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PC Controlled Battery
Charger & Analyzer
Users Manual

DOC: BA302M13

Model BA302
Software Ver: 2.6
for Windows™

LaMantia Products Ltd.

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Please read the entire users manual before attempting to operate the BA302.

Overview:

The BA302 is a battery charger and analyzer that is controlled and operated from a Personal Computer. Now you have a convenient way to really see what is happening as your batteries are charging and you can see a graphical display of the entire session. Not only is the BA302 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 feature you can even simulate real load conditions for your batteries.

Setup is straightforward, simply connect the BA302 to your computer's serial port using the supplied cable (9-pin connector). Then install the supplied software from the 3.5 in diskettes and run the Windows™ program. From the software program you select your charge and test parameters. Connect your battery pack to the BA302 using the supplied cables. These cables have banana jacks that plug into the BA302 module. The other cable ends have alligator clips for you to connect to the + and - terminals of the battery.

Included with the BA302 charger is a 50-Watt external power supply. This connects to the rear of the BA302 and plugs into any AC outlet. This power supply is capable of handling all international AC power requirements and carries many approval certifications.

The BA302 comes equipped with the following items:

- BA302 module unit
- External Power Supply
- Power cord to connect power supply to AC mains (North America only)
- PC Cable to connect BA302 (IN/PC) to PC (RS232 COM Port).
- Expansion cable to connect additional BA302 modules.
- Temp probe cable.
- Battery cables (Banana jacks to alligator clips)

The BA302 must be under control of a Personal Computer (PC) running the supplied software at all times.

Features and benefits:

The BA302 gives you a very powerful platform to improve your battery management capabilities.

Eliminate doubt about whether your batteries have achieved a full charge !

- With the graphical display you can see charge curves for yourself. Plot V, I, T and dT.
- Voltage and current data is constantly and easily visible.
- Gain confidence that your batteries will provide the service you expect.

Versatile multi-chemistry design !

- Handles all secondary battery types up to 14.4 Volts.
- NiCd, NiMH, Gel Cells, Lead Acid, Lithium-Ion, etc...
- Precise on-board constant current & constant voltage regulation.
- Select from many charge termination options.
- You are in control of all parameters from the Windows™ software program.

PC control program gets you operating quickly !

- Chose "Quick Select" setup to automatically set the BA302 for your battery type, OR...
- Create and save battery profiles for user selectable parameters.

Programmable feature lets you program your own testing routines !

- Create a program for custom control of the charge & discharge cycle algorithms.
- Save the program, load and run it all from within the software program.

Set up a battery management system !

- Perform routine tests & print regular reports on battery performance.
- Spot weak batteries before they let you down.
- Provides essential performance analysis for batteries operating in critical applications.
- Recover poorly performing batteries by controlled cycling.
- Analyze those old packs to see if they can be productive.
- Make informed decisions about replacement of expensive battery packs.

Manage many packs simultaneously from one PC !

- The BA302 is an expandable system.
- Connect up to 24 units with the supplied cables.
- You can start with a single unit and add more channels as your requirements change.
- Data for every battery is available from the software program.

Cycling batteries can improve their ability to deliver the maximum power. The BA302 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 improvement in battery life.

Charger Operation:

Note that the BA302 has precise onboard regulation of current or 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. For Lead Acid and Sealed Lead Acid (SLA) batteries they require charging with a *constant voltage*. The voltage is held to the same value throughout the charge session. This means that the current will initially be large as the battery begins charging and then the current will begin to decrease as the battery stores the charge. Lithium Ion (Lilon) batteries use a combination of constant current and constant voltage charge method.

There are 3 method used to operate the BA302.

- 1./ "Quick Select"
- 2./ "Detailed Profile"
- 3./ "Program"

When using the "Quick Select" or "Detailed Profile" method the user does not need to concern themselves with selecting the correct charging algorithm for constant current or constant voltage. The BA302 will automatically select this for you once you select the battery type .

If you use the "Program" feature then you have complete control over the charge and discharge regimes. The first two methods provide convenient and quick setup of your analyzer. The 3rd ("Program") offers complete control and flexibility for users who want to have more control.

Once you setup up your analyzer using the first two methods you can use the "Charge", "Discharge" and "Cycle" control buttons on the main program screen. These functions perform as detailed later in the "Charger Controls" section. These controls to not apply when using the "Program" method of analyzer operation. With the "Program" method you only choose "Run Program" from the pull down menu to begin a session.

Charge Termination:

The following describes the analyzer operation when using the “Quick Select” or “Detailed Profile” methods of analyzer operation.

This analyzer allows you to choose several charge termination algorithms. The charge algorithms and termination methods depend on the type of battery you are using:

1. NiCd, NiMH

For a NiCd & NiMH batteries you will see a slight voltage drop when the battery has reached a state of full charge. The BA302 can detect and measure this voltage drop, known as the negative delta Voltage ($-\Delta V$). When this voltage drop is measured, by the BA302, the battery is fully charged and the charge will terminate automatically. When using the “Quick Select” charger setup options this $-\Delta V$ value is set for you automatically. For NiCd batteries this is set to -0.015 V per cell and for NiMH it is set to -0.010 V per cell. If you wish to use a detailed profile you can have complete control over this value known as the Term Value.

The BA302 will also terminate the charge when the input charge (measured in mA \cdot H) exceeds the standard threshold for the battery chemistry. For NiCd batteries the charge will terminate when the input charge exceeds 140% of the rated capacity or 1.4C. For NiMH the charge will terminate when the input charge exceeds 160% of the rated capacity or 1.6C. This prevents overcharging in the event that the pack does not experience a $-\Delta V$ voltage drop due to an improperly operating battery pack.

