
MC / LC Series Battery Analyzers

User Guide

The Battery Metric analyzers together with the supplied software create a system that allows the user full control to specify many battery charge, discharge and test parameters. In addition the system has options to modify the calibration by the user. These capabilities are designed to provide the user with maximum flexibility to manage many different battery types in many different situations. This capability, by its 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 Lilon 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 Lilon batteries do have built in protection circuitry. If you are uncertain if the Lilon or LiPo battery has built in protection circuitry, check with the battery manufacturer. Always charge, discharge and test all batteries according to the battery manufacturer's specifications. Users should verify that proper voltages and currents are being applied with their own voltage and current measurement equipment.

This manual is a guide to using the MC series 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 MC system is a battery management platform to be used by knowledgeable trained staff. It is not a consumer type product. Read the **Safety Precautions** section in this guide for more information.

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Users who purchase MC/LC series analyzers receive a license to use the *BA500WIN* and *Battery Console* software programs. Users 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 the web site have a license to use it subject to the license agreement listed below:

Under the terms of this license NO warranties of any kind are made with respect to the contents or functionality of this software, nor its fitness for a particular purpose.

Battery Metric 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 the software or the 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 supplied 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 supplied software programs and its associated documentation are copyright © 2018 Battery Metric London, Ontario, Canada. All rights are reserved. Unauthorized duplication or distribution is strictly prohibited.

Overview

The MC Series battery analyzer is a full featured battery charger, discharger, load module, tester and analyzer. It connects to a computer via USB and is managed with several available software tools. This creates a very powerful system to test and manage all battery types.

This system can perform simple battery management tasks or be used for more complicated unique applications. 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 battery conditions. This can provide insight into how various batteries will perform in a particular application.

The MC series devices allows you to perform repeated cycles of discharge and charge. Collect results of each cycle to evaluate battery performance.

There are several models in the MC series with different voltage and current ranges for variety of battery types and ratings.

Hardware Features	Applications
<ul style="list-style-type: none"> ● Control using <i>BA500WIN</i> Windows™ software or <i>Battery Console</i> software ● 4 wire battery connection for remote V sense ● Integrated fully isolated USB 2.0 connection to computer ● Expandable to 96 channels using simple USB hubs ● Built in variable speed fan with auto on/off ● 12 bit A/D & 12 bit D/A ● 16 Voltage auto-ranges for 1mV measurement resolution ● 3 Current ranges for a wide range of precision ● Features internal universal 120/240 VAC power supply ● Programmable audio and visual indicators ● Two Digital I/O ports for external control and triggering ● Precise on board constant voltage and current regulation ● Discharge with constant current, power or resistance ● Multi-chemistry design for all battery types ● Many programmable options for standard tests or run special test routines ● Large selection of termination options ● Accuracy 0.25% full scale (V, I) ● Factory calibrated with calibration certificate ● User calibration software tools included ● On board flash memory for field upgradeable firmware ● Internal resistance measurement ● Short circuit, reverse polarity and overload protection ● Heavy duty construction 	<ul style="list-style-type: none"> ▶ Battery charge, discharge, cycle, trickle & float ▶ Battery capacity measurement ▶ General battery testing ▶ Battery charge monitoring ▶ Battery cycling ▶ Warranty validation ▶ Quality measurement ▶ Load simulation with pulse options ▶ Battery pack commissioning ▶ Creating custom battery testing algorithms ▶ Battery fleet maintenance ▶ Battery management routines ▶ Print reports for test documentation ▶ Life cycle testing ▶ Identify under performing batteries ▶ Select batteries for critical applications ▶ Recondition battery packs ▶ Validate manufacturer's specifications ▶ Programmable battery charger or load ▶ Stand alone battery control or alarm ▶ Protection circuitry testing ▶ Battery fuel gauge initialization

MC Series Specifications

Specification	MC2020	MC2050	MC4030	MC5030
Maximum Voltage (V):	20	20	40	50
Maximum Current (A):	+/- 2	+/- 5	+/- 3	+/- 3
Maximum Power (W/Ch):	40	100	120	150
3 Current Ranges (A):	2 • 0.2 • 0.02	5 • 0.5 • 0.05	3 • 0.3 • 0.03	3 • 0.3 • 0.03
Current Resolution(mA):	1 • 0.1 • 0.01	2 • 0.2 • 0.02	1 • 0.1 • 0.01	1 • 0.1 • 0.01
Voltage Measurement Resolution (mV):	1	1	2.5	3
Voltage Regulation Resolution (mV):	5	5	10	13
Accuracy V,I (%FS):	0.25	0.25	0.25	0.25
Single Channel: (cm) / (kg):	17x19x8 / 2.0	20x25x10 / 3.6	20x25x10 / 3.6	20x25x10 / 3.6
Dual Channel: (cm) / (kg):	31x25x10 / 4.0	31x25x10 / 4.0	31x25x10 / 4.0	31x25x10 / 4.0
Quad Channel: (cm) / (kg):	26x31x10 / 4.0	N/A	N/A	N/A

