BA500WIN Software Application
Version 1.5 Users Manual

Battery Metric™
www.batterymetric.com

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Read This First:

The Battery Metric analyzers together with the BA500WIN software program create a system that allows the user full control to specify many battery charge, discharge and test parameters. In addition the system has options to modify the calibration by the user. These capabilities are designed to provide the user with maximum flexibility to manage many different battery types in many different situations. This capability, by it's very nature, also creates the possibility for the user to use improper charge, discharge , test or calibration parameters. When used improperly, by accident, inadvertently, by mistake or with lack of proper knowledge and training or if the software files become damaged, the system can fail to properly manage the battery under charge, discharge or test. **This can damage batteries and as a result a battery could leak, overheat, explode or catch fire. This could create a dangerous situation involving fires, property damage, personal injury or death.**

It is expected that this system will be used with this information in mind. The user understands this situation and agrees to use due diligence when using this system. The user should only charge LiIon and LiPo batteries that have built in protection circuitry to protect against the possibility of applying improper voltage or current to the battery. Most consumer type LiIon batteries do have built in protection circuitry. If you are uncertain if the LiIon or LiPo battery has built in protection circuitry, check with the battery manufacturer. Always charge, discharge and test all batteries according to the battery manufacturer's specifications. Users should verify that proper voltages and currents are being applied with their own voltage and current measurement equipment.

This manual is a guide to operating the Battery Metric battery test modules using the BA500WIN software. It is not a training manual for understanding proper battery management, charging, discharging or testing. It is expected the user will have this knowledge. This system is a battery management platform to be used by knowledgeable trained staff. It is not a consumer type product. Read and follow all Safety Precautions listed in this manual.

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Users who purchase a Battery Metric analyzer or battery test module receive a license to use the BA500WIN software program. You must read and agree to the license agreement listed below before continuing with the use of the software.

Users who receive this software with an analyzer or download from our web site have a license to use it subject to the license agreement listed below:

Under the terms of this license N0 warranties of any kind are made with respect to the contents or functionality of this software, nor it's fitness for a particular purpose.

LaMantia Products Ltd. shall not be liable for errors in the software or documentation, or for any direct, indirect or consequential damages or financial losses arising from the use of this software or the BA500 analyzer modules. Read and follow the safety precautions specified here and recommended by the battery manufacturer. Also follow the battery manufacturer's recommended charging and discharging procedures. LaMantia Products Ltd. reserves the right to change the specifications and software without notice. Users agree to make their own determination as to the suitability of this analyzer for their particular application.

You accept the terms of this license by continuing with the use of the BA500WIN software. If you do not agree to the terms of this license then return your analyzer to your dealer within 30 days of purchase for refund. The software program BA500WIN for Windows™ and it's associated documentation are copyright © 2019 LaMantia Products Ltd. London, Ontario, Canada. All rights are reserved. Unauthorized duplication or distribution is strictly prohibited.

When using BA500WIN the Battery Metric device must always be connected to a computer running BA500WIN and the computer must not implement power saving shutdown options.

To program and use the device in stand alone mode without a computer, users will need to use the separate *Battery Console* software application.

Please read the entire users manual, supplied with your device before attempting to use it.

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OVERVIEW

A Battery Metric device is a full featured battery charger, discharger, load module and analyzer. It is controlled using a personal computer and the BA500WIN software program. This creates a very powerful system to manage your rechargeable batteries.

Not only is the Battery Metric device a full featured battery charger but it is also a cycler, tester and analyzer. You can use it to perform discharge tests to evaluate battery condition, cycle batteries to improve performance and gain insight into overall battery condition. With the programmable pulse feature you can simulate real load conditions for your batteries. This will provide insight into how various batteries will perform in your application.

You can perform repeated cycles of discharge and charge. You will be able to see the results of each cycle and determine if the battery is providing the required amount of power on each cycle. In fact you can compare cycle data and determine, without doubt, if there has been any changes in battery life.

There are several models of analyzers available from Battery Metric, each with different voltage, current and other specifications. Each analyzer will carry a more specific model number. Refer to www.batterymetric.com for the data sheet that will outline the specifications in detail for each device.

Features	Applications
● Controlled using BA500WIN Windows™ software ● USB connection to PC - Cable included ● Data collection and logging ● Programmable pulsing ● Built in fan with auto on/off ● 12 bit A/D - D/A ● Voltage measurement - 16 auto-ranges for 1mV resolution ● Expandable to 96 channels ● Precise on board constant voltage/current regulation ● Multi-chemistry design for LiIon, LiPo, SLA, NiCd, NiMH ● Optional Thermistor cable with probe for external temperature measurement is available. ● Control using “Quick Select”, custom “Profiles”, or programmable “Program” modes ● -ΔV, TCO, dT/dt, V, mAH, time and minimum current, termination options ● Constant voltage, constant current. Trickle and float charging ● Timed Absorption and Equalization features for 4 step charging of AGM lead acid batteries ● Measure Total Effective internal resistance using a dual pulse test ● Short circuit, reverse polarity and overload protection ● Auto shut down if data link stops operating or power fails	● Battery charge, discharge, cycle, trickle & float charge ● Battery capacity measurement ● Battery charge monitoring ● Warranty validation ● Quality Measurement ● Load testing & simulation with pulse options ● Battery pack commissioning ● Testing custom battery charge & management algorithms ● Battery fleet maintenance ● Battery management routines ● Creating test documentation with printed reports ● Life cycle testing ● Identify under performing batteries ● Select batteries for critical applications ● Recondition battery packs ● Validate battery manufacturer's specifications ● High speed data collection. Up to 73 samples/sec V, I, & Time ● Battery charge ● 3 step or 4 step charging algorithms ● Internal Resistance (IR) measurement

Description

The Battery Metric analyzers provide a powerful system to perform a variety of battery management tasks. This line of analyzers has many advanced features to provide users with advance testing capabilities and good value.

Supplied with the analyzer is the software program BA500WIN that is used to control the battery under test. The BA500WIN software application is used to set the test parameters and operate the analyzer with on screen buttons and controls. Special software tools also make the analyzers easy to set up and perform simple battery management tasks such as charging, cycling, capacity testing and reconditioning.

Using this software the analyzer can also be configured to perform advanced functions included special pulsing capabilities and high speed data collection.

Software Features

• BA500WIN software license included • Software & documentation available online • License includes online software updates • Windows based software • Print reports, Plot Graphs • Export data for analysis • Save session results for future reference • Programmable pulse control • Quick setup, Profiles or Program control	• Graphical display plots V, I, T or dT/dt • Log data to disk • Internal Resistance measurement • Mult-Channel view on one screen • Custom program editor • Calibration software utilities • Advanced data collection & data logging options • Manage up to 10000 cycles • Display using A & AH or mA & mAH

These analyzers require a PC running the supplied software at all times. The software can operate in the background to free your computer for other use.

When using BA500WIN the Battery Metric device must always be connected to a computer running BA500WIN and the computer must not implement power saving shutdown options.

To program and use the device in stand alone mode without a computer, users will need to use the separate ***Battery Console*** software application.

Please read the entire users manual, supplied with your device before attempting to use it.

Setup is straightforward, simply connect the Battery Metric device to your computer's USB port using the supplied USB cable. Then install the supplied software and run the BA500WIN Windows program. From the software program you select your charge and test parameters. Connect your battery pack to the device using the supplied cables. Cables will be supplied with either banana jacks or modular connectors that plug into the module. The other cable ends have alligator clips for you to connect to the **+** and **-** terminals of the battery. Users can customize the cables with their own battery connectors.

Charger Operation

Each Battery Metric device has precise on-board regulation of current and voltage. NiCd and NiMH batteries charge with a constant current flow into the battery. The current does not vary as the battery is charged and the voltage rises as the battery stores the charge. Lead Acid and Sealed Lead Acid (SLA) batteries require charging with a constant voltage and a maximum initial current limit. The initial current is limited to the value you specify, until the voltage rises to the Vreg value you specify. The voltage is then held constant to the Vreg value throughout the remainder of the charge session. The current will begin to decrease as the battery stores the charge. Charge terminates when the current drops below the minimum value you specify. Lithium Ion (LiIon) and Lithium Polymer (LiPo) batteries also use a combination of constant current and constant voltage charge method. In all cases the current will be limited to the value specified in the profile.

Before you can begin a session you need to setup the analyzer with all of the information needed to perform the desired operation. There are 3 methods used to setup a battery test session:

Select 1 of 3 methods of setup to begin a session 1./ Load Profile 2./ Quick Select 3./ Load Program	

When using the *Load Profile* or *Quick Select* method the user does not need to concern themselves with selecting the correct charging algorithm for constant current or constant voltage. BA500WIN will automatically select this for you once you select the battery type.

Once you setup up your analyzer using methods 1 or 2 you can use the onscreen *Analyzer Controls* located on the main program screen. These functions perform as detailed later in the “Analyzer Controls” section.

Alternatively you can create a custom program routine. A program is a series of steps that the analyzer will perform in sequence. Each step will be either a Charge, Discharge, Pause or IR test. With each step you can specify different parameters to create a unique battery test algorithm as required. See the *Program Routines* section in this manual for details on how to edit, load and run a program.

INSTALLATION

Analyzer Modules

To install the analyzer, use the supplied USB cable to connect the analyzer to a USB port on your computer. Connect power to the device. Depending on the model this will be an AC power cord directly or an external DC power supply. **Do not connect battery yet.**

Switch the analyzer on. You should see all three LEDs light. The red LED indicates power status. When the Charge (green) and Discharge (yellow) LED are both illuminated the analyzer is off-line. When you start the BA500WIN software the analyzer will go on-line and the green and yellow LED will go off. The analyzer cannot be used until it is on-line.

Connect your battery only after the analyzer is on-line. The red lead should be connected to the battery’s (+) terminal. The black lead should be connected to the battery’s (-) terminal. The analyzer has reverse battery protection but you need to observe the correct polarity for the unit to function properly. It is also good practice to disconnect the battery from the device before powering it down.

Installing Multiple Channels

A major feature of the system is the ability to connect any number of analyzers to meet your requirements. BA500WIN can accommodate up to 96 channels. To add more channels simply connect additional analyzer modules to other USB ports on your computer. If your computer requires more USB ports, then simply use an inexpensive USB hub to add more USB ports. The USB hub does not need to be powered.

The BA500WIN software will automatically detect how many analyzer are connected to the system. There is no need to configure the software to specify your set up situation. Using BA500WIN you can have full control of all analyzers connected to the computer. Each channel can operate simultaneously and independently from the other channels. You can also mix and match different models to suit your requirements. In BA500WIN there is a channel selector to select and control a specific channel. You can also view data from all analyzers simultaneously with the Multi-Channel view. This is great for a production environment allowing you can see the status of 24 channels in a single window.

When a device is detected by BA500WIN for the first time, it will be assigned and unique channel number. This channel number assignment will now always be dedicated for that particular device. It's helpful to label each device with the assigned number. Press F3 to see all channel assignments.

Installing BA500WIN Software

There are two ways to get the BA500WIN software program:

Download from Web Site - Visit: www.batterymetric.com and download the file - *BA500_full_installation.zip* Unzip this file into a temporary directory. This will create the necessary installation files. Then run *setup.exe*. This will start the setup program that will guide you through the installation process.

Install from supplied CD - Insert the CD in your CD tray. From the task bar select *Start - Run* and then select the setup.exe file located on the CD. Click OK to run this program. This will start the setup program that will guide you through the installation process. The CD also contains this manual in PDF format.

Installation Notes

When running BA500WIN the analyzers and the software program need to continually communicate with each other. This means that you need to ensure that your computer resources are not set to shut down after some period of inactivity. Check the power saving settings for your computer in the Windows control panel. It is ok if the monitor is shut down but the CPU and USB ports must not go into 'Sleep' mode. In the event that this happens the analyzers will go offline and all charge and discharge current will stop. You will need to restart BA500WIN and begin new sessions if this occurs.

If you encounter any problems during the installation you should check the README.TXT file located on the installation CD. This file has special notes that may be applicable to your particular Windows operating system. It also contains notes on known installation issues that you may require.

Upgrading BA500WIN Version

Visit www.batterymetric.com to check that you are running the latest version of BA500WIN. From time to time there may be updates to add new features, enhancements and program corrections. Either download and reinstall the *ba500win_install.zip* file as previously described or download the smaller executable file: *ba500win.exe*. Upgrade by using this single exe file. Just download this 1 file and replace the existing file on your PC with this new file by the same name. You should find this file on your computer at: C:\program files\BA500win\BA500win.exe The version that you are using is displayed in the top title bar of the main program screen. After upgrading, check the top title bar to ensure that your upgrade was successful and you are running the latest version.

Upgrading Device Firmware

Visit www.batterymetric.com to get the latest firmware upgrade hex file.

The firmware is the software that resides in the analyzer itself. Select: Menu/Analyzer/Details from within BA500WIN (F3) to see which version of F/W you are currently using on each channel. Firmware upgrades may provide updates to various features, enhancements and program corrections.

Press and hold the VEC switch, and at the same time turn on the power switch, to put the analyzer into update mode. When in update mode the LED's will alternate. While in update mode open the firmware hex file and load it into the device using one of the following stand alone software applications:

- For the newer MC/LC/BM series modules use the program **fwmanger.exe** to install the proper firmware. The channel number assignments may be different from BA500WIN so switch channels to find the device.

- For older BA500 series analyzers use the program **fwupdate.exe** to install the proper firmware file for this device.

Do not run either of these update programs when BA500WIN is running. Since they both need to communicate with the device to operate, running both at the same time will cause conflict errors. Load F/W into each channel one at a time. After loading the firmware in all channels be sure to power the device Off / On to exit update mode and activate the new firmware.

Starting BA500WIN Software

Start the program by selecting BA500WIN from your start menu. This will bring up the BA500WIN introductory screen. To continue you must read and agree to the license agreement. Use of the BA500WIN software is subject to this agreement. This agreement includes acknowledgment of the dangers and risks that are present if you were to improperly charge or discharge batteries for any reason.
Please see "Read This First on page 2 and the *Safety Precautions* outlined in this manual.

If you agree to the terms and conditions, of the software agreement, then continue by selecting: "*I Agree*"

You will know that the analyzer and software are installed correctly when the Status bar on the main program screen reads *Ready* and the power indicator on the PC is red. Also the charge (green) and the discharge (yellow) LED's on the analyzer should be off. This indicates that the analyzer in online and communicating with the computer. The software will initially load showing channel 1 on the main control screen.

Only when the analyzer is online and you can read the battery voltage on the screen can you begin to use the analyzer.

At this point, if you connect a battery to the analyzer you should be able to read the battery voltage on the computer screen. Always observe the correct polarity when connecting batteries to the analyzer. Red is positive (+) and Black is negative (-).

If at any time the analyzers lose communication with the computer they will go off-line. This will occur approximately 40 seconds after the loss of communications. Any battery session in progress will be terminated. All charge or discharge current will stop and the *charge* and *discharge* LED's will illuminate to indicate an off-line situation.

This is designed to protect any batteries that may be connected to a PC that stops operating for any reason. This can include computer crashes, lockup or loss of power. You will need to restart the software application to restore data communications.