2. Lead-Acid, SLA

For Lead Acid and Sealed Lead Acid (SLA) batteries they will charge under a completely different charging algorithm. These types of batteries require a charge under constant voltage conditions. Normally these types of batteries are charged at 2.45 volts per cell initially. In the event that the initial charge current exceeds the maximum value specified then the current will be limited to the maximum. Under this condition the current will stay constant at the maximum value until the voltage rises to the voltage regulation value. At this point constant voltage charging will begin and the current will decrease as the battery accepts the charge. Once the current reaches a lower threshold charging is complete. This lower threshold will be 1% of the mA \cdot H rating of the battery when using the “Quick Select” charger setup. For example if the battery is rated at 2.5 AH then charging is complete when the current drops to 25mA. If you wish to use a detailed profile you can have complete control over this value known as the Term Value. Once the charge terminates based on this minimum current the regulated voltage will automatically drop to a float voltage of 2.25 volts/cell. This float voltage will be maintained indefinitely until the battery is disconnected or the session is “Reset” from the software program.

If you use the “Quick Select” charger setup then the constant voltage regulation will be 2.45 and the float voltage will be 2.25 volts/cell. The maximum current will be 0.4C (40% of the stated capacity). If you use a detailed profile setup then you can select any value you wish for these parameters.

3. Lithium

Lithium-Ion (Lilon) batteries use a combination of constant current and constant voltage charge algorithms. Lilon batteries require protection from over charging as well as over discharging to ensure peak performance and protect the battery from decomposition. For this reason Lilon battery packs have built in protection circuitry to keep the charge and discharge voltages within limits. The BA302, configured for a Lilon battery type, keeps the battery within these limits and allows for full battery management capabilities. The charging algorithm is as follows:

- If the battery voltage is less than 1.0V/Cell then charging is not allowed because the battery has been degraded. The battery should be replaced.
- If the battery voltage is between 1.0 and 2.45 V/cell then the battery will be charged at 50mA until the battery voltage reaches 2.45 V/Cell.
- When the voltage exceeds 2.45 V/Cell the BA302 will charge at a constant current rate of C/10 until the battery voltage reaches 4.10.
- Once the voltage reaches 4.10 V/Cell the BA302 will automatically change to a constant voltage charge. Under this constant voltage charge the current will begin decreasing as the battery accepts the

charge. Charging will continue in this fashion until the current drops to 50mA. Once the current drops to 50mA the Lilon battery is fully charged and the BA302 will automatically terminate the charge.

Note that the lower voltage limit for Lilon batteries is 3.0 V/Cell the BA302 will ensure that the voltage of the battery is not allowed to go below this threshold.

Also note that the values stated above for Lilon charging methods are the values used in the “Quick Select” charger setup. While you can change any of these values by using a “Detailed Profile” you should always consult the battery manufacturer’s recommended charging methods before altering these values.

For all battery types, when using the optional temperature probe, the charge can terminate if the temperature exceeds a limit specified by you, or if the rate of temperature rise exceeds the value specified in the battery profile details. Also the sessions can terminate if the time exceeds the time limit specified in the profile details.

Programmable Operation:

The “Program” method of charger operation provides no built in controls. You can create and run a program to charge or discharge in any fashion. See the detailed description of using this feature later in this manual.

Features:

- PC controlled via Windows™ software.
- Full PC control of charge and discharge current
- Charge, cycle, discharge, trickle charge
- Reverse polarity protected
- Short circuit protected
- Connects to RS232 serial port
- Many charge termination options
- Multi-Chemistry design for versatility
- NiCd, NiMH, Lead Acid, SLA, Lilon & more
- Precise onboard voltage and current regulation
- Expandable to 24 channels (batteries)
- Print reports, plot graph & export data
- Plot Voltage, Current, Temperature and Delta Temp.

Specifications:

Max. battery voltage	14.4 V
Max. number of cells	12
Max. charging current	2000 mA
Max. discharging current	2000 mA
Max. voltage (full scale)	20 V
Max. Temperature Measurement	80° C
Accuracy (full scale)	+/- 0.1%
A/D & D/A conversion	12 Bit
Dimensions (in)	2.4 x 7.1 x 4.9
Shipping Weight	4 lb.

Charge Termination Options:

- Negative Voltage Drop ($-\Delta V$)
- Temperature Cutoff (T_{co})
- Temperature Rise Rate (dT/dt)
- Minimum Current
- Time limited
- Maximum Charge Input

The BA302 will only operate while under the control of a personal computer.

System Requirements:

- Windows95™ or Windows98™
- 8M RAM memory
- 4M hard disk space
- 3.5" disk drive
- RS232 serial port, COM1,2,3 or 4
- Mouse
- Printer (optional)

Safety Precautions:

Rechargeable batteries can store a tremendous amount of energy. This can be a fire hazard or result in bodily injury if mistreated. 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 BA302 should not be used for charging any kind of primary cells, including reusable alkaline batteries.
- Follow the manufacturers charging recommendations for charge current rate, discharge current rate and time for each battery.
- Never short-circuit the terminals of a battery.
- Do not leave batteries unattended while charging.
- Always observe correct polarity when connecting batteries.
- Remove batteries from your equipment. Do not connect your electronic equipment to the BA302. Failure to do so could damage your equipment and will void the BA302 warranty.
- Keep the charger in a well ventilated location such as on a table top or open shelf. The BA302 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.
- Disconnect batteries when the PC is not in use.
- Only use the charger in a dry location.

Installation:

The BA302 connects to the RS232 COM serial port of your computer. In order to set up the analyzer for the first time connect the modular cable with the DB9 (9-pin) connector to an available serial port. You cannot substitute cables. You must use the PC cable supplied with your BA302. If your serial COM port has a 25-pin connector you will need to use a 9 Pin to 25-pin adapter (not supplied). This is available at most computer supply stores.

