Around the Circuit
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Let's talk about battery testing and maintenance. Radio control modelers of course depend on rechargeable batteries to deliver power for transmitters, receivers, and electric propulsion, and having good performance and reliability is essential if you want to bring your aircraft home in one piece after a day of flying. I, like most modelers, also don't want to spend money needlessly and tend to use battery packs for as long as possible, sometimes for several years. As we shall see, there's nothing wrong with this practice but you have to be aware of possible pitfalls that may be lurking if choose to go down this path.

Many years ago when I was first starting out in radio control, I got curious about how battery packs behaved as they discharged. I discharged several battery packs using an Expanded Scale Voltmeter, a stopwatch, graph paper, and a pencil. An ESV is simply a voltmeter that applies an electrical load to a battery pack and is a good piece of field equipment to have when you go flying. The key is that the electrical load lightly stresses the battery pack and can quickly pick out a pack that's low on voltage for whatever reasons. Using a standard voltmeter, without an electrical load in the circuit, will read "open circuit" battery voltage and that isn't a good indicator of battery health.

In any case, the pencil-and-paper approach was useful to get a good feel for how a battery pack discharges over time but required constant attention to get any meaningful results. Typically I'd take measures every minute for periods lasting up to an hour, not a very good use of personal time – very tedious and boring!

An improvement over pencil-and-paper techniques are semi-automatic devices that discharge a battery pack with a constant load, stop the discharge when a certain minimum pack voltage is reached, then provide a numerical reading of the integrated battery capacity actually measured – in units of milli-amp hours. The big advantage of this type of device, sometimes called "cyclers", is that they don't have to be monitored continuously and can nonambiguously pick out bad packs which aren't delivering their rated capacities. I've used several devices of this type and really like the Super Test and Super Test Pro produced by my good friend George Joy at Peak Electronics. These testers can discharge battery packs of varying cell counts and over a range of discharge currents and best of all, they run the tests without any manual "care and feeding" required – truly a "set it and forget it" piece of test equipment.

These cyclers are very useful pieces of test gear to help provide insight into the health of battery packs and I use these quite regularly – perhaps not as much as I should but nevertheless, I endeavor to test my battery packs once or twice a year, or whenever I suspect a battery pack isn't performing up to par. There's no question that regular use of cyclers can help spot imminent battery failures before they occur.

I've recently acquired a different type of battery checker, the West Mountain Radio CBA (Computerized Battery Analyzer), that will be the subject of a separate product review that will describe its operational features in detail. For now, I'd like to show you the types of battery behaviors that the CBA can uncover, providing levels of insight that haven't been possible with the other types of measurement techniques described above. Many of us, including myself, have various “mental models” in our heads on how our batteries behave and I’d like to show you some data that may or may not align with how you think batteries actually behave.

The first test case shows a 4 cell 600 mah Futaba Nickel Cadmium battery pack tested with the CBA, Figure 1. The nominal rated voltage is 4.8 volts and the pack is being discharged at a nominal 1C rate of 600 milli-amps. Under these conditions, the measured pack capacity should be close to 600 milli-amp hours to register as a “pass”.
Inspecting **Figure 1**, note first that the battery voltage starts out slightly higher than the nominal 4.8 volts, drops fairly rapidly to a voltage level quite close to 4.8 volts, and then stays flat at that level for quite an extended period. At the very end, the pack voltage dies off moderately slowly as the pack nears depletion, and the test is ended at 3.6 volts by the CBA. The measured battery capacity is approximately 590 mah, pretty close to the 600-mah nominal value!