Note: All MC, BM, LC and BA500 series Battery Metric devices are factory calibrated and supplied with a calibration certificate. Calibration is traceable to national standards administered by the U.S. NIST. If however you require calibration to a particular standard, for your specific quality control procedures, then you may choose to calibrate it yourself to your standard. BA500WIN includes software tools to allow you to calibrate the Voltage measurement, Voltage regulation, Current measurement & Current regulation. All calibration data, including factory calibration and user calibration data is stored in flash memory in the device. This calibration data then stays with the analyzer and is available even if the analyzer is moved to a different computer. At any time you may choose to restore the factory calibration data. Even if you re-calibrate you can always choose to revert back to the original factory calibration at any time. See *Calibration* section later in this manual for more information.

Battery Metric also offers a calibration service. Contact Battery Metric for more information.

USING THE ANALYZER

Safety Precautions

Rechargeable batteries can store tremendous amounts of energy. This can be a fire hazard or result in bodily injury, property damage and death if mistreated. If at any time you need to stop the analyzer simply click the on-screen *Reset* button. This will halt all charge and discharge current and return the analyzer to an idle state.

Observe the following precautions:

- Only use this charger to charge secondary rechargeable batteries. Other types of batteries may burst causing personal injury and damage.
- The device should not be used for charging any kind of primary cells, including reusable alkaline batteries. It can be used to discharge primary batteries.
- Always follow the battery manufacturer's recommended charging and discharging requirements.
- Never short-circuit the terminals of a battery.
- Do not leave batteries unattended while charging. This is especially true for LiIon and LiPo battery types. These battery types can explode and cause fires, damage property, cause personal injury and death.

- Consider using an explosion and fire resistance container to house the battery under test if required. This may include but is not limited to charging LiIon and LiPo batteries in instances where the batteries' protection circuitry is suspect or under test.
- Do not defeat any special protection features or circuitry in the battery or battery pack.
- Use your own voltage and measurement equipment to verify current and voltage calibration. Re-calibrate if required.
- Only charge LiIon and LiPo batteries that have built in protection circuitry to protect the battery from improper voltages and currents that may be applied for any reason.
- Always observe correct polarity when connecting batteries.
- Remove batteries from your equipment. Do not connect your electronic equipment to a Battery Metric device. Failure to do so could damage your equipment and will void the warranty.
- Keep the charger in a well ventilated location such as on a table top or open shelf. The device will generate heat during use and as such should not be used in an enclosed area. Do not use it in an enclosed cabinet or tight shelf area. Keep power supplies well spaced and ventilated.
- Only connect batteries once the software program is running and the analyzer is on-line.
- Disconnect batteries when the PC or analyzer is not in use.
- Only use the charger in a dry location.
- Do not connect a battery with a voltage greater than the analyzer's rated voltage.

Data Collection

The analyzer stores up to 7 samples in the analyzer's internal memory. This sample data is then transferred to the PC when the PC polls for this data. Each sample consists 1 voltage, current and time measurement. There is also other operational information transferred from the device to the PC with each poll.

Control the frequency of samples taken by the analyzer in the options panel. Specify from 1 to 76 samples/second in 1 of 16 discrete values. These discrete values are the only values available. You must choose from one of these. The default is 4 samples/second. This is the number of samples/second taken by the analyzer and stored in the analyzer until transferred to the PC when polled.

Control the polling interval in the options panel. Select one of the listed intervals or specify your own. This is the time interval that elapses between each poll. When the polling interval time has elapsed the PC will send a request to the analyzers to report the data that has been collected. The default poll interval is 1 second. For example if you have the sample rate set to 4/sec and the polling interval set to 1 second, the PC will receive 4 data samples each second from the analyzer.

If you set the polling interval too long then the analyzer may begin to overwrite data in memory that has not been polled by the PC. In this case you will see the OVERFLOW indicator come on at the bottom of the screen in the status bar. This does not represent any problem. It simply means that some data is lost so your collected data may not be evenly spaced in time. There will be some time gaps.

What you need to do is adjust the sample rate and polling interval so that you get the desired samples/second without overflows. The maximum data rate can be dependent on the processing speed of you computer. Users will want to adjust these items to suit their situation and requirements. At the bottom of the screen, in the status bar, there is an indicator displaying the average number of samples per second the system is collecting. This is just a tool to help you optimize your data collection.

Note that the actual polling interval and data transfer rate (samples/second received by the PC) is not exact because the PC can sometimes be busy with other tasks. This is why you might occasionally see an overflow and why the Data Rate indicator fluctuates slightly. The actual time recorded with each sample is accurate because this is recorded, stored and transferred from the analyzer with each data sample.

You can view the data uploaded with each poll in the *Data Packet View* window. This window lets you visually see how close you are to overflowing the samples. Note that with short duration polling intervals, keeping this window open can slow down the data transfer resulting in data overflows and reduced data transfer rate. This window is designed just to see how things are operating to help you adjust your data collection.

If you don't need high speed data collection you can select a low sample rate and longer poll interval to save computer resources for other applications. See Section 6 for more information regarding *Data Collection Management.*

Front Panel LED's

These LED's indicate the present status of the analyzer. There are three LEDs:

Red - Power is on	Green - Analyzer is charging	Yellow - Analyzer is discharging

When you power up the analyzer all three LED's will come on. As soon as communications with the PC software starts the Charge and Discharge LED's will go off. You now know that the communications link has been established and you are ready to control the analyzer. If communications with the PC is lost for any reason the analyzer will time-out after about 40 seconds. At this time, all charging and discharging current will stop. The green and yellow LED's will illuminate and the analyzer will go off-line. This is a fail safe mechanism to protect the battery from possible damage.

Temperature Probe Cable

The optional temperature probe can be used to monitoring the temperature of batteries under test. The probe consists of a 10K thermistor on the end of a cable. The other end of the cable has a plug that connects to the TEMP input on the device. The probe can be attached to the battery with tape. Simply tape the end of the probe to the side of the battery pack and plug the cable into the analyzer. This will allow temperature data to be continually recorded.
There are two conditions under which a charge will terminate due to temperature:

1. The temperature exceeds the temperature cutoff limit (TCO) specified in the selected *Profile*.
2. The rate of temperature rise (dT/dt) per minute exceeds the value specified in the selected *Profile*.

It is not necessary to use the temperature probe. This is an option for charge termination and battery protection to prevent battery overheating. TCO and dT/dt is not used to terminate discharging. The thermistor is not a precision thermometer. Comparing the thermistor temperature reading to another thermometer requires care. You need to use a proper thermometer, ensure there is no air movement and that the temperature is not increasing or decreasing. IR type thermometers may not be able to read the exact location of the thermistor.

Fan

The built in fan is designed to remove heat from the analyzer enclosure. Heat can be generated during charge or discharge sessions. The fan is controlled by an auto on/off circuit so that the fan only operates when the internal temperature is above the threshold point. If the fan becomes damaged or compromised in any way, do not operate the unit. The analyzer will be permanently damaged by over heating. Do not use the analyzer in an enclosure or tight fitting shelf. Leave sufficient clearance for the warm air to escape. Also do not operate the analyzer under extremely hot conditions. The specifications for the analyzers are given based on an ambient air temperature of 25°C.

Power Limits

The BM devices have some regulator power limits. If the power limits are exceeded the analyzer will be shut down to avoid over heating. There is heat generated during both charging and discharging as follows:

Charging The analyzer employs a linear charge regulator. As such the heat generated while regulating the charge current can be calculated as: **P = (Vps-Vbat) x Ireg**
This charge regulator power is how much power the analyzer's internal regulator needs to dissipate to regulate current at the desired value. It is not a measure of how much power is being delivered to the battery. This charge power limit could becomes evident when charging low voltage batteries with a higher voltage analyzer at high current. In the event you experience an *Overload* situation while charging you will need to decrease the charge current or use a battery with a higher terminal voltage. If you experience an *Overload* situation while performing the charge calibration you will need to use a battery with a higher terminal voltage.

Discharging The heat generated during discharge can be calculated as: **P = Vbat x Ireg**
This is equal to how much power the battery is delivering. All of this power is dissipated as heat using the analyzer's internal heat sink and fan. In the event you experience an *Overload* situation while discharging you will need to decrease the discharge current.

(**P** is the power dissipated in Watts, **Vps** is the DC voltage of the power supply, **Vbat** is the battery voltage at any given time, **Ireg** is the charge current in effect)

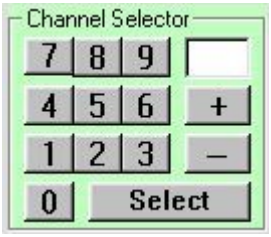
Auto Shutdown Feature

In the event that the AC power is interrupted, the device will reset and all charge and discharge current will stop. When the power is restored the device will power up, but charge and discharge current will remain off. This protects the batteries against over charging or discharging. Since the analyzer must continually report data to the computer, the analyzer will shut down in the event the BA500WIN program stops running. This could be the result of closing the program, shutting down the computer, computer going into power saving sleep mode, computer lockup or software failure. After 40 seconds of inactivity, from the host computer, the device will automatically shut down. All charge and discharge current will stop and all 3 LEDs will be ON indicating an Off-Line status.

In order to resume the session you need to restart the BA500Win program and begin a new session. Any data lost as a result of the power outage or computer failure can be retrieved by viewing the backup file if you had the Auto Backup feature option enabled prior to the failure. See the section on the Auto Backup for more information.

Using Multiple Channels

The Battery Metric system is designed to be expandable. You can add additional analyzer modules to the system. Each module can manage 1 battery or battery pack. Each analyzer is managed as a separate channel. All analyzers in a multi-channel system are completely independent and can operate simultaneously. This means you can load different profiles and have different types of batteries and sessions operating simultaneously. The BA500WIN software supports up to 96 channels. You can also mix and match different Battery Metric devices on the same computer. This can give you a variety of voltage and current capabilities.



Use the *Channel Selector* + and – buttons to conveniently move from one channel to the other. Use the keyboard number pad to quickly select any channel.

The main screen shows all the details for the presently selected channel. The channel number of the presently selected channel appears in the top field in the main screen.

Note: When using multiple channels be careful not to interchange the black (-) leads. These are not ground. The black lead from each channel can be at slightly different potentials. Interchanging the leads by mistake can result in inaccurate measurements and improper operation. It is a good idea to mark each analyzer with a channel number. This will make it easier for the operator to identify which battery is on which channel when using the system.

CHARGING

The BA500WIN supports charging for :

- Nickel Cadmium (NiCd)
- Nickel Metal Hydride (NiMH)
- Lithium Ion (LiIon) / Lithium Polymer (LiPo)
- Sealed Lead Acid or Lead Acid (SLA)

Charging NiCd

NiCd batteries are charged with a constant current as specified in the profile. This constant current continues until one of the charge termination methods stops charging.

Charging NiMH

NiMH batteries are charged with a constant current as specified in the profile. This constant current continues until one of the charge termination methods stops charging.

Note that when charging NiMH batteries the IR resistance can drop during the charge. This decrease in the IR will mean that the battery voltage will also decrease. Normally this is slight and with the natural increase in voltage may never be noticed. However in some cases of very depleted cells this voltage drop due to IR drop can actually cause a -dV charge termination. In these instances you should increase the -dV to avoid the premature charge termination.

Charging SLA

SLA batteries are charged in constant voltage with a maximum current limit. When charging begins you may see an initial period when the charging is limited by the current limit specified in the profile. This constant current will continue until the voltage rises up to the desired Vreg value specified. Once the voltage rises to this upper limit the charge will then automatically switch to a constant voltage mode. Charging will continue in this constant voltage mode and the current will begin to drop as the battery accepts the charge. Once the current drops below a minimum value specified in the profile, the charge will be considered complete and charge termination will occur. Choose current and voltage limits as specified by the manufacturer of the battery.

Charging LiIon, LiPo

LiIon batteries require a special charging methodology to avoid having the voltage rise above the maximum allowable. The BA500WIN will automatically apply the required charging method as follows:

1. If voltage is less than 1.0 V/Cell charging is not allowed because the battery is damaged. The battery should be replaced.
2. If the voltage is between 1 and 2.45 V/Cell then charging will proceed at a low level. This will be 50mA of constant current. This rate of charge will continue until the voltage rises to 2.45 V / Cell. This is for LiIon safety. The battery should be charged at this low rate until the battery voltage moves to the proper range. There could be several reasons why the battery voltage is too low. The battery could be damaged, over discharged or the protection circuitry inside the battery may have tripped preventing current from going in and/or out of the battery. So it is possible that the battery will not even accept 50mA and the voltage may never come into the proper zone if the battery is defective. Also be sure that you have performed a proper voltage calibration. If the calibration is off then the battery voltage could falsely appear as if it is out of range.
3. When the voltage exceeds 2.45V/cell charging will proceed at a constant current. This is the *Charge Current* value specified in the profile. Use this value to limit the initial current to any desired value. This will continue until to voltage rises to the value specified as *Voltage Reg* in the profile. (Usually 4.2V/cell)
4. When the voltage reaches the desired *Voltage Reg* value the analyzer will switch to constant voltage at the *Voltage Reg* value. This will continue and the current will begin to decrease as the battery continues to charge. When the current drops below the *Minimum Current* specified in the profile, the charge is complete and will terminate.

CHARGE TERMINATION

There are many different charge termination options. Some of these are inherent in the system while others are controlled by making adjustments to the *Profile*. Batteries can often act in unexpected ways so it is important to use as many charge termination methods as possible. With experience you will learn how to maximize the benefits of the various termination methods.

Neg Delta V Termination

(-dV) When a NiCd or NiMH battery reaches a full charge situation the voltage will begin to drop and the battery temperature will rise. The amount of voltage drop below the session's maximum will be measured. When this value equals or exceeds the *Neg Delta V* specified in the *profile* the charge will terminate.

Note that if you use a low current, the battery may not experience enough voltage drop to generate this termination. This is why there are several charge termination methods. If you are not getting -dV termination when you expect you can increase the charge current or decrease the -dV value or use a time limit termination.

If the Neg Delta V is set too low you could experience premature charge termination. Typical -dV values to use are:

NiCd - 0.015 V/Cell NiMH -0.012 V/Cell

Note that the *Neg Delta V* voltage you specify in the profile is total voltage. This is not the per cell voltage. For example for a 4 cell NiCd you would enter 0.06 V.

LiPo & other similar battery types have similar charge and discharge characteristics as LiIon batteries. When testing these batteries you just select LiIon for battery type in the profile.
Only charge LiIon & LiPo batteries that have built in protection circuitry. This will protect the battery in the event improper parameters are applied for any reason. See notice called "*Read This First*" on page 2 and S*afety Precautions* outlined previously in this manual regarding these types of batteries.

Temperature Cutoff

(TCO) You can attach the optional temperature probe to your battery. Taping this to the battery or battery pack works well. This will then allow the analyzer to constantly measure the battery temperature. When a NiCd or NiMH battery reaches full charge the temperature will begin to rise. If the charge is allowed to continue past the point of full charge, excessive heating of the battery will occur. This can be damaging to the battery and be a safety hazard.

The TCO termination options allows you to automatically have the charge terminated if the battery temperature rises above the upper limit. Use the *Profile* to specify the TCO temperature limit in C . Setting this value to 0 will disable the TCO option. It is recommended that you use this feature as a fail safe mechanism. TCO is typically used for NiCd and NiMH battery types. Other battery types should not heat appreciably if charged correctly. TCO and dT/dt is not used to terminate during discharge.