It is recommended to use COM1 or COM2 ports. Most PC's are equipped with these two output serial ports. COM3 or COM4 can be used if your PC is so equipped. Most PC's are not equipped with COM3 or COM4 RS232 serial output ports unless you have specifically purchased and installed these ports. At the other end of the PC cable is a modular connector. This plugs into the jack on the rear of the BA302 labeled IN/PC.

Supplied with the BA302 is an AC power converter. Plug this AC adapter into an AC outlet and connect the adapter to the rear of the BA302 at the DC power jack.

Power up the BA302 by pressing the On/Off switch. A red LED will illuminate to indicate you are ready to start the software. You are now ready to run the BA302WIN software program in order to operate the BA302.

After installing the analyzer you should calibrate the unit by following the calibration instructions on page 20. This will ensure that your unit is calibrated for precise current measurements. This is important and should not be omitted.

Rechargeable Battery

You will need to connect your battery to the banana jacks mounted on the right side of the unit. How you make this connection depends on the type of battery you are using. If your battery has terminals you may be able to connect the alligator clips on the supplied cables directly to the battery. If you are using individual standard cell batteries sizes such as AAA,A,C,D etc. you can use battery holders available from your local electronics store. In all cases you should remove the battery from your equipment for safety reasons.

Be certain to observe the correct polarity when connecting your battery to the tester. Connect: + from the battery to + (Red) of BA302
and - from the battery to - (Black) of BA302

You should not connect any battery that has a rated voltage greater than 14.4 Volts.

Temperature Probe Cable

Supplied with your BA302 is a cable for monitoring the temperature of batteries under test. This cable plugs into the TEMP jack located on the rear of the BA302.

The other end contains a temperature sensor. This can be attached to the battery with tape. Simply tape the end of the probe to the side of the battery pack. It is not necessary to use the temperature probe. This is an option for charge termination and protection to prevent battery overheating. The BA302 will take temperature readings during the session. There are two conditions under which a charge will terminate due to temperature changes.

1. If the temperature exceeds the temperature limit specified in the options screen.
2. The rate of temperature rise per minute exceeds the value specified in the selected profile parameters.

The temperature feature needs to be enabled in the profile details for the session to use these temperature termination options.

You also have the option of disabling all temperature measurement data collection from the PC software program. This will allow for faster data collection of the other data. If you don't plan on using the temperature probes then it's a good idea to disable the software using the PROFILE--OPTIONS menu selection.

Also in the OPTIONS screen you specify which temperature probe model you will be using. All units shipped prior to August 1999 have temperature probes with a black covered shrink-wrap at the sensor end. These are the 2K (Black) probes. All units shipped after August 1999 have temperature probes with a blue covered shrink-wrap at the sensor end. These are the 10K (Blue) probes. Select the probe type you have.

Connecting multiple BA302 chargers using the expansion cable:

A major feature of the BA302 system is the ability to connect additional charger modules so that you can manage several batteries simultaneously.

The additional BA302 modules are connected in series. The OUT jack from the first BA302 is connected to the IN jack of the next BA302 and so on. You can connect up to 24 chargers in this fashion. The charger connected directly to the PC will be Channel 1, the next will be Channel 2 and so on. Supplied with each charger is an expansion cable to connect to the next charger. The OUT jack of the last charger is left vacant.

When using multiple BA302 modules you will need to have all BA302 chargers powered up. This allows the data to communicate through each charger in the system back to the PC. This is true even when you are only using some of the chargers.

Note: when using multiple BA302 modules:

NEVER set the number of working channels in the software program to less than the actual number of connected BA302 modules. This would leave a BA302 charger module unsupervised by the PC. A battery connected to an unsupervised charger could be damaged.

Order of Operation

When using the BA302 it is recommended that you perform the following operations in this order:

1. Power up **all** connected BA302 charger units. Ensure the red light is illuminated on each charger.
2. Start the software program and ensure that the software is running and communicating with the BA302 unit(s). You should read a stable voltage near zero volts. Ensure that you do not have any more BA302 charger modules connected to your PC than you have listed on the PC screen.
3. Now you can connect your batteries and set up the charger from the PC software using the "Charger Setup Controls".

Using the Software:

The software must be installed on your hard disk. To install the software on a hard disk simply insert diskette 1 of 2 and then run **SETUP.EXE** from either the desktop or file manager.

NOTE: Be certain your PC has at least 8M of RAM. Ensure that no memory resident programs are running and you should close all other applications prior to installing this software. If you are upgrading from an earlier version of BA302WIN program then you should delete the following two files BEFORE you begin the new installation. The new installation will not overwrite these files.

C:\BA302WIN\BA302WIN.EXE

C:\WINDOWS\BA302WIN.INI

The setup program will create a directory called BA302WIN and copy all the files contained on the supplied diskettes to your hard disk. Simply follow the onscreen instructions to complete the installation. Start the software by double clicking the BA302 icon that will be created for you during installation.

The first time that you use the software you will have to set the COM port for the serial port you are using. After you make your selection press the **Begin** command button to begin. Note that failure to select the proper serial port will result in the program failing to operate. You will only need to set the COM port once, unless you make hardware changes.

Note that the green and yellow lights on the front of the BA302 module indicate if the charger is in charge or discharge mode respectively.

One or the other will always be lit indicating the mode. However it does not necessarily mean that charge or discharge current is flowing. This information is shown on the PC screen. When a battery session completes, and the charge or discharge current shuts off, the green and yellow lights will alternately flash indicating that the session is complete. If using the trickle charger feature (NiCd, NiMH) or float voltage feature (SLA) then the charge light will remain on even though the session is complete. This is because a small amount of current is still flowing into the battery.

A mouse controls the software. To use a mouse you simply click on the command buttons and menus of your choice. You can use the keyboard for making menu selections from the top of the main screen. To use the keyboard for making menu selections simply press and the ALT key then press the underlined letter on your item of choice. e.g. ALT then P then C to create a new detailed profile. Notice that when you press ALT there is a letter on each of the menu selections that is underlined for you to choose.

