

# Computerized Battery Analyzer Software Version 2.1

## Introduction

The CBA is much more than a simple battery voltage tester or a battery load tester. Unlike a simple load tester the CBA will test virtually any type or size of battery, any chemistry or number of cells, up to 55 volts. For the first time and for a reasonable price, anyone can do scientific tests of their batteries.

By itself the CBA is capable of much higher test rates than most other testers; up to 40 amps or 150 watts, whichever is higher. With an optional amplifier tests can be done at 500 watts, and with two amplifiers 1000 watts.

The CBA not only tests the total amount of energy stored in a battery (capacity in amp-hrs) but it graphically displays and charts the voltage versus time using a constant current load. Graphs may be displayed, saved and printed. Multiple test graphs of the same battery, or multiple batteries, may be compared or overlaid; a very useful feature. The battery test data can be printed on a color or black and white printer. You may also print convenient test labels to put directly on your batteries. The optional external temperature probe provides automatic over temperature test cutoff.

It is ruggedly built and supplied with 13-gauge high-grade wire and Powerpole connectors for the battery connection. It is small with a high performance cooling system and quiet fan. It is provided with LED indicators, visible from across a room, display communication and test status.

The CBA II uses an 8051 based microcontroller to measure voltage, current and temperature with high accuracy. Each CBA is individually calibrated with a computerized automated test system. It has 12 bit effective resolution in three auto-switched voltage ranges. The current is set with 12 bit resolution below three amps and it is measured with 12 bit effective resolution above three Amps.

The electronic load uses two PWM-controlled power MOS FETs with electronic current regulation and software feedback control. The microcontroller provides an integrated plug-and-play USB interface to the computer. There is an arcing connection protection circuit to protect the CBA FET's from over current with a loose connection to a battery.

The software supplied with the CBA, is easy to use and intuitive. It provides automatic sensing of the battery cell count, a safety check of the test rate, and recommends a minimum safe discharge voltage. It is designed to protect both the CBA and the batteries that you are testing. There are user editable and recallable battery test profiles. Capacity discharge tests may be viewed in Amp Hours, Watt Hours or minutes. There is a charge monitor test to chart and record the voltage rise during a charge. There is a lab calibrate

current adjustment to improve the accuracy for testing at very low discharge rates, or for critical applications.

An optional Pro version upgrade for the software provides all the features of the standard version and adds different types of tests; duty cycle, and constant power. The different graph types are Amp hours, Watt hours, Minutes and Ragone (adding weight as a variable). The Pro version also adds the ability to graph the battery temperature (when the optional temp probe is connected). Lab calibration is possible to compensate for test lead resistance, giving accurate readings at the battery terminals.

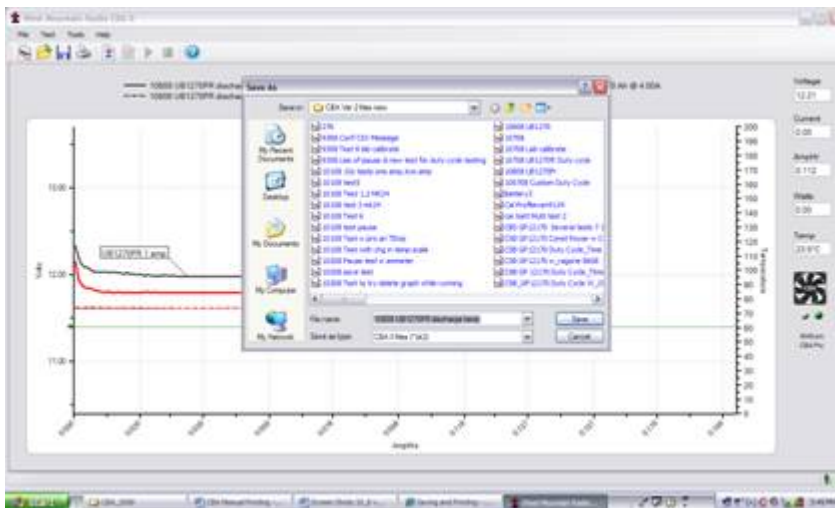
The Pro version is supplied with a CBA Amplifier and provides provision for operation with one or two amplifiers for testing at high discharge rates or doing destructive testing.

We hope that you enjoy using the CBA and find it useful. You will learn valuable information about the batteries that you test.

## Save & Printing

### Saving:

After completing a battery test, you should have saved it in your computer. Go to the “File” menu and select “Save” or click on the icon that looks like a floppy disk. The name in the “Test Name” box will be suggested as the default name, or you may edit and pick a different file name. It is important that you choose a name that identifies what test, or tests are contained in the saved file. **Tip: Changing the file name will not change the test name of the graphs on the screen.**

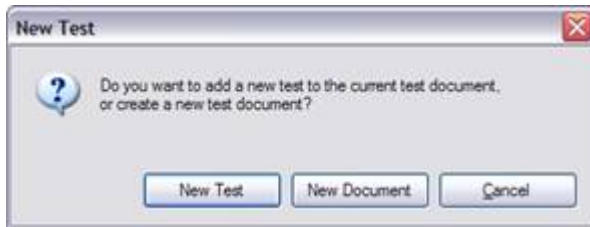


The first time you save a file you will get a window requesting confirmation of the file name and directory.

Subsequent saves (file save or click the floppy disc symbol) will save the file, but will not ask again for file name or directory

If you attempt to close the program, or the test that is on the screen you will be asked if you would like to save that test, or tests, to a file.

If you attempt to start another test with a test on the screen the program will give you the following choices:



Selecting "New Test" will overlay a new test over currently displayed graph.

Selecting "New Document" gives you a new test and graph, no overlay

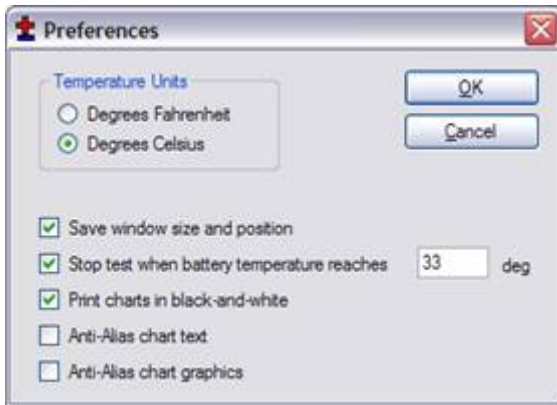
If you choose, "new test", you will later be able to save the tests on the screen as one file with all the individually named tests in it. You will have the option of choosing an appropriate file name whenever you save it.

**NOTE: If you wish to save multiple tests in the same file they MUST be of the same "Test Type" (Discharge, Constant Power). If you attempt to overlay a new test the test type will be grayed out.**

Tip: If you open a previously saved file, with previous test/tests on it, you may add more tests to it. With the "File", "Overlay" menu choice you may open additional test files and those graphs will automatically be overlaid over the test graphs that are already on the screen. If you try and save an over-lay screen with multiple test files on it you will be asked if you if you would like to overwrite (erase) the last file opened and replace it. Be careful to choose what you would like.

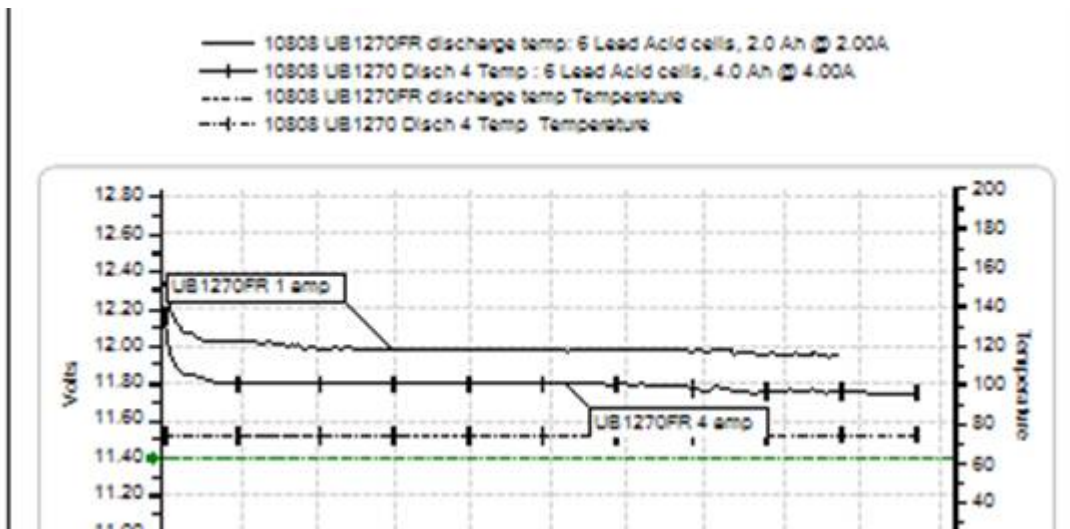
### **Printing Test Graphs:**

Since the CBA is able to save a file with multiple overlaid graphs we have provided the option to print in either color or black and white. For B&W printing we provide unique tick marks on each graph to identify each graph trace with a corresponding legend key. For color printing each graph has its own color. You must select B&W if you wish to print on a black and white printer. Go to "Tools" and then "Preferences" and select B&W if you would like each graph plot uniquely identified with a B&W legend keys. After selecting color or B&W go to the "File" menu and select "Print Setup" and then the printer that you would like to use. While you are there you would normally select portrait mode for the print out.

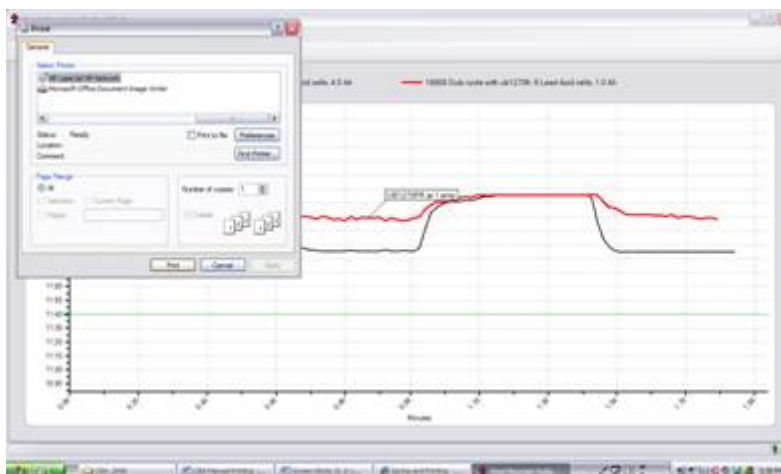


To select black and white printing select “Tools”, “Preferences” and then select “print charts in black and white”.

See print preview below to see an example of the tick marks (different marks identify different graphs)



Go to the “File” menu and select “Print”. You may select the number of copies you would like and you will be given another opportunity to select the printer.