Time Limits

Time limits can also be used to create timed charges. This can be used for termination or fail-safe protection. Normally it would be better to use the other more sophisticated methods to detect full charge. However it can be used by setting the time limits in the *Profile*. Time limits are a benefit in providing additional safe guards against over charging. If you have an expectation of how long a charge session should normally take, you can then set the time limit to some value just slightly greater than the expected time. This will then generate a charge termination in the event that the charge did not terminate normally with any of the other charge termination methods.

dT/dt

This is the rate of temperature rise. Once a battery is nearing a full charge situation the battery temperature will start to rise dramatically. This increase in the rate of temperature rise can be used to terminate the charge just as it approaches a full charge situation. This helps to keep the battery from overcharging and prevents battery deterioration.

The BA500WIN will monitor the temperature and calculate the rate of temperature rise per minute. To use this feature, connect the temperature probe to the battery and specify the dT/dt value in the Profile. Typically you would use 2 or 3 ºC/Min. NiMH experience greater temperature increases than NiCd. Setting this value to 0 in the *Profile* will disable the dT/dt option. It is recommended that you use this feature as a fail safe mechanism.

dT/dt is typically used for NiCd and NiMH battery types. Other battery types should not heat appreciably if charged correctly.

Maximum Charge Input

During charge the charge input is calculated in mAH. The analyzer will stop the charge for NiCd or NiMH batteries if the charge input exceeds the following: NiCd - 140% of capacity NiMH - 130% of capacity

These values are inherent in the system and cannot be changed. These values are sufficient to fully charge the battery but provide extra protection from over charging. Also there are fields in the Profiles that you can use to specify a maximum mAH. This provides the option to terminate charge or discharge based on an maximum input or output charge.

Minimum Current

During the constant voltage portion of a LiIon, LiPO, LFP or SLA charge session the current will drop as the battery accepts the charge. In the profile you can specify the minimum current value that will generate a charge termination. By using a lower value you will apply more charge to the battery but the charge time will increase. Select a value that provides a reasonable balance. C/50 would be typical. Once the charge current drops low there is less and less benefit of continuing with the charge. For other battery types this value is not used and can be left blank.

DISCHARGING

The analyzer can be used to discharge any type of battery. This is used to measure the output from the battery to measure the capacity of the battery. The analyzer will regulate a constant current flow from the battery and use this together with the elapsed time to report the output of the battery in mAH. See **Capacity Rating** Section for more information on understanding the mAH value.

Constant Current Discharging

Normally you use a constant current to do all your discharge testing. The current used during discharge is the value specified in the profile you are using. As the battery is discharged current continues to flow from the battery and the voltage will drop. This will continue until the battery voltage drops down to the lower *Discharge Cut-Off* voltage specified in the profile. The following values can be used as a guide but you should consult the battery manufacturer's recommended lower cutoff voltage. Discharging the battery to a voltage that is too low may damage the battery. Typical Discharge Cut-off voltages are: NiCd-1.0 V/cell, NiMH-1.0 V/cell, SLA-1.75 V/cell, LiIon/LiPo-3.0 V/cell

Note that the *Discharge Cut-Off* voltage you specify in the profile is total voltage. Not the per cell voltage. For example when discharging a 4 cell NiCd enter 4.0 volts.

You can discharge primary (non rechargeable) cells in order to measure the capacity. To do this you can select the Primary battery type in the selected Profile or Quick Select. Selecting this battery type will not allow charging. Do not charge this battery type. Charging primary batteries can be dangerous and cause explosion or fire.

Constant Power Discharging

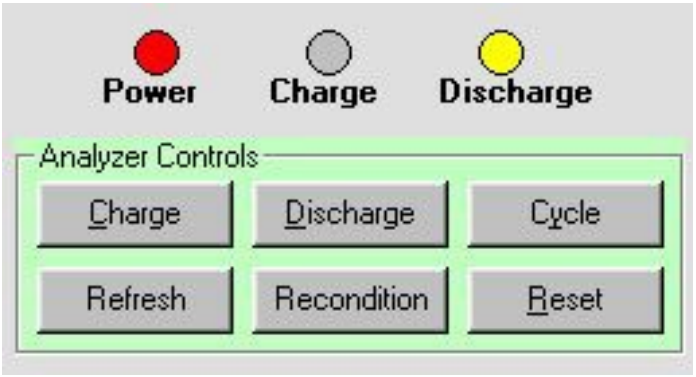
It's possible to have the discharge test proceed at a constant rate of discharge power (Wreg), rather than at a constant rate of current. With this option enabled the discharge current will increase as the battery voltage drops in order to maintain the constant power output from the battery. This feature may be used in order to simulate some load conditions a battery may experience.

In order to use this feature specify a constant power value in the profile you wish to use. Enter this value in Watts. See *Profile Selection - Options - Wreg Discharge*.

Any value other than 0 will enable the Wreg option during all discharges. Entering 0 in this field will disable the feature and all discharge sessions will default to constant current (Ireg).

Using the BA500WIN Software

Analyzer Controls



Located on the lower left of the main control screen are the *Analyzer Controls* that are used to begin any session.

After setting up an analyzer by using *Quick Select* or *Detailed Profile,* the on screen *Status* should read *Ready*. When you see this, the analyzer is ready to begin a session. There are 5 session types to choose from.

1 - Charge: This will charge the battery. The charge termination type will vary depending on items in the *Profile*. Using the *Options* you can elect to insert an IR measurement following the charge.

2 - Discharge: This will discharge the battery. The discharge will be a constant current discharge. The amount of current is specified in the profile you selected. Discharging will continue until the battery voltage drops below the *Discharge Cutoff* voltage specified in the *Profile*.

3 - Cycle: This will cycle a battery. One cycle consists of a discharge followed by a charge. The cycles will continue one after the other until the number of cycles specified in the *Profile* are completed. Using the *Options* you can elect to insert pauses and IR measurements between cycles.

4 - Refresh: This will perform one discharge followed by one charge. You can use this rather than charge if you would like to perform a charge from a fully discharged battery. This can exercise a NiCd battery. You can also use this type of session to measure the remaining charge in a battery following use in your application. This can give you an idea of how much remaining time was available from the battery in your application. This is useful for planing your battery charging

routines to prevent unexpected battery exhaustion in the future. From a fully charged state a Refresh session can be used to perform a discharge to measure the output (capacity) and then perform a full charge. This is a 1 cycle test session.

5 - Recondition: This is the same as Cycle except that following each discharge the analyzer will begin a secondary discharge (recondition) to 0.4 V/Cell. This reconditioning discharge to a very low value will be a constant current at a C/10 rate. Where C is the rated capacity of the battery. This session type is only allowed for NiCd and NiMH batteries.

Recondition may restore a NiCd or NiMH battery that is under performing. This should only be performed in the event that the battery is failing to deliver sufficient capacity. It should not be performed on properly operating batteries. However in the event of premature battery failure you may be able to restore the battery to acceptable levels. A recondition should be attempted before discarding NiCd or NiMH batteries. It may improve performance by re-balancing the cells in a pack.

Reset: This will stop a session, clear all data, graph and results. If, at any time, you want to halt a session simply click this button. *Reset* will not clear the profile. You can begin a new session after selecting reset without having to reload a profile. **The Reset button will be used often as you experiment with various settings. This is also the emergency stop !**

Menu Items

File - Open: Open a previously saved session. When a session is opened from a file it is opened as channel 0. Channel 0 is not an active channel. It is simply the area for viewing saved sessions. You will notice that some of the controls are disabled. This will remind you that you cannot control a battery from this channel. Sessions are saved with a file format of *.ba5. You can only open these file types. When you open a saved session you can view the graph and results. You can also print reports and export data.

File - Save: This will open the file save dialog box that will allow you to save the session's results. At any time during or after a session it can be saved for future reference. You can only save it with a file type of *.ba5. If you want to save session data, you must save it before pressing *Reset* for that channel, otherwise all the data and results will be lost.

File - Delete: This will open a file open dialog box. Use this dialog box to select a file for deletion. Delete any file type.

File – Quit (F1): This will clear all data, shut down all analyzers and exit the program.

Analyzer - Options(F2): Use this to open the *Options* window.

Analyzer - Details(F3): Opens the *Analyzer Details* window displaying all model numbers, F/W versions & channel assignments. This includes all devices on the system.

Analyzer - Multi-Channel View(F4): Opens a display window to see information & control all channels simultaneously.

Analyzer - Internal Resistance(F5): Used to display IR results or run an IR test. See *Internal Resistance Measurement*.

Analyzer - Lead Resistance: View or update LR value for the current channel. See *Lead Resistance* section for details.

Analyzer - Data Packet View: The *Datapacket View* window is convenient for watching data transmission.

Analyzer - Manual Control: Opens manual current control window. See *Manual Control* section for details.

Analyzer – Battery Adapter: Displays information about the optional battery adapter currently in use.

Programs - Edit Programs: Create, edit and save program details. See *Program Routines* for details on using programs.

Programs - Load Programs: Load a saved program so that it and be run.

Programs - Delete Programs: Use this to delete programs no longer required.

Programs - Run Programs: Start executing the loaded program. The program will now direct the analyzer to run through the series of steps as defined in the program routine.

Analyzer - Voltage Calibration: Open the voltage *Calibration* tool. See *Calibration* section for details.

Analyzer - Charge Current Calibration: Open the Charge Current *Calibration* tool. See *Calibration* section for details.

Analyzer - Discharge Current Calibration: Open the Discharge Current *Calibration* tool. See *Calibration* section for details.

Analyzer - Restore Factory Calibration: Delete user calibration data & revert back to global original factory cal data.

Reports - Print Charge Report: Use this to print a report for a *Charge* session.

Reports - Print Discharge Report: Use this to print a report for a *Discharge* session.

Reports - Print Cycle Report: Use this to print a report for a *Cycle* session.

Reports - Print Program Report: Use this to print a report during or after a Programmed Session.

Reports - Print Battery Label: Use this to print a small label with battery performance information that can be affixed to a battery. See *Printing Battery Labels* section for details on creating battery labels.

Reports - Edit Report Notes: Use this to enter a note that will appear on the printed reports instead of the memo specified in the Profile. This could be used by the operator to enter comments just prior to printing the report. For example you may want to keep the printed reports for a record of the test. You can then enter a battery name, serial number or other detail that you want included on the printed report.

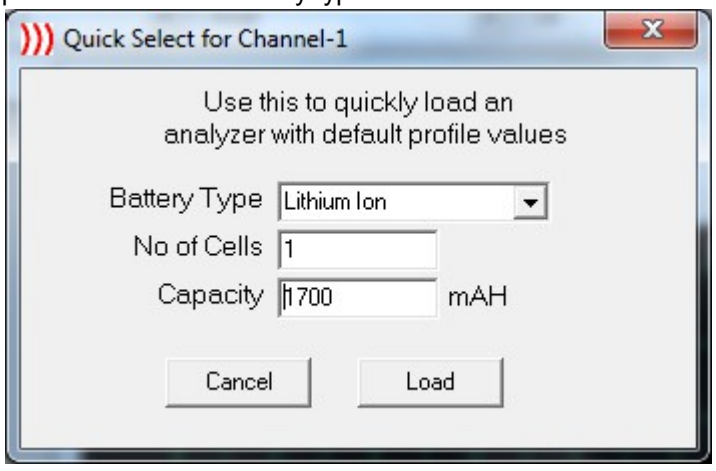
Reports - Footer: This will open a window that you can use to specify the footer that will appear on your printed reports. This can be used to enter company or any other contact information.

Reports - About: Use this to open the *About* window. This displays BA500WIN software version and copyright details.

Quick Select

You need to setup the analyzer before a battery session can begin. The quickest and easiest way to do this, is to setup the analyzer using the *Quick Select* method. This will load default parameters for the battery type selected.

***Quick Select* Window**



With this method of analyzer setup there are only 3 entries required. All 3 fields are mandatory and must be completed.

Battery Type: Select the battery type (chemistry) being tested. You must always ensure that you have the battery type set correctly for proper operation. The available battery types are:

- NiCd
- NiMH
- LiIon (also used for LiPo)
- SLA
- Primary (non-rechargeable)

No of Cells: This is the number of cells connected in series. Note that you can determine the number of cells in a battery pack by dividing the rated voltage of the battery pack by the voltage per cell. The voltage per cell varies by battery type as follows:

Volts per Cell by battery type	Examples
NiCd - 1.2 V NiMH - 1.2 V LiIon - 3.6 or 3.7 V SLA - 2 V Primary - 1.5 V	9.6 V NiCd - 8 cells in series 7.2 V NiMH - 6 cells in series 1.2 V NiMH - 1 single cell 3.6 V LiIon - 1 single cell 12 V SLA - 6 cells in series etc.

Capacity: This is the manufacturer's rated capacity for the battery. This figure will often be printed on the battery. In the event that you do not know this value you can enter an estimate and then use BA500WIN to actually calculate the capacity. The capacity determined this way can then be used in subsequent sessions.

After entering these three items, simply click *Done* to load the analyzer with a set of default values. The default values depend on the battery type as follows:

NiCd	NiMH	LiIon	SLA	PRIMARY
Charge Current - C/10 mA Discharge Current - C/5 mA Discharge Cutoff - 1.0 V / Cell -delta V - 15 mV / Cell Trickle Current - C/50 mA	Charge Current - C/10 mA Discharge Current - C/5 mA Discharge Cutoff - 1.0 V / Cell -delta V -12 mV / Cell	Max Charge Current - C/10 mA Discharge Current -C/5 mA Discharge Cutoff -3.0 V / Cell Voltage Reg - 4.2 V / Cell I-Min (Crg Term) - C/100 mA	Max Charge Current - C/5 mA Discharge Current - C/20 mA Discharge Cutoff -1.75 V / Cell Voltage Reg -2.45 V / Cell I-Min (Crg Term) - C/100 mA Float Voltage -2.25 V / Cell	Discharge Current -C/5 mA Discharge Cutoff -1.0 V / Cell

To change a *Quick Select* entries, once a session begins, you will need to reset the session and begin a new session.

Profile Selection

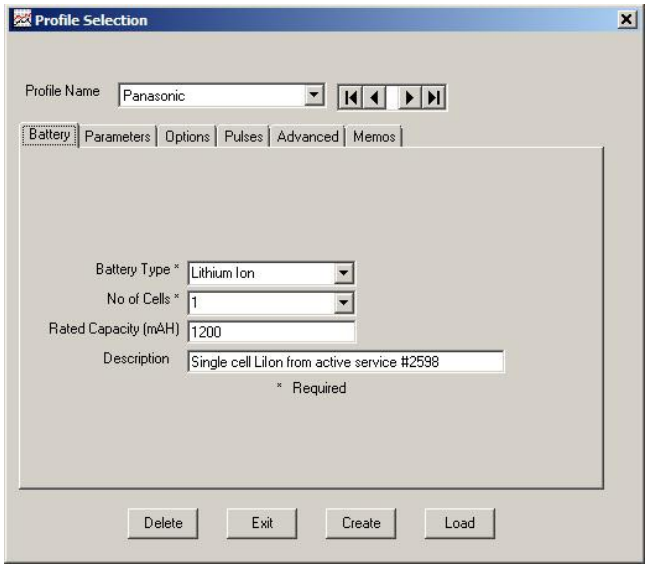
You need to setup the analyzer before a battery test session can begin. An alternate to the *Quick Select* method is the *Load Profile* method. By loading a profile you have complete control over all the test parameters.

