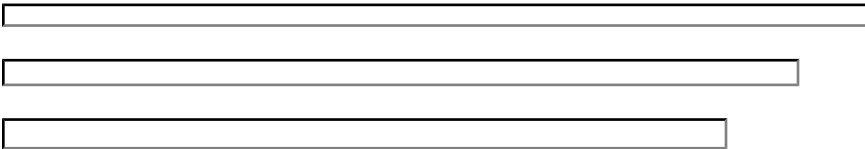# BA400 Series Battery Analyzers

- Users Manual
- BA400WIN Software Version 2.1

LaMantia Products Ltd.
www.lamantia.ca

Read This First

The BA400 analyzers together with the BA400WIN software program create a system that allows the user full control to specify many battery charge, discharge and test parameters. In addition the system requires calibration by the user to ensure proper operation. This capability is 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 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 using the BA400 system. It is not a training manual for understanding proper battery management, charging, discharging and testing. It is expected the user will have this knowledge. The BA400 system is a battery management platform to be used by knowledgeable trained staff. It is not a consumer type product.   Read and follow the Safety Precautions listed in Section 3 of this manual.

Users who purchase a BA400 series analyzers receive a license to use the BA400WIN 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 BA400 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 BA400WIN 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 BA400WIN for Windows(TM) and it's associated documentation are copyright (c) 2009 LaMantia Products Ltd. London, Ontario, Canada. All rights are reserved. Unauthorized duplication or distribution is strictly prohibited.

Note that the BA400 analyzer will only operate while under control of a personal computer using this supplied software. Please read the entire users manual, supplied with your BA400 before attempting to use your BA400 analyzer.

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OVERVIEW

There are several models in this line of analyzers, each with different voltage, current and other specifications. In this manual, BA400 refers to all analyzers within this product line. Each analyzer will carry a more specific model number such as BA402, BA403, BA405 etc. Refer to the data sheet: BA400Data.pdf for specific specifications for each model.

The BA400 battery analyzer is a full featured battery charger, discharger and analyzer. It is controlled using a personal computer and the BA400WIN software program.

This creates a very powerful system to manage your rechargeable batteries.

Not only is the BA400 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.

The BA400 allows you to 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.

Features	Applications
- Controlled using BA400WIN Windows^{TM} software - Connects to RS232 serial port using supplied cable - An optional USB to RS232 converter is available - High speed data collection 56K baud - Programmable pulsing - Pulses can be overlaid on standard charge and discharge algorithms - Built in fan with auto on/off 12 bit A/D - D/A - Voltage measurement - 16 auto-ranges - Expandable to 100 channels - Precise on board constant voltage/current regulation - Multi-chemistry design for LiIon, LiPo, SLA, NiCd, NiMH - Thermistor cable with probe for external temperature measurement supplied. Or use internal thermistor - Analyzer control using "Quick Select", custom "Profiles" or programmable "Program" modes -V, 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 - Internal DC resistance measurement - Short circuit, reverse polarity and overload protection - Auto shut down if data link stops operating or power fails	- Controlled using BA400WIN Windows^{TM} software - Connects to RS232 serial port using supplied cable - An optional USB to RS232 converter is available - High speed data collection 56K baud - Programmable pulsing - Pulses can be overlaid on standard charge and discharge algorithms - Built in fan with auto on/off 12 bit A/D - D/A - Voltage measurement - 16 auto-ranges - Expandable to 100 channels - Precise on board constant voltage/current regulation - Multi-chemistry design for LiIon, LiPo, SLA, NiCd, NiMH - Thermistor cable with probe for external temperature measurement supplied. Or use internal thermistor - Analyzer control using "Quick Select", custom "Profiles" or programmable "Program" modes -V, TCO, dT/dt, V, mAH, time and minimum current, termination options - Constant voltage, constant current. Trickle and float charging. 3 step or 4 step charging algorithms - Internal DC resistance measurement - Short circuit, reverse polarity and overload protection - Auto shut down if data link stops operating or power fails

Specifications

PARAMETER	BA402	BA403	BA405	BA453	BA410	BA460	Units
Maximum Charge Current	2000	3000	5000	3000	10000	2500	mA
Maximum Discharge Current	2000	3000	5000	3000	10000	2500	mA
Maximum Charge Power	40	120	100	120	120	120	W
Maximum Discharge Power	40	120	100	120	120	120	W
Maximum Voltage	20	40	20	56	10	60	V
Max No of Series Cells NiCd/SLA/LiIon	12/8/4	24/16/9	12/8/4	34/22/12	7/4/2	45/24/13	Cells
Full Scale Voltage	20	40	20	56	10	60	V
Full Scale Current	2000	3000	5000	3000	10000	2500	mA
Accuracy % Full Scale	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	+/- 0.5	%
Minimum Pulse Interval	100	100	100	100	100	100	mS
D/A – A/D Conversion	12	12	12	12	12	12	bits
Voltage Measurement Res. -16 auto-ranges	1	1	1	1	1	1	mV
Current Measurement Resolution	1	1	1.5	1	2.5	1	mA
Charge Measurement Resolution	0.1	0.1	0.1	0.1	0.1	0.1	mAH
Voltage Regulation Resolution	5	10	5	14	2.5	15	mV
Current Regulation Resolution	1	1	1.5	1	2.5	1	mA
Size WxHxD	19x7x14	25x10x19	25x10x19	25x10x19	25x10x19	25x10x19	cm
Power Supply	External	Internal	Internal	Internal	Internal	Internal	

Data and specifications subject to change without notice.
Also available for low current testing: BA421 (+/- 200mA / 10V) ,   BA420 (+/- 20mA/10V),   BA422 (+/- 2mA/6V)
Other voltage and current configurations available by special order.

Description

The BA400 series of battery analyzers provides 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.

This analyzer is supplied with the software program BA400WIN that is used to control the battery under test. The test parameters are set using the software program. You control all functions 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.

The analyzer can also be configured to perform advanced functions included special pulsing capabilities and high speed data collection.

Each analyzer is supplied with PC cable, built in fan, temperature probe and battery cables (banana plugs to alligator clips). No additional equipment or power supplies are required. Just connect the analyzer to your computer's serial port, install the software and connect battery.

An optional USB-Serial Port converter is available if a serial port is not available on your computer.

Software

- BA400WIN Windows software license included
- Software & documentation available online
- License includes software updates via internet
- Windows95, 98, 2000, ME, NT, XP compatible
- Print reports
- Plot graphs
- Export data for analysis
- Save session results for future reference
- Programmable pulse control
- Software allows for quick setup or detailed control
- Requires 8M memory, 4M hard disk storage
- Graphical display plots V, I, T or dT/dt
- Log data to disk

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.

Setup is straightforward, simply connect the BA400 to your computer's serial port using the supplied cable (9-pin connector). Then install the supplied software and run the BA400WIN Windows^{TM} program. From the software program you select your charge and test parameters. Connect your battery pack to the BA400 using the supplied cables. These cables have banana jacks that plug into the BA400 module. The other cable ends have alligator clips for you to connect to the **+** and **-** terminals of the battery.

Included with the BA402 charger is a 50-Watt external power supply. This connects to the rear of the BA402 and plugs into any AC outlet. This power supply is capable of handling all international AC power requirements and carries many approval certifications. The other models are powered by an internal universal 120/240 VAC, 50/60 Hz power supply.

Charger Operation

The BA400 has precise onboard 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 but 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 held constant to the Vreg value throughout 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 can be limited to the amount you specify.

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 the BA400:

Select 1 of 3 methods of setup to begin a session 1./ Load Profile 2./ Quick Select 3./ Load Program (See Section 7)	Analyzer Setup Load Profile Quick Select
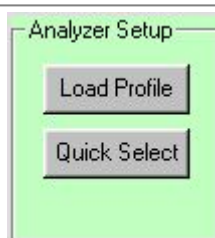
When using the *Load Profile* or *Quick Select* method the user does not need to concern themselves with selecting the correct charging algorithm for constant current or constant voltage. The BA400 will automatically select this for you once you select the battery type.

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. 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 Using Programs 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 computer cable to connect the analyzer to your computer's serial port. The cable from the PC connects to the data IN port on the rear of the analyzer.

The BA402 is supplied with an external power supply. This supply can handle all international power requirements. Plug the power supply to the AC mains. Connect the power supply output to the rear of the analyzer. The other BA400 models have a built in universal 120/240 VAC, 50/60Hz power supply. Plug the supplied AC power cord into the rear of the analyzer.

Do not connect battery yet.

Switch the analyzer on. You should see all three LEDs light. The red LED indicates power in on. When the Charge (green) and Discharge (yellow) LED are both illuminated the analyzer is off-line. When you start the BA400WIN 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.

Installing Multiple Channels

A major feature of the BA400 system is the ability to connect any number of analyzers to meet your requirements. The BA400 system can accommodate up to 100 channels.

On the rear of each analyzer is a data port IN and a data port OUT. To add additional channels you connect the OUT port from one channel to the IN port on the next channel. All units are serially connected in this manner. The channel closest to the PC will be channel 1. The next will be channel 2 and so on.