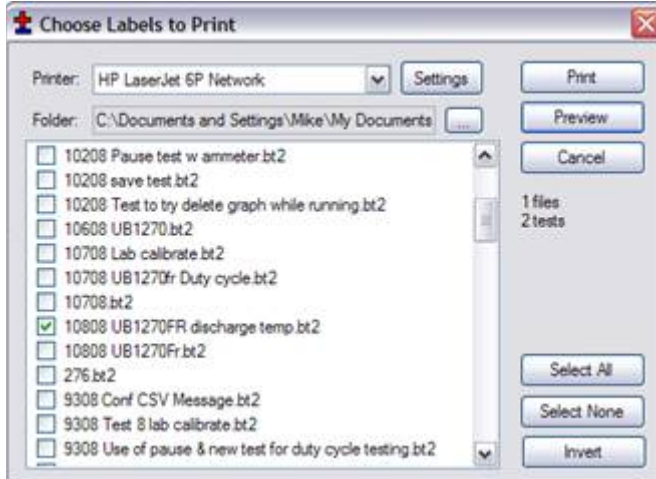
If you wish you may go to “File”, “Print Preview” window to see how it will look before printing. If it is OK, press “Print” at the top of the preview window. If it is not OK, close that window and go back to correct your printer setup.

## Printing Battery Labels:

A convenient way to save test information is right on the battery, so we have given you a label printing utility that prints labels to place directly on the battery that was tested. In order to print labels for the batteries you have tested, select print labels from the file menu and have Avery 5160 standard address labels loaded in your printer.



Select the file names from the directory list with the tests that you need labels for, or use the “Select All” button for all files and tests.



At this point you can check print preview to see what labels you will get. The program will print a label for each test in each file no matter how many each file contains.

Tip: You are selecting file names. Files may have multiple tests in them and one label will be printed for each test in the selected files.

Tip: You may turn a partial sheet around in your printer if you are printing a few labels and wish to use up a partial sheet.

# Computer System Requirements

## Basic Requirements:

A PC with a Pentium 233 or better  
At least an 800 X 600 graphics card and display monitor  
Windows 98SE, ME, NT, 2000, XP, Vista 32 or 64 bit  
An available USB port.

## Recommended:

AMD or Pentium, 1.2 GHz better.  
Better than 800 X 600 graphics card and display monitor.  
Windows XP, Vista 32 or 64bit  
1 GB or more RAM  
An available USB port.

## For graph and label printing:

Any Windows compatible, laser or ink jet, color or black and white, printer.  
Avery 5160 labels are required for label printing.

# Temperature Probe

Plug the probe's two-pin connector in to the right hand two pins (closest to the LEDs) of the three available pins in the cover slot. It does NOT make any difference which way it goes in as long as it is plugged in to the far right two pins. The extra pins are for future options. If you are using this software with a CBAII Do NOT remove the blue jumper, a CBAlII does not have this jumper.

Let the probe sit in a location away from any heat source for enough time to allow it to acclimate to room temperature. Have a good thermometer near by, if you wish, for more accurate calibration. If you do not have a good thermometer handy set it to any room temperature reference. For laboratory quality measurements you may wish to calibrate it near the temperature of interest by submersing the probe in hot water near 140 deg F and immerse a high accuracy thermometer in the water with the CBA probe.

With a temperature probe connected to the CBA, go to "Tools", "Lab Calibrate", "Calibrate Temperature Probe" and enter in either deg C, or F, your reference temperature reading and then click OK to save that calibration. Note: As long as you do not change to a different CBA or temperature probe you should not have to calibrate the probe again.

To use the probe, attach it in close physical contact with the center of the battery, or battery pack that you are testing. Hold it in place with the probe's magnet (most round cells are magnetic), or with tape or a rubber band (for better contact and more accurate readings thermal compound may be used). Be certain it stays in close contact with the battery during your test. The CBA temperature readings are quite accurate over the range that a battery may be operated at, however the readings will be incorrect if the probe is not in close contact with the battery or there is air moving over it. Unlike an instant response IR thermometer other types of thermometers take a considerable amount of time to display their temperature reading. There is a noticeable thermal lag with our thermistor type probe.

The CBA may be set for automatic over temperature cutoff. Place the probe on the battery. Go to "Tools"/ "Preferences" and check the check box next to "Stop test when battery reaches ? deg". Fill in a temperature appropriate for your battery (60 deg C or less should be safe for most batteries).

### **Temperature Graphing (Pro version license only)**

If you have purchased the pro upgrade to the software you will have the option of graphing temperature along with the voltage in both a discharge test or charge monitor mode. Simply click the "Graph Temperature" radio button when setting up a test. If you are doing a standard discharge you will also have a "Recovery Time" check box and time box. Recovery time allows you to continue a test for a given length of time after the discharge is complete to see any overshoot in the temperature rise. Note: if you are doing a duty cycle test temperature graphing is not available.

**WARNING: DO NOT** continue a test if the "Temp:" indication reaches or exceeds the maximum temperature specification for the battery being tested.

## **Advanced Pro Feature**

This section covers the advanced features available only with the Pro Version of the software. These features will be grayed out unless you have purchased the downloadable update and have registered your license by entering your name, CBA serial # and license key.

To purchase a Pro license follow the instructions on our web page. You will be sent a validation key code by email for your name and CBA serial number.

After receiving the information enter it precisely, as the slightest error in typing (case sensitive) will not be accepted by the software. Start the program and go to "Tools", "Register CBA units..."; click the "Add" button on the window that pops up and enter your registration information to upgrade your license to Pro operation.



Enter the information exactly as shown in the email we sent for “Licensee:”, “CBA serial #:” and the “License Key:”. A “CBA Name:” is optional but is needed if you plan to purchase a Multi CBA version license in the future. If you are a commercial user and expect to need multiple CBAs running on one computer close a name to identify this one of multiple CBAs you might have now or in the future.

After registering your Pro license, close the program and restart it.

You will now see that you have a Pro license as it will say “(CBA Pro)” on the “New Test” screen along with the CBA name you may or may not have chosen.



You will also notice the same information under the virtual fan and LEDs on the right hand side of the program window.

The PRO version includes all the features included with the standard version and adds two new test types, a programmable duty cycle test, and a constant power discharge.

The duty cycle test is particularly valuable when attempting to evaluate the performance of a battery in an application which typically involves a cyclic or variable duty cycle. Custom duty cycle tests can be manually accomplished by utilizing the pause feature.

Additional graph styles include temperature graphing with recovery time options, as well as a Ragone test which adds battery weight to the equation, allowing the user to evaluate performance against battery weight.

In addition the Pro version includes provision for operating with one or two CBA Amplifiers, which allows the user to test at up to 500 watts or 1000, respectively.

The Pro version has a voltage calibration utility which allows the user to lab calibrate his test setup to automatically correct for resistance in the test wiring to the battery. This is typically necessary if you must have accurate voltage readings directly across a cell or at a battery connector.

Another feature allows the user to add a note to each graph to further indentify a particular test graph.

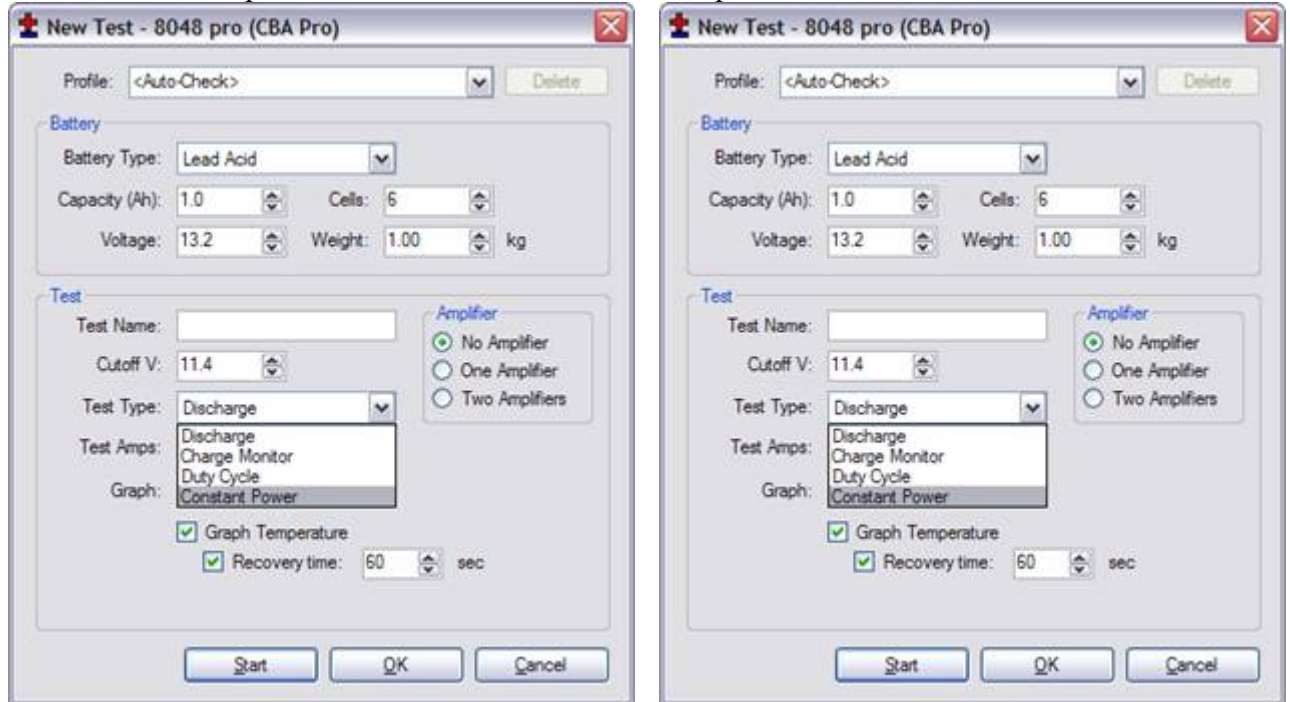
### **Intended uses for Pro Version software**

We recommend that you are familiar with the standard operation before learning and using the pro features. The “New Test” window will have several additional features.

There will be buttons to click and check off or on for operation with one or two CBA Amplifiers. You must be careful NOT to check these buttons if you do not have an amplifier or amplifiers connected and turned on. If you do have amplifiers connected and they are on YOU MUST check the appropriate button so that the software sets and records the current correctly. The amplifiers have a current gain of 10X and a power



rating of 500 watts each. The software reduces the CBA drive to exactly 1/10 of the selected “Test Amps” and records 10X the current and power.