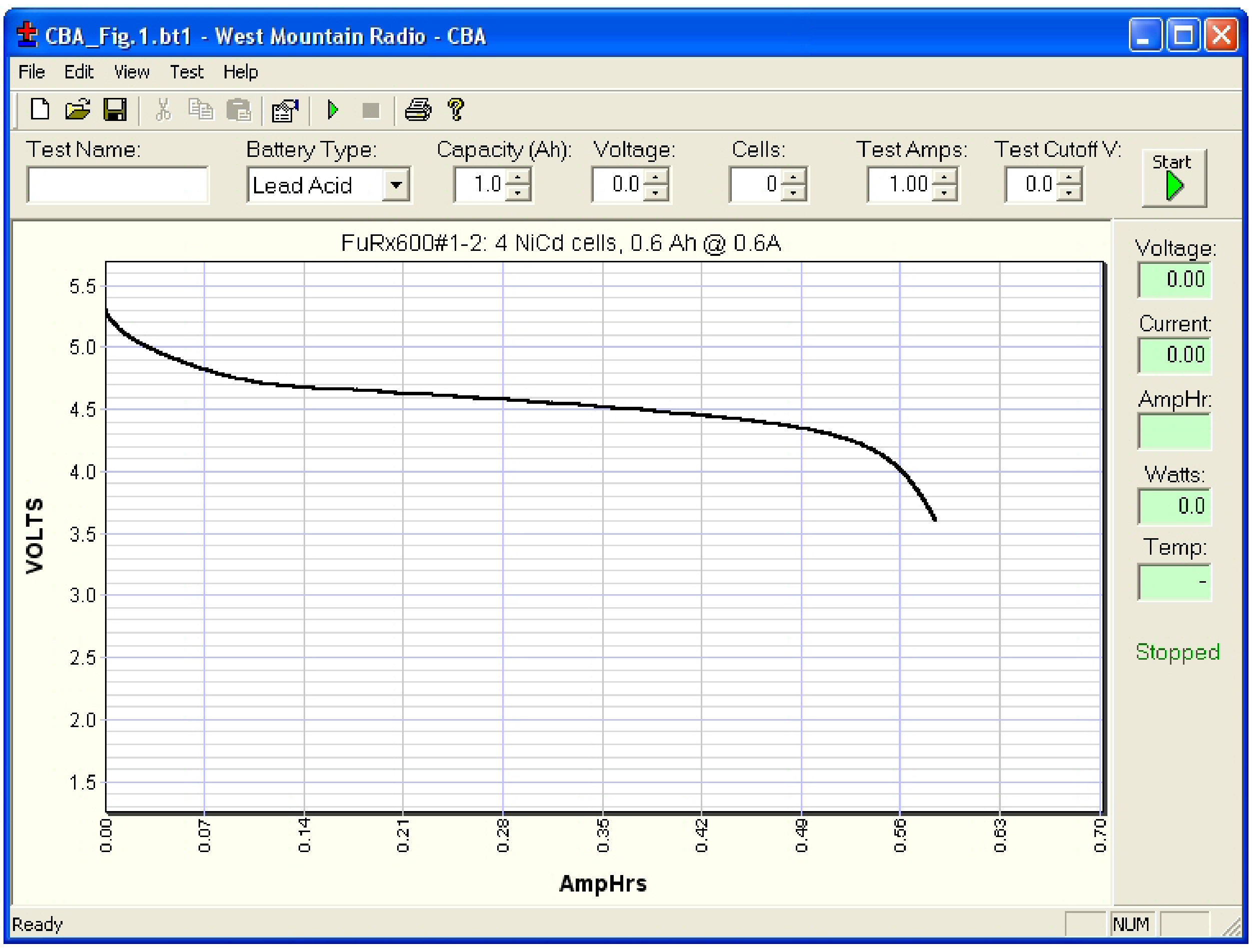

Figure 1

Thus we can characterize this pack as being normal, well-behaved, and good for continued use. Periodic checking will pick out if the battery is degrading at some future time but for now, this pack appears to be a good one. I believe you’ll agree that this behavior is what most of us would expect to see for a nominally behaving battery pack.

The second test case, **Figure 2**, depicts two Nickel Metal Hydride packs that I’ve been using for about two years. These are 4 cell units rated at 4.8 volts and 1000 mah apiece and were assembled at the same time. Note the same general discharge shape as in the first test case but first observe the curve that’s slightly higher than the other. This pack’s test stopped at approximately 930 mah, pretty close to 1000 mah and not too bad considering the age of the pack. But look at its sibling pack! Its capacity is only 670 mah, which is very troubling. This means that I'm carrying the weight of a 1000 mah pack but getting only 2/3 of the capacity that I'm expecting! This second pack is significantly down on capacity and as it is distinctly "out of family" and thus indicating degradation, this pack was unceremoniously discarded after these tests. Note also that the voltage traces for the two packs are fairly similar and both packs would have passed an ESV field check, at least checks performed before the battery voltages "rolled off".