Each analyzer is supplied with a 9 pin data cable for you to connect the analyzer into your system.

The BA400WIN 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.

You need to run the calibration routines for each new channel added. See the Calibration section of this manual for more information.

Each analyzer re-transmits data from the preceding analyzer. This means that you need to have all the analyzers between an analyzer in use and the PC powered on.

Baud Rate Selection

The Baud rate is the speed of data transmission between the computer and analyzers. Each analyzer is factory set to a 56K baud rate when shipped. This is the fastest data rate available. With each baud rate there is a limit on the number of analyzers that can be connected.

Baud rate	Max No of Channels	Jumper A Connect Pins	Jumper B Connect Pins
56.0 K	15	1-2	4-5
38.4 K	21	1-2	5-6
19.2 K	45	2-3	4-5
9.6 K	90	2-3	5-6

If you exceed the number of channels listed above then the computer will be unable to communicate with the analyzers that exceed the limit.   All analyzers connected to a single computer must have the same baud rates. The baud rate can be selected by adjusting jumpers located on the board inside the analyzer.   Locate screws on each side. Remove these and lift the top up. Locate the baud rate selector jumpers and configure appropriately.   Turn off power before attempting to adjust the baud rate selector jumpers. You will need to switch the power on in order for the new baud rate to take effect.

Installing BA400WIN Software

There are two ways to get the BA400WIN software program:

Download from Web Site - Visit: www.lamantia.ca

From this site you can download a file called: *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. See BA400WIN folder to find this file. 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. There is an Acrobat Reader program that you can install to read the PDF manual in the event you do not have the PDF reader.

If you want to install the software on a PC that does not have a CD ROM drive you can copy the individual installation files from the CD or downloaded program to diskettes. These can then be copied to a common directory on the hard drive. Run setup.exe from this directory location.

Installation Notes

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 BA400WIN Version

Also on our web site you will find upgrades from time to time. These updates provide updates to various features, new enhancements and program corrections. You can either download and reinstall the *full_installation.zip*   file as previously described or you can download the smaller executable file: ba400win.exe. To upgrade by using this single exe file you just need to 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\ba400win\ba400win.exe   The version that you are using is displayed in the top title bar of the main program screen. After upgrading check this to ensure that your upgrade was successful.

Starting BA400WIN Software

Start the program by selecting BA400WIN from your start menu. This will bring up the BA400WIN introductory screen. This is where you select which COM port the analyzer is using. You can select from COM1,2,3 or 4. Once you make the selection you are ready to continue. To continue you must read the license agreement. Use of the BA400WIN software is subject to this agreement. This agreement includes acknowledgment of the dangers and risks that are present if you were to improperly charge some batteries for any reason.
Please see "Read This First on page 2 and the Safety Precautions in Section 3 of 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.

Always observe the correct polarity when connecting batteries to the analyzer. Red is positive (+) and Black is negative (-).

In the event that you are having difficulty getting the analyzer on-line the most likely cause is that you have a COM port configuration problem. The following are some items to check

- Try restarting the program with a different COM port number.
- Ensure that the COM port you are trying to use is actually operational. If you can test it with some other equipment then that will help you test that it is indeed functioning.
- Ensure that you have the PC cable connected to the IN/PC data port on the rear of the analyzer.
- Sometimes computers have a serial port connection on the rear of the computer but it can be disconnected on the inside of the computer. Also the COM port can possibly be disabled inside the computer. The COM port may also be disabled in the computers CMOS BIOS program.
- Check that the serial port is installed in your windows control panel. Find this at: *Start - Settings - Control Panel - System - Device Manager - Ports*

Again - only when the analyzer is online, are you ready to begin a session.

If at any time the analyzers loose 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. This can include computer crashes, lockup or loss of power.

You will need to restart the software application to restore data communications.

Note: <u>Calibration of your analyzer is important for precise measurements, regulation and safety.</u> The BA400WIN software has 2 routines that can be used to calibrate the voltage and current measurement and regulation. This only needs to be done once for each channel and take just a few minutes. See Section 8 for details on how to calibrate your analyzer.

<u>USING THE ANALYZER</u>

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.

You should 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 BA400 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 the voltage and current software calibration tools after initial setup. See Section 8 for details.
- 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 the BA400. Failure to do so could damage your equipment and will void the BA400 warranty.
- Keep the charger in a well ventilated location such as on a table top or open shelf. The BA400 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 15 samples in the analyzer's internal memory. This sample data is then transferred to the PC when the PC polls for this data.

A sample consists of 1 voltage, current, time and temperature measurement.

You control the frequency of samples taken by the analyzer in the options panel. You can 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.
You control the polling interval in the options panel. You can 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 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 with each data sample by the analyzer.

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 charge and discharge LED's will go out and the analyzer will go off-line. This is a fail safe mechanism to protect the battery from possible damage.

Temperature Probe Cable

Supplied with your BA400 is a temperature probe for 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 jack on the rear of the BA400 analyzer. 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 rear of 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.

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 BA400 analyzers have some regulator power limits. If the power limits are exceeded the analyzer will be shut down to avoid over heating. The BA400WIN software monitors the power situation and will shut down the analyzer if a power limit is exceed. There is heat generated during both charging and discharging at follows:

   <u>Charging</u> 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.

   <u>Discharging</u> 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 BA400 analyzer will reset and all charge and discharge current will stop.   When the power is restored the BA400 analyzer will power up but charge and discharge current will remain off. This protects the batteries against over charging or discharging. Since the BA400 analyzer must continually report data to the computer, the analyzer will shut down in the event the BA400WIN program stops running. This could be the result of closing the program, shutting down the computer, computer lockup or software failure. After 40 seconds of inactivity from

the host computer the BA400 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 BA400Win 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.

Open Circuit Option

The open circuit option allows you to measure battery voltage without the load connected. This is referred to as the Open Circuit Voltage (OCV).

When charging or discharging there is a voltage drop across the leads and connections that can have a significant impact on the voltage measurements. As well there is internal resistance within the battery that can cause voltage increases and decreases during charging and discharging respectively.

To avoid this effect you can use the OCV option to open the circuit momentarily. The voltage is then measured and then the circuit is closed and the current is restarted.
This feature is controlled in the *OPTIONS-ADVANCED* panel. Disable the open circuit feature by setting it to 0 (Off) . To enable the feature you select an open circuit interval greater than 0. This is a time value in mS. When the circuit opens, the analyzer will wait this time interval and then perform the voltage and temperature measurements.

By default the open circuit option is set to off (OC time= 0). If you want to use this option 30mS is a typical OC interval. This is enough time for the current to drop to 0 but not so long that the battery voltage will change due to chemical effects. Users are free to select any value from 0 (Off) to 60 mS.   Note that if you set the open circuit time too low you may not allow sufficient time for the current to drop to zero. This could result in voltage measurement fluctuations and premature charge or discharge termination.

This open circuit time is required on each sample. This means, for example, that if you are using an open circuit interval of 30 mS and are measuring 5 samples per second, you will have an open circuit for 150 mS every second. This will be 15% of the time.

Note that when you use the OC feature it will take longer to charge and discharge because there can be a significant amount of time when no current is flowing. The mAH measurements will take the OC interval into account and still report accurate mAH results. However when validating your results the mAH reported will be less than simply current X Time. For example if you have the circuit open 12% of the time (OC=30 ms for 4 samples/sec) then the mAH will be:
current (mA) X time (H) X .88 = mAH

You need to determine what it is that you want the analyzer to do for you. If you don't want the circuit open time to increase the session time you may want to disable the OC (Set OC=0) and make the necessary adjustments to the lower discharge cutoff voltage.
The OC option is only available during constant current conditions. This includes constant current discharging for all battery types and constant current charging for NiCD & NiMH. It is not available when charging SLA or LiIon/LiPO because the OC would interfere with the normal charging algorithm.

Note: With the OC>0 you cannot measure voltage and current with a multi-meter because the current is pulsing on and off too fast to read with a standard meter. However you can set the OC=0 so that the current is steady state making it possible to measure and validate current measurements with your multi-meter.

Using Multiple Channels

The BA400 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 BA400WIN software supports up to 100 channels.

The BA400WIN software allows you to conveniently move from one channel to the other using the on screen channel selector.
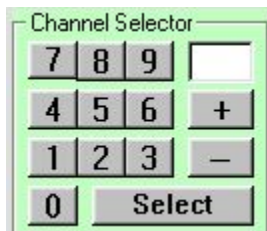
 The main screen shows all the details for the presently selected channel. To switch to another channel simply key in the desired channel number and click *Select*. Alternatively if you want to move up or down to the next channel you can use the + or - buttons. The channel number of the presently selected channel appears in the top field in the main screen.

Note that when using multiple channels you need to <u>be careful not to interchange the black (-) leads</u>. These are not ground. Each black lead of each channel can be at slightly different potentials. Interchanging the by leads by mistake can result in inaccurate measurements and improper operation.

