Review: The West Mountain Radio CBA-IV Battery Analyzer
Phil Salas – AD5X

Figure 1: West Mountain Radio CBA-IV Battery Analyzer

Introduction

There has been more emphasis on battery power of late, particularly for those of us interested in portable operation. And while it is easy to find the amp-hour battery specifications, it is not always clear as to what this means when it comes to the true battery operating time you can expect, as well as the overall health of your battery. The West Mountain Radio CBA-IV battery analyzer can answer these questions.

CBA-IV Description

The CBA-IV battery analyzer consists of a 3" x 3" x 3.5" software-controlled constant current load box with an integral heat-sink and fan. It is powered by your computer via the included USB cable, and PowerPole™ connectors provide the battery interface. The software permits testing and analyzing most batteries up to 55 volts, regardless of chemistry. Battery voltage versus time is measured under a continuous load of up to 100 watts, and up to a 150 watt load for short periods of time. The CBA-IV software automatically senses the battery cell count, provides a safety check of the proposed test rate, and recommends a minimum safe discharge voltage. The data is graphically displayed in amp-hours, watt-hours or minutes. And you can overlay multiple battery graphs for comparison. Finally, there is a "calibrate current" adjustment for improved accuracy at very low discharge rates or critical applications, and a means to compensate for test lead resistance for maximum accuracy.

Determining Battery Test Requirements

My main interest is portable battery operation of my Elecraft KX3 transceiver. So to begin, I made some KX3 current measurements at 5- and 10-watts transmit power. The typical measured currents were as follows:

Receive (backlight on):	210ma
Receive (backlight off):	170ma
Transmit, key-up (5W/10W semi break-in):	540ma
Transmit, key-up (5W/10W full break-in):	Same as receive current
Transmit, key-down @10W:	2200ma
Transmit, key-down @ 5W:	1230ma

When operating portable, I turn on my radio with the specific purpose of making QSOs. So my portable operation is approximately 50% listening and 50% QSOs, which is a much higher duty cycle than my typical non-contest home operation. During a QSO I assume 50% receiving and 50% transmitting times. Finally, the CW duty cycle using the standard PARIS format is 44% (key-down 44% of the time, key-up 66% during the transmission). So for 50% listening, backlight on, and 50% QSOs at 5- and 10-watts transmit power:

Listening: 0.50(0.21) = 0.105A

QSO

- Receive: 0.25(0.21) = 0.053A
- Transmit 5W semi break-in: 0.25(0.44x1.23 + 0.66x0.54) = 0.224A
- Transmit 5W full break-in: 0.25(0.44x1.23 + 0.66x0.21) = 0.170A
- Transmit 10W semi break-in: 0.25(0.44x2.2 + 0.66x0.54) = 0.331A
- Transmit 10W full break-in: 0.25(0.44x2.2 + 0.66x0.21) = 0.277A

For determining battery requirements with back-light on and semi break-in operation, the average current is 382ma at 5-watts, going to 489ma at 10-watts. I rounded these to 400ma and 500ma, respectively so as to provide some operating margin. Note that you can save about 80ma if you keep the backlight off and operate full break-in.

The batteries I had available to test were the following (see Figure 2):

Table 1: Batteries Analyzed

Chemistry/Make	#cells/Amp-Hr	Nominal V	Discharged V	Charged V
Alkaline/Utilitech*	10 AA cells/?AH	15V	10V	16V (new)
NiMH/Tenergy	10 AA cells/2.6AH	12V	10V	13.5V
Lead Acid/Power Kingdom	6 cell/7AH	12.6V	10.5V	13.8V
LiPo/Sanyo	4S2P/5.2AH	14.8V	12V	16.8V

*Generic batteries sold at local super-hardware store. No amp-hour rating is specified.

Figure 2: Batteries evaluated

The lead-acid and LiPo batteries were tested at 500ma (10-watts transmit power) as these batteries easily source the required 2.2-amps required. The AA Alkaline and NiMH batteries were tested at 400ma (5-watts transmit power) as these have a lower amp-hour rating than the lead-acid and LiPo batteries, and there is considerable voltage drop at the 10-watt 2.2 amp current drain due to the 10-cell AA holder steel spring contacts.

