsheet to look at.



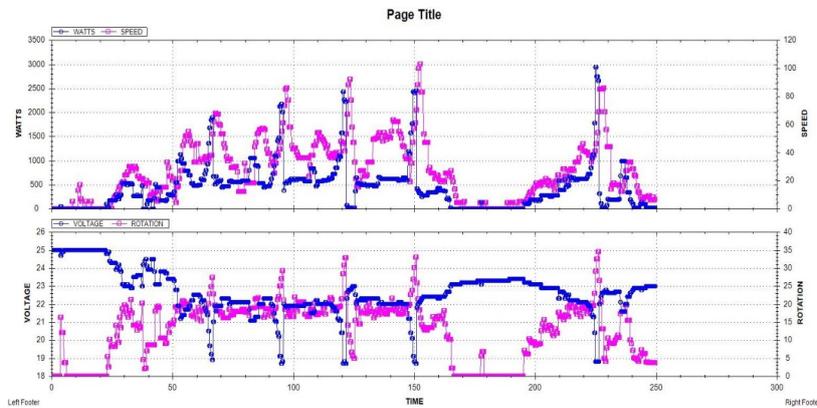
Lots of data can be collected from an ESC with a data logger as you can see from the list on the RHS of the display below and the graphics make the data easy to visualise.



Note that the relatively high temperature of the ESC is probably due to the excessive use of the throttle to achieve high speeds within the confines of the lake. This is a record from one motor in a

catamaran reaching speeds of just below 70 mph, thankfully the motors and ESCs were well matched to within a few percent.

Telemetry data sent to the transmitter and stored on a card usually has to be presented using your own graphics program. With a bespoke system it is possible to log all the parameters including speed at a relatively high (10 points per second) data rate at essentially the same time and graph the data you most want to examine.



So, in my humble opinion data logging is a worthwhile facility – the level to which it is applied is a matter of personal choice – usually based on your experience and the detail you feel is required.

Please let me know if there are any errors in the above.