Using the BA302:

Selecting a Channel:

Many of the command buttons and controls on the main PC software screen relate only to the channel that is presently selected. Since the BA302 is capable of up to 24 channels, it is necessary to select the channel you wish to control before you attempt any function. Each channel has a display frame for Voltage, Current and Status information. These frames are located on the left side of the PC screen. You select your desired channel by clicking the command button located in the frame for each channel displayed. When you select a channel the frame will become hi-lighted with a blue border.

The number of channels that you have installed will dictate how many channel frames will be displayed. Of course if you only are using a single BA302 module then only one frame will be displayed and you will never need to choose another channel.

Status field color:

The background color of the status information field changes color to provide a visual indication of the channel status details. This is useful to see at a glance what is happening on each channel. The color also changes to indicate the pass/fail situation of the battery under test. You set the pass/fail threshold % of your choice in the OPTIONS screen.

- Green =Charging
- Yellow =Discharging
- Blue =Discharge complete (Pass)mAH exceeded threshold.
- Red =Discharge complete (Fail) mAH did not exceed threshold.
- Orange =Temperature Shut off or Time-out
- Pink =Charge complete
- Pink with blue text = Cycle charge complete with previous discharge exceeding threshold (pass).
- Pink with red text = Cycle charge complete with previous discharge not exceeding threshold (fail).

Charger Setup Controls

Before you can use the BA302 to begin a battery session you must set the charger up with some information about your battery. This will set all of the parameters required for the session. Things like desired charge current, discharge current, lower cutoff voltage etc. are all set based on the type and size of battery you are working with. These setup controls allow you to setup the charge in two different ways. These do not apply if you are using the "Program" feature.

1. "Quick Select"

You can take advantage of the BA302 software features to automatically set these for you by inputting only 3 pieces of information. This is called the "Quick Select" setup. With this option an input screen will be displayed asking you to select the Battery Type, Number of Battery Cells in the pack and the Rated Capacity of the battery pack.

2. "Detailed Profile"

You can have full control over many of the options and parameters by using a detailed profile. You create your own profiles by selecting PROFILE --CREATE from the pull down menus. Once you have created and saved the profile information you setup the BA302 using these values by selecting the "Detailed Profile" option. You then can select from all of the available profiles that you have created.

Charger Controls:

The BA302 performs 3 standard functions that you select from 3 command buttons located in the lower right hand area. These "Charger Controls" are only available once you have setup the analyzer using the "Quick Select" or "Detailed Profile" methods of operation.

1. "Charge"

Press the charge button to charge a battery normally. This will charge until termination of your choice has been reached. When charging has completed a message will be displayed in the "Status" window for that channel. Charge termination can happen if the battery has been fully charged, or if the time-out Interval has elapsed, or the temperature rises above the threshold.

2. "Discharge"

Press this button to discharge a battery. The battery will discharge at the rate of current specified in the profile data. mAH data will be displayed on the screen and this will continue until the battery reaches the lower cutoff voltage as input by you. Use this function if you want to measure the actual capacity of a battery. If this test is performed following a full charge then the total capacity is measured in mAH. You can compare this to the rated capacity, or past discharge tests to determine how the battery is performing. This data is useful in determining if the battery will meet your expectations. You can know without doubt if the battery is improving or if it is degrading and requires replacement.

3. "Cycle"

This will begin a process of repeated discharging and charging. Data will be collected and will continue until all the cycles have been completed. Cycling NiCd batteries can actually improve their performance. This feature will allow you to cycle your battery any number of times and measure the stored charge for each cycle. This will tell you without doubt if the battery has realized some improvement and give you a measure of this capacity improvement. Note that one cycle consists of a discharge followed by a charge. The "Quick Select" profile will automatically select 1 cycle. If you wish to cycle more than once you will need to use a detailed profile. You can choose to begin cycling with a charge rather than a discharge if you prefer. This option is selected in the PROFILE – OPTIONS panel.

Note that during all of these functions you can view the data history on the voltage graph. You can change this graph to a full screen size and make a print at any time. Data is available in several of the reports.

PC Controls:

1. "Full Screen"

A full screen to display a larger graph and session results on the same screen is available by selecting this control. This control displays the full screen data for the channel that is presently selected. This full screen display gives you the ability to print the session's results at any time.

2. "Graph" / "Details"

This control is used to toggle the display window back and forth between the graph and the details for the selected channel.

3. "Reset"

This will stop all of the BA302 functions. All charge and discharge current will cease and all collected data will be erased. You should be sure to view, print or save any data you need before selecting this function. Remember that each channel of your BA302 system is controlled fully independently from the other channels. This means that you will reset whatever channel is currently selected.

The reset will not clear the profile information. The profile information is never cleared. If you wish to change any profile information you simply select a new profile.

Selecting a new profile will also reset the channel and all data will be lost. You cannot change any profile information once the session has begun. If you need to change any parameters once a session has started it will be necessary to start the session over again.

Auto-Save Feature:

The software program will save data to a file every minute as a backup precaution. There will be a separate file for each channel. The file name will have the format: C:\BA302WIN\BACKUPX.BA3 where X is the channel number. In the event that you have a system failure and are unable to save your data, then you can go and retrieve this file for viewing or printing. Remember that you should still always save your data in a file name of your choice at the end of a session if you wish to retain the data. This backup file called BACKUPX.BA3 will get over-written the next time you begin a new session on that channel. If you need to keep the backup file then you should copy it or rename this file before beginning a new session on that channel.

Menu Items:

The following describes the use of each of the menu options located at the top of the screen. You can pull down (select) these menu items with a mouse or keyboard.