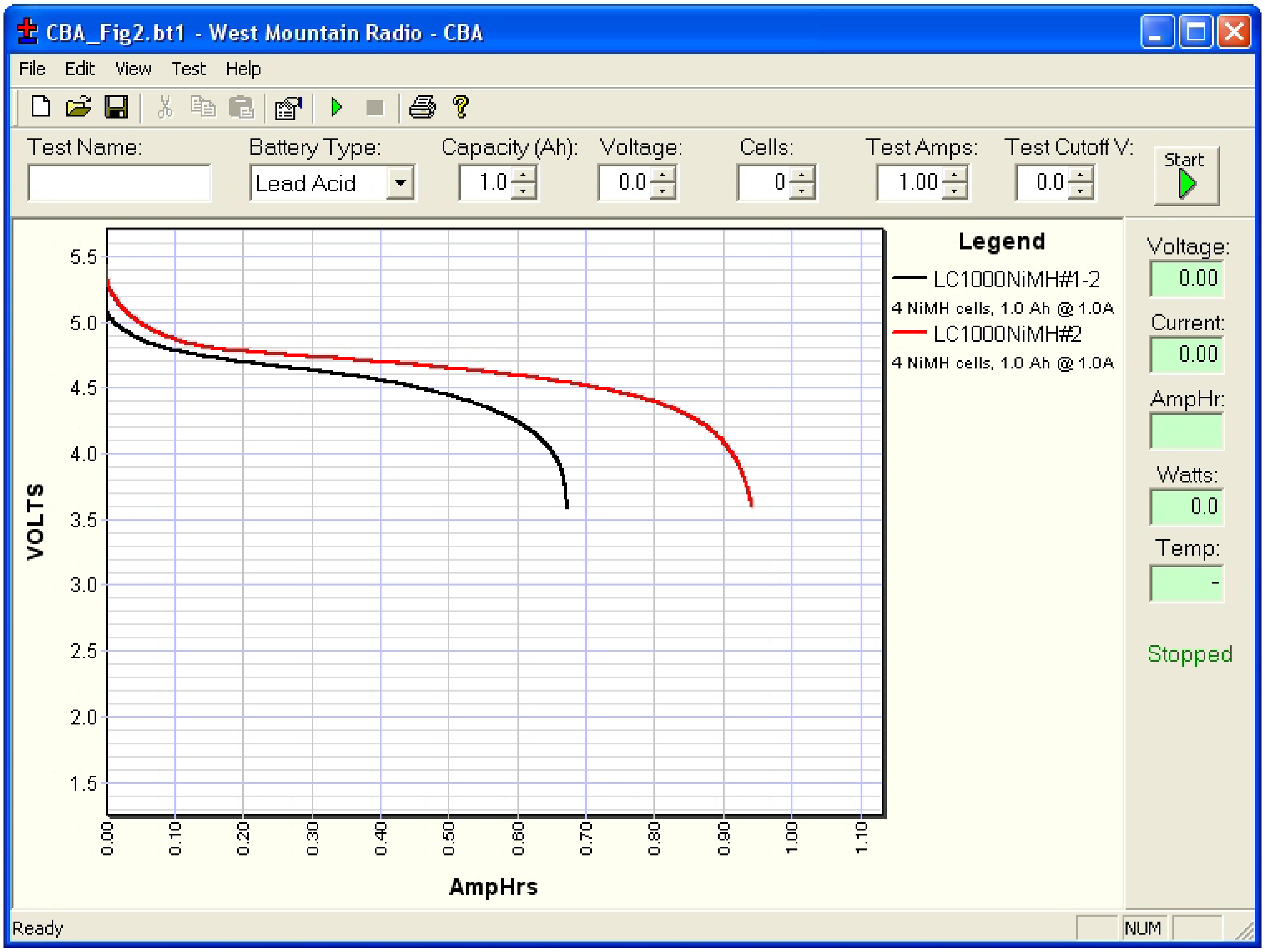

Figure 2

The third test case, **Figure 3**, involves a transmitter battery pack approximately 4 years old. This is an 8 cell Nickel Cadmium pack rated at a nominal 9.6 volts. Now this is an entirely different animal than discussed previously! Note that the battery voltage starts out and plateaus normally, then abruptly dies at the 350 mah point. This behavior points to one or more of the eight cells being bad and a condition that would not have been picked up by an ESV field test at the beginning of a flight session. In use, there would be almost no warning that the pack voltage was about to drop, compared to the much more shallow discharge of a well-behaved pack as depicted in the first test case. If an airplane was being flown when this discharge state was reached, the plane would probably crash due to the sudden drop in signal strength!