All units have USB isolation. Channel isolation in multi-channel units is available as an additional option.

Input Resistance > 120K Ω. Specifications subject to change without notice.

Other voltage and current configurations available by special order.

Description

The MC series of Battery Test analyzers extends Battery Metric's history of delivering features and flexibility in a system that provides excellent performance and value.

There are several models to choose from in the MC series. Select from various voltage and current capabilities to suit your application. Models with current up to 5A and voltages up to 50V are available. Combine channels with current sharing feature for higher current applications.

Choose from a variety of software tools to operate your Battery Metric device. Use the MC series device in a lab type application, a more specific test or a production application. The Battery Metric device has the flexibility to meet many battery testing and management functions.

The MC series battery analyzers are supplied with USB cable, AC power cord, built in fan, battery cables (banana plugs to alligator clips) and integrated power supply. No additional equipment or power supplies are required. Just connect the analyzer to your USB port, install the software and connect the battery.

The MC series devices are available in Single (1 channel), Dual (2 channel) and Quad (4 channel) configurations. Each channel can operate simultaneously and independently from the other channels. Each channel can manage one battery cell or pack. Create a multi-channel system by connecting more analyzers to your computer. Mix different models for added versatility. The Dual and Quad configurations offer space and cost savings.

A front panel 8 position port is available to connect a battery with 4 wire connection as well as connecting a temperature cable, optional battery adapters, and digital circuits for external control and triggering. See [Front Panel Data Port](#) section for more details. The Single and Dual channel configuration also feature front panel banana jack for versatility and convenience.

The MC 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.

There are two software applications that support the MC analyzers. Choose from [BA500WIN](#) or [Battery Console](#). Choose the software tool best suited to the battery management function required.

The MC series analyzers together with the software tools create a unique testing platform. Use this system to perform simple battery management tasks such as charging, cycling, capacity testing and reconditioning to more complex data collection, production and quality control tasks.

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

Software Features	
<ul style="list-style-type: none"> ◆ Software program licenses included ◆ Software & documentation available online ◆ License includes software updates via internet ◆ Windows based software ◆ 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 	<ul style="list-style-type: none"> ◆ Graphical display plots V, I, T or dT/dt ◆ Log data to disk ◆ Internal Resistance measurement ◆ Multi-Channel view on one screen ◆ Custom program editor ◆ Calibration software utilities ◆ Advanced data collection & data logging options ◆ Manage up to 10000 cycles ◆ Display using A & AH or mA & mAH ◆ Program device for stand alone operation

LC Series Specifications

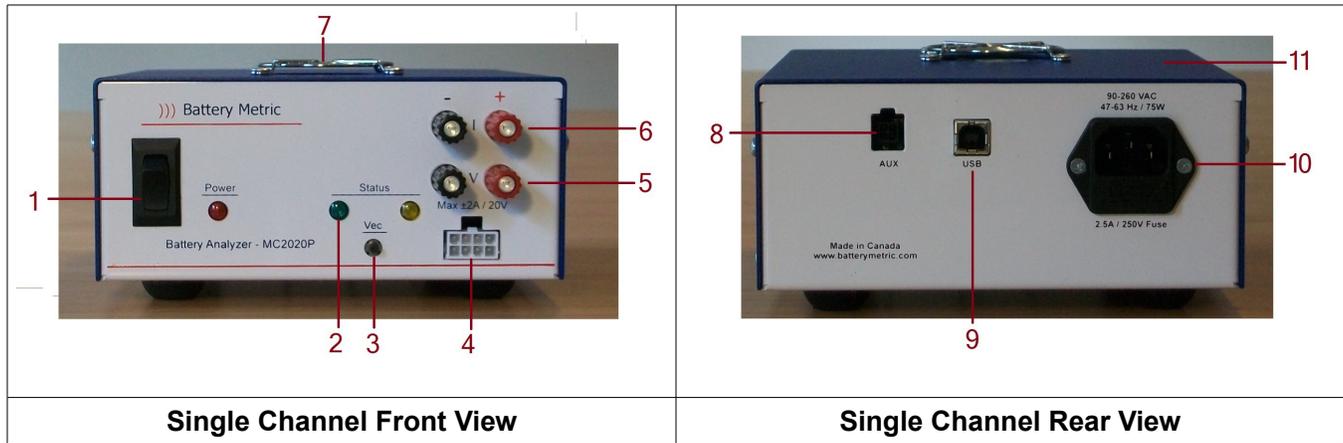
The LC Series machines are low current, low power devices configured for management of low capacity batteries. These devices offer very high input resistance and have current control as low as 1 micro-Ampere. These machines also offer 3 current ranges. Select the device that has the current ranges required for the intended application.