File:

1. "Save"

Using this feature you can save the graph and other results in a file for viewing at a later time. This is useful to keep a permanent record of your session's results. The file can be stored to any directory or diskette of your choice. A standard dialog box will be displayed for you to select the directory and file name. The file name can be up to 8 characters. The saved data will automatically be given a file extension of **BA3**.

2. "Open"

Use this menu item to retrieve and view session data that you previously saved to disk. A standard dialog box to open the data file will allow you to retrieve the **BA3** file from any drive or directory. Once the file is opened it will automatically be displayed in a full screen window.

3. "View"

This allows you to redisplay the results screen if you leave it to return to the BA302 main control screen. This view data will allow you to view previously opened data without have to reopen the file. To view a different saved session then you must open the new file.

4. "Delete"

Saved data that you no longer need to keep can be deleted permanently using this menu item.

5. "Footer"

Use this to input your company information that appears at the bottom of the printed report.

6. "About"

This displays the version number and copyright information. Please note that the software is copyright © 1997-2000 LaMantia Products Ltd., London, Ontario, Canada. All rights are reserved and unauthorized copying or duplication in whole or in part by any means is strictly forbidden.

7. "Quit"

This will exit the program. All BA302 functions will cease and all collected data will be lost. Ctrl + Q can be used to quickly make this selection without having to pull down the menu.

Setup:**1. "Channels"**

This is how you set up your charger for the correct number of BA302 charger modules that you have connected together.

Note: when using multiple BA302 modules:

NEVER set the number of working channels in the software program to less than the actual number of connected BA302 modules. This would leave a BA302 charger module unsupervised by the PC. A battery connected to an unsupervised charger could be damaged.

When using multiple BA302 modules you should ensure that *each* module is powered up and that the RED light is illuminated. This will allow all the data to transmit through the system to the PC. This is true even if you plan to only use one channel.

When you select the number of channels (i.e. the number of BA302 modules you have connected) a frame for each channel will be displayed down the left-hand side of the screen. Contact LaMantia Products Ltd. for the appropriate software package if you wish to use more than 12 channels.

2. "Current Calibration Wizard"

This wizard is a routine that you can follow to set the calibration values for current measurements. This will ensure that your unit is calibrated for precise current measurements. This is important and should not be omitted. The routine automates the calibration for you. You need to run through this routine for each analyzer you have on your system. The wizard routine applies to the channel you have selected when you start the wizard.

To begin the calibration routine you will need to connect a current meter in series with a battery to measure the actual current values. There are 4 input fields for inputting the actual current that you measure with your current meter. You enter one current value for each step of the wizard.

The current is always entered in mA (milli-amperes). The polarity is ignored so you can enter positive or negative values.

With each step, wait until the current reading on the PC stabilizes to the value associated with each step. The 4 steps are:

1200 mA	Charge	(high current charge)
300 mA	Charge	(low current charge)
1200 mA	Discharge	(high current discharge)
300 mA	Discharge	(low current discharge)

The values you enter will be near these values but not exact. For example: on the first step the PC will read 1200mA and the current meter might measure 1149mA. In this example you would enter 1149 into the input field.

The “Restore Defaults” resets the calibration values to the factory selected values, but it does not provide for precise current calibration. For precise calibration you need to follow through the complete wizard routine.

You will only need to perform this once. The calibration values will be stored for permanent use. You may wish to repeat this annually in the event that the calibration values changes slightly with age.

3. “Voltage Calibration Wizard”

This wizard is a routine that you can follow to set the calibration values for voltage measurements. This will ensure that your unit is calibrated for precise voltage measurements. This is important and should not be omitted. The routine automates the calibration for you. You need to run through this routine for each analyzer you have on your system. The wizard routine applies to the channel you have selected when you start the wizard.

To begin the calibration routine you will need to connect a volt meter across the terminals of the battery to measure the actual current values. There is only one input field for inputting the actual voltage that you measure with your volt meter. The voltage is always entered in volts.

Profile:

1. “Create Profile”

You use this to create a custom battery profile. Even with this custom profile the BA302 software provides you with some assistance. First you should select your battery type then the software will display the inputs that you should make. The fields that are not required for your battery type will be disabled. Also as you TAB from one field to the next entering data you will notice that some data is automatically created for you. These are suggested default values but you are free to override any of these as you see fit. Any fields that do not apply to the battery type will be disabled. The following are some brief explanations of each field:

Battery Type - Select this item first.

Termination Options - You can enable the *Timed Shut off* and the *Temperature Shut off* as you see fit.

Description - This is a short description of the pack. This will print on the reports so you can use some type of useful battery description here.

No of Cells - This is the number of cells in the battery pack. This data is used to auto data fill the *Lower Limit* cutoff voltage, as well as the Voltage Reg. & Float V. for SLA & Lilon batteries.

Rated Capacity - This is the mAH rating of the battery pack. This is usually marked on the battery. However, if it is not, you can input some value and use the BA302 to calculate this for you by performing a discharge test from a fully charged state. This data is used to auto fill the discharge current for all batteries. The discharge current will be auto set to the rated capacity/5. For NiCd and NiMH this field will also auto set the charge current to the rated capacity/10. Again, remember that any auto set fields can be overridden.

Time Out Interval - This is a fail save feature to stop the session if, for any reason, it fails to terminate normally. This value is entered in hours. This should always be used for safety purposes. Enter a value that you expect will exceed the time required. In the event of a defective battery, or other session problem, then all charge and discharge current will cease, and the session will end when the time-out interval has elapsed.

Number of Cycles – This sets the number of cycles to be completed when you select a cycle session.

dT/dt Term – During charge the temperature is monitored if you are using the temperature probe option. Once the rate of temperature rise exceeds this value the charge will terminate. This is an optional method used to terminate the charge for some battery types. For NiCd batteries the rate of temperature rise increases dramatically once the battery reaches full charge. The value you enter here is a temperature rise per minute value.