CHARGING

The BA400 analyzer supports charging for :
- Nickel Cadmium (NiCd)
- Nickel Metal Hydride (NiMH)
- Lithium Ion / Lithium Polymer (LiIon/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.

By taking advantage of the *Open Circuit* feature you can minimize this effect, however it can still occur. In these instances you should use the open circuit feature and 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 a full 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 and LiPo

LiIon batteries require a special charging methodology to avoid having the voltage rise above the maximum allowable. The BA400 analyzer 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.
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.

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 (Lithium Polymer) batteries have similar charge and discharge characteristics as LiIon batteries. When testing LiPo batteries you just select LiIon for battery type in the profile.

Only charge LiIon and LiPo batteries that have built in protection circuitry. This will protect the battery in the event improper parameters are applied for any reason. <u>See notice called "Read This First" on page 2 and Safety Precautions in Section 3 regarding these types of batteries.</u>

Temperature Cutoff

(TCO) You can attach the supplied 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 would be used only in special situations because normally it would be better to use the other more sophisticated methods to detect full charge. However it can be done 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 BA400 will monitor the temperature and calculate the rate of temperature rise per minute. Again to use this feature you need to connect the temperature probe to the battery and specify the dT/dt value in the Profile. Typically you would use 2 or 3 C/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.

Minimum Current

During the constant voltage portion of a LiIon or SLA charge 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 a more 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.

DISCHARGING

The BA400 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 time duration to report the output of the battery in mAH. See **Capacity Rating** in Section 8 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 you specified in the profile. The following values can be used as a guide but you should consult the battery manufactures recommended lower cutoff voltage. Discharging the battery to a voltage that is too low may damage the battery.   Typical lower cut-off voltages to use would be:

NiCd 1.0 Volts/cell	NiMH 1.0 Volts/cell	SLA 1.75 Volts/cell	LiIon 3.0 Volts/cell

Note that the *Discharge Cut-Off* voltage you specify in the profile is total voltage. Not the per cell voltage. For example if you are discharging a 4 cell NiCd you would 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

If you want you a discharge test to proceed at a constant rate of discharge power (Wreg), rather than at a constant rate of discharge current you have this option. 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 you need to 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).

Note: Pulsing cannot be used during constant power discharging. The constant power discharge mode can only be used with a steady state constant power.   Constant power regulation is done by the computer. The current is evaluated by the PC approximately every 1 second. The power is then adjusted by changing the current if it is off by more than 5 mA. This means that you can expect an update speed of 2 - 3 seconds. The % error of this power deviation will be determined by the power level selected. At high power discharge levels the % error will be quite low and negligible. At low constant power levels this may become more significant.

Using the BA400WIN 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.
If you have a fully charged battery, the Refresh session could be used to perform a discharge to measure the output (capacity) and then perform a full charge. This would be 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 because they may be recoverable.

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.

Menu Items

File - Open: This will allow you to open a previously save 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 *.BA4. 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 a file save dialog box that will allow you to save the session's results. At any time during or after a session you can save it for future use. You can only save it with a file type of *.BA4. If a session is important 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. You can use this dialog box to select a file for deletion. You can delete any file type. E.g. ba4, pg4 &, log files.
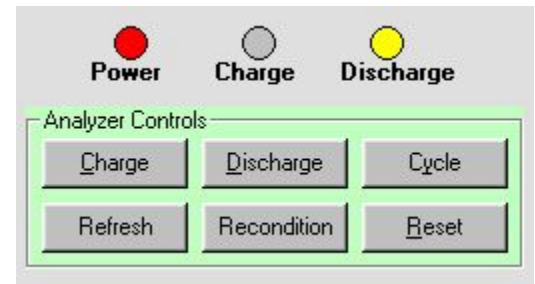
File - Footer: This will open a window that you can use to specify the footer that will appear on your printed reports. This footer is a message that will appear on the bottom of your reports. This can be used to enter company or any other contact information.

File - Quit: This will clear all data, shut down all analyzers and exit the program.

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

Analyzer - Details: Use this to open the *Analyzer Details* window.

Analyzer - Current Calibration Wizard: Use this to open the current *Calibration* tool. See *Current Calibration Wizard* in Section 7 of this manual.

Analyzer - Voltage Calibration Wizard: Use this to open the voltage *Calibration* tool. See *Voltage Calibration Wizard* in Section 7 of this manual.

Analyzer - Temperature Calibration: Use this to input a + or – temperature offset if you want to adjust the temperature measurement reading. See Temperature Calibration in Section 7 of this manual.

Analyzer - Datapacket View: Use this to open the *Datapacket View* window.

Analyzer - Manual Control: Use this to open the *Manual Control* window.

Programs - Edit Programs: Use this to open the program edit window where you can create, edit, view and save your program details. See Section 6 for details on how to use programs.

Programs - Load Programs: Use this to load a saved program so that it and be run.

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

Programs - Run Programs: Use this to start executing the loaded program. The program will now direct the analyzer through the series of steps that are defined in the program.

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 Section 7 for details on creating battery labels.

Reports - Edit Note: 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.

Reports - Internal resistance: Use this to open the *Internal Resistance* window. See Section 8 for more information.

Reports - About: Use this to open the *About* window. This displays 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.

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:
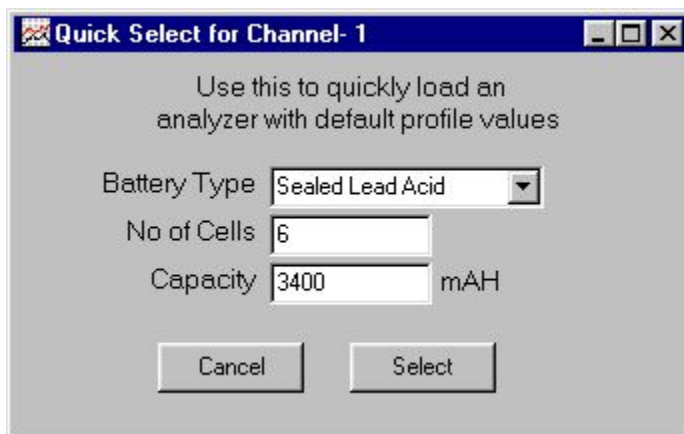
Volts per Cell by battery type	Examples
NiCd - 1.2 V NiMH- 1.2 V LiIon- 3.6 or 3.7 V SLA - 2 V Primary - 1.5 V	9.6 V NiCd - 8 cells in series 7.2 V NiCd - 6 cells in series 7.2 V NiMH - 6 cells in series 1.2 V NiMH - 1 single cell 12.6 V LiIon - 3 cells in series 12 V SLA - 6 cells in series etc.

Rated Capacity: This is the manufacturer's rated capacity for the battery. This is entered in mAH. 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 the BA400 to actually calculate the capacity. The capacity determined this way can then be used in subsequent sessions.

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)

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, then redo the *Quick Select* and start a new session.

Profile Selection

You need to setup the analyzer before a battery 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.

You enter the *Profile* control panel under the menu *Analyzer - Profiles* or 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. This allows you an opportunity to 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. Using the Profile Name drop down selector, you select your desired profile. This will then open this profile and allow you to select (load) this 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: **BA400Example_Parameters.pdf**   This document is on your setup CD and provides some additional help in choosing the profile parameters for various battery types.

Battery Tab

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
              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 the BA400 to actually calculate the capacity. The capacity determined this way can then be entered into the profile for subsequent sessions.

Description: This is any information you want to provide to help describe the profile or battery. This will be printed on the reports.

Parameters Tab

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 goes above 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 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 blank.

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.

It is a total value, NOT a per cell value.

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 Tab
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 C/Min. For example you may want to use 2 C/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. This could be a pause or the start of discharge of the next cycle. Enter the value in minutes. A value of 0 will disable this feature.

Session Time Limit: You can enter a value here to set a maximum time for an entire session. A session could be a cycle session that consists of a series of discharges, pauses, and charges. This is an optional feature that allows you to limit the duration of an entire session. This is normally used as a fail safe mechanism in the event that a session does not complete within this time limit. A time-out will occur if this time is exceeded. This will stop all charging or discharging current and no additional steps will be executed. Enter the value in minutes. 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 in mA 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.

Pulses Tab

Using the pulse feature of the BA400 you 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:

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 parameters.

Discharge: This will cause a constant current discharge. 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. 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.

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.

External Load Tab

This tab is used to control the optional external load modules. These optional modules can be used to increase the discharge current during tests. These can be used to shorten the discharge time for large capacity batteries or to increase the pulse discharge current for load tests.

The external load module connects to the OUT port on the rear of the BA400 series analyzer. The battery is then connected to the external load module and the BA400 simultaneously. Discharge current will flow through the external load module as well as the BA400 analyzer.

This tab of the profile selection is used to manage the load module. There are 2 types of optional load modules. Constant resistance and constant current.