Parameter	LC0510	LC0520	LC0540
Maximum Voltage:	5 V	5 V	5 V
Voltage Resolution:	1 mV	1 mV	1 mV
High Current Range:	± 100 mA	± 200 mA	± 400 mA
Med Current Range:	± 10 mA	± 20 mA	± 40 mA
Low Current Range:	± 1 mA	± 2 mA	± 4 mA
Current Resolution:	1 µA	1 µA	1 µA
Accuracy (V,I - % FS):	0.25%	0.25%	0.25%
Input Resistance:	10MΩ	10MΩ	10MΩ

The LC Series machines are ideal for testing button cells and other low current applications. They are operated with the same software applications as the MC series and feature similar features in all other regards.

Available in Single (1 Channel), Quad (4 Channel) configurations.

Introduction to the MC/LC series



1. AC power switch and red LED power indicator.
2. Green and Yellow LED status indicators. These are programmable by the user to provide visual status information. e.g. Solid On, Alternate, Intermittent, flash, blink to indicate current function and other information like: Pass, Fail, Charging, Discharging, Complete, etc...
3. The Vector (Vec) switch is programmable to control the battery test situation. This switch is context sensitive in that it will route the analyzer to an alternate step in the test routine. Each test step can be programmed differently to start, halt or skip a step as required when this switch is pressed.
4. Data Port is used to connect battery, optional smart battery adapters, temperature measurement cable, and external digital I/O circuitry.
5. Voltage (V) sense input terminals. Accommodates banana jacks, 16AWG wire or #8 spade connector.
6. Current (I) carrying terminals. Separate V / I connections allows for remote V sense.
7. Variable speed fan, reduces noise and extends life.
8. Aux connector for connecting a variety of optional accessories.
9. USB 2.0. Type B, full speed data connection to computer.
10. AC input connector for universal 120/240 VAC internal power supply.
11. Internal audio indicator is programmable to provide context sensitive status information. Program beeper for Solid ON, Fast beep, Intermittent beep or Off. Can be used to indicate session complete, pass, fail or warning status.

Note that the current range is automatically selected by the software depending on the charge and discharge current specified. The current range will then be fixed for the duration of the step. There is no need to set or adjust the current range. This way the optimum current range will always be used for the maximum current resolution.

Getting Started

Setup is straightforward, simply connect the MC series device to your computer's USB port using the supplied USB cable. Choose and install the software that you plan to use: *BA500WIN* or *Battery Console*. From the software program you select your charge, discharge and other test parameters. Connect your battery pack to the device using the supplied cables. These cables have banana jacks that plug into the device. The other cable ends have alligator clips for you to connect to the + and - terminals of the battery. See 2 wire vs 4 wire battery connection methods later in this guide.

For additional information on connecting the battery see the ***Front Panel Data Port*** and ***Optional Accessories*** sections later in this guide.

The MC/LC device is shipped without any routines loaded. If you are planning on using *Battery Console* (rather than *BA500WIN*) then the device will need to be loaded with the appropriate routine before it can be used.

If the device has previously been loaded with an application specific routine you can begin to use the device in stand alone mode by connecting the battery. See details for using the ***Battery Console*** software application later in this guide for more information.

If the device has not been previously loaded with the appropriate routine or you plan to use *BA500WIN* instead then you should start the software, you plan to use, before connecting the battery.

The red lead should be connected to the battery's (+) terminal. The black lead should be connected to the battery's (-) terminal. The analyzer has reverse battery protection but you need to observe the correct polarity for the unit to function properly.