Trickle Current - This sets the trickle current rate for NiCd and NiMH batteries. This rate will be auto set to the rated capacity/50 when the rated capacity is input.

Voltage Reg. - This is the voltage used for charging at constant voltage for Lead Acid, SLA and Lilon batteries. Under constant voltage charging the initial current will be limited to 2000 mA since this is the upper limit of the BA302. The Voltage Reg. values are auto filled to default values based on the type of battery and number of cells. You can override these default values if you want to select different values.

Float V - This is the float voltage used to maintain lead acid batteries in standby condition once the charge current has dropped to the selected minimum current value. This value is only used for Lead Acid and SLA battery types.

Lower Limit - This is the lower cutoff voltage used for all battery types. During discharge and Cycle discharging the discharge current will stop when the battery voltage moves down to this limit. This is auto filled to 1.0 V/Cell for NiCd and NiMH batteries, 2.0 V/Cell for Lead Acid and SLA, and 3.0 V/Cell for Lilon batteries. For deep discharging the user has complete control over this parameter.

Charge Current – For NiCd and NiMH this is the current used for constant current charging. This is auto filled to the rated capacity/10. Most battery manufactures recommend that you charge these batteries at this 10-hour rate C/10.

For Lilon this is the current used for the constant current portion of the charge algorithm. This is auto filled to C/10 for Lilon.

For Lead Acid and SLA this is the maximum current that will be used during charging. These batteries are normally charged at constant voltage. However if the initial current exceeds this maximum value then the battery will be current limited to this value. This will continue until the voltage reaches the stated Voltage Reg value, at which time the analyzer will switch to the constant voltage value specified under Voltage Reg. If the battery is very depleted when charging begins then you may experience this current limiting. This will only be seen at the beginning of the charge. However if the charging current using constant voltage never exceeds this maximum current value then this value is never used. This is auto filled to 1000mA for LA/SLA.

Discharge Current - This is the current used for discharging all battery types. This is auto filled to the rated capacity/5. Most battery manufactures recommend that you discharge these batteries at this 5-hour rate C/5. Manufacturers often rate the battery based on the delivered charge when discharged at the 5-hour rate.

Neg. deltaV - This is the termination value used for the negative delta V charge termination algorithm as described earlier in this manual. For NiCd it will auto fill to -0.015 V/Cell and for NiMH it will auto fill to -0.010 V/Cell. When these batteries reach a state of full charge the voltage will begin to drop. Once the voltage drops by these amounts the charge will terminate because the battery is fully charged. For SLA and Lilon battery types the name of this field will change to Min. Current. For these battery types the current will drop as the battery receives a charge. The charge will terminate when the current drops below this threshold. This field changes depending of the type of battery selected.

Min Current - This is the lower current limit that is used to terminate the charge for constant voltage charge methods. For example, lead acid batteries charge at constant voltage until the current drops down to this minimum value. Once this minimum value is reached the battery is considered fully charged and the voltage switches to a lower maintenance voltage. This is also used for Lilon to terminate the constant voltage part of the charge algorithm. This field changes depending of the type of battery selected.

Battery Details - Selecting this command button will provide an input screen to enter additional details about the battery for which this profile will be used. Again, if you are using a serial numbering system then you can have a profile for each battery that you will be managing. You now have the opportunity to enter more specific information on a particular battery. This includes, *Model Number, In Service Date, Manufacturer* and any special *Notes*. This information will appear on the printed report.

After you have set up your profile, as you like it, click **SAVE** to save it for later retrieval and use. If you wish to start over or prepare another profile then click **RESET**. You can create a duplicate profile by changing any items and saving the profile with a different name. When you are finished creating profiles click **DONE**.

2. "Modify Profile"

This gives you the ability to recall a profile to make modifications. Select the profile then click **View/Modify**.

3. "Delete Profile"

This gives you the ability to delete profiles that you no longer plan to use. Select the profile then click **Delete**.

4. "Battery Details"

This will display the battery details for the selected channel. These battery details are the ones entered into the detailed profile at the time the profile was created. Alternatively you can enter in any battery details and notes at any time so that they will print on the printed report.

5. "Options"

These are options that you can select to customize your system. Some of these options do not apply when using the "Program" mode as indicated below. The following describes each option:

Auto Trickle Charge - For NiCd and NiMH batteries you have the option of having the BA302 automatically revert to a trickle charge current to maintain the batteries in a fully charged state. The trickle charge current will come on following a *Charge* session or at the end of the last *Cycle* charge. Click on the option button of your choice to make the selection. This option also has a duty time. The duty time allows you to have the trickle current applied intermittently. You input a value for the duty time and this value will be the amount of time in minutes that the trickle current will be suspended. Following this time interval the trickle current will then come on for 1 minute. After 1 minute it will then again be suspended for this same interval. This will be repeated indefinitely. Set this to 0 for a constant trickle current. The Duty Time is ignored if the Trickle Charge feature is disabled. (This option does not apply to "Program" mode.)

Rest Period Between Cycles - This feature allows you to have a rest period between cycles when no charge or discharge current is flowing. This allows the battery to cool and stabilize should this be necessary. The rest period will follow each charge and discharge portion of the cycle. You select the rest time you desire. If the option is disabled the rest time is ignored. (This option does not apply to "Program" mode.)

Graph – This allows you to select what parameters you would like to plot on the graph. You can chose from Voltage, Current, Temperature and Rate of Temperature rise (delta Temp). You can change these values at any time before or during a session. The graph will be replotted to your new requirements.

Also in this area you can specify a scale factor for each parameter. This is used as a multiplying factor to scale the data up or down to make effective use of the entire graph area.

Grid Lines - Use this feature to turn the graph grid lines on or off as you see fit.