When using a constant resistance load module you would specify the resistance of the load module in the first field. The other two fields are disabled by setting them to 0. A value in the *Constant Resistance* field will trigger the external load module to turn on whenever the analyzer is in discharge mode. The BA400WIN software will use the specified resistance value and the actual measured voltage to calculate the additional current discharging through the load module. This additional discharge current is added to the BA400 discharge current. It is also included in the screen display, used to calculate mAH and is included in all reports. The *Constant Resistance* value can be adjusted slightly as required to calibrate the load module current to the actual as measured by you.

When using a constant current load module you would specify the current that is discharging through the load module. The constant resistance field is disabled by setting it to 0. A value in the *Constant Current* field will trigger the external load module to turn on whenever the analyzer is in discharge mode. The BA400Win software will use the specified current value and add it to the BA400 discharge current. It is also included in the screen display, used to calculate mAH and is included in all reports. The *Constant Current* value can be adjusted as required to calibrate the load module to the actual current as measured by you.

If your external load module has the capability to adjust the current using an analog control line then you can enter a value in the *Analog Output* field to set this load current. This analog output is a 0 - 10 V signal that is specified by entering a % of full scale. e.g. for 10V enter 100%, for 2.5V enter 25% etc.

When using the analog output to control the external load module you still need to specify the actual current in the *Constant Current* field to inform the BA400Win software of the actual external load discharge current.

Specify either a *Constant Resistance* value or a *Constant Current* value, but not both. You will be using either a constant resistance load module or a constant current load module. The analog output value is only used with a constant current load module

The OUT connector on the rear of the analyzer (DB9-Male) has the following pin assignments for external control purposes:

> Pin 4: External source digital output control (0V=Not Charging, 5V=charging)
>
> Pin 1: External load digital output control (0V=Not Discharging, 5V=Discharging)
>
> Pin 9: Analog output 0 - 10 V
>
> Pin 7: +12V maximum 50mA
>
> Pin 6: + 5V maximum 50mA
>
> Pin 5: Ground

Advanced Tab

The BA400 system 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. TheAbsorption 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 Tab
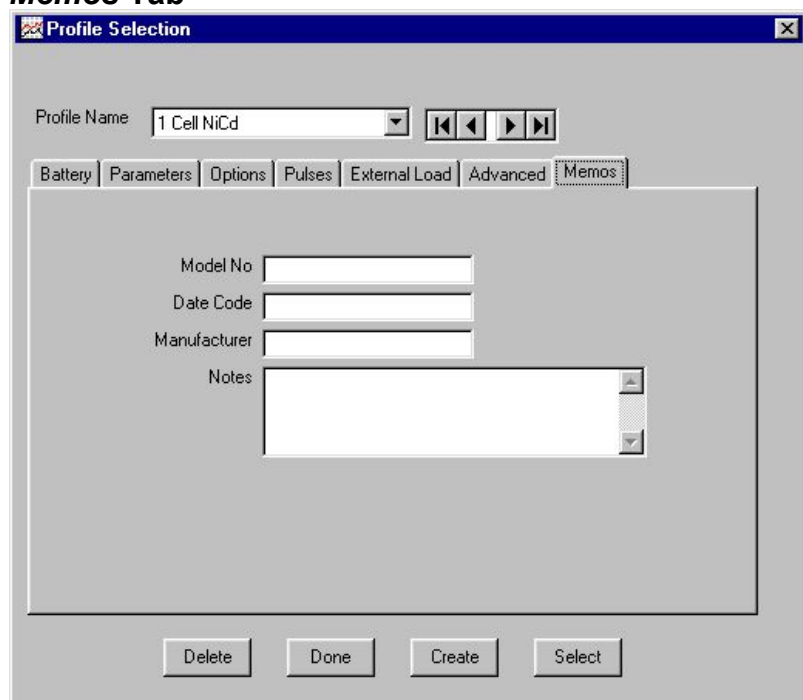
Model No: Optional field for recording battery model number or other information. This will print on reports.

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.

Using Programs

The *Program* capability of the BA400 system 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 BA400 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.)

The programs are operated using the Programs drop down menu as shown here.
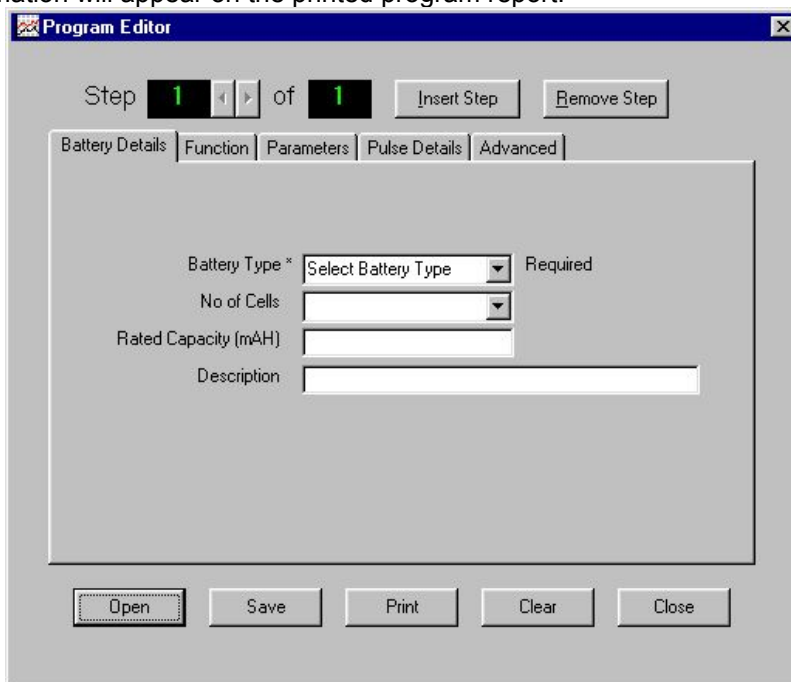
To use a program you have to create it by defining the function and parameters for each of the steps in your program. This is done with the *Edit Program* window. The program editor consist of a window with 5 tabs where you can edit parameters for each of the steps. Notice in the pictures below that 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* Tab

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* Tab

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
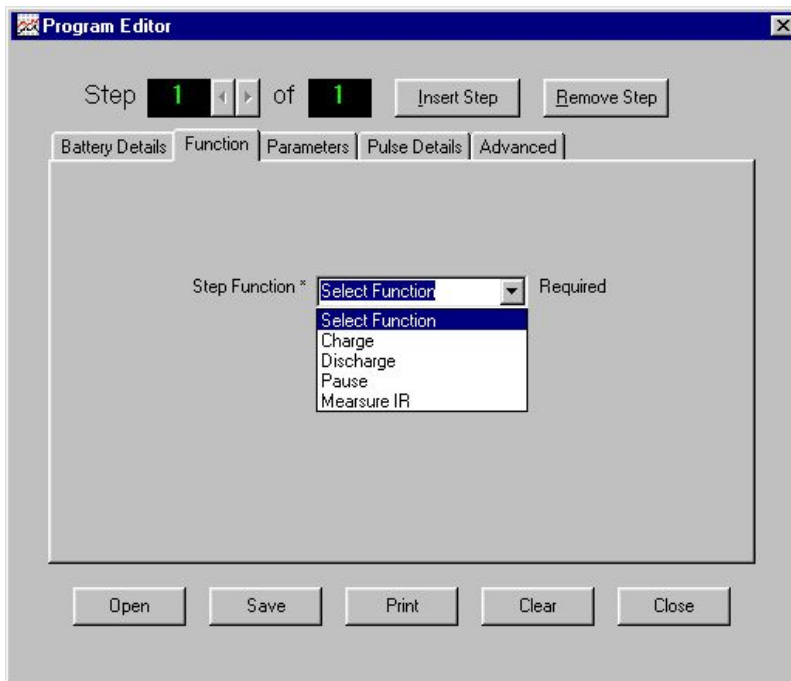
Program- Parameters Tab

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*.
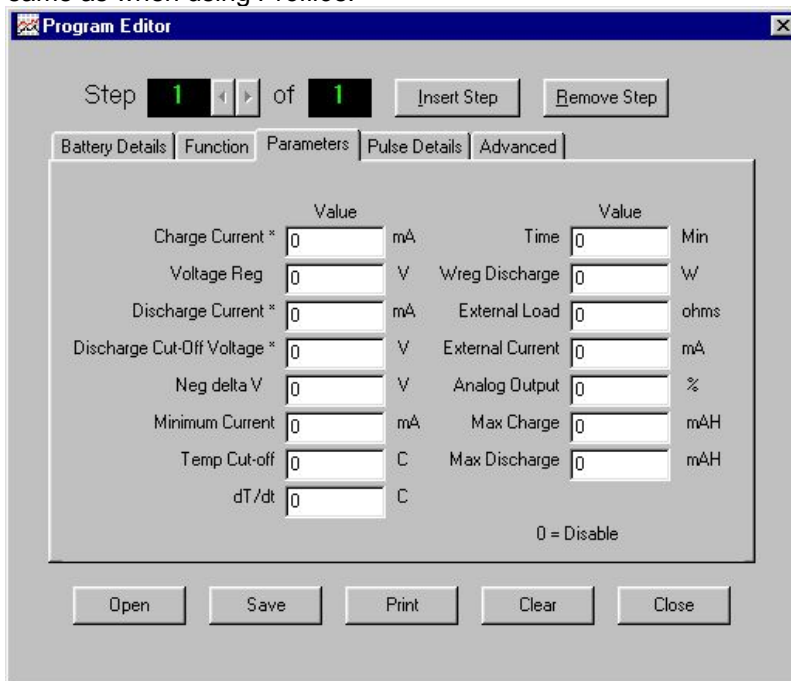
Program- Pulse Details Tab