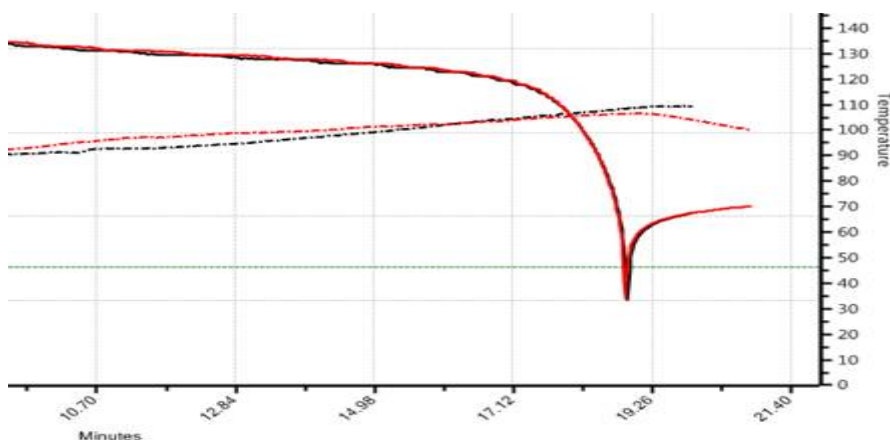


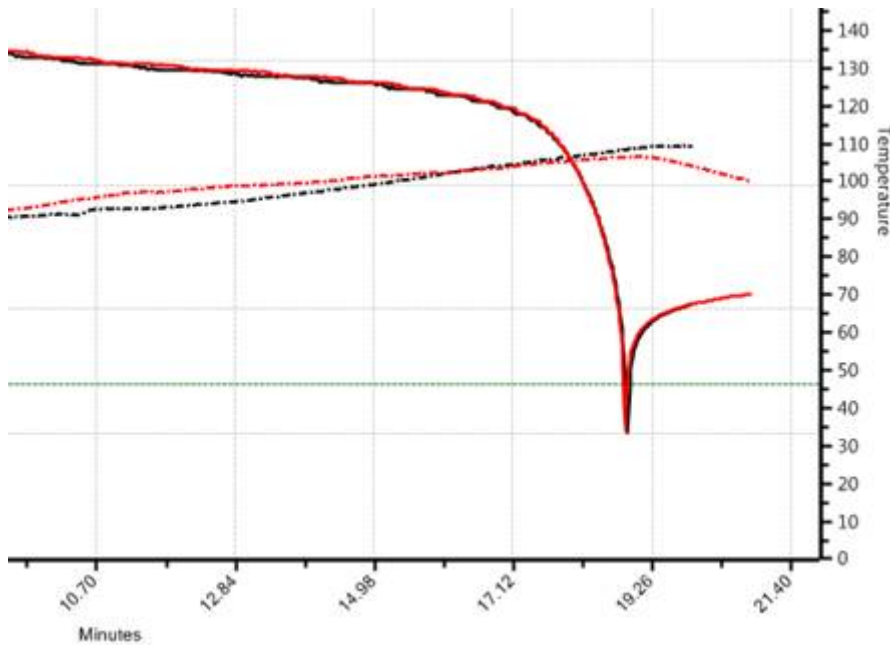
The “New Test: header includes the CBA serial number and name and indicates that the software is registered to run the Pro features enabled.

Note that CBA amplifier operation is included in the Pro version. Select one amplifier if one is connected and on, or two if two amplifiers are connected and on.

Additional test types: The Pro version includes a duty cycle test and a constant power test for specific applications also temperature graphing in the “Discharge” (Constant current “Test Type”.

### Temperature Graphing (Pro Version)





Note that you can select “Graph Temperature” for most of the test types, but not all. This will put a second graph on each test screen with the temperature. You must have a temperature probe connected to the CBA and calibrated with the sensor in intimate contact with the center of the battery.

There is also a “Recovery time:” selection which will allow the graphing to continue after the discharge stops for the period of time that you select. To see the results over time for battery temperature cool down and voltage recovery you need to use a minutes graph, not amp or watt hours.

### Lab Calibrate (Pro Version)

The PRO software version provides the ability to calibrate the user test setup to eliminate the test setup connection resistance for each specific test profile (test setup). The CBA is normally calibrated to read voltage at the Powerpole® connector. The resistance of other wire and connections to your battery cannot be accounted for electronically but this calibration utility will automatically correct using Ohm’s Law. If you need accurate voltage measurements follow the lab calibrate/ voltage calibration procedure (below).

Calibrate Voltage Drop

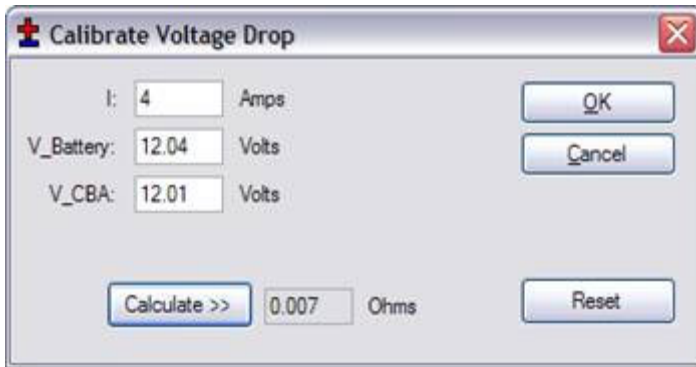
I: 4 Amps

V\_Battery: 12.04 Volts

V\_CBA: 12.01 Volts

Calculate >> 0.007 Ohms

OK Cancel Reset



For maximum accuracy and safety always use very secure connections with very low resistance!

Put a high accuracy voltmeter across the point you wish to read calibrated voltage, perhaps across a cell for single cell testing or at the connector supplied with a battery pack.

Start a test at the intended current for the battery you are planning to test with the wiring you are planning to use for your test set up.

Record the voltage that the software reads “V\_CBA:”

Record the voltage that your voltmeter reads “V\_Battery:” at the calibration point

Record the average “Current” “I:” shown by the software while the voltages are being measured.

Stop the test and go to “Tools”, “Lab Calibrate”, and select “Voltage Calibrate”.

In the calibrate voltage drop window, select “Reset”, to clear any previous calibration and then enter readings you have recorded. Press “Calculate” and the calculated resistance will be displayed for all future tests with this battery test setup. The voltage readings graphed and displayed will be corrected accordingly. Press "OK" to save the calibration settings for future tests with your particular setup. If you change the test setup in any way you should re-calibrate the setup or reset the calibration to reading at the CBA connector.

Current offset may also be completed by selecting Tools/ Lab calibrate / Current Calibrate. As previously covered in the Program section, the current offset calibration is intended for low currents (<500 ma) and only used if the user has an accurate calibrated ammeter connected in series with the battery. The correction is limited to a maximum of +/- 100 ma.

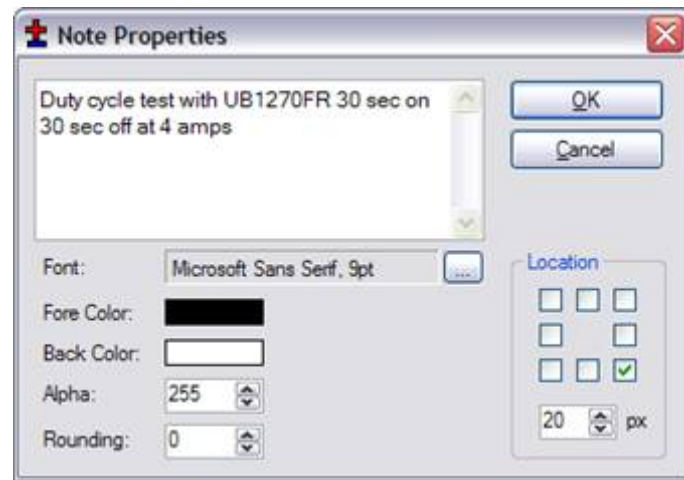
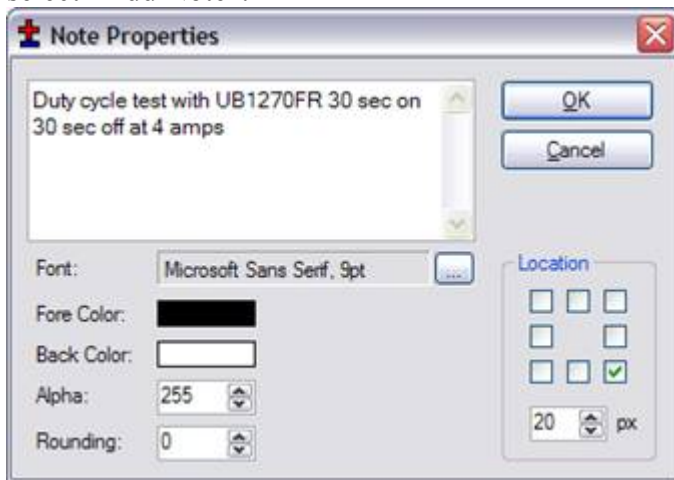
**Notes (Pro Version)**



Adding notes is a feature that may be used for any purpose you wish. The following is a pictorial view of the steps required to add a note.

The test below is a graph of a duty cycle test with graph style time selected. The test was set for 30 seconds on and 30 seconds off at a 4 amp load.

Move the cursor to the graph until you see the test name displayed Step 2, right click and select “Add Note”.



The note properties screen besides letting you type the note lets you select the location of the start of the sentence relative to where you clicked.

Set the pixels in the “px box and the direction of offset with the “Location” check boxes.

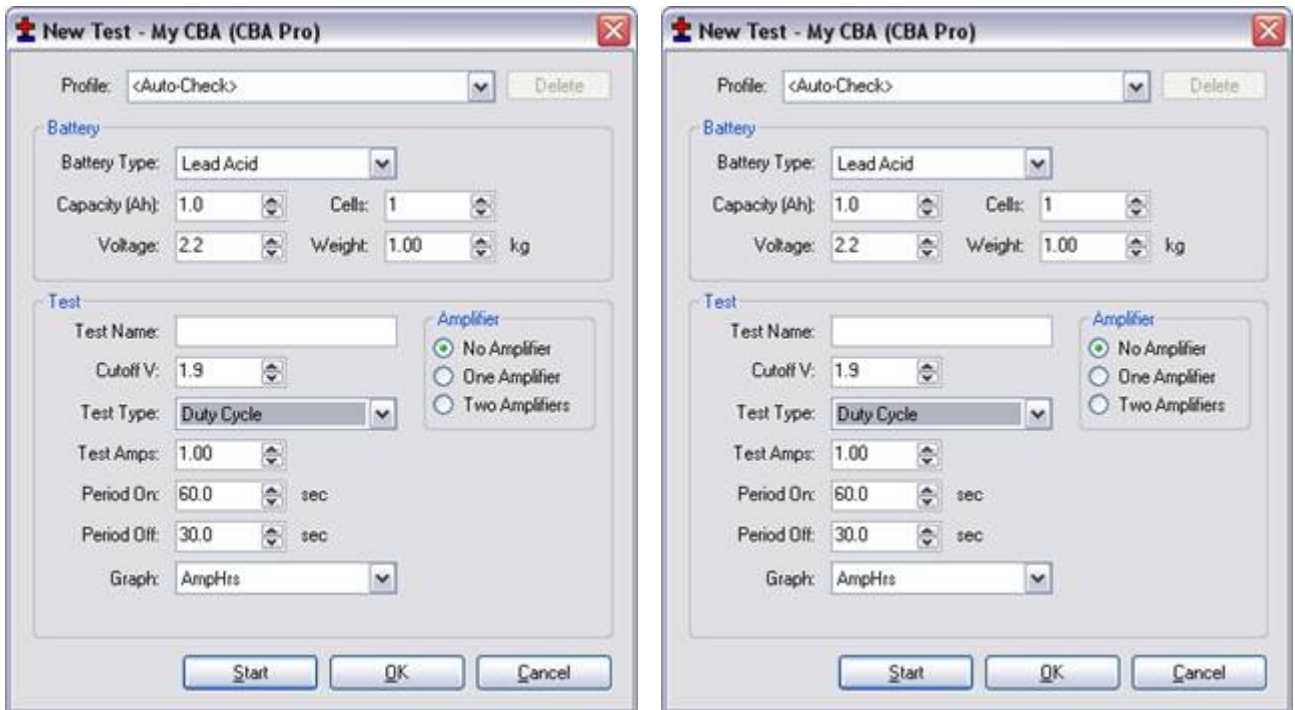
You may also change font style and size with the selections to the left.