Enter the *Profile* control panel by clicking *Load Profile* button. This will display an area to adjust various profile parameters and options. These are grouped together under various tabs. Some fields in each tab are mandatory. Failure to enter a required value will result in a notification window when you try to select the profile for use. Enter or correct the value.

The profiles are collected with a designated name in a database. These profiles, once created, can be loaded over and over again for any channel without having to re-enter the data. When you enter the Profile Selection window you can *Create*, *Delete* or *Modify* profiles in your profile database. To create a new profile click "Create" and then enter the new "Profile Name" in the upper field. At this point a new profile will be created and you can now enter the various parameters.

To load an existing profile simply enter the Profile Selection window. Use the *Profile Name* drop down selector to select the desired profile. This opens the profile for viewing or loading for use with the presently selected channel.

Clicking select when a session is in progress on the presently selected channel will reset the session and clear all the data. If you wish to browse or modify your profile data base during a session simply open the Profile Selection window. Make your changes and then click done. This will close the database and leave the presently selected channel unaffected.



Note that you cannot modify any parameters for a channel with a session in progress. If, during a session in progress, you want to change test parameters, you will need to reset the session, adjust and then select (load) the new profile then restart a new session. For some assistance with selecting the parameters for your particular battery see the document: **BA500Example_Parameters.pdf** This document is on your setup CD and provides some additional help in choosing the profile parameters for various battery types.

Battery

Battery Type: This is a required field. Select the battery type (chemistry) for which this profile will be used. This information will be used by the analyzer for many aspects of the analyzer and software operation. You must always ensure that you have the battery type set correctly for proper operation. The available battery types are: NiCd, NiMH, LiIon(LiPo) , SLA and Primary (Non-Rechargeable)

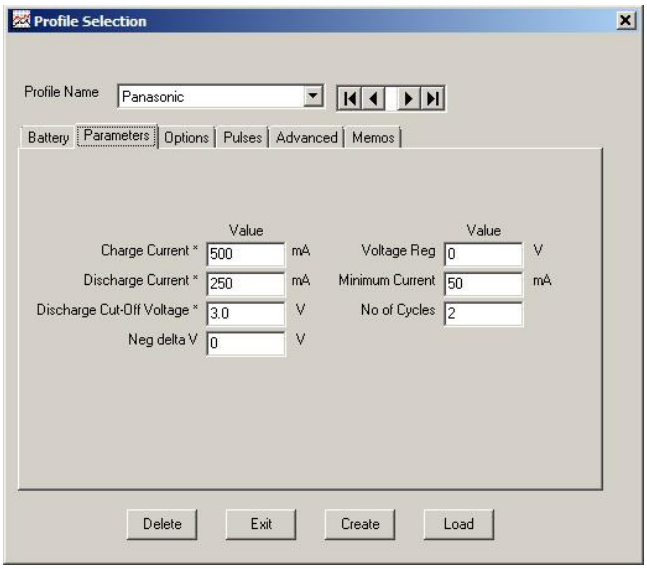
No of Cells: This is the number of cells connected in series. This is a required field.
Note that you can determine the number of cells in a battery pack by dividing the rated voltage of the battery pack by the voltage per cell. The voltage per cell varies by battery type as follows:
If you have a battery pack consisting of cells in parallel and series you should enter the number of cells in series. For

example if you have an 8 cell 9.6V NiCd pack consisting of 2 parallel groups of 4 cells in series (4S2P), enter 4 as the number of cells.

Rated Capacity: This is the manufacturer's rated capacity for the battery. This is a required field and is entered in mAH. This will be used for many aspects of the analyzer and software operation and is a required field. For example this is required for the calculation of *% of Capacity*. The rated capacity will often be printed on the battery. In the event that you do not know this value you can enter an estimate and then use BA500WIN to actually calculate the capacity. The capacity determined this way can then be entered into the profile for subsequent sessions.

Description: Any information that helps describe the profile or battery. This will be printed on the reports.

Parameters



Charge Current: This is the desired charge current for the profile. Use of the parameter varies by battery type:

NiCd & NiMH- This is the constant current that is applied during the entire charge.

LiIon - This is the current that is applied during the constant current portion of the charge. Once the LiIon battery voltage goes above the *Voltage Reg* limit the analyzer will switch to constant voltage and the charge current will drop below this maximum.

SLA - This is the maximum current that will be allowed. This provides a current limit to avoid excessively high initial currents. This is important for the first part of a charge. Once the SLA battery voltage reaches the *Voltage Reg* limit the analyzer will switch to constant voltage and the charge current will drop below this maximum.

Primary - Charging of primary batteries is not allowed. This value does not apply.

In no case will the charge current will exceed this value.

Discharge Current: This is the desired discharge constant current value for all battery types. This is a required field. All sessions normally use a constant current during discharge. The only exception to this is if you specify a value in the optional Wreg field.

Discharge Cut-Off Voltage: This is the low voltage limit for discharge. During a discharge the battery will continue discharging until the voltage drops to this lower limit. This is a required field.

Enter the total battery pack discharge cut-off voltage. Not the per cell voltage. e.g. for a 10 cell NiCd if you want to discharge to 1.0 V/Cell then enter 10 in this field. It is a total value, NOT a per cell value.

Neg delta V: For NiCd and NiMH this is the amount of voltage drop that will terminate the charge. These battery types normally experience a voltage drop from peak once fully charged. This can be used to detect the full charge situation and cause termination. Typical values that you can use are: NiCd = 0.015 V/Cell NiMH = 0.012 V/Cell

Note that the *Neg Delta V* voltage you specify in the profile is total voltage. This is not the per cell voltage. For example for a 5 cell NiMH you would enter 0.06 V. For other battery types this value is not used and can be left as zero.

Voltage Reg: This is the desired constant voltage to be applied to the battery during the constant voltage portion of a LiIon or SLA charge. Note that the maximum current specified in the *Charge Current* may override this value temporarily during a charge to limit the current. For other battery types this value is not used and can be left blank.

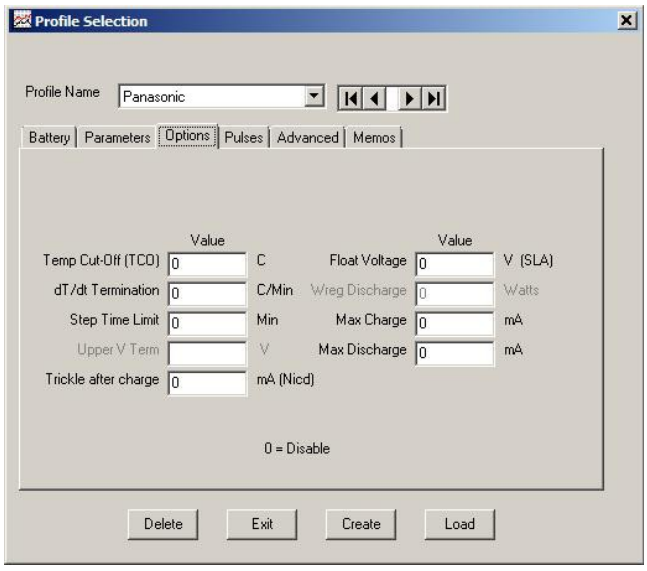
Enter the total battery pack Vreg voltage (not the per cell voltage).
e.g. for a 6 cell SLA, if you want to charge at 2.45 V/Cell then enter 14.7 in this field.
e.g. for a 2 cell LiIon, if you want to charge at 4.2 V/Cell then enter 8.4 in this field.

Minimum Current: During the constant voltage portion of a LiIon or SLA charge the current will drop as the battery accepts the charge. The *Minimum Current* value is used to terminate the charge. Once the charge current drops down to this value the charge will terminate. By using a lower value you will apply a longer charge to the battery but the charge time will increase. Select a value that provides a reasonable balance. Once the charge current drops low there is less and less benefit to continuing with the charge. For other battery types this value is not used and can be left blank.

No of Cycles: This is the number of cycles that will be executed during a *Cycle* session.

Options

Temp Cut-Off (TCO): This value will cause a charge to terminate if the battery temperature rises above this value. This provides a safety mechanism to avoid overheating the battery. Enter the TCO temperature in C. Entering 0 will disable this option.



dT/dt Termination: When using the temperature probe the analyzer will calculate the rate of temperature rise (dT/dt). This can be used to terminate a charge. NiMH and NiCd batteries will exhibit a significant increase in the rate of temperature rise when the battery reaches full charge. This can be used to terminate the charge and avoid overcharge and overheating. Enter the value in ºC/Min. For example you may want to use 2 ºC/Min. Entering 0 will disable this option.

Step Time Limit: You can enter a value here to limit any step. A step can be a charge, discharge or pause. This is an optional feature that allows you to limit the duration of any of these steps. This is normally used as a fail safe mechanism in the event that a battery does not terminate a charge for any reason. This will stop the charging or discharging current and the analyzer will enter into the next step. For example if a charge during a multi cycle session does not complete within this time then the analyzer will enter into the next step. The next step might be a pause or the start of discharge for the next cycle. Enter the value in minutes. A value of 0 will disable this feature.

Upper V Term: Enter a value to terminate a charge when the voltage rises to this upper limit. Using this is usually a fail safe option and will not necessarily mean the battery has received a full charge. A value of 0 will disable this feature.

Trickle after charge: This applies to NiCd batteries only. After a *charge* or *cycle* session completes you can have a trickle charge current applied indefinitely to the battery. Enter a value to enable this option. Enter 0 to disable this option.

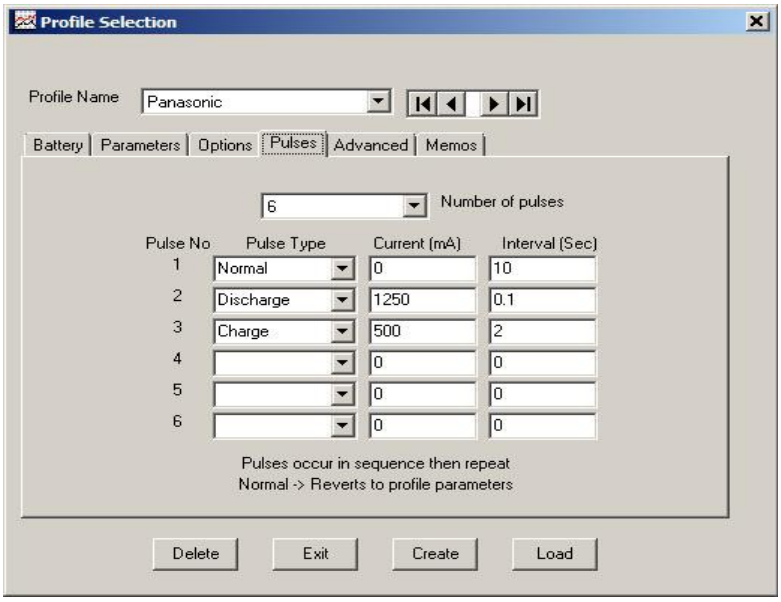
Float Voltage: This applies to SLA batteries only. After a *charge* or *cycle* session completes you can have a constant voltage applied to the battery. This is lower than the *Voltage Reg* charge voltage and will maintain the charge state of the battery. This is called a Float Voltage. Enter a value in Volts to enable this option. Enter 0 to disable this option. For example a typical 12V SLA battery would use a float voltage of 13.8 V.

Wreg Discharge: This is an optional discharge method that allows for the ability of the battery to be discharged at a constant rate of power. Specifying a value in this field will override the *Discharge Current* parameter. See *Constant Power Discharging* in Section 5 for more information.

Max Charge: Terminate charge when this level of charge input (mAH) has been achieved.

Max Disharge: Terminate discharge when this level of discharge output (mAH) has been achieved.

Pulses



The pulse feature can overlay pulses of various currents and duration on top of the normal discharge or charge current. This feature allows you to simulate real load conditions or develop special charging and discharge procedures.

Use this tab to define the type of pulses you would like to apply to your sessions. You can define up to 6 different pulse definitions.
You need to activate the pulsing feature in the Analyzer-*Options-Advanced* panel to use this feature (This is not the profile options). Pulses will be enabled when you have the pulse option activated and you set the number of pulses in this panel to 2 or more.

You can elect to have the pulses activated during a charge or discharge or both. Again see *Options-Advanced* panel to control this.

The pulses will continually occur in sequence and then repeat. For example if you have 2 pulse definitions then the pulses will occur 1-2-1-2-1-2-1-2… until the session is complete. Using 3 pulse definitions then the pulses will occur 1-2-3-1-2-3-1-2-3-1-2… until the session is complete etc.

The pulses override the charge or discharge current specified in the *Parameter* profile tab.

There are 4 pulse types you can define:

Discharge: This will cause a constant current discharge pulse. The amount of discharge current is specified in the *Current* field. The duration for this discharge pulse is specified in the *Interval* field. *Current* is entered in mA and *Interval* is entered in Sec.

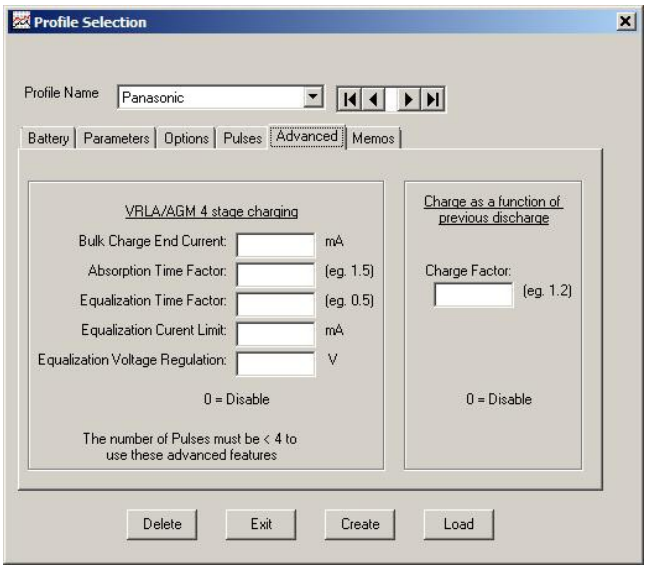
Charge: This will cause a constant current charge pulse. The amount of charge current is specified in the Current field. The duration for this charge pulse is specified in the *Interval* field. *Current* is entered in mA and *Interval* is entered in Sec.

Pause: This will cause a pause. A pause is a time interval during which there is no charge or discharge current. The duration of the pause is specified in the *Interval* field. If you select a pause pulse type the current field is not required for the pulse. Any value entered in *Current* will be ignored.

Normal: This causes the session to revert to the normal charge or discharge values specified in the *Parameters* tab. If you select a normal pulse type the current field is not required for the pulse. Any value entered in *Current* will be ignored. You need to specify the *Interval* that you want the pulse to operate with the normal current. A normal pulse type is not required. It is easier to manage the pulse setup by only using Discharge, Charge or Pause pulse types.

The Discharge, Charge or Pause pulses will be overlaid during a session's normal discharge, charge or pause in any combination. To disable all pulses for this profile set the *Number of Pulses* to 0.