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.
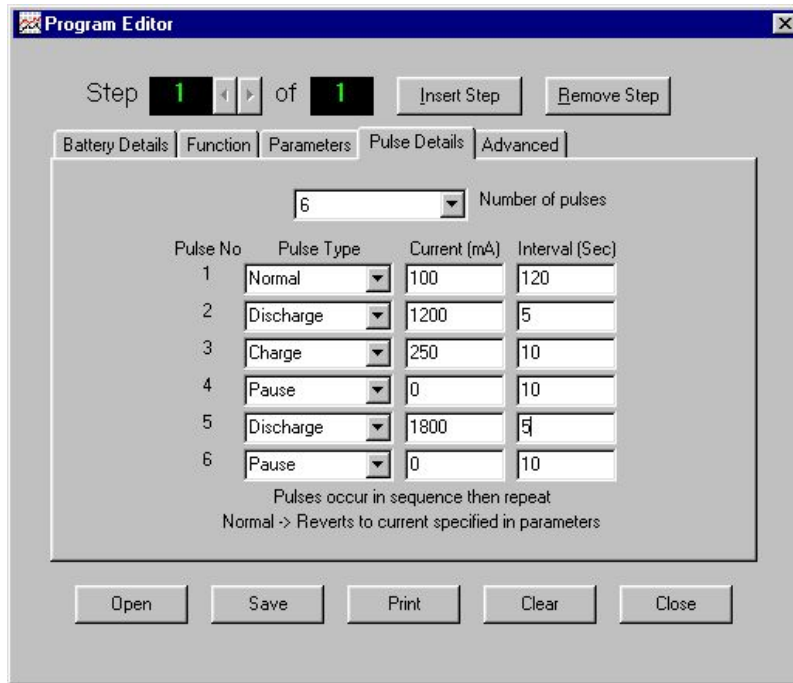
Program Advanced Tab

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.
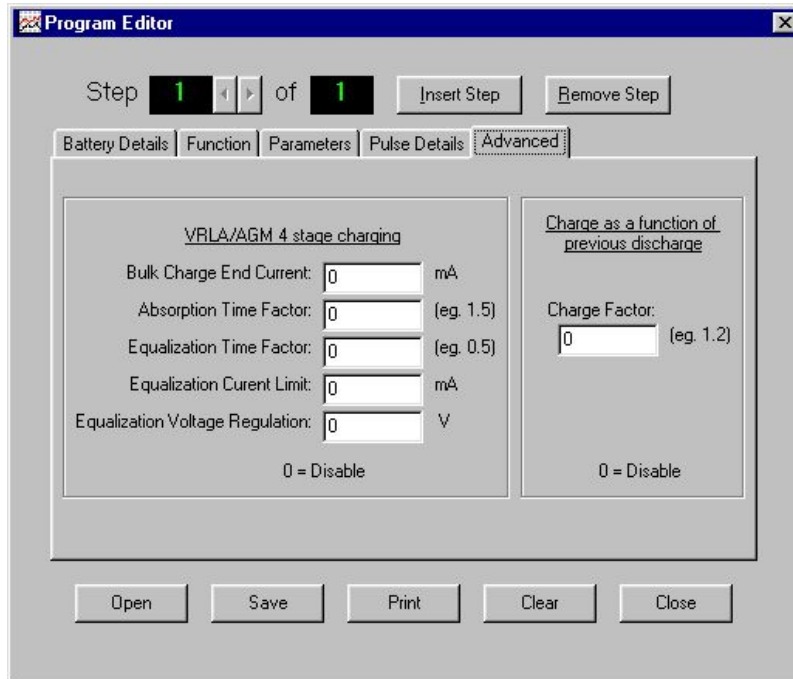
After selecting and entering functions and other data for every step in your program you need to save the program. Click the save button and you will be prompted to enter the file name for the program. The file will automatically be given a .pg4 extension so that you can recognize your program files. 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 pg4 formatting. Each line of the pg4 file represents 1 step of the program. Knowing this, it is possible to copy and paste lines to create large programs.

The BA400Win 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 pg4 file and records all the steps, data and parameters in memory to make the analyzer ready to run the program.

You then 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

You 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 select *Restore Defaults*. This will return all the options in all the tabs to original values.

General Tab

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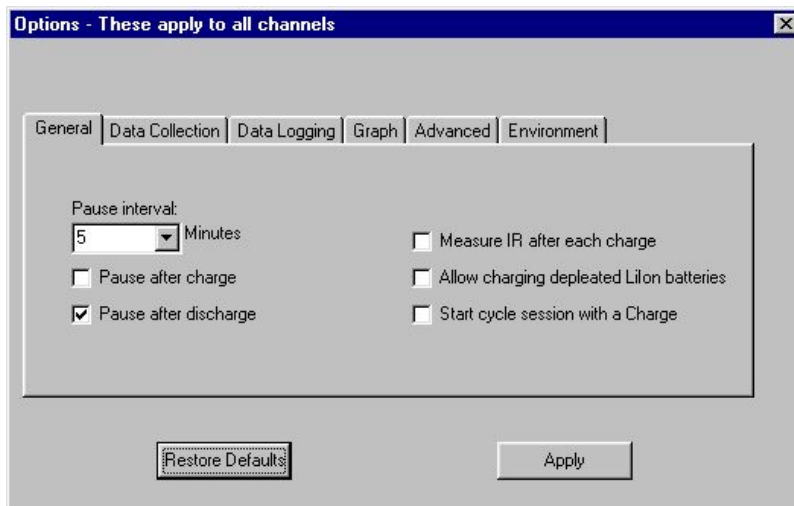
If you have checked the option to Measure IR after each charge then the IR test will occur following the pause. This allows the battery to cool and stabilize prior to measuring the internal resistance and starting a new discharge cycle if applicable.

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 the 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 value then will be displayed on the 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.

Measure IR after each charge: Checking this option will cause the analyzer to automatically measure the battery internal resistance after each charge. This will include *Charge* sessions or the charge portion of a *Cycle* session.

If you select this option a pause (if enabled) will be inserted after each charge and then the internal resistance will be measured. The length of pause is the value specified in the Pause option. This measured IR value will be displayed in the *Session Results* panel and appear on printed reports.

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 cycle session of 2 cycles 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. Charge		5. Measure IR
6. Pause		6. Discharge
		7. Pause
		8 Charge
		9. Pause
		10. Measure IR

Data Collection **Tab**

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. See Data Collection in section 3.

Poll Interval: This is how often the PC will poll for data from the analyzer. 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 15 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*.
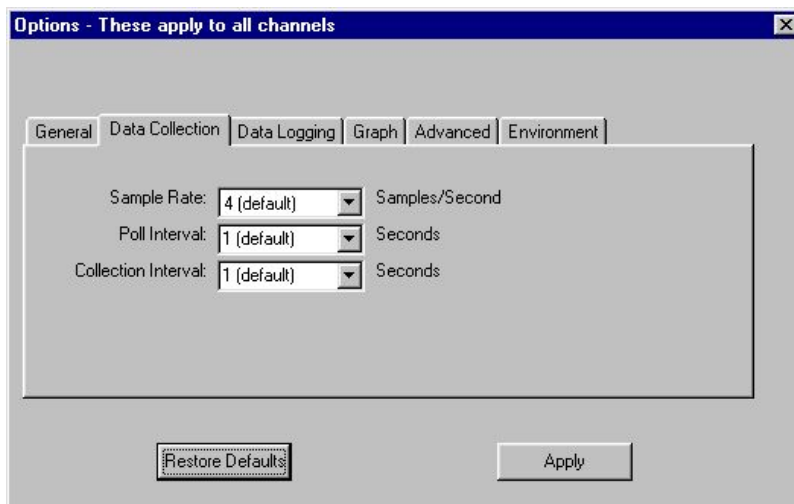
When using multiple analyzers you may wish to increase the poll interval (decreased the frequency) in order to relive the PC and speed up the software response time.

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 it takes 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. If you want to completely disable the graph to save computer resource time you can set the update interval to 0. |

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 **Tab**

The Data Logging feature allows you to collect data in a file for your own purposes. By selecting a data log interval greater than 0 you 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 session.

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.