The final note is shown on the graph.

Tip: If you have a number of graphs overlaid, notes are helpful in identifying different tests and graph features

### Duty Cycle Measurements (Pro Version)



In the “New Test” setup window you will see an option under “Test Type” for “Duty Cycle” with “Period On” and “Period Off” time selection. Simply set the duty cycle times as you wish to run a intermittent cycle test. Note: if you graph in Ahr or Whr the graphing will stop when off but the cycle will be obvious if displayed in minutes.

Note: You may also do a manual cycle with the pause button at the top of the window. It works similar to the pause button on a CD player.

## Constant Power Testing (Pro Version)

**New Test - My CBA (CBA Pro)**

Profile: <Auto-Check> Delete

**Battery**

Battery Type: Lead Acid

Capacity (Ah): 1.0    Cells: 1

Voltage: 2.2    Weight: 1.00 kg

**Test**

Test Name:

Cutoff V: 1.9

Test Type: Constant Power

Watts: 2.20

Graph: AmpHrs

**Amplifier**

No Amplifier

One Amplifier

Two Amplifiers

Start    OK    Cancel

**New Test - My CBA (CBA Pro)**

Profile: <Auto-Check> Delete

**Battery**

Battery Type: Lead Acid

Capacity (Ah): 1.0 Cells: 1

Voltage: 2.2 Weight: 1.00 kg

**Test**

Test Name:

Cutoff V: 1.9

Test Type: Constant Power

Watts: 2.20

Graph: AmpHrs

**Amplifier**

No Amplifier

One Amplifier

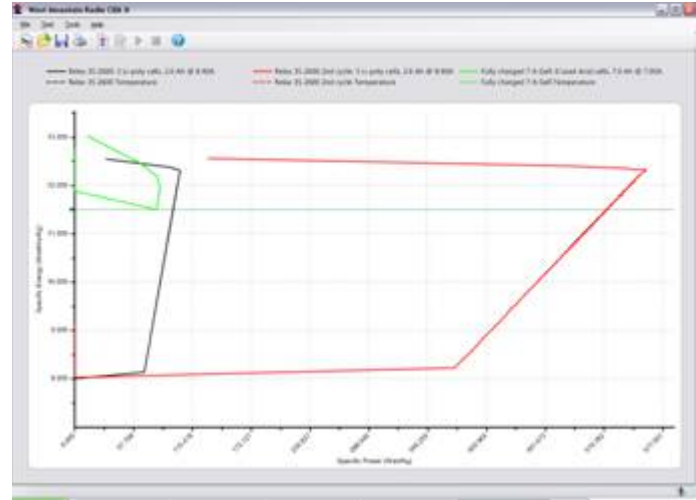
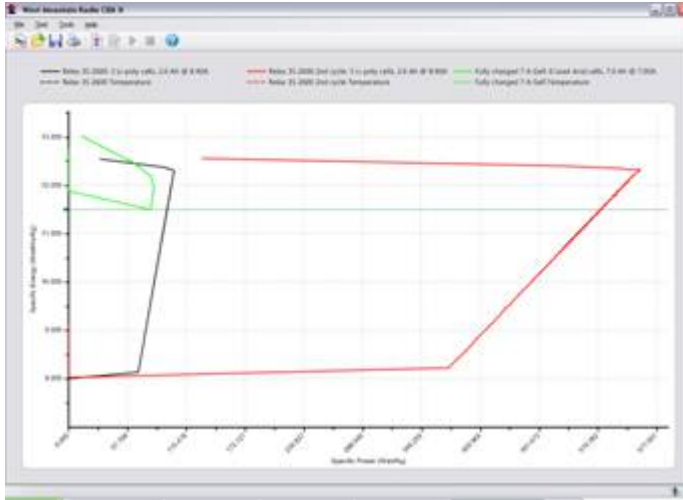
Two Amplifiers

Start OK Cancel

You may also run a test with constant power instead of constant current. With this test the current will be constantly ramped up as the battery voltage drops giving regulation of the power drawn from the battery.

Note that power in “Watts” is selected instead of “Test Amps”.

## Ragone “Graph” type (Pro Version):



An additional graph type is available with the Pro version that allows you to compare radically different type and size batteries on the basis of power density (power to weight). This graphing type is particularly useful when selecting a battery to power a device that is weight sensitive, such as anything that moves.

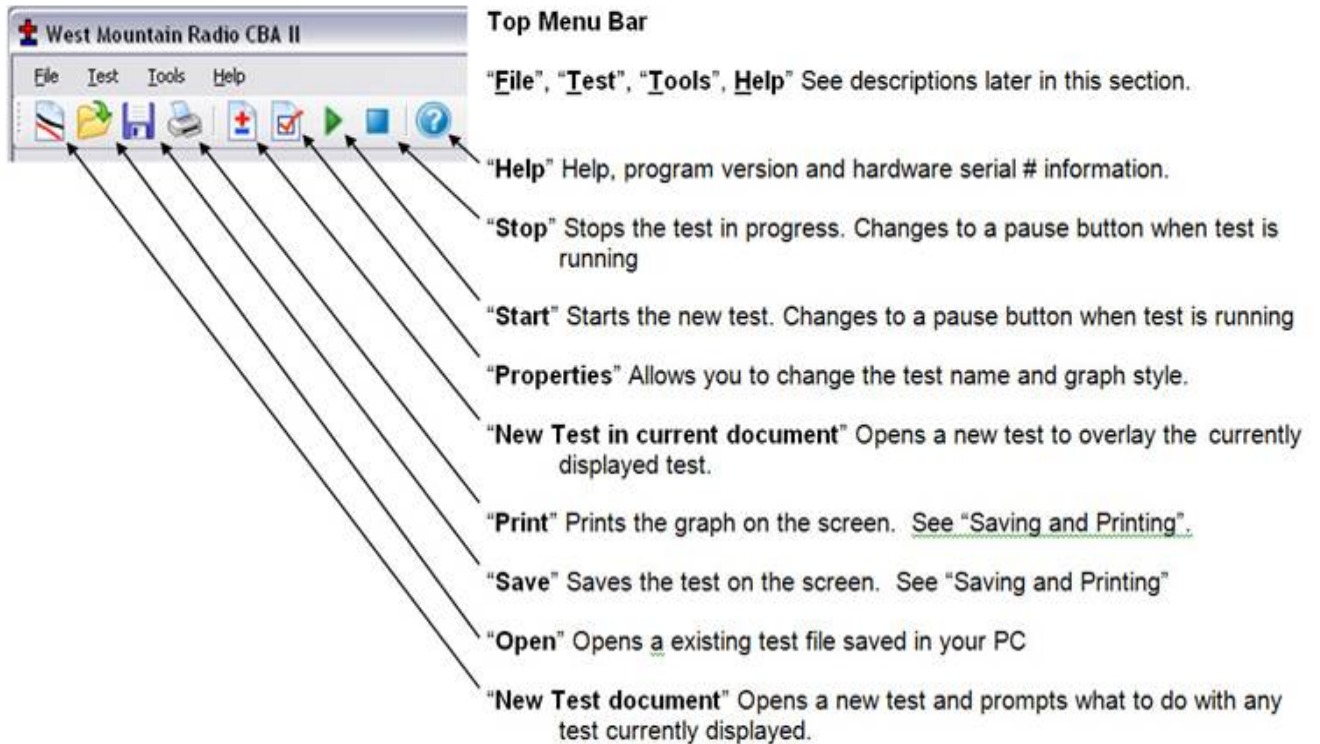
Note: This graph can only be displayed if a test was started and save with entering the correct weight of the battery being tested.

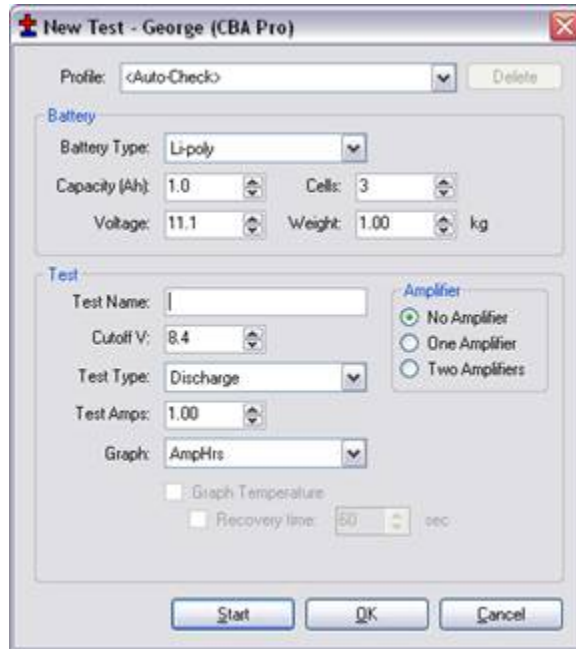
If you are not familiar with Ragone plotting see [http://en.wikipedia.org/wiki/Ragone\\_chart](http://en.wikipedia.org/wiki/Ragone_chart)



# CBA Program Details

The installation and basic operation is covered in the “Getting Started” section of this manual / help. This section gives a detailed explanation of using the program and its features.





**“New Test” setup window:**

When starting the software and a CBA is connected to your computer’s USB port, you are given a “New Test” setup window.

You will notice that the “New Test” window defaults to the “Profile” “<Auto-Check>” and is in the auto check mode. With this profile you only need to provide the basic information to run a test, and the software will do the rest. All you need to supply is the “Test Name”, the “Battery Type” (chemistry) and provide the batteries rated “Capacity”.