Advanced



The BA500WIN allows you to perform both Absorption and Equalization charging. This is used for special applications of Lead Acid charging designed to optimize the charging process. This optional Absorption feature allows you to specify the length of the Absorption phase (constant voltage & decreasing current) as a time multiple of the bulk charge (Initial constant current) phase. The optional Equalization feature allows you to specify a different Vreg and Ireg to be used for a specified duration once the Absorption period has completed. This Equalization normally consists of a slightly higher Vreg with a current limit.

If you are not using these advanced features then all the fields should be set to 0.

The following describe the inputs associated with this advanced charging algorithm

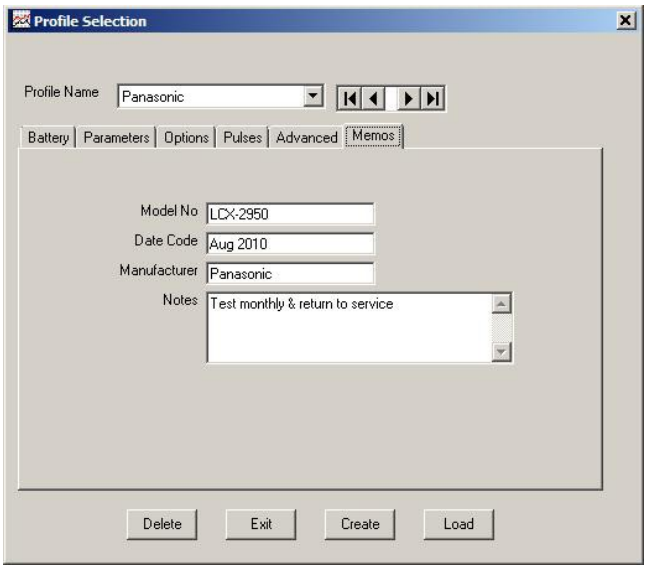
Bulk Charge End Current - This specifies when the bulk charge stage ends. When the battery enters Vreg mode and the current drops below this value the bulk charge stage ends. For example you might set the current limit to 2000mA and the Bulk Charge End Current to 1950mA. So when the battery enters the Vreg mode the current will drop below the 1950 and trigger the Bulk Charge stage to end. Bulk charging uses the Charge Current limit and Voltage Reg values specified in the Parameters tab. The time is measured from when Bulk Charging starts to when it ends. This becomes the base time for both the Absorption and Equalization stages. Setting this value to 0 disables these features

Absorption Time Factor - When bulk charging ends, the absorption stage begins. The absorption stage time is specified by using the Absorption Time Factor. The absorption time will be the base time (measured during bulk stage) multiplied by the Absorption Time Factor. So for example, if you use 1.2 as an Absorption time factor and the bulk charge stage lasted for 60 minutes - then the Absorption Stage will last for 72 minutes. The Absorption stage uses the same Charge Current limit and Voltage Reg value used in the bulk stage.

Equalization Time Factor - Equalization offers the chance to charge at different Voltage Reg and Current limit, for a time period, at the end of a charge. Again, the Equalization time will be the Bulk Charge base time multiplied by the Equalization Time Factor. To use this Equalization Feature set this Time Factor to a value > 0. You specify the Volt Reg and Current Limits for equalization in the Equalization Current Limit and Equalization Vol Reg fields.

The "Charge as a function of previous discharge" is a special feature that can be used for any battery type. This can be useful if you are trying to perform tests on the charge efficiency of various battery types. This would be used when cycling. The last discharge mAH data is retained and the following charge can be terminated based on a factor of this previous discharge value. For example if you are cycling and the last discharge output was 500mAH then, with this feature enable using a charge factor of 1.3, the charge will terminate at 650mAH input.

Memos



Model No: Optional field for recording battery model number or other information. This will print on reports.

Date Code: Optional field for recording battery date code or other information. This will print on reports.

Manufacturer: Optional field for recording battery brand name or other information. This will print on reports.

Notes: Optional field for any other information associated with the profile or battery. This will print on reports.

Program Routines

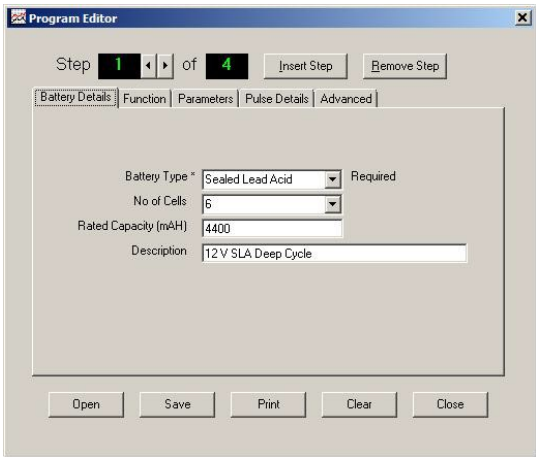
The *Program* capability allows users to perform custom test routines that go beyond the Charge, Discharge, Cycle sessions that are used with the *Quick Select* or *Profile* setup methods.

To use this feature you create a program using the program editor. A program consists of a series of steps that are performed in sequence one after the other until all steps of the program are complete. Each step can be defined as either a Charge, Discharge, Pause or IR test. With each step you can define separate test parameters to truly customize the operation of the analyzer. (Note this is different than when using *Quick Select* or *Profile* setup where the same test parameters such as charge, discharge current, Vcut, TCO etc. etc. are used for all cycles.)

Program- Menu

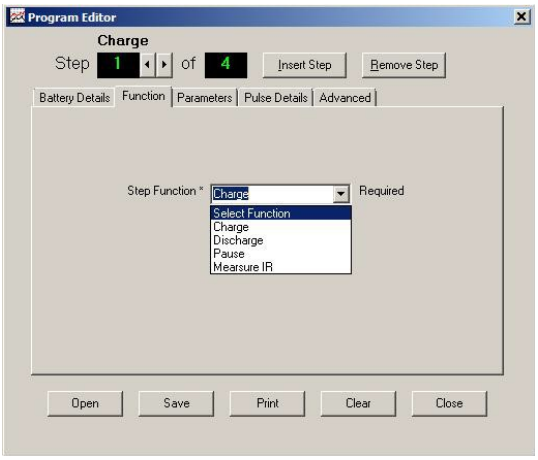
The programs are operated using the Programs drop down menu as shown here. To use a program you have to create it by defining the function and parameters for each of the steps in your program. This is done with the *Edit Program* window. The program editor consist of a window with 5 tabs where you can edit parameters for each of the steps. Notice in the pictures below that you can insert any number of steps in your program. The arrow buttons are used to navigate from one step to another. The step presently under edit as well as the total number of steps are displayed at the top.
The program when running will use all of the normal charge and discharge terminations as applicable to the battery type and/or the parameters you have specified for the step.

Program- Battery Details



This first tab *Battery Details* is where you can enter some information about the battery under test. The *Battery Type* field will configure the correct charging algorithm required for the various battery types. The *No of Cells*, *Rated Capacity* and *Description* fields are for information purposes only and do not affect the operation of the program. This information will appear on the printed program report.

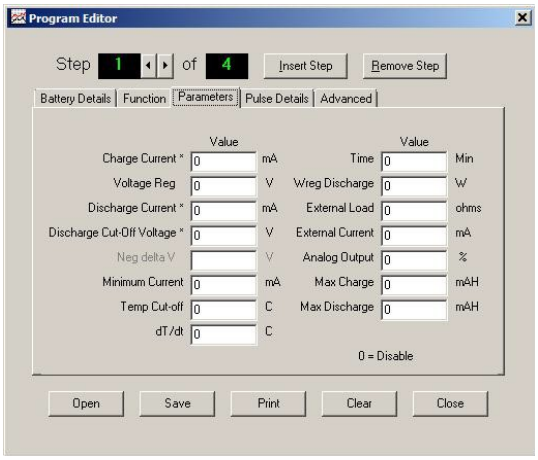
Program- Function



The function tab is where you specify what function each step is to perform. There are 4 possible functions available:

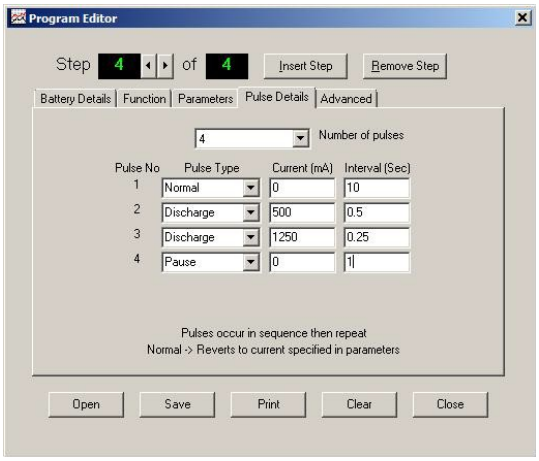
1 - Charge
2 - Discharge
3 - Pause
4 - IR Test

Program- Parameters



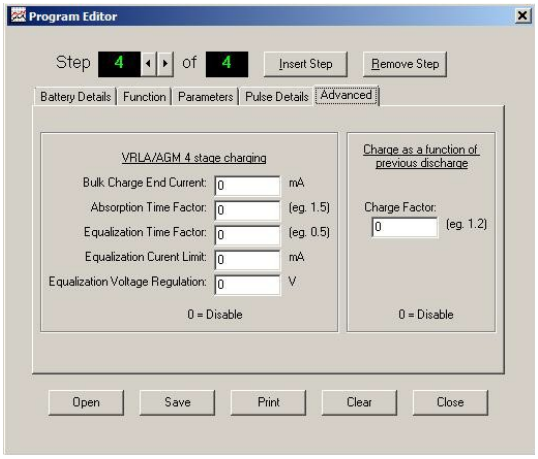
The Parameter tab is used to enter all test parameters for the presently displayed step. The explanation for each of these fields is the same as when using Profiles.

Program- Pulse Details



As with parameters you can also define different pulse definitions for each of the steps in the program. If you do not want pulses applied during the step then set the number of pulses to 0. This will disable all pulsing for this step and the current will be as specified in the Parameters for this step. Specify up to 6 different pulse definitions

Program Advanced



The Advanced tab has inputs for specifying Absorption and Equalization options. See the section on Profile Selection for details on how to use these Advanced features.

After selecting and entering functions and other data for every step in your program you need to save the program. Click the save button and you will be prompted to enter the file name for the program. The file will automatically be given a .pg5 extension so that you can recognize your program files. The program files are saved as standard text files. They can be copied, saved to any location and they can even be opened with a text editor such as Wordpad. If you have many similar steps you can even edit your program with a text editor. You will just need to be careful and ensure that the format and syntax follows the standard pg5 formatting. Each line of the pg5 file represents 1 step of the program. Knowing this, it is

possible to copy and paste lines to create large programs.

The BA500Win program editor has some validations that are performed when the file is saved. If you edit a program using a text editor you may want to open and save it with the Program Editor in order to take advantage of the validations. If you get any error messages after editing your file with a text editor it means that you altered the syntax of the text file.

After you have created and saved your program you can now use it. In order to run the program you have to *Load* the Program and then select *Run* to run the program. Loading the program reads the pg5 file and records all the steps, data and parameters in memory to make the analyzer ready to run the program.

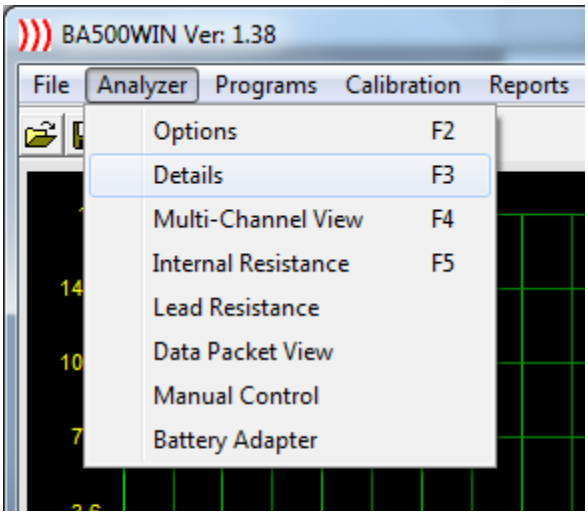
Select *Run* from the pull down menu to begin running the program. The program will execute each step one at a time until all the steps are complete. The program results can be viewed under the Program tab on the main screen and the results can also be printed in the Program Report.

You must take special care when running programs. Batteries can store tremendous amounts of energy and if they are not charged or discharged properly then they can overheat, burst, exploded and cause fire, personal injury or death.

The **Program** feature allows you complete control to manage the battery charge and discharge function in any manner you choose. This means to you need to take responsibility for creating, testing and using the program. For this reason the following warning message is displayed when you begin running a program.

Caution ! Read this safety warning !
Running a program does not have any automatic supervision. Control is left entirely to the program you have created and loaded ! Always test your programs carefully to ensure they operate as expected and follow the battery manufacturer's recommended charging and discharging methods.

Options

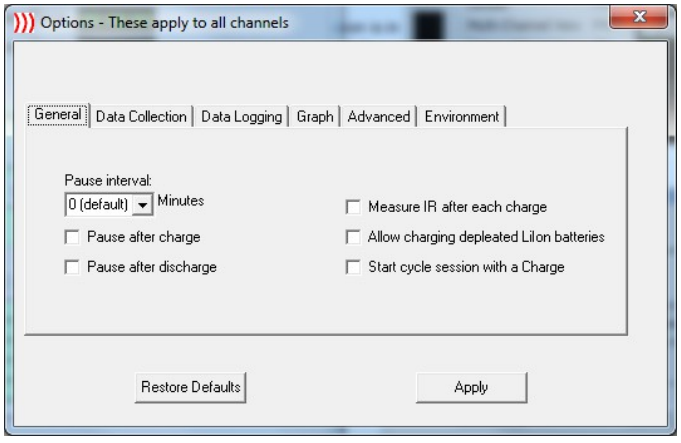


Enter the *Options* control panel under the menu *Analyzer / Options*. This will display an area to adjust various options. These options are grouped together under various tabs. The options that you select here apply to all channels.

Options can be changed at any point. This includes while a session is in progress, however some may only take effect once a new session is started.

If at some point you want to revert to all the original settings you can click *Restore Defaults*. This will return all the options in all the tabs to original values.

General



Pause Interval: During battery cycling sessions you can elect to insert a pause between each step in the cycles. Setting this value will determine the duration of the pause. The pause is a period when no current flows. This rest period is often used to allow a battery to cool in the event that the battery heats during a charge or discharge. This is specified in minutes.

The check boxes for *'Pause after charge'* and '*Pause after discharge*' allow you to have the pause only occur in the part of the cycle as required. For example if you expect heating only during the charge then you can check the *'Pause after charge'* and leave the *'Pause after discharge'* unchecked.

If you have checked the option to '*Measure IR after each charge*' then the IR test will occur following the pause. This allows the battery to cool and stabilize prior to measuring the internal resistance and starting a new discharge cycle if applicable.