<u>Using the CBA-IV</u>

The software is enclosed in a supplied CD, although it doesn't hurt to check the West Mountain Radio web site for the latest software. Software installation is trivial, involving just a few prompted mouse clicks. Once the software is installed, you may need to install the appropriate driver (also included on the CD). However driver installation occurred automatically when I connected the CBA-IV to both my Windows 7 and Windows 8 computers.

I first evaluated the lead-acid and LiPo batteries. My lead-acid battery has been heavily used over the last 5-years, and I've suspected that it is far from meeting its 7AH rating. The LiPo battery is new, and is planned for my future portable use as it is very light for its capacity. Figure 3 shows the set-up menu for the lead-acid battery. While most of the test information is auto-sensed and suggested, I did set the actual battery amp-hour and test current discharge rates for my specific batteries and application. Once you press "Start", the CBA-IV software will check the battery and begin the test.

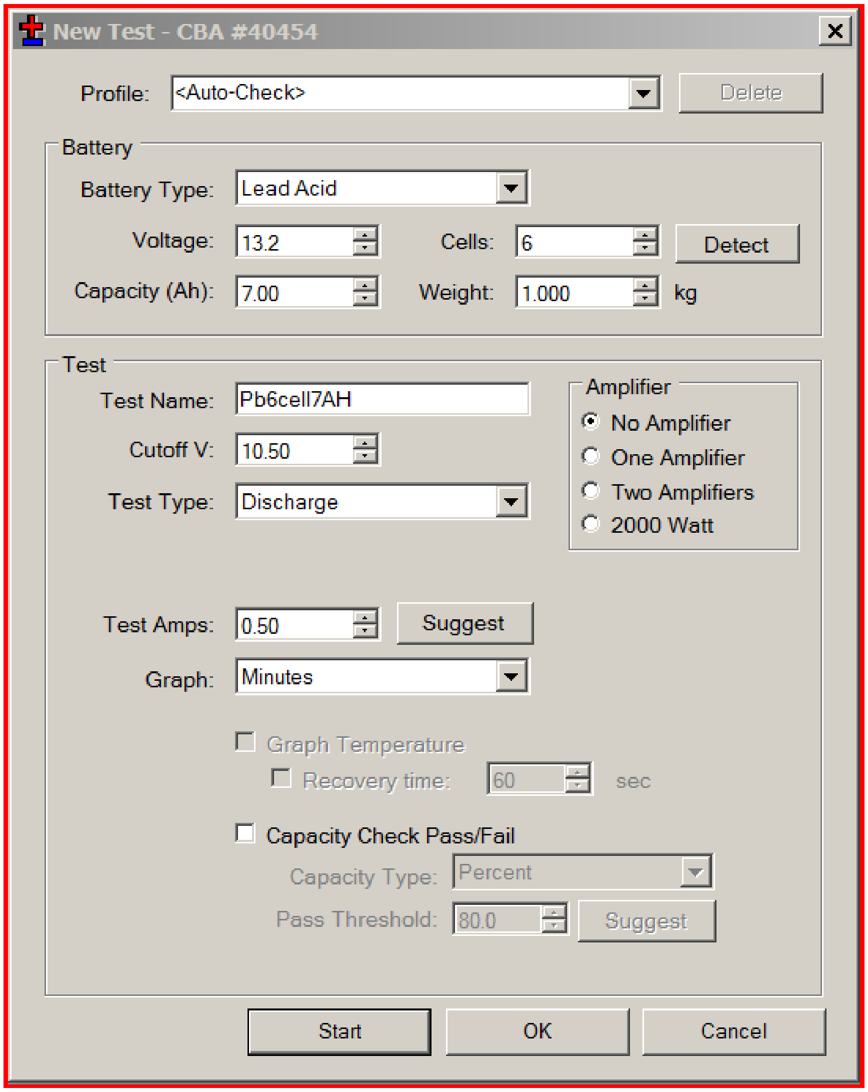

Figure 3: Lead-acid battery start-up screen

When the lead-acid test was complete, I started the LiPo test. I elected to append the two graphs together since both batteries could be used in a 10-watt application. As I suspected, the lead-acid battery should be retired as it only measured 3.6 amp-hours of capacity. The LiPo battery is new, and delivers 5.11 amp-hours of capacity – nearly identical to its 5.2 amp-hour specification. Figure 4 shows the results plotted versus minutes at the 500ma average current. It is easy to change the graph to display amp-hours if desired.