Profile defaults to "<Auto Check>" which causes the program to automatically recommend appropriate test discharge current and cutoff voltage from the user entered "Battery Type" and "Capacity". It then reads battery's fully charged voltage and makes a cell count estimate and recommends a test cutoff voltage and discharge current.

The user can manually override any parameter and run a test or save those custom settings as a "Profile". To add and save a new profile use your mouse to highlight "<Auto Check>". Then type in an appropriate name for a new custom profile. The program will ask you if you want to save it as a new profile or update the information for the existing "<Auto Check>" information.

After saving a profile or profiles you may recall them by typing in part of the profile name or selecting it by clicking the down arrow to the right side of the "Profile:" window.



Note: if you select a saved profile and change the settings the program will ask you if you would like to save those changes to the

existing profile or create and save a new profile.

If you no longer need a profile you may highlight it and use the "Delete" button to the top right of the "New Test" window.

### **Battery Type**

The "Battery Type", drop-down selection, must be chosen correctly in order for the software to recommend how to test that particular type of battery. Select the type of battery you are about to test.

**Note:** if you have an unusual type of battery that is not on the list, select whatever you wish or whatever you know to be similar, then manually set the test parameters. If you have no idea what type of battery it is it is best to not attempt to test it until you find out.

### **Capacity**

The "Capacity (Ah): is the rated capacity of the battery in Ah (Ampere Hours). This must be typed in or selected in order for the software to recommend a appropriate discharge rate. Normally this information is on a sticker on the battery, otherwise contact the manufacturer. If the capacity is in mAh (milliamperere Hours) simply divide that rating by 1000 to get Ah.

### **Cells**

In the "<Auto Check>" mode this is automatically filled in according to the battery type and by reading the fully charged battery voltage upon connecting a battery.

**Double check that the number of cells is correct before starting a test!**

**Note:** Changing this manually will also change the battery voltage rating.

### **Voltage**

This is the rated average pack or cell voltage (average of a discharge cycle) of a battery, not the fully charged voltage which is actually measured by the CBA when a battery is first connected. In the "<Auto Check>" mode this is automatically calculated from the user provided battery type information and from the CBA's reading of the fully charged battery voltage.

**Double check that this voltage is correct before starting a test!**

**Note:** Changing this manually will also change the battery cell count.

### **Weight**

The "Weight" of the battery is optional information, not needed to run a test. It is saved with the file and is needed to plot a Ragone graph but only with the Pro version software upgrade.

### **Test Name**

This is a required field and a test may not be started without a test name. You should choose a name which positively identifies the battery and the test you're about to perform so that you may identify the test perhaps years or months later. Depending on your testing application, decide what naming system you would wish to use. Note that the software automatically records the battery chemistry, Ah rating and the discharge rate with every battery test. A saved file may or may not contain multiple tests and will have a Windows® date and time stamp. If you wish to take advantage of saving files with multiple tests in them you may wish to include the date and/or time in the test name so you may identify a test among a series of tests of the same battery.

### **Test Cutoff Voltage**

The program will automatically recommend the “Test Cutoff V” (the voltage where the test and discharge stops) that is appropriate for the chemistry you have selected in the “Battery Type”.

Note that 100% discharge is never 0 volts for any type of battery. There is an industry standard for each chemistry. Lead batteries 1.775 volts per cell; nickel 0.9 volts per cell and lithium 2.8 volts per cell. The 100% discharge voltages may vary slightly between different manufacturers and may be dependent on temperature. You may wish to verify this voltage from battery manufacturers' specifications.

You may manually change the cutoff voltage for any reason, but with caution! Do not lower the voltage without good reason as most batteries can be damaged due to over discharge. Lead and lithium chemistries are particularly susceptible to this type of damage. It is commonly believed that nickel cells actually benefit from discharge to 0 volts if they are then quickly re-charged. However a pack of nickel cells should never discharged to near zero volts as a pack of cells could become unbalanced and damaged. The software will give a warning before starting a test if you have lowered the test cutoff voltage below recommendations.

### **Test Type**

Normally you would leave this set to discharge. A discharge provides an electronically and software regulated constant current discharge. The other option in the standard version is “Charge Monitor” which uses the CBA as a recording voltmeter to chart voltage vs. time for evaluation of a charger.

**Caution: Never hook the CBA to a battery that has something else connected that is not totally ground isolated. To test a charger in the charge monitor mode the charger must be totally electrically isolated from the computer ground.**

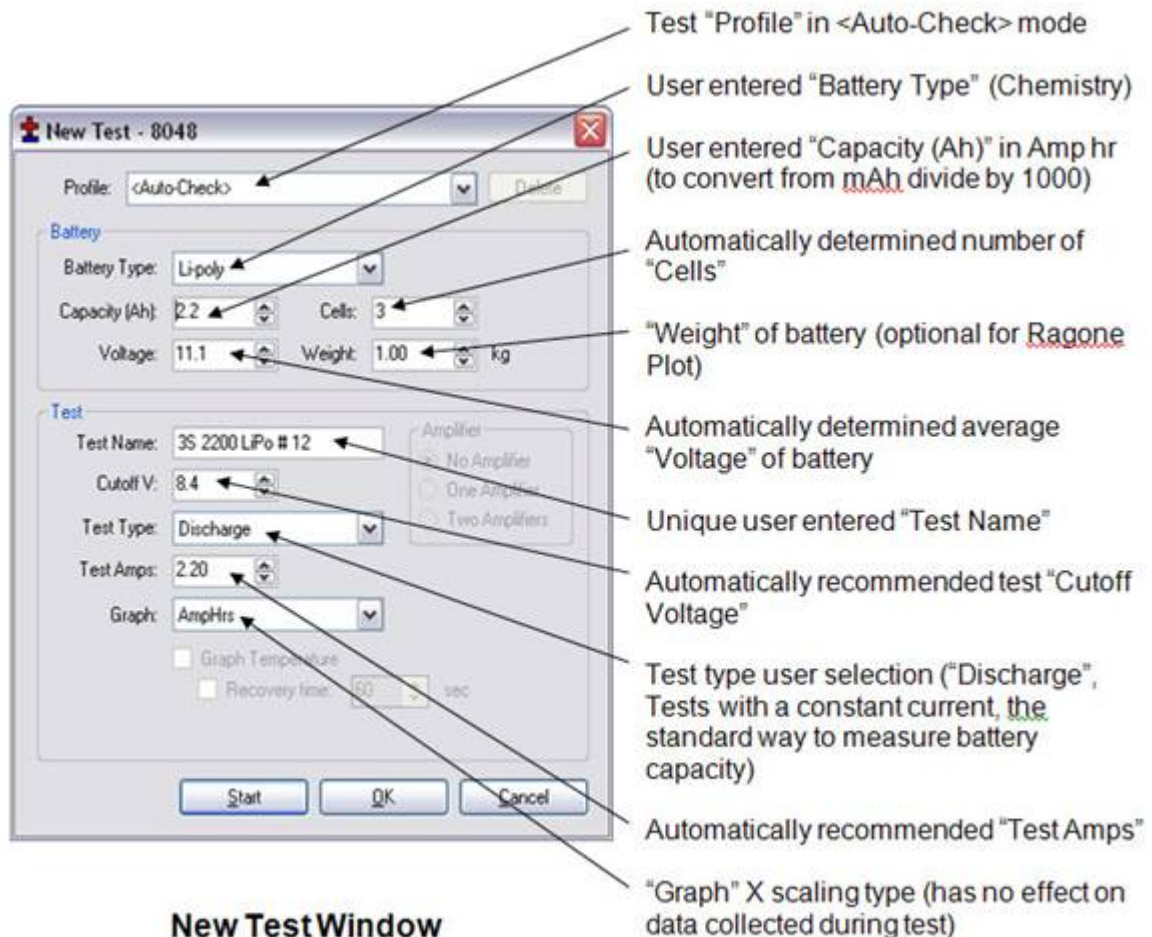
### **Graph**

This drop down selection gives you three choices of charting battery voltage. It provides the choice of horizontal scales for AmpHrs, WattHrs or minutes. No matter which you select to display the same test will be run and data recorded. The only difference is the horizontal scale that is displayed on the graph.

Note: In the future the graph type may be changed and displayed as you wish, no matter what graph scale was chosen when the test was run.

### Test Example: Testing a battery

The following example will lead you through testing a 3 cell (3S, 11.1 volt) lithium polymer battery.



The image shows a software window titled "New Test - 8048" with several input fields and annotations. The "Profile" is set to "<Auto-Check>". Under the "Battery" section, "Battery Type" is "Li-poly", "Capacity (Ah)" is "2.2", "Cells" is "3", "Voltage" is "11.1", and "Weight" is "1.00 kg". Under the "Test" section, "Test Name" is "3S 2200 LiPo # 12", "Cutoff V" is "8.4", "Test Type" is "Discharge", "Test Amps" is "2.20", and "Graph" is "AmpHrs". There are also checkboxes for "Graph Temperature" and "Recovery time" (set to 50 sec). Annotations on the right side of the window point to these fields with the following text:

- Test "Profile" in <Auto-Check> mode
- User entered "Battery Type" (Chemistry)
- User entered "Capacity (Ah)" in Amp hr (to convert from mAh divide by 1000)
- Automatically determined number of "Cells"
- "Weight" of battery (optional for Ragone Plot)
- Automatically determined average "Voltage" of battery
- Unique user entered "Test Name"
- Automatically recommended test "Cutoff Voltage"
- Test type user selection ("Discharge", Tests with a constant current, the standard way to measure battery capacity)
- Automatically recommended "Test Amps"
- "Graph" X scaling type (has no effect on data collected during test)

**New TestWindow**

After starting the program you will be presented with a "New Test" pop up window. Notice that the Profile is set to the default "<Auto-Check>" selection. Leave it like this as we will use the "<Auto-Check>" to help test this battery.

We are testing a lithium polymer battery so let's select "Li-Poly" in "Battery Type". At this time you may plug in this battery. Be careful to make a solid connection with the correct polarity.

You will notice that when you plugged in the battery that the CBA measures the actual voltage and the program automatically changed the “Cells” to 3 and the nominal “Voltage” to 11.1 (average voltage for a three cell LiPoly pack). The program will also recommend the “Test Cutoff V”. Make sure that this is all correct.

Type in or scroll the rated capacity for the battery; in this case 2.2 Ah. The sticker reads 2200 mAh so we had to divide that by 1000 for units conversion to Ah. The program will automatically recommend the discharge rate. A one hour discharge for most battery types.

Enter the Weight of the battery (if you are interested in a Ragone graph which adds weight as a variable in the graph).

Next enter the test name (suggest date/ battery info/ other optional).

The CBA standard software version has selections of “Discharge” (A constant current discharge which is the most common way to evaluate battery capacity) and “Charge Monitor” which monitors the battery voltage as you charge it. Leave it on “Discharge”.