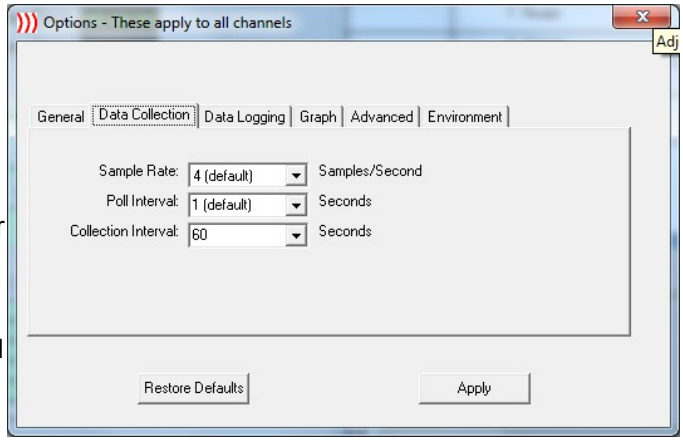
Measure IR after each charge: During battery charging and cycling you can elect to have the analyzer perform an internal resistance test after the charge portion of each cycle. The IR test should normally be performed on a fully charged battery. This option, when checked, will automatically perform this test for each charge cycle. This will include *Charge* only session or the charge portion of a *Cycle* session. These values will be displayed in the *Session Results* panel and appear on printed reports.

Allow charging depleted LiIon batteries: LiIon batteries should not normally be charged when the voltage drops below 3V per cell. This is a normal safety precaution for LiIon battery packs. However if you wish to override this feature then you can check this box.

Start cycle with a charge: When cycling batteries, each cycle is defined as a discharge, followed by a charge. The reports display results in this format. However if you would prefer to skip the discharge on the first cycle then you can check this option. This will start cycle 1 with a charge. The data for Cycle 1 discharge in this case would be blank. Subsequent cycles will consist of a discharge then charge. Note that all cycle sessions end with a charge regardless of how this option is checked. This ensures that the battery is fully charged upon completion of the cycle session. This option only applies to cycle sessions. It does not affect discharge, charge, recondition or refresh sessions.

Example of steps in a 2 cycle session with pauses enabled following discharge and charge:	Example of steps in a cycle session of 2 cycles with pauses disabled:	Example of steps in a 2 cycle session with pause and IR enabled
1. Discharge	1. Discharge	1. Discharge
2. Pause	2. Charge	2. Pause
3. Charge	3. Discharge	3. Charge
4. Pause	4. Charge	4. Pause
5. Discharge		5. Measure IR
6. Pause		6. Discharge
7. Charge		7. Pause
8. Pause		8 Charge
		9. Pause
		10. Measure IR

Data Collection



Sample Rate: This is the number of samples that the analyzer will perform each second. This includes measurement of voltage current and time. This data is stored in the analyzer and then transferred to the PC when the PC polls for the data.

Poll Interval: This is how often the PC will poll the device to collect the data. This is entered in seconds. When the PC polls for data from the analyzer the data is transferred to the PC. There can be up to 7 samples transferred with each poll request. Any data that is not transferred from the analyzer will be overwritten in the analyzer and unrecoverable. When data is overwritten you will see the *Overflow* indicator in the lower *Status Bar*.

When using multiple analyzers you may wish to increase the poll interval (decreased the frequency) in order to relive the PC and speed up the software response time.

Collection Interval: This is used to specify how much data the PC retains. The software program retains data received from each analyzer. This data is collected for use by the program for such things as graphics display, analysis and exporting. This is not the same data that is retained in the *Data Logging* tab.
The data retained here is streamed to the hard disk. This can be a very large amount of data and can result in very large files. This option allows you to have control over how much data is retained and how large the files become.

The graph has capabilities to zoom in to view specific areas of interest. You will want to consider how much data to collect. For best computer performance don't collect more data than you require.

Data Collection Management

Keep in mind, the more data you collect the larger the files become and the amount of processing required increases. If this situation becomes extreme it can slow down your computer significantly and affect the operation. This may not be evident initially, but as a session proceeds can become a problem if you are collecting too much data. You should control the amount of data collection to avoid overwhelming your computer.

The following is an example of how you can manage the data collection to improve performance.
Try turning down the data collection options so that you are collecting and processing less data. For example in:

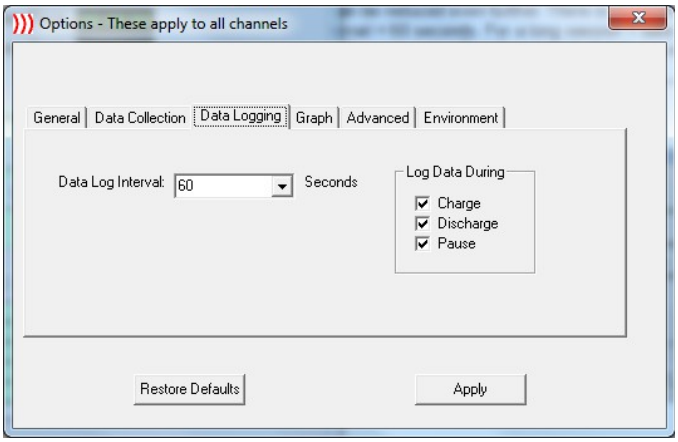
ANALYZER-OPTIONS- DATA COLLECTION
Set Sample rate=1 sample/sec (decreasing this to avoid overflows)
Set Poll interval=2 seconds (increasing this to poll less often)
Set Collection interval=10 seconds (increasing this to reduce amount of saved data)
GRAPH
Set Update interval=30 seconds (increase this to update graph less often)

Updating the graph can take a lot of processing time. So if you are collecting a lot of data during a very long session, it will take a longer and longer amount of time to process all of the collected data to update the graph. As the session progresses this can overwhelm the computer. When this start to become a problem, BA500WIN and the battery analyzers may start to exhibit unusual behavior. This is a sign that your computer is having trouble processing the data, especially updating the graph. With each graph update the computer needs to re-read these extremely large files to select data points to graph. You can save computer resource time by setting the graph to update less often or completely disable the graph by setting the update interval to 0. You can always re-enable the graph at a later time or when the session is complete and you will still have complete graphs with all the data.

These values are just examples. If required, the data collection can be reduced even further. There is no need to collect more data than is required. You could even go to a Collection interval = 60 seconds. For a long session 1 data point per minute is more than enough to display good looking graphs. The idea is to just collect the amount of data necessary to accomplish your objectives.

Data Logging

The Data Logging feature allows you to collect data in a separate file for your own purposes. You may want to collect data for your own analysis requirements. You can log the data to a file and later examine the file or import it into a spreadsheet program for processing and analysis.



Selecting a data log interval greater than 0 will activate the data logging feature. When this feature is activated you will be prompted to enter a file name and location when you begin a new session. Note that some Windows operating systems may place the data in a special AppData location for security reasons. When the session completes, users may need to locate their log file in a separate directory such as:
C: /Users/Name/AppData/Local/VirtualStore/Program Files/BA500WIN

Data Log Interval: This is the time interval between log entries. After this time interval has elapsed, a data set will be written to the

log file. This is repeated continuously until the session completes. You are not limited to the values in the drop down box. Enter any value in seconds.

Log Data During: This set of check boxes allows you to only log certain types of data. This will allow you to only collect the data of interest and avoid creating unnecessarily large files that become difficult to examine.

You **cannot** view log files with the File-Open menu selection. The File-Open menu is only used to open and view sessions previously saved with the File-Save menu selection. To view a log files you will need to import it into your spreadsheet program such as Excel or Open Office.

This log file records data in ASCII text format. The data file contains one data sample per line. Each line has the following data:

Log#	Log entry number
Event#:	Increments with each step
Cycle#:	Cycle number
Event Type:	Charge, Discharge, Pause, IR Test
Event Time(S):	Elapsed time for this step
Total Time(S):	Elapsed time for this session
Voltage(V):	Battery Voltage
Current(mA):	Charge or Discharge current level in mA
Result:	Input/Output charge in mAH (mΩ for IR Test event)
Power(W):	Source/Sink power to battery (+/-)
Energy(WH):	Source/Sink energy to battery (+/-)
Temp(C):	Probe temperature in °C
Real Time:	Date and Time

Note that pauses and IR measurements that occur between cycles will each count as 1 event.
The data in the log file is separated by commas (CSV format) to allow importation into a spreadsheet program. Most spreadsheet programs have an option to define what the delimiter character will be. Since the data in the log file is separated by a comma, set the delimiter character in your spreadsheet program to a comma " , ". Then, when you open or paste the log data into your spreadsheet, each data field will be nicely formatted into separate cells. You can then analyze the data or plot special graphs and reports.

Graphing

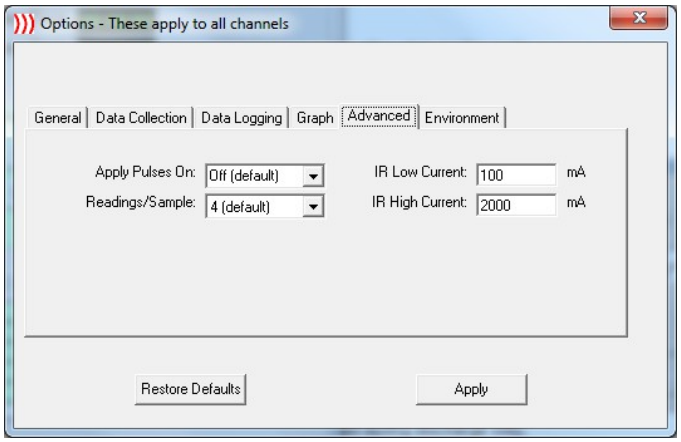
Update Interval: This is used to control the frequency of the graph update. Since the data files can get quite large, setting this interval higher can reduce computer processing requirements.

Note that when graphing pulse wave forms, the pulses occur in very uniform time sequences. These can sometimes be in phase or out of phase with the data points that are plotted. It does not mean that the pulses did not occur. It simply means that those data points did not plot. If you pan left / right they will become visible.

Plot Options: Use this to enable or disable the 4 different types of data plots. This is also where to specify the scale factor to be applied to each plot. The data is multiplied by the scale factors as it is plotted. Use these scale factors to make the graph easier to view.

Usually you would set the scale factor for V = 1 and normalize the other plots to this scale.

Advanced



Apply Pulses On: This is a master control switch for the pulsing feature. The pulses are defined in the profile, however you need to make this entry to enable the pulses. This entry allows you to active the pulse in 4 ways:

Off - Disables all pulses
Discharge - Pulse activated during discharge only,
Charge - Pulses activated during charge only
Both - Pulses activated during all discharges and charges.

For your convenience this selection is shown in the status bar located on the bottom of the main screen.

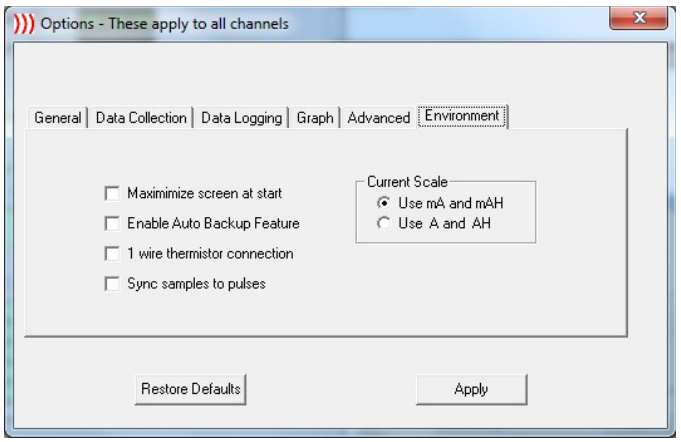
Readings / Sample: When the analyzer measures the voltage, current and temperature the analyzer actually measures these items several times and then reports the average as the sample data. The number of readings the analyzer performs for each sample is adjustable using this field. The purpose for providing averaged samples is to reduce noise during the measurement process.

You would only want to reduce this value when performing high speed pulse testing. During high speed pulse testing you may want to reduce the time that the analyzer's processor spends taking samples. This will spare up processor real time available for pulse updates.

Unless you are performing high speed pulse testing you should keep this to the default value of 4 or more.

IR High Current: Use this to set the high current (I-high) for the Internal Resistance (IR) test. See *Internal Resistance Measurement* for more information.

IR Low Current: Use this to set the low current (I-low) for the Internal Resistance (IR) test. See *Internal Resistance Measurement* for more information.



Environment

Maximize Screen: If you want the software program to open in a maximized state you can check this box.

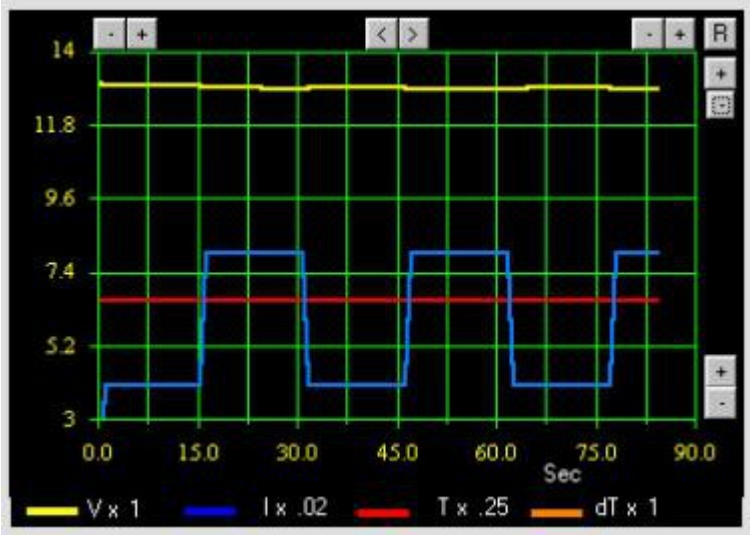
Auto Backup: This is where you enable the auto backup feature. See: *Auto Data Backup* section for more information on using the Auto Backup feature.

1 Wire Thermistor connection: This is used when using the battery back internal thermistor. This option will open the circuit to measure temperature to ensure a common ground point. See: *Using Battery Pack Internal Thermistor* section for more information.

Sync Samples to pulses: This option will force a voltage and current sample just before a pulse change to ensure that data is captured during the pulse.

Current Scale: BA500WIN provides the option to use 'mA and mAH' or 'A and AH'. This is where you make the change. Be careful if you switch to A because any profile or program data specified in mA when you switch to the A option is not adjusted. You will need to re-examine your test parameters after switching to ensure they are, as you intend. For example you might have discharge current in a profile set to 500mA. If you switch to the A/AH option then, if you do not adjust your profile parameters, you will be specifying 500A for discharge current. This will cause the analyzer to discharge at it's maximum current with unexpected results. If parameters are specified improperly it could damage the battery and present a hazard. Review the *Safety Precautions* and the *Read Me First* section at the beginning of this manual.

Graphing



Located on the main screen is the graph area that plots the collected data for the selected channel. This graph can plot 4 data sets:

- Voltage (V)
- Current (I)
- Temperature (T)
- delta Temperature (dT/dt)

Select which of these data sets to display in the *Options-Graph* tab area.

When a session begins, data will begin to plot on this graph. The graph will auto-scroll to the right to expand the X axis as the elapsed time increases.

In order to make the data sets easier to view, each data set has an associated *Scale Factor*. You set the scale factor in the *Options-Graph* tab. All the data that is plotted on the graph is multiplied by this Y axis scale factor when plotted. Adjust the scale factors as required to make the plot lines easier to view. You will see the corresponding scale factor listed in the graph legend for your convenience. It is best to keep the scale factor for voltage at 1 and then normalize the other data sets to this scale. If you cannot see an expected plot line, it may be way off the scale at the top. You may need to reduce the scale factor to bring it into view.