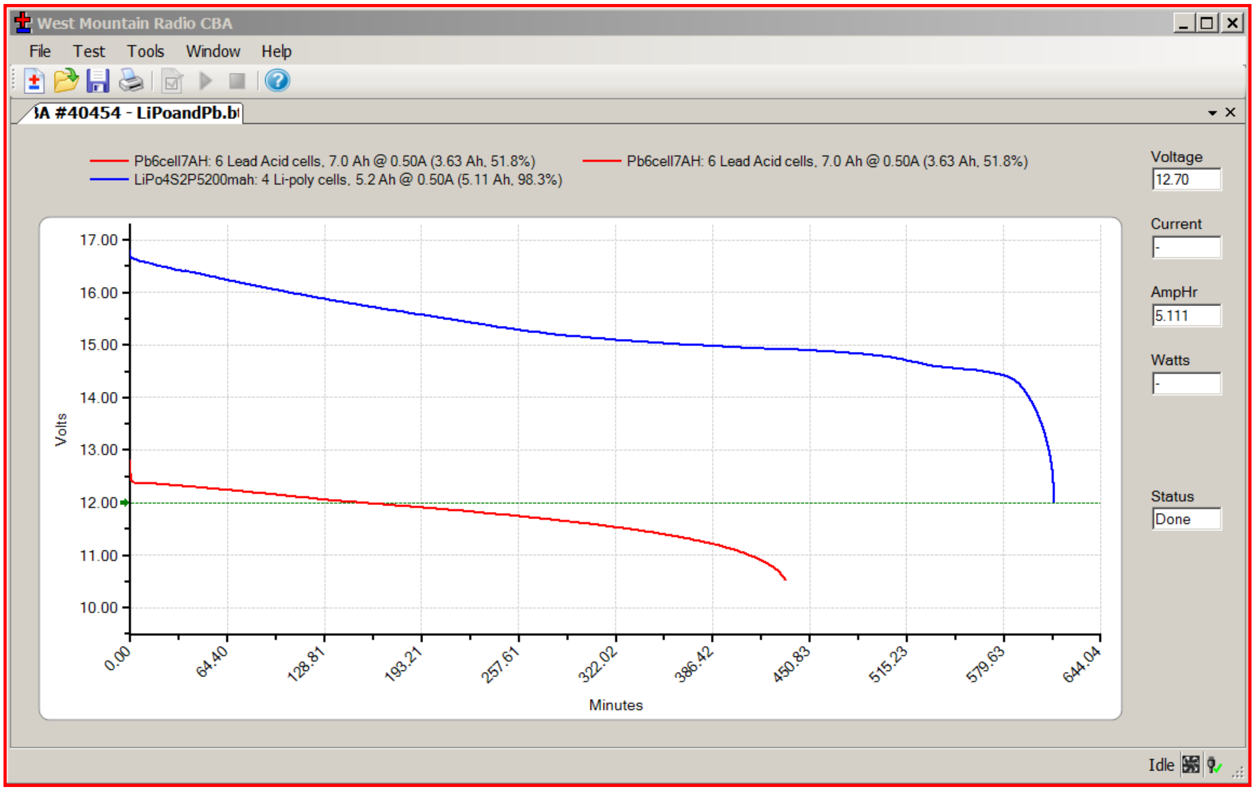

Figure 4: LiPo & Lead-acid Battery Testing showing minutes of use at 500ma average current

Next I measured the NiMH and Alkaline AA batteries. I've always been interested in the capacity of generic alkaline batteries as these can be purchased anywhere. Figure 5 shows the results. As you can see, while the NiMH batteries don't quite meet their 2.6 amp-hour specification, they still have twice the capacity of the alkaline batteries, as well as hold a more constant voltage over most of the discharge time.