Safety Precautions

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

Observe the following safety precautions:

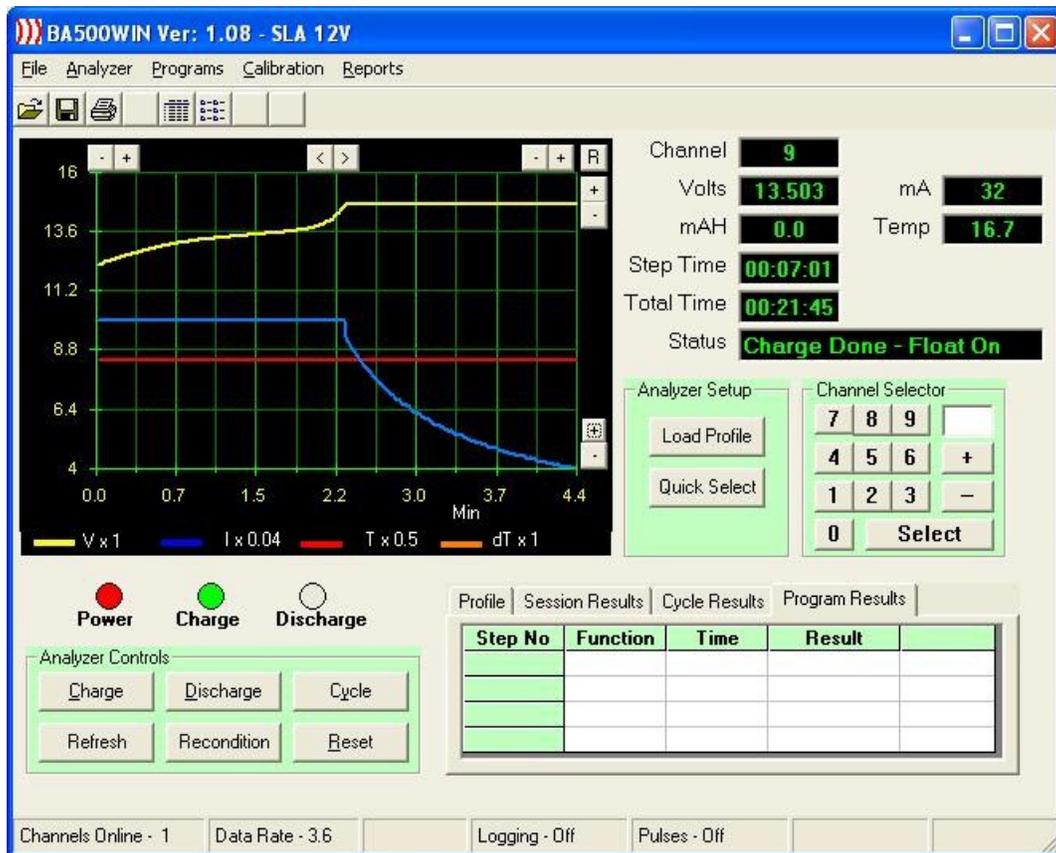
- ❖ Only use this test system to charge secondary rechargeable batteries. Other types of batteries may burst causing personal injury and damage. The MC series device should not be used for charging any kind of primary cells, including reusable alkaline batteries. It can be used to discharge primary batteries.
- ❖ Always follow the battery manufacturer's recommended charging and discharging requirements.
- ❖ Never short-circuit the terminals of a battery.
- ❖ Do not leave batteries unattended while charging. This is especially true for Lilon 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 Lilon 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 or smart battery adapter.
- ❖ Use your own voltage and measurement equipment to verify current and voltage calibration. Re-calibrate if required.
- ❖ Only charge Lilon 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 MC device. Failure to do so could damage your equipment and will void the warranty.
- ❖ Keep the device in a well ventilated location such as on a table top or open shelf. The MC device will generate heat during use and as such should not be used in an enclosed area. Do not use it in an enclosed cabinet or tight shelf area. Keep devices well spaced and ventilated.
- ❖ Only connect batteries once the software program is selected and running properly.
- ❖ Disconnect batteries when the device 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.
- ❖ Use special care when writing or modifying battery test routines to ensure they operate as expected. All new test routines need to be tested and evaluated for proper functionality by trained and qualified personnel. This includes evaluating all possible outcomes and verifying that proper voltage and current levels are correct in all circumstances.

Using the MC Analyzers

BA500WIN and **Battery Console** are two different software applications that can be used to manage the MC series analyzers. They offer different features and benefits. Choose the method that best suits the application.