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 or open it with a text reader such as Wordpad.
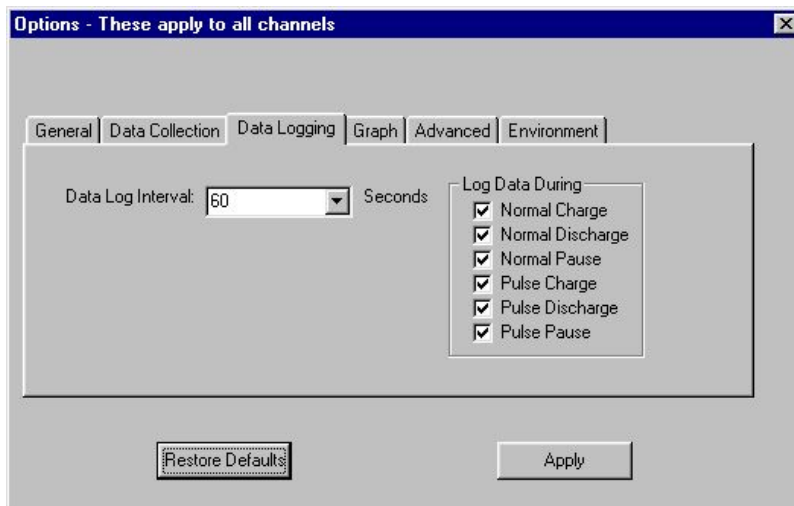
Data Log Interval: This is the time interval between logs. After this time has elapsed a data set will be written to the log file. This is repeated continuously until the session is completed. You are not limited to the values in the drop down box. For example if you want data logged 2 times per second then just enter 0.5 seconds in this field.

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.

This log file records data in ASCII text format. The data is separated by commas (CSV format) to allow importation into a spreadsheet program. The data file contains one data sample per line. Each line has the following data:

        Event#: Increments with each step
 Event_Type: 1=charging,   0=Pause,   -1=Discharging,   -2=IR Test
        Cycle#: Cycle number
 Event Time: Time stamp in seconds
       Voltage: Voltage in Volts
      Current: Current in mA
         Temp: Temperature in °C
       Pulse#: Pulse definition in effect
       Charge: Input/Output charge in mAH (mΩ for IR Test event)

Note that pauses and IR measurements that you have set between cycles will each count as 1 event.

Graph Tab

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.

Resolution: This is the number of data points that are used to plot the graph. Not all the data points are always plotted. This controls the maximum number of discrete points. With very large data files over longer periods of time there is no point in plotting every single data point. By reducing the resolution some data points will be skipped during the graph update.   This reduces computer processing requirements. This does not in any way limit what is available to view. All the data continues to exist and is still able to plot on the graph if you choose to zoom into a particular area of the graph.
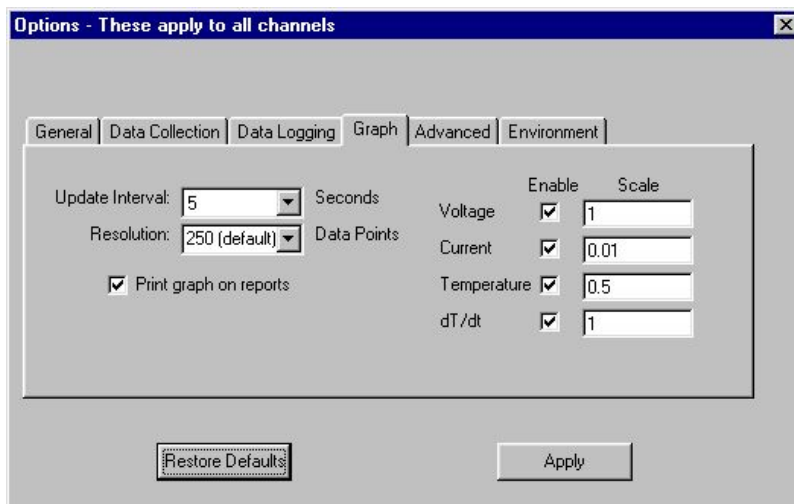
Note that when graphing pulse wave forms, the pulses occur in very uniform time sequences. These can sometimes be in phase with the data points that are skipped during graph updates. It does not mean that the pulses did not occur. It simply means that those data points did not plot. If you increase the resolution or pan left / right they will become visible. Also if you adjust the graph controls you can see them.

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 Tab

Open Circuit Time: Enter the desired open circuit interval you want to use. See *Open Circuit Optin* in Section 3 for details on how this affects the measurements. Set this to 0 to disable the open circuit option.   The value represent milli-seconds (mS). This is the duration that the circuit is opened before the voltage is sampled.

The entry you make here will also be displayed in the Status Bar at the bottom of the main screen.

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
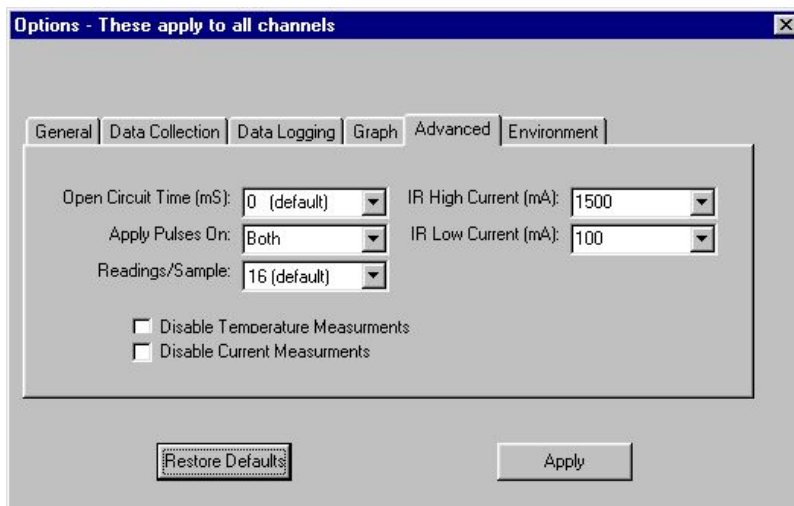
performs for each sample is adjustable using this field.   The purpose for providing averaged samples is to reduce noise during the measurement process. For this reason you should keep this to the maximum value of 16 unless you have a reason to reduce this. Other possible values are 8, 4, 2, and 1.

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 16.

Disable Temperature Measurements: If you want to reduce the processors sample time you can disable the temperature measurement when not in use. This would only be useful when performing high speed pulsing, other wise there is no reason to disable the temperature measurements. The default value is unchecked.

Disable Current Measurements: If you want to reduce the processors sample time further you can disable the current measurement when not required. This would only be useful when performing high speed pulsing, other wise you would always want current measurements enabled. The default value is unchecked.

IR High Current: Use this to set the high current (I-high) for the Internal Resistance (IR) test. See *Internal Resistance* in Section 7 for more information.

IR Low Current: Use this to set the low current
(I-low) for the Internal Resistance (IR) test. See *Internal Resistance* in Section 7 for more information.

Environment Tab
There are 2 check boxes in this tab. If you want the software program to open in a maximized state you can check this box. If you want to enable the Auto Backup feature then check the appropriate checkbox. See Section 8 for more information on using the Auto Backup feature.

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)

You can select which of these data sets you want displayed in the *Options-Graph* tab area.

When a session begins the 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.
You may elect 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.
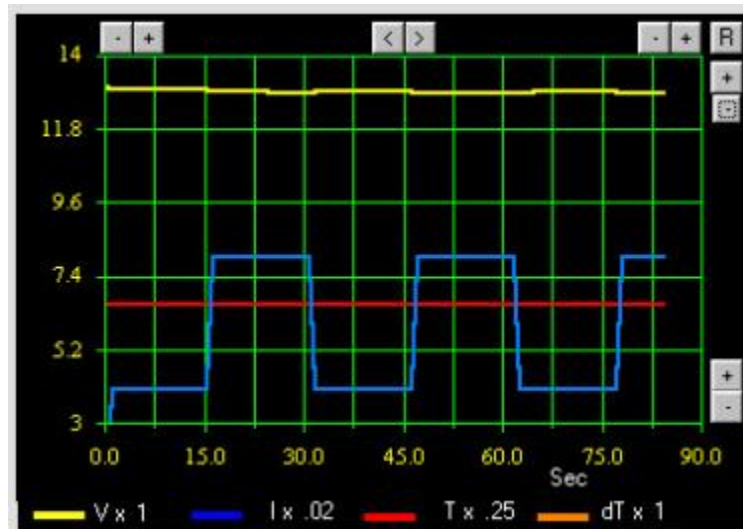
This graphics feature is a powerful tool to add dramatically to your understanding of what is happening during the battery sessions. You will also note that there are graph controls located on the graph. These controls can be used to expand, contract and pan across the axis. With this capability you 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 controlling the graph update interval and resolution.