Sound - The PC will sound a tone as charge and discharge events complete for each channel. You can turn this feature on or off as you see fit.

Legend - Use this feature to turn the legend for graph data on and off. Turning the legend off will provide more graph area.

Start Cycle with - This feature gives you the option of beginning a cycle session with a charge rather than the normal discharge. This gives you flexibility in how you manage your sessions. For example, if you wanted to charge - discharge - charge to commission a battery for service then you can select a detailed profile for 2 cycles and begin the first cycle with a charge. Note that all of the reports will continue to show that each cycle consists of a discharge followed by a charge. If you choose to start with a charge using this option then the data for the first half of the cycle will be zero. This feature simply allows you to bypass the discharge portion of the first cycle. (This option does not apply to "Program" mode.)

Discharge Pass/Fail Threshold - This is the % of capacity value that determines the color of the status background as described earlier. This is designed to give you a very quick visual indication of batteries that are not meeting requirements. This is particularly useful when managing many batteries with multiple analyzers. (This option does not apply to "Program" mode.)

Data Logging - This feature allows you to save data in a file in the event that you wish to perform more detailed data analysis.

Select any time interval you wish for the data to be logged to disk. Each time this interval elapses one line will be written to the log file. If this feature is enabled you will be prompted to enter a filename when you begin a charge, discharge or cycle session. Enter in a filename of the type *.TXT.

This will then create an ASCII text file that logs the following information on each line of the log file:

Event No, Event Type, Cycle No, Event Time, Voltage, Current, Temperature, mAH

Where:

Event No - increments each time the analyzer switches to a new event type.

Event Type - 1=charging, 0=idle, -1=discharging

Cycle No - increments each time a new cycle begins.

Event Time - elapsed time in minutes for the event

Voltage - present voltage in Volts

Current - present current in mA (+=charge, -=discharge)

Temperature- present temperature

mAH - mill amp hours for present event (+=charge, -discharge)

This data file is comma delimited so you can open the file and copy the information into a spreadsheet program for your analysis. You can view the data log file using the “Log Data” report only after the session is complete. You cannot view data log during data collection.

Internal Resistance - This allows you to set the current values used for the Internal Resistance calculations (see Internal Resistance Report later in this manual). The results can depend on the values used for I1 and I2. You can adjust these values here by specifying the % of load current to achieve the desired currents for I1 and I2. With trial and error you can quickly make the adjustments until the current values are appropriate. If unsure you can use I1=50% and I2=10%. Adjust as necessary.

Temperature Scale - This feature allows you to select the temperature measurement scale of your choice. Choose from °F or °C.

High Temperature Shut-Off – Charge will terminate when this limit is reached and the profile temperature shut-off option is selected. (This option does not apply to “Program” mode.)

Temperature Probes - This feature gives you the option of disabling all temperature measurement for all channels on your system. By disabling the temperature probes you can increase the data collection speed of the other parameters.

Temperature Probes - Select this option as required to indicate the location of the temperature sensor. This feature gives you the option of using the external temperature probe (supplied with your analyzer), or using the internal thermistor inside a battery pack. To use a thermistor built into the battery pack you make a single wire connection from the TIP of the temperature plug to the temperature connection of the battery pack. You only need a single wire because the circuit is completed through the common battery negative cable. The internal thermistor should be 10K ohms.

Temp Probe Model – Select the type of temperature probe that you are using as described earlier in the Temperature Probe Cable instructions.

Reports:

The reports contain the information that you will want to print and save for your records. The cycle report provides data on a Cycle session and the discharge report provides data for a Discharge session

1. “Cycle Data” - This report only has data when you are performing a “Cycle” session. For each cycle you will see:

Discharge mAH - This is the delivered charge for the discharge portion of each cycle. This is the data that you will want to compare to other cycles to see if you are realizing and improvement in the charge retention capacity of the battery.

Discharge h:m - This is the elapsed time for the discharge portion of the cycle in hours and minutes.

Discharge % - This is the delivered charge in mAH expressed as a percentage of the rated capacity as input by you. This value is used as part of your battery management routines. You may be willing to only accept a % rating above some threshold. Alternatively you could use this to grade batteries for critical and non-critical applications.

Charge mAH - This is how much charge went into the battery during the charge portion of the cycle. It does not tell you how much was actually retained by the battery however. This will only be revealed during discharge. This charge mAH does give you a feel for how the session is proceeding and if the charge portion of the cycle is proceeding normally.

Charge h:m - This is the elapsed time for the charge portion of the cycle.

2. "Discharge Data" - This report provides information similar to above for a single discharge test. When this report is printed it is small enough to attach to your battery for maintenance purposes. You can use tape to affix it to the battery. The report has the date, description and performance data. This can be used to compare the battery's present performance to past performance the next time the battery comes in for routine evaluation. Note that data is only available when you are performing a "Discharge" session.
3. "Log Data" - If you have saved session data using the data logging option then you can open the data log file to view or print the data. You can view the data log file using the "Log Data" report only after the session is complete. You cannot view the data log during data collection.
4. "Graph Data" - This is the data that is used in the graph plot.
5. "Program Data" – When using the analyzer in "Program" mode you can view and print the program steps, results and termination details.
6. "Internal Resistance Report" – This report can be used to calculate and print data on the internal resistance of the battery. This uses the direct current method to calculate the d.c. resistance of the battery by measuring the terminal voltage at two different discharge loads. The battery is loaded with discharge current I1 and a voltage reading V1 is determined. Then the discharge current load is reduced to I2 and the new voltage V2 is determined. The internal resistance IR is calculated as:

$$IR = \frac{\Delta V}{\Delta I} = \frac{(V1-V2)}{(I1 - I2)}$$

The results can depend on the values used for I1 and I2. You can adjust these values in the Options panel by specifying the % of load current to achieve the desired currents for I1 and I2. With trial and error you can quickly make the adjustments until the current values are appropriate. If unsure you can use I1=50% and I2=10%. Adjust as necessary.