Figure 5: NiMH and Alkaline battery test resultsat 400ma average current

<u>Some Options</u>

While the basic CBA-IV is more than adequate for most ham applications, there are several options available that extend the CBA-IV for industrial applications:

- Optional amplifiers permit testing in 500 watt load increments up to 2000 watts.
- Optional external temperature probe permits automatic over-temperature test termination.
- Optional CBA Charger interfaces the CBA-IV with a user-provided battery charger to automatically switch between charge and discharge cycles for battery lifetime testing.
- Optional Extended Software license adds duty cycle, constant power, multiple discharge and constant resistance test capability, and adds the ability to graph the battery temperature when the optional temp probe is connected.

<u>Conclusion</u>

The West Mountain Radio CBA-IV is a sophisticated, yet relatively inexpensive battery analyzer that is at home for both amateur and commercial battery evaluation. If you really want to know what your batteries are capable of, and where they are in their lifetime, the CBA-IV is worth considering.

Manufacturer: West Mountain Radio, www.westmountainradio.com.
List Price: $159.95

Bottom Line: The West Mountain Radio CBA-IV is a useful piece of test equipment that permits detailed battery analysis for anyone interested in portable or battery back-up applications.

Sidebar/Addendum - LiPo Battery 4S Voltage reducer

Lithium batteries have an excellent capacity-to-weight ratio, so they are great for portable ham radio operation. But there is a problem. A LiPo 3-cell battery (3S) has a nominal voltage of 10.8VDC, and a fully charged voltage of 12.6V. A LiPo 4-cell battery (4S) has a nominal voltage of 14.4VDC, and a fully charged voltage of 16.8VDC. So a 3-cell battery is nominally under-voltage for many transceivers. The 4-cell battery is much more suitable for 12V transceivers, but the fully charged voltage of 16.8VDC exceeds the maximum input permitted by many transceivers. For example, my Elecraft KX3 has a maximum input voltage specification of +15VDC.

A simple way to reduce voltage is to put power diodes in series with the battery. A 1N5401 diode has typically a 1V forward drop, so two diodes will have a 2VDC drop. Figure 6 shows the simple schematic. The 10K resistor and LED shows that the assembly is connected to the battery, and is connected in the right direction, The 3000mcd or higher ultra-bright LED is easily seen in daylight even with just 1.5ma forward current (I used a Mouser 604-WP710A10SEC/J3)

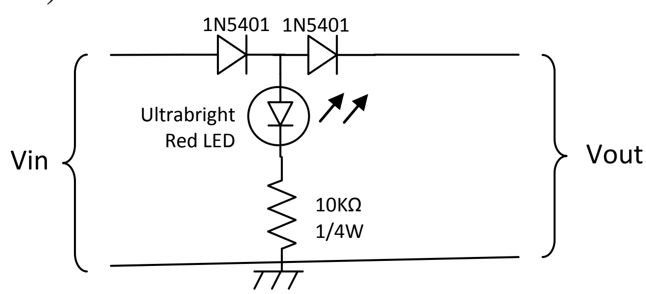

Figure 6: LiPo 4S Voltage Reducer

The reducer is built between two sets of PowerPole™ connectors making it easy to insert between my battery and KX3, and easy to remove as the battery discharges. Figure 7 shows the physical wiring. The full 1N5401 lead lengths provide the correct spacing for the assembly.

Figure 7: Physical wiring

I put some hot glue over the LED/diode/resistor assembly to fix everything in place, and then used silicon self-fusing tape to cover the wiring. I used black tape for the input (battery side), and red tape for the output (radio side), though if you connect the reducer backwards no current will be drawn by the radio and the LED will not light.. See Figure 8.

Figure 8: Completed reducer assembly. Battery connects to right side, and radio to left side.

Finally I made some voltage measurements with my KX3 connected to a fully charged 4S2P LiPo battery with the voltage reducer in-line. The voltage was monitored by the KX3 internal voltmeter. The results were as follows:

LiPo Battery Voltage	Reducer/Rcv	Reducer/TX key-up	Reducer/TX key-down (10W)
16.8VDC	14.9VDC	14.6VDC	14.1VDC

When the KX3 internal voltmeter indicates a voltage of 13VDC or less, just unplug the voltage reducer and keep operating at full power until the 4S LiPo battery reaches the discharged voltage level of 12VDC.

Remember that the reducer draws some current (1.5ma max), so don’t leave it connected to the battery when it is not being used. I normally leave the reducer connected to my KX3 power cable for storage and transport.