SPECIAL FUNCTIONS

Analyzer Details
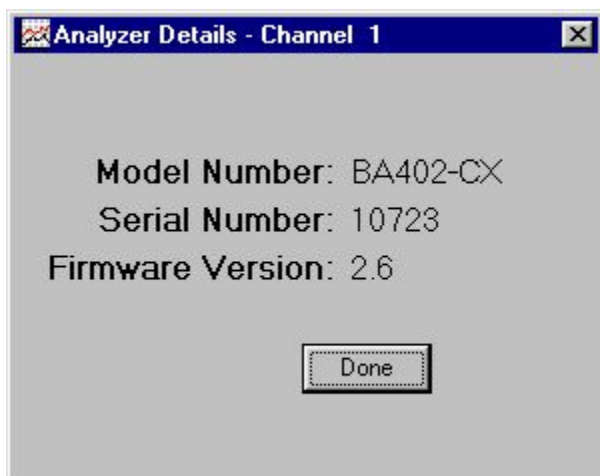
The *Analyzer Details* window provides details about the analyzer for the presently selected channel.

Calibration

The BA400WIN has two software calibration wizard tools that you can use to calibrate the voltage and current measurements. These will calibrate the analyzer's voltage and current regulation as well as the voltage and current data collected by the PC. These calibration routines should be performed to ensure precise regulation and measurement and safety. Once you complete the calibration routine the data is saved in the PC registry for future use. Each channel needs

to be calibrated separately. These software calibration routines allow you to calibrate the analyzer to your reference. For example if you have calibration certificates for your current and voltage meters then you can calibrate to that standard.

When using multiple BA400 analyzers you will need to recalibrate if you relocate an analyzer to a different channel position. When you upgrade to a newer version of BA400WIN recalibration is not necessary since this data has been stored in the registry and is unaffected by upgrading.

The current and voltage calibration tools are important and should be run after installing a new analyzer on your system. These only need to be done once. The calibration values will be stored on the computer for future use. The voltage calibration tool calibrates voltage measurement as well as voltage regulation. If you do not perform the voltage calibration, you may experience a situation where the current is less than required during constant voltage charging of SLA and LiIon batteries. This would be due to the voltage regulation being under value.

The calibration values are stored on the computer. When logged on to Windows using a particular Windows user profile (Such as Windows XP or Vista) you will have unique calibration values that are applicable to that Windows user profile only. For this reason you should perform the calibration routines logged on to the same Windows profile that you plan to operate the analyzers.

Current Calibration Wizard

The current calibration wizard is found in the main menu under *Analyzer*. This wizard will guide you through the calibration process required to calibrate the current regulation and measurements for this channel. To complete this calibration procedure you will need to connect a battery with a current meter in series. This will allow you to measure the current in and out of the battery.   There are 4 input entries required:

 1.   High current charge   2.   Low current charge   3.   High current discharge 4.   Low current discharge

You should use a battery capable of being charged and discharged at full current range without exceeding the voltage limits of your particular BA400 model or becoming exahusted. For this reason you may want to avoid SLA and LiIon batteries to avoid an over voltage situation during the charge calibration portion of the routine. NiCd or NiMH are recommended.   If at any time you want to clear the current calibration values and return to the original default values simply select *Restore Defaults* from within this wizard routine. The inputs should be a positive number expressed in mA. If the battery voltage is starting to get near the top of the analyzer's range then it could be difficult to get sufficient current flow. This could result in an unsuccessful current calibration.

Voltage Calibration Wizard

The voltage calibration wizard is found in the main menu under *Analyzer*. This wizard will guide you through the calibration process required to calibrate the voltage regulation and measurements for this channel. To complete this calibration procedure you will need to remove the battery from the analyzer and connect a voltage meter across the leads. This will allow you to measure the voltage at the analyzer output. There are 2 inputs required for each of the 16 auto-ranges for a total of 32 inputs.   Be sure to use a voltage meter capable of measuring over the complete voltage range of you particular BA400 model. If at any time you want to clear the voltage calibration values and return to the original default values simple select *Restore Defaults* from within this wizard routine.

Validating Calibration

When you have finished running the calibration routines you can validate that everything is calibrated properly 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.

Please Note: The calibration wizards will automatically shut off the Open Circuit (OC) option so that you can take readings with your meter. Remember that when validating your analyzer's calibration, after you have completed the

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calibration wizard routines, you will need to <u>ensure you have shut off the OC option</u>. Ensure that: Analyzer/Options/ Advanced/Open Circuit Time = 0 mS. Otherwise the current will be going to zero for every voltage measurement making it impossible to measure the steady state current and voltage with your meter. Also, to avoid discrepancies, use the same range on your meter for validation that you used during calibration.

Temperature Calibration

The temperature probe supplied with the BA400 uses a thermistor for sensing temperature. This is designed for TCO or dT/dt charge termination. It is well suitable for battery charge termination. It is not a precision thermometer. If want to compare or reference this to your own temperature measurement device you can do this. This input area allows you the option to enter a + or – offset factor to adjust the temperature reading.

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. While the BA400WIN program incorporates a lookup table to linearize the data, you may still want to measure the offset in the target temperature range.

Normally temperature calibration is not required and you can just leave the offset = 0. However for laboratory applications this option exists.

Manual Control (Electronic Load)
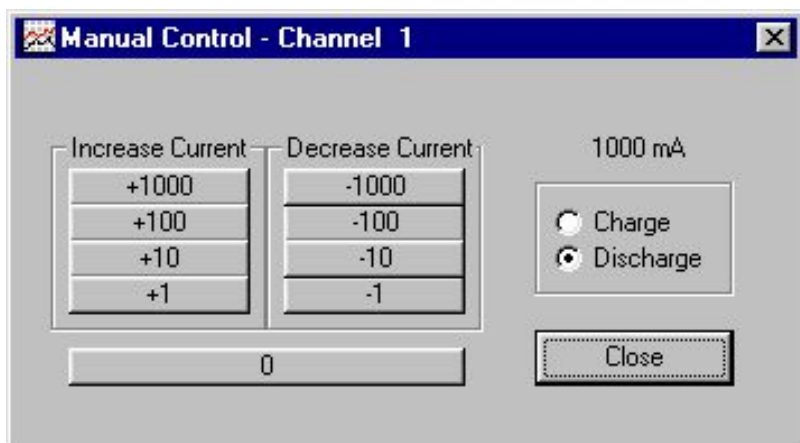
There may be instances when you want to be able to collect data using a manual control. This allows you to adjust the current in real time. Using this feature you can create charge or discharge currents of any value.

By controlling the discharge current the BA400 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.

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

<u>Caution...safety warning !</u>
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. With manual control voltage regulation is not available.

Internal Resistance Measurement

```
Internal Resistance - Channel 1                    [X]

              mA          V
High Current:  1488.2     11.467
Low Current:   110.9      12.277

Internal Resistance:    589      mOhms

[Manual Lead Res]   [Print]           [Measure IR]
[Save Lead Results] [Test Leads]      [Done]

Lead resistance used for measurement = 0 mOhms
Set "High Current" and "Low Current" in Options
```

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 the BA400 to measure this IR. To perform the test, open the *Internal Resistance* control window using the menu *Reports-Internal Resistance.* You then proceed with the test by connecting the battery to the analyzer and clicking *Measure*. The test takes only a few seconds and the results are reported in this window. This measurement will also be printed on reports.

The BA400 measures the DC Internal Resistance (Rdc). When you perform an IR test the battery is discharged momentarily with two different currents. A high and low discharge current are activated.

First the high current (I-high) is started and voltage (V-high) is measured. Then the low current (I-low) is started and voltage (V-low) is measured. The resistance offered by the battery, leads and connections is then calculated as:

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

You can control what values of I-high and I-low are used. These are set under *Options -Advanced*. Default values are 1300 ma for I-high and 300 ma for I-low.

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. The BA400 system has a feature to measure the lead and connection resistance. This value is then saved and the BA400 system uses this value to calculate and correct the voltage based on the + or - current flow.

Since the IR measurement also includes the resistance of the test leads and connections, the BA400 also adjusts the IR measurement to subtract the lead resistance. This then provides a pure battery IR measurement.

You measure this lead resistance by connecting (shorting) the leads together. Remove the battery before shorting the leads. No battery is involved in this test.

When the leads are connected together begin the test by clicking *Test Leads*. This will then pass a high and low charge current through the leads and measure the lead + connection resistance. By clicking on the *Save Lead Results* the results are permanently saved. This saved result is automatically removed from the normal battery IR measurement so you have a pure IR measurement.

It is also used to correct the battery voltage during normal (OC interval = 0) charging and discharging based on actual measured current flow and this saved lead resistance value.

Only one lead resistance is saved. When using multiple channels, it is assumed that the leads and connections are all similar.

Rather than measuring the lead resistance if you prefer you can use the *Manual Lead Res* to manually enter a lead resistance value to force the program to use a specified value.

If you are using the Open Circuit (OC) feature then there is no voltage drop across the leads because current is shut off momentarily during the voltage measurement. The OC feature is used for this very reason. When you have the OC

feature enable (OC>0) then there is no voltage drop across the leads since the current drops to zero just before the voltage measurement is taken. So when the OC > 0 there is no voltage correction made for lead resistance.

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 measurement methods. Even if you change I-high or I-low you may get different results. It is best to use the BA400 to establish benchmarks for yourself and then use the BA400 for comparison purposes.