This graphics feature is a powerful tool to add dramatically to your understanding of what is happening during the battery sessions. You will also note that there are graph controls located on the graph. These controls can be used to expand, contract and pan across the axis. With this capability you can zoom in to view particular data points or areas of interest. Placing your mouse on top of the graph controls will display a window describing the function of the control:

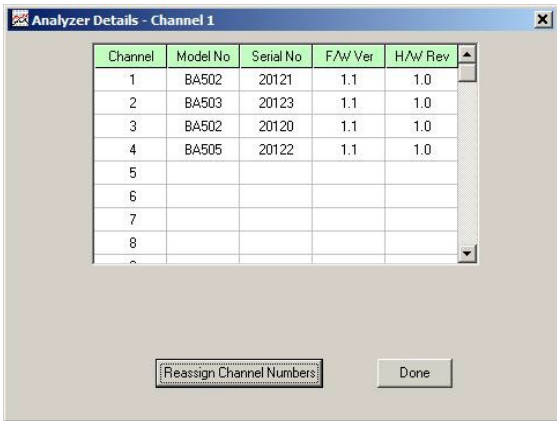
Top Left - Decrement X Scale Min	Top Middle < Pan Left	Top right - Decrement X Scale Max	Top right R Restore Scales	Right Top + Increment Y Scale Max	Right Bottom + Increment Y Scale Min
Top Left + Increment X Scale Min	Top Middle > Pan Right	Top right + Increment X Scale Max		Right Top - Decrement Y Scale Max	Right Bottom - Decrement Y Scale Min

These controls adjust the range of the scale to eliminate unused area for better views of the displayed data. Each time you adjust the scales the graph is redrawn with the new adjusted scales.

Note that if you adjust the top controls you are adjusting the X scale. This will disable the auto-scroll feature so that you can zoom into the time area of interest. This means that as new data comes in, it may lie to the right of the X scale maximum and be off the graph area. To turn the auto-scroll feature back on you should click the R (Restore Scales) control located in the upper right corner. See *Options* section for information on the graph update interval and resolution. If other graphing functionality is required users can create a log file of the session. The csv log file can then be imported into a spreadsheet for custom graphing solutions.

SPECIAL FUNCTIONS

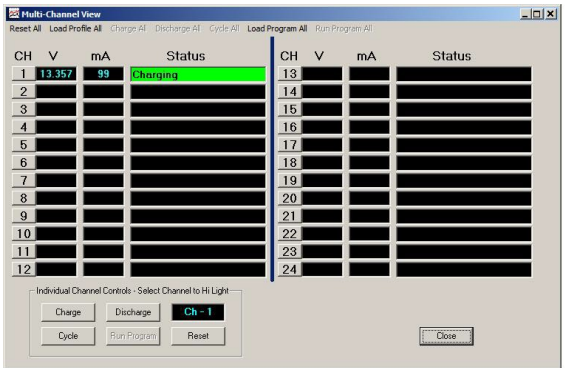
Analyzer Details



The *'Analyzer Details*' window provides details about all Battery Metric devices current online.

On a multi-channel system the channel number stay constant. You have the ability to reassign the channel numbers if required.

Multi-Channel View



When using multiple channels it can be very convenient to view and control all channels at once. View all channels from one screen, control all channels as a group or start and stop individual channels.

You will also appreciate the color coding nature of the '*Status*' field. This allows the operator to quickly & easily identify, even from a distance, which channel may require attention.

Calibration

The MC, LC, BM and BA500 series analyzers have been factory calibrated and supplied with a calibration certificate. Calibration by the user is not required. Should there be a need to re-calibrate, BA500WIN has three software calibration tools that can be used to calibrate voltage and current. These can be used to calibrate the analyzer's voltage and current regulation as well as the voltage and current measurement. If you require calibration to a particular standard you can use these software tools to calibrate to your own quality standards.

Voltage Calibration

The Battery Metric analyzers have a voltage auto-ranging feature that measures voltage in 1 of 16 ranges. This means that all 16 ranges need to be calibrated. The Voltage Calibration routine make this easy for you. Disconnect the battery from the analyzer. A battery is not used in this procedure. Connect a voltmeter to the analyzer output terminals and simply run through the voltage calibration routine inputting the voltage readings from your volt meter. There are 2 inputs for each range for a total of 32 inputs. This process is quick and easy with on-screen instructions. When complete, click '*Finish*' to download the voltage calibration data to the analyzer. At any time during the calibration process you can click '*Cancel*' to abort the calibration procedure. In this case no changes are made to the calibration data. This routine will calibrate both the voltage measurement and voltage regulation.

Charge Current Calibration

Charge current measurement and regulation is calibrated by connecting the analyzer, battery and current meter in series. This allows you to measure the charge current going into the battery. You should use a battery capable of being charged at the full current range of the analyzer. There is no voltage regulation during this current calibration routine. If you use a SLA or LiIon battery you could be applying voltages above normal. So either, monitor this closely, to ensure that it does not happen or use a NiMH or NiCD battery that is not voltage sensitive. The routine only takes a few seconds, during which a high and a low charge current will be applied for each current range. Input each of these 2 current reading from the current meter when prompted. When complete click '*Finish*' to download the charge current calibration data to the analyzer. At any time during the calibration process you can click '*Cancel*' to abort the calibration procedure. In this case no changes are made to the calibration data. This routine will calibrate both the charge current measurement and charge current regulation.

(**Note:** If you use a low voltage battery on some of the higher voltage devices, when performing this routine, you may overload the charge current regulator. If you receive a message that there is an 'Overload' situation, use a higher voltage battery.)

Discharge Current Calibration

Discharge current measurement and regulation is calibrated by connecting the analyzer, battery and current meter in series. This allows you to measure the discharge current coming out of the battery. You should use a battery capable of being discharged at the full current range of the analyzer. The battery you choose to use for this procedure should have sufficient charge so that it can supply the full current without having the voltage drop too low. The routine only takes a few seconds, during which a high and a low discharge current will be applied for each current range. Input each of these current readings from the current meter when prompted. When complete click '*Finish*' to download the discharge current calibration data to the analyzer. At any time during the calibration process you can click '*Cancel*' to abort the calibration procedure. In this case no changes are made to the calibration data. This routine will calibrate both the discharge current measurement and discharge current regulation.

(**Tip:** When performing any of the calibration routines you may experience a situation where your meter is fluctuating between two readings. In this case you can get better accuracy by inputting a value between to two changing values. For example: You might be doing a current calibration and your multi-meter is toggling between 1856 mA and 1857 mA. This is telling you the value is somewhere in between these 2 values, so enter 1856.5)

Restore Factory Calibration

Each of the calibration routines have an option to restore the factory calibration setting for that function only. There is also a global restore that will restore all calibration values to original factory settings.

All calibration data, including factory calibration or your own user calibration data is stored in flash memory in the Battery Metric device. This calibration data then stays with the device and is available even if it is moved to a different computer. At any time you may choose to restore the factory calibration data. Even if you recalibrate, you can always choose to revert back to the original factory calibration at any time.

Validating Calibration

When you have finished running a calibration routines you can validate the calibration by measuring the current and voltage readings during a regular session. You may want to do this periodically as necessary to ensure proper operation. For example you may want to validate the calibration annually and recalibrate if necessary.

To validate the voltage measurement connect a battery and simultaneously read the battery voltage with your volt meter and compare it to the on screen voltage reading. You should do this with no current flowing. If current is flowing then the on screen voltage readings have compensation applied as per your '*Lead Resistance*' setting.

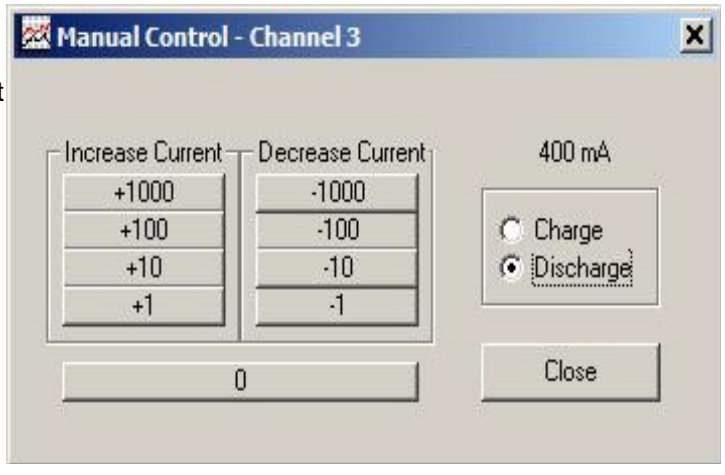
Validate voltage regulation when charging a SLA or Lilon battery in constant voltage. The volt meter and on screen readings should be comparable. In a 2 wire setup there can be some deviation if current is flowing. Place the volt meter at the analyzer input rather than at the battery terminals. In a 4 wire setup there is no deviation due to current flow.

Validate current measurement and regulation by connecting a current meter in series with the battery. Start a discharge and compare the current meter readings to the on screen readings. Do the same for charge. This way you can ensure they are within acceptable limits.

Manual Control (Electronic Load)

There may be instances when you want to be able to collect data using a manual control. This allows you to adjust the current in real time. Using this feature you can create charge or discharge currents of any value. You cannot use this manual control to adjust current during a running session. Only use this feature when no session is currently in operation.

By controlling the discharge current the analyzer is actually an electronic load with full control at your fingertip. You can use all the graphing and data collection features of the software to perform custom tests and analysis.

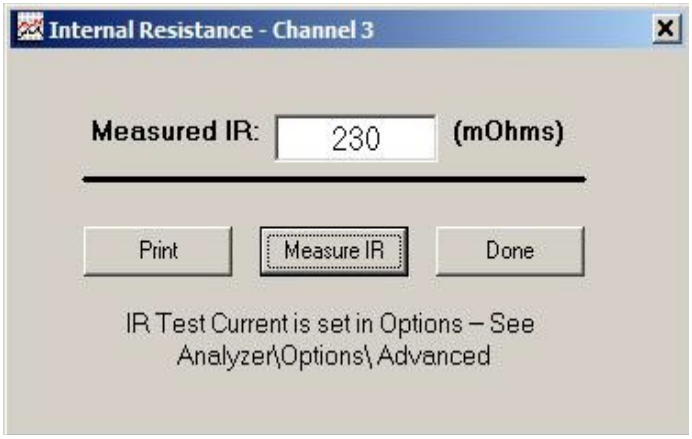


The charge and discharge currents are all constant current, fully regulated by the analyzer. You have the ability to specify and adjust the current in 1mA increments. There is no voltage regulation during charge. So be careful if using this to put charge current into a SLA or LiIon type battery. The voltage can rise up and damage the battery. Also there is no voltage cut-off during discharge so the battery voltage can go down to 0 and damage the battery.

When you are finished a manual control session you should press *Reset* to end the session and clear all data.

Caution...safety warning ! Manual control does not have any automatic supervision. Do not leave batteries unattended, they can be damaged, explode or cause a fire ! Always follow the battery manufacturer's recommended charging and discharging methods. Manual control is only for applying charge or discharge current while the operator is present and monitoring the situation closely.

Internal Resistance Measurement



Batteries have an Internal Resistance (IR) that causes a voltage drop when current is drained from battery. The IR also causes the terminal voltage to rise when current flows into the battery during charge.

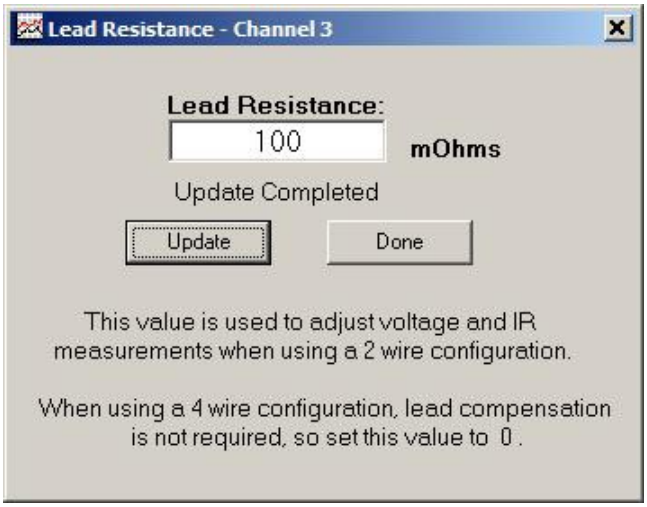
You can use BA500WIN to measure this IR. To perform the test, open the *Internal Resistance* control window using the menu *Analyzer-Internal Resistance.* Proceed with the test by connecting the battery to the analyzer and clicking *Measure IR*. The test takes place immediately and the results are reported in this window. This measurement will also be printed on reports. If you have options set to measure IR as part of a regular session, then the last measured IR value will be displayed as soon as you open this window.

The internal resistance measurement is the Total Effective Resistance (TER) using a dual pulse test. This test will capture the effect of ionic and electronic Internal Resistance (IR). When you perform an IR test the battery is discharged momentarily with two different currents. A low and a high discharge current are activated. First the high current (I-high) is started and voltage (V-low) is measured. Then the low current load (I-low) is started and a higher voltage (V-high) is measured. The resistance offered by the battery, leads and connections is then calculated as:

$$IR = \Delta V / \Delta I = (V\text{-high}) - (V\text{-low}) / (I\text{-high}) - (I\text{-low})$$

You can control what values of I-high and I-low are used. These are set under *Options -Advanced*. Default values are 2000 mA for I-high and 100 mA for I-low. By increasing the difference between I-high and I-low you can get improved IR measurement resolution.

Lead Resistance



The value of the given lead resistance is subtracted from the IR measurement to remove this amount from the reported data. This means that the actual IR reported is actually the IR as measured in the formula above, minus the lead resistance value being using for this channel.

IR = IR - Lead Resistance

Adjust the lead resistance value for each channel using the lead resistance input window. See Analyzer/Lead Resistance. The lead resistance input window will display the lead resistance value that this channel is currently using. To update this value, simple enter a new value and click 'Update'. This will permanently store the lead resistance value for this channel in the analyzer itself. This new lead resistance value will now be used for all future IR tests as well as all voltage measurements. A typical value to use for the lead resistance would be 100mΩ when using the cables supplied with the analyzer.

Note that when using the analyzer during normal charging and discharging the analyzer is at one end of the leads and the battery is at the other. This means that as charge or discharge current flows, the analyzer will see a slightly different voltage than what is actually at the battery terminals. This is due to the fact that the leads and connections have a slight resistance that results in + and - voltage drops during charge and discharge respectively. This value is then used by the IR measurement routine as described above as well as the Voltage measurements. See the section on Two Wire Battery Connection for more details on this. This Lead Resistance value is saved in the analyzer and is used to correct the voltage measurement based on the + or - current flow.

Interpreting Internal Resistance Value

The battery IR resistance measurement can be used for comparison purposes to identify potential battery weakness. For example, you will routinely see similar measurements on one type of battery under similar test conditions. However, when you see one measurement that is different, you know that some different situation exists. This could give you reason to question the performance of that battery.

Also note that when testing IR and comparing to battery manufacturers specs you should know exactly what testing parameters and methods were used to arrive at the manufacturers quoted specs. Results can deviate from the manufacturers quoted spec if you do not use the exact same measurement methods. Even if you change I-high or I-low you may get different results. It is best to use the analyzer to establish benchmarks for yourself and then use the IR measurement for comparison purposes.