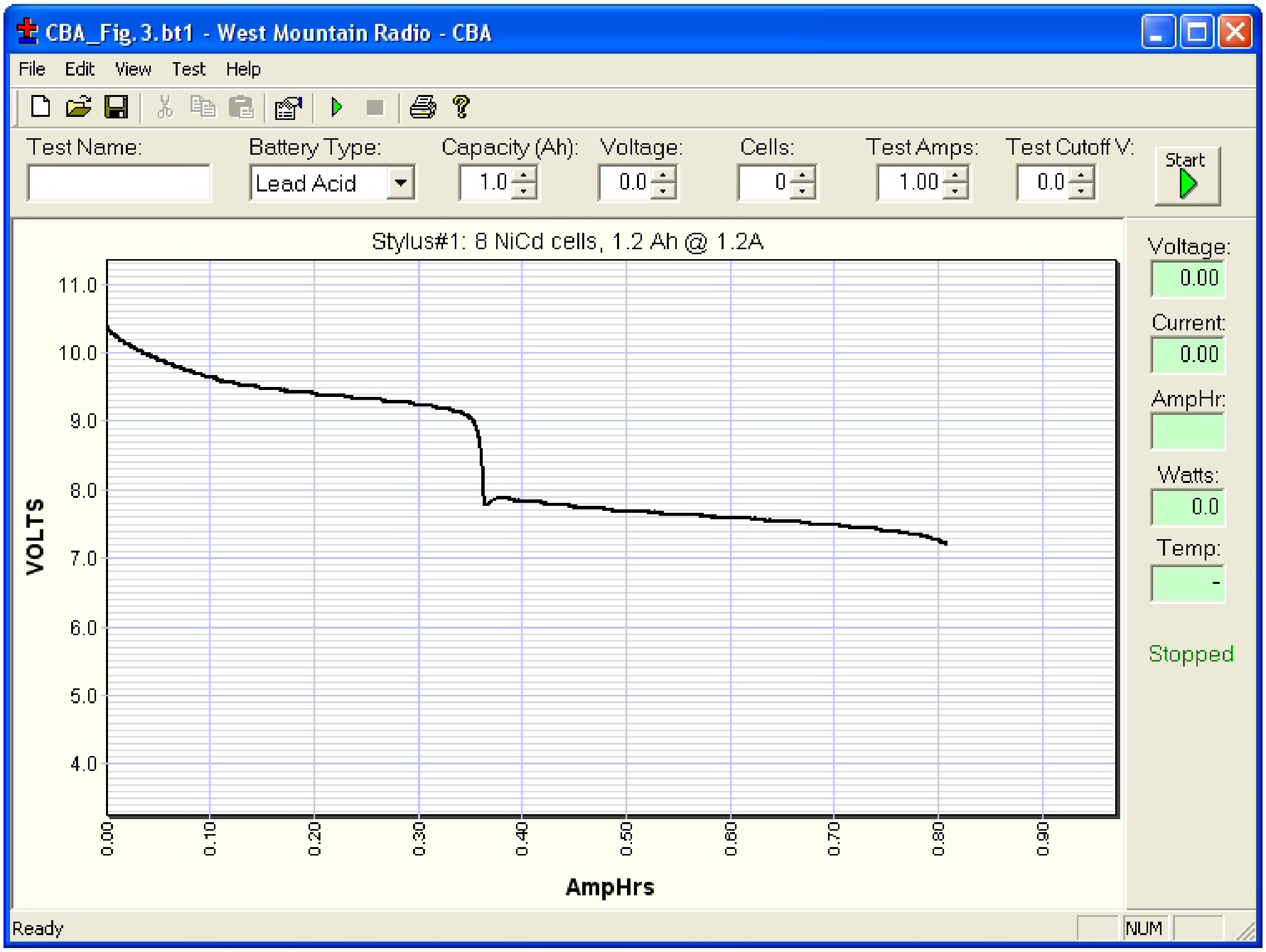

Figure 3

A real cheapskate (like the Editor) would be tempted to isolate and replace the bad cell(s) but on further reflection, this isn't a very good idea! First, all the other cells in the pack are equally old and may be ready to die off at any time. Second, the replacement cells would probably be newer vintage cells and wouldn't have the same charge and discharge characteristics as its brethren cells - their use would lead to significant battery cell stresses during normal charge and discharge use.

The fourth test case, **Figure 4**, shows what I measured with a brand new battery receiver pack straight from a vendor. This is a 5 cell Nickel Metal Hydride pack rated at 1300 mah. I first gave the pack an overnight charge and upon its first discharge, the pack died at approximately 250 mah! Ouch!