If you get an error when measuring IR then you may have the lead resistance set too high resulting in a negative IR measurement. This could happen when measuring very low IR batteries. You will need to lower the lead resistance value slightly. Also by increasing the difference between I-high and I-low you can get improved IR measurement resolution.

2 Wire Operation

The BA402 and some other low power analyzers use a 2 wire system. This means there is 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 BA400WIN under Reports - IR measurement.   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 terminals instead since they have much less contact resistance
C. Use short leads. The shorter the better.
D. Use a lower current limit.

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 leads required. 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.
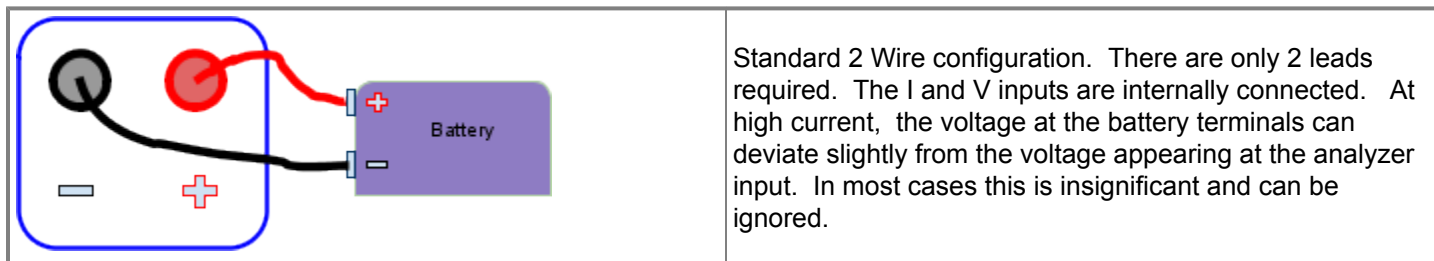
4 Wire Operation

The higher power BA400 analyzers (BA405, BA403, BA453, BA460) are supplied with a 4 wire option. The analyzer has 4 output terminals: 1 pair for Current (I) and 1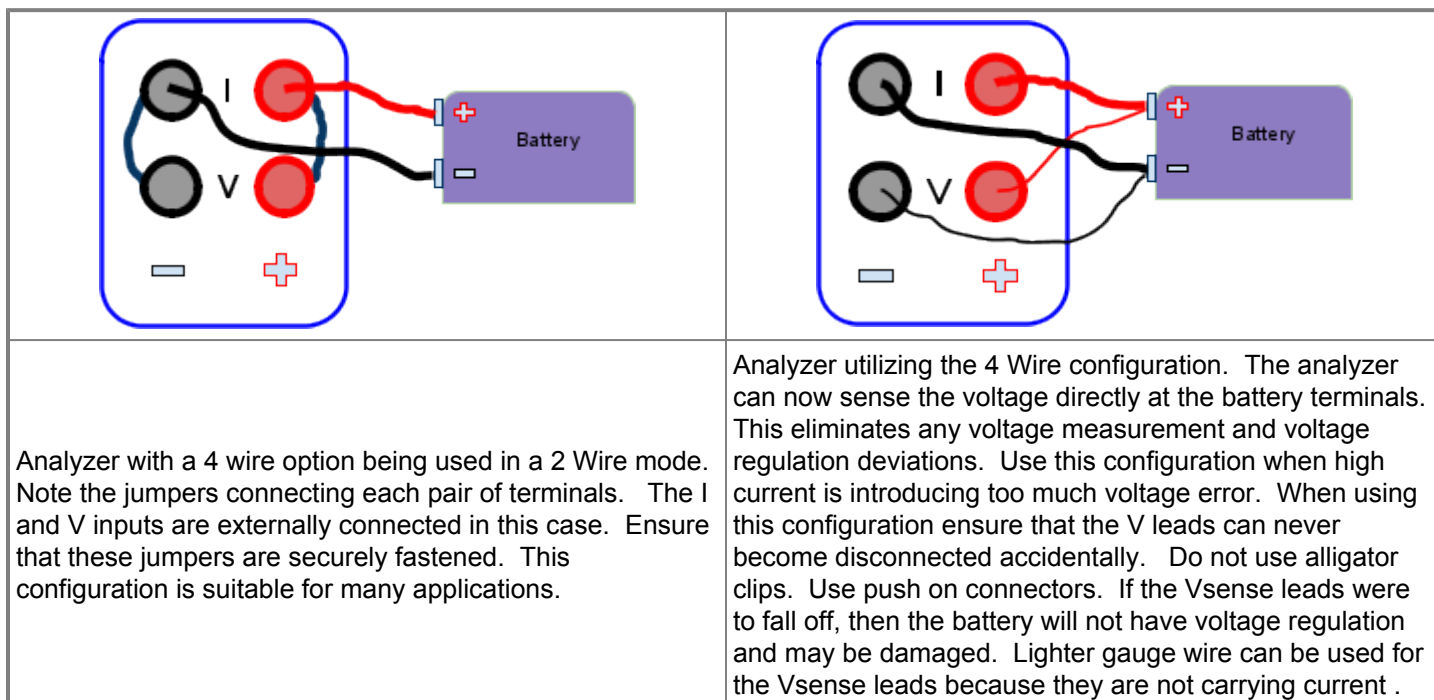 pair for Vsense (V) . This allows for separate voltage sense and current carrying paths. With this feature you can eliminate any voltage error caused by current flowing through the leads. When using this feature 1 pair of leads carry the current (I) and another pair of leads are used to sense the battery 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 in BA400WIN.   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 and a 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. If your application requires you to use the 4 wire feature, 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 with a 4 wire option being used in a 2 Wire mode. Note the jumpers connecting each pair of terminals.   The I and V inputs are externally connected in this case. Ensure that these jumpers are securely fastened. This configuration is suitable for many applications.

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 with the BA400 system. The BA400 analyzer temperature probe 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 thermistor temperature probe supplied with your BA400 analyzer. 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 a 3.5mm jack and connect to the rear of the BA400.

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 TIP of a 3.5mm jack. You can then connect this to the rear input on the BA400 analyzer.

However when you use this single wire thermistor arrangement you must use the OC feature of the BA400 when charging. This is because the black Negative (--) battery lead is not at ground with respect to the BA400 when charging. This offset from ground will corrupt the temperature measurement circuit when sharing a common Neg & T connection. By using the OC feature the current is interrupted to take voltage and temperature measurements. Interrupting the current momentarily will return the Neg lead to ground and allows for proper temperature measurements. Once the voltage and temperature measurements are completed the circuit is closed and charging continues. See Section 3 for more on using the OC feature.

During discharging and pauses the Neg wire is at ground potential and the OC feature can be used but is not required.

Printing Battery Labels

The BA400 system allows you 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:	03-19-2009
Description:	NiMH Mobile 12RT
Rated Capacity:	800 mAH
Output:	778 mAH
Performance:	97.3%
Internal Res:	146 mOhms
Profile:	Panasonic 6 Cel

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 BA400WIN program. Go to File-Open and open the file BACKUPX.BA4 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 you do not want to save backup copies you can disable the feature. This will save hard disk space and other computer resources. 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.

<u>BATTERY MANAGEMENT</u>

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 after the battery has been fully charged, 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 all the cells in the battery pack. This can improve the battery's ability to deliver power and may return poorly performing batteries to expected performance levels.

Performing a discharge test, followed by a full charge is called cycling. Repeated cycles can rematch the cells in a battery pack that have become mismatched over time for a variety of reasons. While this may not work for all batteries, it certainly should be performed. Discharge data from each cycle can then be examined in order to make sound decisions regarding battery replacement.

Periodic cycling and 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. The BA400 is an ideal tool to meet all your cycling and battery testing requirements.

Capacity Rating

The power that a Nickel Cadmium battery stores and later delivers to power your equipment is expressed by a rating called mAH. This is short for milli-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 and 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.

The BA400 is a perfect tool to introduce a battery management program and routine. It is a good idea to periodically cycle test each battery that you use on a routine basis. You can 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 Rate

A NiCd battery will lose 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.

The BA400 system allows you to automatically start a trickle charge 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 BA400WIN 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 BA400 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 not recommended for Lead Acid or SLA 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*.

The BA400 system allows you to automatically start 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 BA400WIN software will not apply float voltages for batteries other than SLA. For other types of batteries the *Float Voltage* parameter is ignored.

Battery Disposal

Remember that batteries contain harmful materials. Never incinerate old discarded batteries. Many communities have hazardous waste collection depots to avoid sending them to landfill sites. Using these collection depots ensures batteries are disposed in an environmentally responsible manner. There are many non - profit organizations dedicated to helping individuals and organizations. Please take the time to find the appropriate drop off depot in your area.

IN CASE OF TROUBLE

If you experience any problems or software troubles please read the **ReadMe.txt** file contained on your original software CD. This file had notes and advise for solving some common problems and answering questions specific to your installation.

We trust that this analyzer will be a valuable tool for your battery management needs. If you have any questions or comments please forward them to:

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