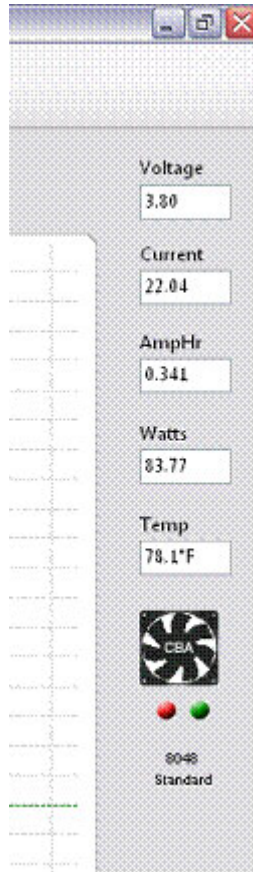
The program has automatically recommended the “Test Amps” discharge rate, and a safe “Test Cutoff V”. This is based on the battery type and capacity that you typed in. and on the measured voltage.

Tip: You may optionally change the discharge rate, “Test Amps” or cutoff Voltage, however the program will “ask you if you are sure”, if you have chosen higher discharge rate or a lower cutoff voltage, before allowing you to start the test.

Make sure that all the information, displayed in the New Test Box, is correct. If necessary, fix the entries, before starting the test.

Press the “Start” button at the bottom of the test box and start the test,

Tip: Selecting OK will close the test box and display the graph allowing you to check or change advanced variables. You may then start the test by selecting the green start arrow > in the main menu.



To the right there is an example of the readings displayed while testing a single cell Lithium at 22 amps. Note the readings displayed and that the virtual fan is running and virtual LEDs lit as the CBA will have.

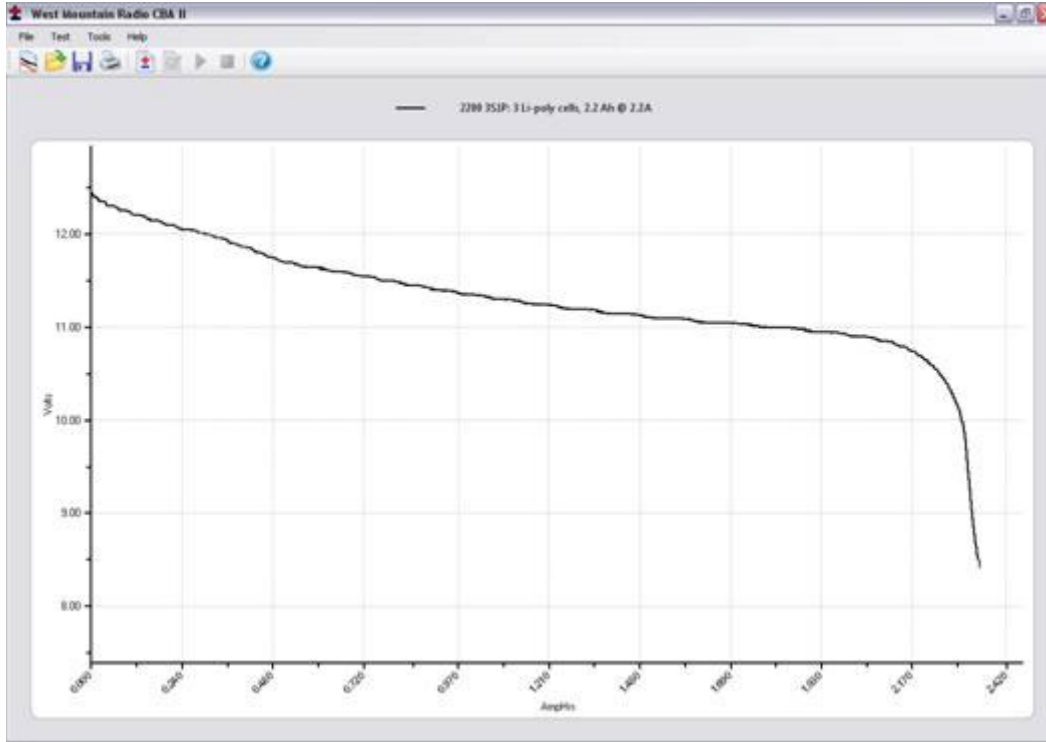
It is near the start of a test and the “Voltage” is at 3.80 V at 22 amps. Note that the “Current” is not exactly at 22 amps, but 22.04: this is normal. The current will fluctuate perhaps 1% as the CBA is constantly adjusting.

The “AmpHr” will steadily increase as the discharge continues and the power in “Watts” will decrease as the battery voltage drops. If you have a temperature probe connected and on the battery, that reading will continue to increase according to battery heating.

Only three things will stop the test: the voltage of the battery dropping to the pre-set “Test Cutoff V”, the optional temperature probe sensing that the user set over-temperature limit has been reached, or the CBA itself overheats due to lack of cooling or high room ambient temperature.

**Never run a test unattended! Even though we have put in every safety feature we could unexpected things could happen that could cause a battery explosion or fire. Also certain types of computer lock ups could cause the CBA to over discharge the battery.**

The graph of our completed test is shown below:



Test Data: During the test all variables are displayed.

Voltage: Initial voltage (was 12.6 volts, end voltage was 8.4volts)

Amp Hr: the rated capacity of this battery is 2.2 Ah and the test measured 2.347 Ah. This is a 1 hour (1C discharge). Most lithium batteries are rated at 2 hour (.5C discharge). Even at this higher rate the capacity of this battery is better than its ratings.

After completing this test we have several options for starting another test.

We could save this file by selecting File/ save or save as and name and save the file in the default My Documents/CBA directory, or the directory of our choice.

- We could select File/ New and start a new test document (the program will prompt you to save this unsaved test). You would then start a new test with a new test window.
- We could also select Test/ New and the program will ask you if you want to overlay a new test on the previous test. If you have a similar battery you would like to compare you would select this option.
- If you select the +/- on the top menu bar, you will also have the choice of overlaying the new graph or starting a new test.



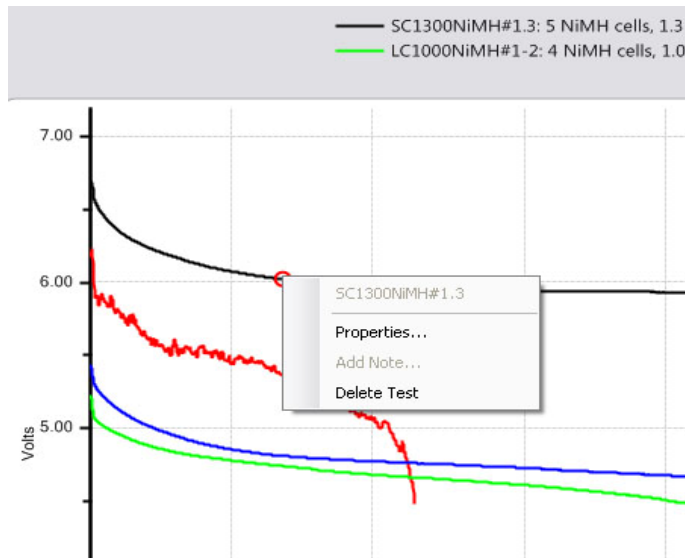
# File Menu

## New:

Starts a new test document.

## Overlay:

Will allow you to open a saved test document and allow you to overlay the tests in that file over the test graph or graphs already on the screen. Once you have a series of graphs for battery comparison on the screen you may save those under an existing or new file name.



**Note:** If you have test graphs on the screen that you wish to remove you may left click on the graph trace and select "Delete test" to remove that graph trace.

You may also select properties and change the graph style but only if the test was done and saved on this version 2 program.

## Open:

Allows you to open any saved file. Old test files from the previous version 1 of CBA software may be opened by selecting "Files of type" from .bt2 to .bt1. When you save an opened and displayed old style .bt1 file it will be converted to the new version 2 (.bt2) and saved in that new format.

## Close:

Will close the file displayed on the screen and prompt you to save it.

## Save:

Saves the test document graph currently displayed on the screen.

## Save As:

Allows you to save a test under a new file name as a copy or to save the same file in a different folder location.

**Export:**

Converts the test file to .CSV (Comma Separated Values) comma separated file format and allows you to save it for data manipulation with a spreadsheet program such as Excel®, or with text viewer.

**Print, Print Preview and Print Labels:**

For a discussion of printing functions refer to the help section on printing.

**Recent files:**

A convenient way to open files that you were recently using from a list of the last eight files.

**Exit:**

Closes the program and will prompt you to save a file of the tests on the screen.

## Test Menu

**New Test:**

Opens a “New Test” window as explained above.

**Start, Stop, Properties:**

These will be grayed out unless you have filled out a “New Test” window and selected “OK” instead of “Start”. If available you may start a test or stop a test in progress. Properties will allow you to change the test name before starting a test or graph type at any time.

**Connect to CBA, Disconnect from CBA and Identify CBA:**

These are not normally used and are provided for multi CBA users. If you have multiple CBAs you may switch CBAs with these utilities without closing the program, otherwise it is done automatically.

**Chart Properties:**

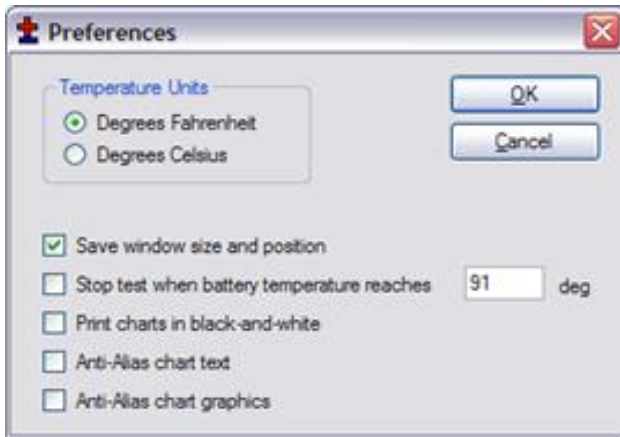
Allows you to change the graph scaling or put a title on the graph

**Tip:** You do not normally want to change the graph scaling as the automatic scaling works very well.

# Tool Menu

## Preferences:

Lets you customize certain settings for the program such as “Temperature Units” allowing you to pick either degrees C or F.



“Save window size and position” causes the program to come back with the same window the next time you open it.

“Stop test when battery temperature reaches”

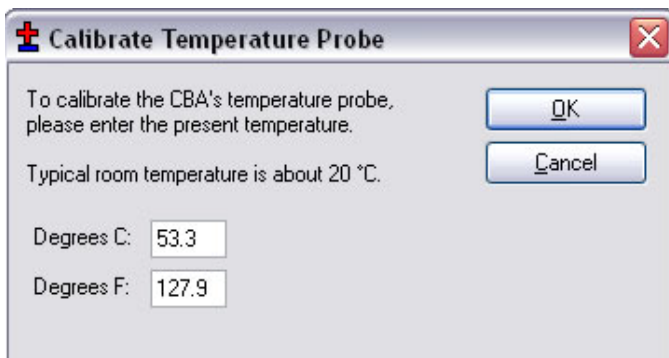
“Print charts in black-and-white” is for setting it to code the graphs for identity when not color coded.