In order to make the IR measurement you simply click on the Measure button. This will then apply the two load pulses and automatically perform the calculations for you. The collected data and results will appear in the report. You can repeat this as often as required. This measurement is normally taken following a full charge termination. You will find that the IR increases with charge depletion. This IR value will also print on the Printed Session Report if you have performed this measurement. This data will be useful for in your battery management functions. You can compare this value over time looking for changes in the battery or to compare two different batteries. A low IR is beneficial if the battery will be used in a high current application.

7. "Print Session Report" - This provides a printed report for the selected channel. This is a hard copy of the session's data. This is handy to keep for your records or give to your clients. The contents of this report will change depending on the battery and session type. A printed report gives you the documentation you need for your battery management routines. Note that you can also save your data and retrieve it for printing at a later date if required. To print saved data you open the file then print it from the full screen viewing area.

Multi-Channel:

These menu choices allow you to setup, control and reset many analyzers simultaneously when using multiple chargers. This saves time by not having to select each channel individually before making changes.

Program:

These are the controls for using the analyzer in program mode. The program feature allows for complete control over the analyzer. You create a program consisting of steps. Each step will continue until the termination option, as specified in the program, is encountered. When the program completes each step the program will automatically proceed to the next step and execute the details in this new step. The program will then run through each step in this manner until all the steps are complete.

To use the program mode you will need to create a program, then load the program into the appropriate channel, then run the program.

1. "Create Program"

This will enter into the program editor to create a new program. There are 3 actions that you can select. Each action will be specified in it's own separate step. The 3 actions are charge, discharge and pause. For each step first select an action. Then the fields available for this action will become enabled. Enter the desired termination options for the action selected. Once you have selected the options for one step you can create a new step by clicking NEXT. You can have up to 999 steps. If you do not want additional steps then click FINISH. You will then be prompted to save the program. The program will be saved with the extension PG3. The following explains the options for each action:

Action=Charge

- Charge Type* - You must select either constant current or voltage.
- Value* - This is the constant current (mA) or voltage (V) value.
- Neg-DeltaV* - Check to enable and enter value in box.
- Time* - For timed charge. Check to enable and enter value.
- Upper Vol.* - Terminate on voltage rise. Check to enable and enter voltage value
- Input* - Terminate based on mAH input. Check to enable and enter value in box.
- dT/dt* - Terminate on temperature rise rate. Check to enable and enter value in degrees/minute.
- Upper Temp.* - Terminate on temperature (TCO). Check to enable and enter value in box.
- Min Current* - For constant voltage use this to terminate when current drops down to this value. Check to enable & enter value.

Action=Discharge

- Dis. Current* - Enter the discharge current you want.
- Time* - For timed discharge. Check to enable and enter value.
- Lower Vol.* - Terminate on voltage drop. Check to enable and enter value.
- Output* - Terminate on delivered output charge. Measured in mAH. Check to enable and enter value.

Action=Pause

- Time* - For a timed pause enter the time to wait in minutes.

2. "Edit Program"

This will enter into the program editor to edit an existing program. You will be prompted to select the file and then you can browse the program and make any changes required. Save the changes by clicking FINISH.

3. "Delete Program"

Use this to delete unwanted programs.

4. "Load Program"

This will load the program for use into the selected channel. You need to load the program into a channel before you can run the program.

5. "Run Program"

This will start executing the program. The program will proceed through each step until all the steps are complete. When you run the program many of the program parameters will be displayed on the details window.

CAUTION

You need to exercise caution when running programs. The programs you create will run according to the instructions in the program. This means that you could damage your batteries if you fail to correctly specify the correct options and values. You could overcharge, over discharge, over heat and cause permanent harm to the battery. Please ensure that you understand the options you selected and how they will be applied. You should charge and discharge according to the battery manufacturers recommended values, limits & methods.

Battery Management:

In order to truly have confidence that your rechargeable batteries will be able to deliver the power 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 full charge state and measure how much charge has been delivered. A poorly performing battery will not be able to deliver up to it's rated capacity during a discharge test.

This involves discharging the battery and measuring the power that your 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. 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 BA302 is an ideal tool to meet all your cycling and battery testing requirements.

Understanding the mAH measurement:

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 its 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 BA302 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.

Remember that batteries contain harmful materials. Never incinerate old discarded batteries. Many communities have hazardous waste collection depots. Using these collection depots ensures batteries are disposed in an environmentally responsible manner.

Trickle Charge Rate:

A battery that has been left on trickle charge will not lose charge normally associated with the storage of batteries. For example 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. However 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.

For your information:

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. For example you might try 0.5 V/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.

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.

Lilon batteries are often rated at 3.6V per cell.

In Case of Trouble:

- Problem:** Battery Cycles too rapidly
Possible situation:
- Poor battery connections
 - $-\Delta V$ set too low
 - Defective battery
 - Intermittent battery problem (battery unstable)
- Problem:** Charge terminates before full charge
Possible situation:
- Poor battery connections
 - $-\Delta V$ set too low
 - Defective battery
 - Intermittent battery problem (battery unstable)
- Problem:** Software stops responding
Possible situation:
- Communications with BA302 have been interrupted
 - Ensure you do not apply any voltage $> 20V$, even momentarily
 - If this happens restart software program
- Problem:** Current flashes "2000" and status reads "Check power"
Possible situation:
- The BA302 is not connected to the serial port properly. Check your installation and that the BA302 is powered on.
- Problem:** Internal fuse blows when I try to charge when using multiple chargers.
Possible situation:
- Check to see if you have the correct ground (Black) wire from the BA302 module to the battery under test. If you mix up the ground wires, the BA302 module appears fine however the fuse may blow when you begin a session.

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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