If you get an IR measurement of 0 then you may have the lead resistance set too high. If the lead resistance value is set greater than the actual measured IR then the analyzer will report IR = 0. In this case lower your lead resistance value. When using a 4 Wire configuration compensations for lead resistance is not required, so set this value to 0.

Two Wire Battery Connection

The BA502 and some other low power analyzers use a 2 wire system. There are only two output terminal and thus only 1 pair of leads that are used to carry the current and measure the voltage. The flow of current will cause a small voltage drop across the leads due to the very small lead resistance. Normally, at the low current levels used in these analyzers, the error in voltage measurement and regulation is insignificant. This error will also have an insignificant effect on charging, discharging and capacity measurements. When using a 2 wire system there is a compensation factor (lead resistance) that can be used to adjust the voltage measurements based on the actual current measured. You can set this adjustment factor in BA500WIN. See Menu/Analyzer/Lead Resistance . A typical value to use for compensation (lead resistance) in a 2 wire setup is 100 mΩ. You can increase or decrease this if you want to adjust the compensation. Note that this compensation only adjusts the Voltage measurements. It does not adjust the actual voltage regulation at the battery terminals, which can also be slightly affected by current values as well. Normally these small errors in voltage are insignificant in regular charging, discharging and capacity measurements. Only in a laboratory situation would these voltage errors become significant at these lower current levels. If you find that this is an issue in your application you may want to consider the following when using a 2 wire system.

The amount of voltage deviation will depend on :

1. The gauge of the wire used to connect the battery to the analyzer.
2. The method of connection used to connect the leads to the battery.
3. The length of the leads.
4. The current in effect at any given time.

From these points it follows that you can lessen this deviation through the following.

A. Use a heavier gauge of wire leads.
B. Do not use alligator clips. Use push on terminals instead since they have much less contact resistance.
C. Use short leads. The shorter the better.
D. Use a lower current values.

When charging with a 2 wire system, any error in voltage regulation will result in Vreg at the battery terminals being slightly less than the Vreg measured at the input to the analyzer. This means that the Vreg at the battery will always be < or = to the specified value and as such the battery will not be in an over voltage situation. The voltage at the battery terminals will approach the specified Vreg value as the current approaches zero. This situation does not cause any problems with charging and is insignificant in affecting the charge time.

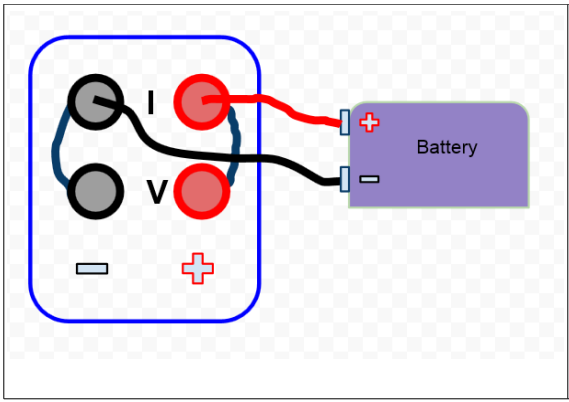
Standard 2 Wire configuration. There are only 2 output terminals available. The I and V inputs are internally connected. At high current, the voltage at the battery terminals can deviate slightly from the voltage appearing at the analyzer input. In most cases this is insignificant and can be ignored.

Four Wire Battery Connection

The higher power BA500 analyzers and all MC, LC & BM devices are supplied with a 4 wire capability. The analyzer has 4 output terminals: 1 pair for Current (**I**) and 1 pair for Vsense (**V**) . This allows for separate voltage sense and current carrying paths. With this feature you can eliminate any voltage error caused by current flowing through the leads. When using this feature 1 pair of leads carry the current (**I**) and another pair of leads are used to sense the battery voltage (**V**). By having a separate pair of voltage sense leads that do not carry current, you can sense voltage directly at the battery terminals. This will eliminate any error in both Voltage measurements and Voltage regulations regardless of the current.

In a 4 wire system the compensation value (Lead Resistance) should be set to 0. This is because the voltage measurements are now unaffected by current flow and compensation is not required.

The analyzer is supplied with only 1 pair of leads. Jumpers are placed across the separate output terminals. This means that you can use the analyzer, out of the box, in a simple 2 wire configuration as previously described.

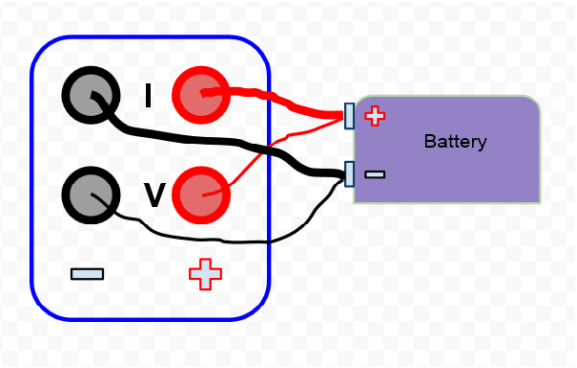


Analyzer being used with a **2 wire battery connection**. Note the jumpers connecting each pair of terminals at the analyzer.

The I and V inputs are now connected in this configuration at the analyzer inputs. Ensure that these jumpers are securely fastened.

This configuration is suitable for many applications.

If the application requires a 4 wire connection, then you will need to source and extra pair of leads and remove the 2 jumpers installed across the 2 POS and 2 NEG terminals respectively. Once you do this, the two terminals marked **I** will be the current carrying terminals and the 2 terminals marked **V** will be the voltage sense terminals.



Analyzer utilizing the 4 Wire configuration. The analyzer can now sense the voltage directly at the battery terminals. This eliminates any voltage measurement and voltage regulation deviations. Use this configuration when high current is introducing too much voltage error. When using this configuration ensure that the V leads can never become disconnected accidentally. Do not use alligator clips. Use push on connectors. If the Vsense leads were to fall off, then the battery will not have voltage regulation and may be damaged.

Lighter gauge wire can be used for the Vsense leads because they are not carrying current .

Using Battery Pack Internal Thermistor

Many battery packs have a built in thermistor. It may be possible to use this thermistor for temperature measurements. The Battery Metric analyzer temperature probes uses a 10K Ω thermistor. This is also the most common thermistor value found in commercial battery packs. If your pack uses a 10K thermistor and you want to utilize it, then the following information must be considered.

The 10K thermistor may have a different temperature – resistance relationship than the optional thermistor temperature

probe supplied by Battery Metric. This could affect temperature measurements and so you may need to adjust the TCO and dT/dt values in your profiles accordingly.

If you have access to both sides of the thermistor then you can just wire the two thermistor contacts to to two thermistor inputs on the device. Many battery packs have an internal thermistor that shares a wire with the battery negative (--) contact. In this case the battery pack may only have 3 contacts: Pos (+) Neg (--) and Thermistor (T)
In these cases the T is only one side of the thermistor. The other side of the thermistor shares a lead with the Neg contact. In this situation, when the Neg and T share a common connection, you will need to connect the single wire T to the T input on the device.

When using the single wire thermistor connection, be sure to check the 1 Wire Thermistor Connection option in BA500WIN. See Analyzer/Options/Environment. This will open the circuit (Stop all charge current flow to the battery) before making the temperature measurement. This is required because the black Negative (--) battery lead is not at ground with respect to the device when charging. This offset from ground will corrupt the temperature measurement circuit when sharing a common Neg & T connection. By enabling this option the current is interrupted to take the temperature measurements. Interrupting the current momentarily will return the Neg lead to ground and allows for proper temperature measurement. Once the temperature measurement is completed the circuit is closed and charging continues. During discharging and pauses the Neg wire is at ground potential and the circuit does not need to open for T measurement.

Printing Battery Labels

Use BA500WIN to print small labels with test results that can be affixed to the tested battery. This can be useful when managing a many batteries to identify the last time a particular battery has been tested. The format of the label is as follows:

Battery Report

Date:	03-19-2017
Description:	NiMH Mobile 12RT
Rated Capacity:	800 mAH
Output:	778 mAH
Performance:	97.3%
Internal Res:	146 mOhms
Profile:	Panasonic 6 Cell

This report can be printed following a discharge or cycle session. If printed following a cycle session the output delivered during the last discharge cycle is presented. The internal resistance is only shown when the report is generated following a cycle session (the *Measure IR After Each Charge* option must be enabled). The IR is measured after each charge and the last IR measurement is the one displayed on the report. This report can be printed on your printer and attached to the battery.

Auto Data Backup

In the event a session is interrupted for any reason, you can retrieve the data, if you had this feature enabled prior to the interruption. This feature is enabled using the check box found in: Analyzer/Options/Environment

When this feature is enabled the session is saved approximately every 10 minutes. To view the data you will need to open the file using the BA500WIN program. Go to File/Open and open the file BACKUPX.BA5 where X is the channel number you want to retrieve. This will open the session up to the point of the last auto save allowing you to view or print reports. This will open up as channel 0. You cannot resume an interrupted session. You will need to start a new session as required.

Note that in order to retrieve a backup up session you will need to open the backup file before beginning a new session. Once you begin a new session the previous backup file is overwritten.

If backup copies are not needed this feature can be disable to save computer resources. This will save hard disk space and computer processing capacity. Auto Saving sessions will take computer time and disk space, especially if you are collecting a lot of data. Again don't collect any more data than you require. This can save computer resources to improve your computer's performance. BA500WIN may need to run with administrator privileges to avoid access errors to the auto-save file location.

BATTERY MANAGEMENT

Battery Service Time

In order to truly have confidence that your rechargeable batteries will be able to deliver the service you expect, you need to perform a discharge test regularly. The only true way of measuring how much power a rechargeable battery is capable of delivering is to discharge it from a fully charged state and measure how much output charge (mAH) is delivered. A poorly performing battery will not be able to deliver up to it's rated capacity during a discharge test.

A discharge test involves discharging the battery and measuring the power that the battery provides. When this test is performed on a fully charged battery, you can measure the current delivered during the time of discharge and calculate a rating called the milli-Ampere-Hour (mAH) rating. This is how battery manufacturers rate the capacity of their batteries.

By comparing the actual mAH of your battery to the rating, or expected capacity, you will know if the battery is able to give you the service that you expect. Repeated discharging testing also can improve the NiCd battery's performance by exercising & re-balancing all the cells in the battery pack. This can improve the battery's ability to deliver power and may return poorly performing batteries to acceptable performance levels.

Performing a discharge test, followed by a full charge is called cycling. Discharge data from each cycle can then be examined in order to make sound decisions regarding battery replacement.

Periodic discharge testing should be part of your regular battery maintenance routines. How often you perform a discharge test depends on several factors:

● Amount of use ● Number of charges ● Critical use application
● Age ● Type of battery ● Cost of failure ● Cost of lost productivity

What you will need to do is establish battery management routines to suit your needs. After implementing these tests you will begin to understand how your batteries are performing and have confidence that they will give you the service you demand. A Battery Metric analyzer is an ideal tool to meet all your cycling and battery testing requirements.

Capacity Rating

The power that a battery stores and later delivers to power your equipment is expressed by a rating called mAH or AH. This is short for milli-Ampere Hour or Ampere Hour. This rating is useful because it states how much current a battery can deliver over time. A battery pack that is rated for 1200 mAH can deliver 1200 milli-Amperes for 1 hour before becoming exhausted. Similarly it could deliver 2400 mA for 30 minutes or 600 mA for 2 hours, etc. While the battery does not have to deliver a set current, this measurement simply states what a battery is capable of delivering or how much was actually delivered.

The delivered charge in mAH is shown on the screen and in the data reports for each discharge cycle. Compare this number to the rated capacity to determine how the battery is performing. For example, if a battery is rated at 600 mAH but is only delivering 300 mAH then it is only performing at 50 % of it's original condition.

You should discharge a NiCd battery down to 1.0 volts per cell to calculate this value. For example if the battery is a 10 cell battery then you should use a lower cutoff voltage of 10 volts. You can determine how many cells are in a NiCd battery pack by dividing the rated voltage by 1.2. For example if a NiCd battery is rated at 9.6 volts then it has 8 cells. This should be discharged to 8.0 volts.

It is a good idea to introduce a battery management program and routine. This can be done by periodically cycle testing each battery that you use on a routine basis. Mark the battery with some identification number if you have many packs. Then as you perform your routine tests record the mAH values delivered from a fully charged battery. You can input the identification number into the software program and print a report for each session. This data can be saved for reference in the future. These numbers compared over time will allow you to have full confidence that your batteries will give you the service you require. Batteries that are not performing can be replaced with full knowledge that this is the best decision for reliability, cost and productivity reasons.

Voltage Rating

NiCd batteries and NiMH batteries are given a voltage rating. From this voltage rating you can determine how many cells are in the battery pack. Since each cell is rated at 1.2V you can calculate that a 4.8V battery will have 4 cells and a 9.6V battery will have 8 cells and so on.

For Lead Acid and Sealed Lead Acid (SLA) batteries each cell is rated at 2.0 volts. This means that a 6V SLA battery has 3 cells and a 12V SLA battery will have 6 - 2.0V cells connected in series. LiIon batteries are often rated at 3.6V or 3.7V per cell.

Trickle Charge

A NiCd battery will naturally lose up to 2% of its charge each day. This means that a NiCd battery has a very poor shelf life when left idle. A NiCd battery that has been left on trickle charge will not lose charge normally associated with the storage of batteries. By keeping it under a trickle charge the battery will always be ready to use.

A normal trickle charge rate is equal to the batteries rated capacity in mAH divided by 50 (C/50). For example if your battery were rated at 600 mAH, then a suggested trickle charge rate would be 12 mA.

With BA500WIN a trickle charge can be set to automatically start when a *Charge* or *Cycle* session completes. You enable this feature by setting the trickle charge current to a value greater than 0 in the *Profile - Parameters*. This trickle charge will last indefinitely until the session is reset.

NiMH, LiIon and SLA should not be left on trickle charge indefinitely. The BA500WIN software will not apply an automatic trickle charge for these battery types. If you want to charge these battery types with low currents you should specify a normal charge current of the desired value.

Reconditioning

If you have a battery pack that is under performing it may be worthwhile to perform a deep discharge to see if this can restore the battery to satisfactory performance. This is called *reconditioning*. To do this, discharge the battery pack to a lower than normal cutoff voltage. The device performs a recondition discharge to 0.4 V per cell. This may get one or two cells that are very mismatched operational to some extent. Deep discharging should only be performed on marginal battery packs as part of your replacement decision process. Note that discharging a battery or battery pack to zero volts can impair battery performance. This procedure is generally for NiCd batteries and is not recommended for Lead Acid or LiIon/LiPo batteries.

Float Voltage

When SLA batteries are used in standby applications they are usually stored with a constant voltage applied. This is often 2.25 V / Cell. This is a low voltage that will just allow a small amount of charge current to flow into the battery, as required, to maintain the fully charged state. This low constant voltage is called a *Float Voltage*.

BA500WIN can automatically apply a *Float Voltage* when a *Charge* or *Cycle* session completes. You enable this feature by setting the *Float Voltage* to a value greater than 0 in the *Profile - Parameters*. This *Float Voltage* will last indefinitely until the session is reset.

The BA500WIN software will not apply float voltages for batteries other than SLA. For other types of batteries the *Float Voltage* parameter is ignored.