“Anti-Alias chart text” smoothes the text graphics.

“Anti-Alias chart graphics ext” smoothes the graph graphics.

## Lab Calibrate:

"Tools", "Lab Calibrate" gives you the option of calibration of temperature, discharge current. The Pro software version also has test lead resistance compensation to calibrate voltage. These are advanced options and should only be used by technically competent users having access to laboratory calibration standards.



**Temperature Calibrate:** The optional temperature probe may be calibrated at room temperature comparing it to a room temp thermometer. For highest

accuracy place a lab grade thermometer and the CBA temperature probe placed in water heated to the temperature of interest for testing.

In the standard version of the software the temperature is displayed and the temperature may be used as a safety feature to automatically stop a test at a user set maximum battery temperature.



**Current Calibrate:** is an advanced option that only functions below 3 Amps. If you have a need for the most precise measurements and you have access to a lab quality ammeter that has known NBS traceable calibration you may wish to use this option. This option allows a calibration offset to center the CBA's calibration within a 12 bit window. In other words, you may adjust the discharge current in 1 ma increments but only within a 10 ma measurement window. You may not see a change unless you are on the cusp of switching to the next 12 bit data level. This feature is useful to calibrate at especially low discharge rates below 500 ma. Do not normally use this option without a full understanding.

Voltage Calibrate is grayed out and only available in the CBA Pro version of the software. See the section of the manual on Advanced Pro Features.

## Help

### **Contents, Index, Search:**


This gives you access to these files directly from the program instead of from the CDROM or our web page.

### **About CBA:**

The about CBA window shows the CBA Device serial number, a calibration serial number, hardware version number, date calibrated and whether or not the CBA is a CBAI or CBAII. If it says "DA Current Mode" "NO" you have a CBAI and the proper operation of this software is not supported. You should be using the older version of the software or you may purchase a hardware update via our web page and return your CBA for update

# Getting Started

**We highly suggest that you read this entire manual and help files for a full understanding of the CBA and software operation!**

1. From the CD ROM opening screen click on “Software and Hardware Installation”. Follow the instructions on the screen to complete both the hardware and software installations.
2. Connect the CBA to your computer’s USB port using the supplied cable before connecting a battery.  
Note: If Windows says: “Found new Hardware”, you did not complete the previous step.
3. Start the West Mountain Radio CBA program by clicking on the icon:   
Note: The CBA’s green LED should come on and the program should start with a “New Test” screen in the “Auto-Check” profile.
4. In the “New test” window select the “Battery Type” (chemistry) and select or type in the “Capacity Ah” Note: To convert mAh (milliampere hours) to Ah (Ampere hours) divide by 1000. Note: if the capacity rating is not printed on the battery contact the manufacturer or visit their web page.
5. Connect the battery with very short, solid, low resistance connections using the proper connectors and polarity. **WARNING: BE CERTAIN THAT YOU HAVE THE POLARITY CORRECT! RED TO RED, BLACK TO BLACK AND PLUS TO PLUS, MINUS TO MINUS!**
6. The battery voltage will display the resting fully charged battery voltage on the right side of the screen. You will see the program automatically make an estimate of the number of cells and average pack voltage in the “New Test” window.

If the number of cells or average pack voltage is not correct, check that you have entered the proper battery type. If you are sure the average pack voltage or cell count is incorrect, change the software estimate to the correct value in either the “Voltage” or “Cells”.

7. The discharge current in the “Test Amps” window will be recommended by the software. If you would like to run in a test at another test range change the “Test Amps” window. **CAUTION: DO NOT CHOOSE A HIGHER DISCHARGE RATE THAN THE BATTERY IS CAPABLE OF. SEE THE BATTERY MANUFACTURE’S SPECS.** Note: If the no load battery “Voltage” multiplied times the “Test Amps”

selected ( $\text{Volts} \times \text{Amps} = \text{Watts}$ ) exceeds the wattage rating of the CBA, or the default recommended maximum discharge rate for a given battery type, our software will prompt you to lower the discharge current before starting a test. The CBA will run tests at up to 150 watts with a battery that has a rated capacity of 1 Amp-Hr or less, up to 125 watts below 3.5 Amp-Hrs and 100 watts for any capacity battery.

8. Type in a “Test Name” for the test that positively identifies the test for future reference, perhaps write a number on your battery and use that number, or a unique description of the battery and the test.


9. Press the “Start” button in the “New Test” window.

If you have the settings correct you will see the graph appear and auto-scale. The red LED on the CBA will come on and the fan will start. The virtual LED and fan will start also. The “Current” will ramp up to the “Test Rate” value and the voltage will start to record on the graph.

10. The test will continue until the test “Cutoff V” is reached. At that point the test will automatically stop and the program will beep and display “Test Complete”. Everything will return to the stopped condition ready for another test or for you to save the file.

**Disconnect the battery at this time. Do not ever leave a battery connected after a test completes! Prolonged connection to the CBA of a discharged battery could over discharge and damage the battery. CAUTION: The battery and the CBA may be HOT!**

11. When the test is complete go to the “File” menu and save the file if you wish to keep it. **Note: The file name will default to the test name but you may change it to another name if you wish. If you close the program or try to run another test you will be asked if you wish to save the completed test already on the screen.**

12. If you wish to run another test, start at step 4 of these instructions. Click the  button or Test/ New. When starting the new test to you will be asked if you would like to save the previous test and start a new test or add that test to the graph on the screen.

After running a discharge test on a battery, the battery should be recharged. Most batteries are rated for many recharge cycles depending on the battery type and on the discharge rates, sometimes 1000's of cycles. Most batteries should not be left at their fully discharged cutoff voltages but should be stored in a partially charged state for maximum battery life.

**This completes the getting started section. Read this entire manual and help files for a full understanding of battery testing with a CBA.**

# Battery Testing

## Introduction

Your primary concern when using batteries is probably that they do not cause a problem by failing in service. Of course you may have many other requirements; such as, how to get the most life out of a battery, or which batteries are best for cost, size, weight etc.. You may simply be interested in getting maximum performance.

CBA battery tests clearly show the health of a battery measured in terms of capacity and voltage. A battery may be tested over a wide range of discharge currents with a CBA. The time it takes to perform a test is directly related to the discharge or rate (current in amps) but batteries have limits as to how fast you may discharge them.

Generally the bigger (higher capacity) the battery the faster it may be discharged without overheating. The heating of a battery during discharge or charging is a direct function of the battery's internal resistance, and larger batteries have lower internal resistance, and poorly made, worn or damaged batteries, have higher internal resistance. The voltage drop, due to this resistance, turns into heat with a corresponding loss of capacity. In addition to graphing the voltage versus ampere hours our optional temperature probe will measure the temperature indicating the power that is lost as heat. The performance due to charging techniques, load current, temperature, and battery aging can be measured and easily interpreted by viewing the CBA graphs.

Always recharge your batteries after testing. Contact West Mountain Radio for information on the best charger for your battery.

## How Can I be sure a Battery is Good?

That is a good question! It depends.... It may depend on if it is used to power a multi-billion dollar satellite or your kid's video game. Of course if the video game goes dead on a long trip in the car you may have wished that you had a better battery! There is no hard and fast way to determine if a battery should be taken out of service, or replaced. That depends entirely on the application. The CBA only determines how much energy is stored in a battery.

You can easily determine if you got what you paid for, with a new battery, by checking the published capacity ratings (In Ampere hours or milliampere hours) against the manufacturer's specifications. Of course a battery may have 90 % of the capacity of similar battery that is twice the price but only has 20% more.

In any critical application the battery should be correct for that application and be at, or exceed, the capacity ratings. Any non critical application it depends how long you would like the device to work for or how much a new battery is. A cordless drill may drill a hole or two or three with a battery at 30 % of ratings but what if you need to get the job done and have thirty holes to drill.

The only way to verify the capacity of a battery is to know what the manufacturer or supplier of the battery rates that capacity at. Included in that spec should be how it should be charged, what discharge rate it should be measured at and down to what voltage per cell the discharge was stopped at, and perhaps the temperature it is specified for. Normally reputable battery manufacturers will supply this information, perhaps on a web page. If you use the CBA with the same discharge rate and cutoff voltage you can determine if the battery is meeting published specifications when new. Be aware that most batteries get better after two or three charge/discharge cycles and then after that it is downhill.

## **Glossary of Terms**

A basic understanding of terms used for testing batteries is needed:

Capacity Ahr: Measured in ampere hours: Ahr Example: 2 amp for 2 hour is four ampere hours. It is like the gallons of water that are in the tank. **Tip: batteries are rated in both milliamps and amps; the conversion factor from A to mA is to multiply X 1000.**

Capacity Whr: Measured in watt: Wh Example: 1 watt for 1 hour is one watt hour. It is like the how fast the water can come out of a tank for how long.

Voltage: Measured in volts: V. Volts are the International System unit of electric potential and electromotive force. It is like the pressure in the water pipe.

Current: Measured in amperes: A. An ampere is the basic unit of electric current. It is like how much water is flowing at an instant in time.

Wattage: Measured in watts, W. Watts = Volts X Amps. It is like the pressure and also how much water is flowing at an instant.

Resistance: Measured in ohms, R or  $\Omega$ . Resistance is like the size of the pipe, the smaller the pipe the higher the resistance.

Time and Temperature: You should know these. **Tip the CBA with the optional temperature probe may be set to read either degrees F or C.**

## **Connecting a battery**



The CBA comes with Anderson Powerpole connectors. If you are already using these fine DC connectors you are all set. If you are using Powerpoles that are oriented differently you may slide apart the black and red halves and re-arrange them to match your battery. If you are using other connectors you may cut off the Powerpoles and install your own connectors, make an adaptor or purchase adaptors from West Mountain Radio. If you choose to use another connector it must be high performance. Poor or loose connections will show up on the battery test as a loss of voltage and capacity, or have intermittent readings.

### **Using the CBA program**

The basic operation is covered in the “Quick Start” section of these manual/help files and detailed information is provided in the "Program Features" section.

### **How Often to Perform Tests:**

Any time a battery has been sitting for a long period, such as months, it should be tested.

A good strategy is to measure the pack when it is new by doing a slow charge and then alternately charging it and testing it several times (cycling), or until you get similar test results. You may wish to print a test label for your new battery using the CBA label-printing feature.

After the battery either has been used a great deal or has been sitting for some time repeat the new battery procedure. Overlay the graphs to determine if the battery is still performing well. If when using a battery, it seems to work poorly, try to perform a test before using it again.