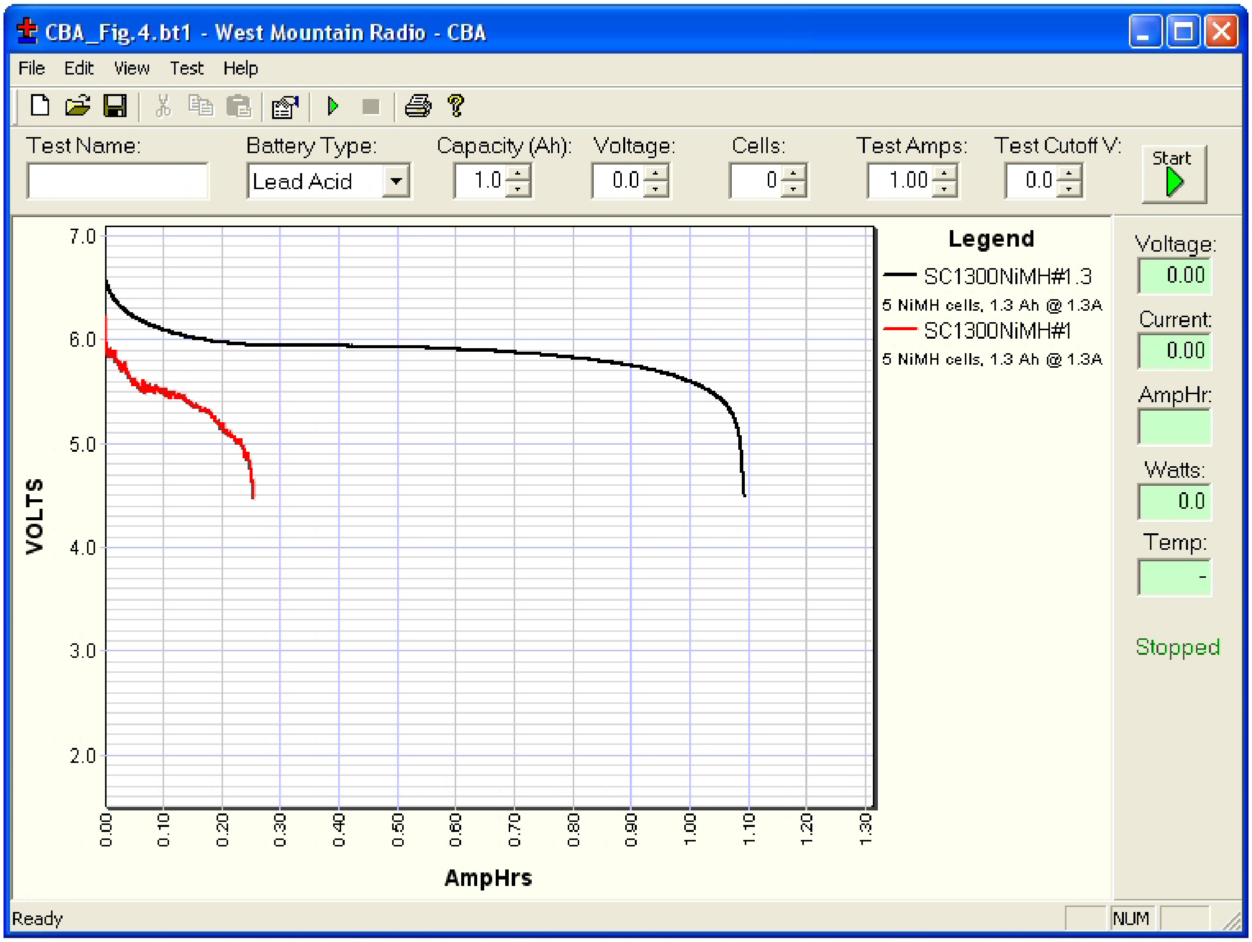

Figure 4

However this first low reading isn't necessarily the sign of a bad pack. New battery packs need to be cycled several times to achieve full capacity and the succeeding discharge cycles are shown in figure 5. Note that the follow-up curves are almost perfect overlays of each other so I'm confident that the first discharge cycle was simply the signature of a new uncycled pack. What do you think could have happened, though, if this pack had been used for flights after that first initial overnight charge? Answer: a crash would probably occur if the pack had died while the plane was flying, and the flyer would have thought, "New pack, overnight charge, what could have been the problem?"

Purchasing new battery packs can be quite expensive if you buy from retail sources but there are alternatives. I've bought transmitter and receiver battery packs from Cermark in California with excellent results. Their website is www.cermark.com, their service is fast and reliable and their prices are very reasonable. When you think about it, the cost of replacement batteries is not that great and is far exceeded by the value of the aircraft that you're flying! So the moral of this story is – test your batteries using ESVs, cyclers, or a battery analyzer, and know the condition of the batteries you're using, especially the older ones!

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