We do not recommend performing tests or cycling batteries if they are used regularly and seem to be working well. We do recommend periodically slow charging a pack of batteries if you normally use a fast charger. There are many battery maintenance and battery care issues that are unrelated to using a CBA.

### **Battery Capacity and Charger Performance Testing**

Follow the “Quick Start” instructions to do your first test. The capacity in A-h is displayed both graphically and numerically when a test is completed.

Compare the battery capacity reading in A-h to the battery capacity specifications. If your battery is perhaps 20% lower in capacity than it should be, you should be suspect. If a battery is 40 or 50% lower in capacity it may be incompletely charged, at the end of its life, or defective. Remember that battery capacity is a function of the charge state. You may actually be testing your charger and not the batteries, therefore the name of this

section. If all of the batteries you use with a particular charger seem poor in performance it would be a good idea to try another charger or charging technique.

Contact West Mountain Radio for recommendations for the best charger for your application.

You may use the CBA to check your charging techniques or charger. Do a slow charge at a rate of 1/10 to 1/20 of the battery capacity for 24 hours. Test the battery with the CBA. Let the battery cool down completely and do a fast charge, using the charger that you are concerned about. Let the battery cool down again and do a second test. If you get at least the same results with your fast charger compared to slow charging that is a good indication that your fast charger is good.

There are many pitfalls using fast chargers. A fast charger does not have X-ray vision; it cannot see (measure) the individual voltage of each cell in a pack, only the total, the CBA cannot either. Packs of multiple cells eventually become imbalanced. A fast charger, charges until the voltage reaches a certain point, it shuts off when it “thinks” the entire pack is charged. These chargers will detect one cell being fully charged before the others and shut off before the entire pack is fully charged. A fast charger may also overcharge some cells, undercharge others. An over-discharged and unbalanced pack may have a totally dead cell or two, when charged it will actually reverse charge the dead cells and destroy the pack.

A way to help an unbalanced pack is to charge it with a slow overnight charge. After charging, use the CBA to discharge it to the minimum cutoff voltage for the pack and then charge it again. This is sometimes called cycling or rejuvenating a pack. The pack will probably come back and work much better for some time.

The phenomena of packs of cells coming back to life after all the cells are properly balanced is what some people erroneously think is memory effect.

### **Finding a Bad Cell in a Pack**

Unfortunately, this can only be accomplished by making an electrical connection to each cell, then test them, one at a time. Before you tear the covering off of the pack make sure it tests poorly and you have done a slow charge before the test. **Tip: Number the cells with a permanent marker and use those numbers to identify the tests.**

Slow charge the pack and make connection to each cell and test them one at a time on the same graph or do multiple tests and open all of those test files to overlay the results. It should be quite obvious which cell or cells are bad.

### **Matching Cells**

This is done in basically the same way as finding a bad cell. Slow charging is not necessary. Charge each cell, in the batch of cells you are choosing from, in exactly the same way. Charge them each identically and let each of the cells sit the same amount of time to cool before testing each one. Compare the overlaid tests for the best match of voltage and capacity. **Tip: Number the cells with a permanent marker and use those numbers to identify the tests.** It is important that you use the identical charging technique, cooling time and test method! Look for high-grade cell holders from West Mountain Radio to make it easy to connect and test individual cells.

### **Internal Resistance Testing**

You can get a good idea of the quality or condition of a pack by measuring the voltage drop at different test current levels. This will give you a measure of the packs internal resistance. High internal resistance is a sign of a poor pack, one that gets hot and is inefficient.

Charge the pack, set the CBA, for example, to 11 A; assuming the battery is safe at that level. Run the test for 30 seconds and record the voltage at the end of this test. Run a test again at perhaps 1 amp for another 30 seconds and record the voltage again. If the battery has .5 volts less at 11 A than it does at 1 A use Ohms law:  $R=E/I$ . R being resistance in Ohms, E is voltage in volts and I current in amperes. The internal resistance of the pack, in this example, would be:  $R = .5/10$  or .05 ohms. Note that we used the difference in current and the difference in voltage between the two tests, 10 A and 0.5 volts. Lower resistance means that the battery will have lower voltage drop under load or it is in better condition.

## **Safety Precautions**

CBA is inherently safe but the batteries it tests are not. Anything that stores energy is potentially dangerous! A can of gasoline can be safe if treated properly but imagine what can happen. Some types of batteries are safer than others but they are all capable of causing explosions or fires.

For technical information on your battery, refer to the Battery Manufacturers web site to get detailed information on the rating of your battery. Most battery labels have limited information, but the manufacturer's web site may have more detailed information. General Information on batteries is also available on your West Mountain Radio CD. Select Battery Information and FAQ's.

### Primary safety considerations:

Never discharge a battery at a higher discharge rate than it is designed for.

Never use a battery that has poorly insulated or frayed wiring or exposed metal parts.

Never connect a battery with reverse polarity.

Never test a battery near flammable materials.

Never allow a battery reach a temperature that causes it to get so hot that it may be too hot to touch.

Recharge your batteries immediately with an appropriate battery charger after you have completed your test. Some types do not like to sit discharged for extended periods of time.

Never test or charge your batteries while unattended.

Have a fire extinguisher nearby.

### CBA operating requirements:

Never connect a battery with the polarity reversed!

Always connect the USB cable BEFORE connecting the battery!

Never connect a battery to the CBA that is connected to something else.

Contact West Mountain Radio for support before connecting to a USB hub.

Operate the CBA in a cool dry location.

Never allow metal parts or wiring of the battery come in contact with the metal heat sink.

Never allow the cooling fan to be blocked or jammed.

Do not ignore the warnings that our software may give you.

The CBA can get hot. Do not touch the metal heat sink while, or shortly after, conducting a high power test.

### Lead acid battery safety warnings:

There may not be a consideration while testing lead acid batteries but there certainly is while charging lead acid batteries. These batteries, especially automotive and marine types, give off explosive hydrogen gas when charged. A nearby or internal spark or flame can cause a lead acid battery to explode sending liquid acid and lead shrapnel in all directions. This is particularly dangerous and frequently causes blindness or severe scarring injuries.

Never use a standard lead acid battery without proper ventilation. Sealed lead acid batteries such as gelled or AGM (absorbed glass mat) types are much safer. Automotive and marine types are not safe and should be used in protective ventilated housings, such as under the hood of a car.

Never make the last connection to a lead acid battery causing a spark on the terminal. Always connect the load or charger last, and at a safe distance away from the battery.

### NiCad, NiMh, and Alkaline safety warnings:

These batteries can be dangerous also. If they are shorted out, or charged or discharged at too high a rate, they can overheat and explode. A single D size NiCad cell can actually melt a 10 penny nail, don't try this!

### Lithium safety warnings:

#### **Reprinted with permission of the Academy of Model Aeronautics**

Words in () in red were added by West Mountain Radio

#### **Lithium Battery Fires**

Lithium batteries are becoming very popular for powering the control and power systems in our models. This is true because of their very high energy density (amp-hrs/wt. ratio) compared to NiCads or other batteries. With high energy comes increased risk in their use. The, principal, risk is FIRE which can result from improper charging, crash damage, or shorting the batteries. All vendors of these batteries warn their customers of this danger and recommend extreme caution in their use. In spite of this **many** fires have occurred as a result of the use of Lithium Polymer batteries, resulting in loss of models, automobiles, and other property. Homes and garages and workshops have also burned. A lithium battery fire is **very hot** (several thousand degrees) and is an excellent initiator for ancillary (resulting) fires. Fire occurs due to contact between Lithium and oxygen in the air. **It does not need any other source of ignition, or fuel to start**, and burns almost explosively.

These batteries must be used in a manner that precludes ancillary fire. The following is recommended:

1. Store, and charge (**discharge**), in a fireproof container; never in your model.

2. Charge **(discharge)**, in a protected area devoid of combustibles. Always stand watch over the charging **(discharging)**, process. **Never leave the charging process unattended.**

3. In the event of damage from crashes, etc, carefully remove to a safe place for at least a half hour to observe. Physically damaged cells could erupt into flame, and, after sufficient time to ensure safety, should be discarded in accordance with the instructions which came with the batteries. **Never attempt to charge (discharge) a cell with physical damage**, regardless of how slight.

4. Always use chargers designed for the **specific** purpose, preferably having a fixed setting for your particular pack. Many fires occur in using selectable/adjustable chargers improperly set. Never attempt to charge Lithium cells with a charger which is not, specifically, designed for charging Lithium cells. **Never use chargers designed for Nickel Cadmium batteries.**

5. Use charging systems that monitor and control the charge state of each cell in the pack. Unbalanced cells can lead to disaster if it permits overcharge of a single cell in the pack. If the batteries show **any sign of swelling**, discontinue charging, and **remove them to a safe place outside** as they could erupt into flames.

6. Most important: **NEVER PLUG IN A BATTERY AND LEAVE IT TO CHARGE (DISCHARGE), UNATTENDED OVERNIGHT.** Serious fires have resulted from this practice.

7. Do not attempt to make your own battery packs from individual cells. These batteries CANNOT be handled and charged casually such as has been the practice for years with other types of batteries. The consequence of this practice can be very serious resulting in major property damage and/ or personal harm.

Again:

Primary safety considerations:

Never discharge a battery at a higher discharge rate than it is designed for.

Never use a battery that has poorly insulated or frayed wiring or exposed metal parts.

Never connect a battery with reverse polarity.

Never test a battery near flammable materials.

Never allow a battery reach a temperature that causes it to get so hot that it may be too hot to touch.

Recharge your batteries with an appropriate battery charger after you have completed your test.

Never test or charge your batteries while unattended.

Have a fire extinguisher nearby.

## Troubleshooting

If the CBA program indicates “No CBA units available” when opening a new test window and/or the CBA green LED or virtual LEDs are not on when a CBA is connected and the program is running you may not have correctly completed the Windows® CBA USB driver installation. Re-boot your computer. Plug the CBA back in. Repeat our hardware installation instructions and try it again.

If it still doesn't work, go to “Start” “Settings” “Control Panel” “System” and navigate to Hardware Device Manager. From the device manager scroll down to “USB Serial Bus Controllers” and expand + that list. If you see WMR CBA as a USB device, try the following. Highlight the WMR CBA, right click and un-install it. Disconnect it and plug it back in. Let Windows re-install automatically.

### **CBA does not indicate voltage**

The battery may not be connected or it is completely dead. Otherwise, you may have a damaged CBA; please contact us for support.

### **CBA gets too hot and shuts itself off**

The CBA has an internal temperature monitor is programmed to protect it from overheating when operated at maximum ratings and at normal room temperature.

Make sure that the fan is running during a test, nothing is blocking the cooling inlet and that it is being operated in a cool location. Do not use it in direct sunlight or on near a heat source, such as too near the battery you're testing.

Do not attempt to conduct successive high current tests without letting the CBA cool down and shut off its fan between tests.