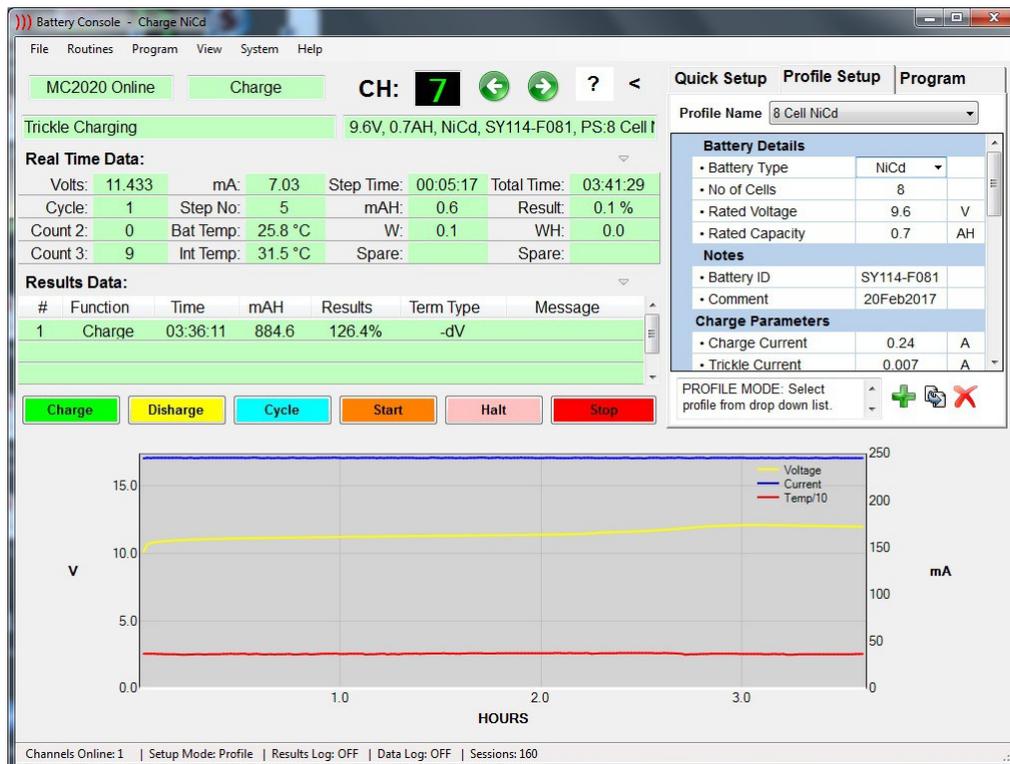
(A) Operate MC series analyzer with the **BA500WIN** software application

- BA500WIN is a legacy program that can be used to operate the MC/LC series analyzers.
- BA500WIN has direct control over the MC analyzer.
- In this mode BA500WIN must continually run while operating the analyzer. Disable any Windows™ Control Panel power saving features that may inhibit BA500WIN from exercising control.
- This mode is good for a laboratory type application where the user wants the maximum control to change parameters easily and frequently.
- Good for data collection and flexible control of the test session.
- Easy to set up, save and load test parameter profiles from database.
- This method is used by knowledgeable staff who are comfortable setting and adjusting the test parameters as required.
- BA500WIN can be obtained from the website. [Download BA500WIN](#) full installation file and install the software. The [BA500WIN manual](#) is a separate document available for download.



(B) Operate the MC series analyzer with the **Battery Console application.**

- This is the next generation software for Battery Metric devices. This software produces standard or custom routines that get loaded into the analyzer itself. Once the routines are loaded the device can run autonomously from the computer. The Battery Console application can be used to collect, view, save and process data as well as control the operating battery test routine currently operating. This creates the opportunity to create routines that allow you to program the Battery Metric device to operate without a computer connection. This way you can build a stand alone device with it's own specialized functionality. Program user defines steps to begin once the battery in connected or when the vector push button is activated. LED indicators can provide real time status and test result.
- Of course a computer connection can still be used for data collection and control. Real time data, session progress, test data, status, saved data, results and graph can be viewed in the on screen Console. The console allows you to monitor the data as the test proceeds and after the test session is complete. The on screen console provides more information and control that you would see with a typical LCD display.
- The MC device is loaded with an App that is programmed to perform a specific function.
- The *Battery Console* software is used to load a specific application routine into the MC device. The routine only needs to be loaded into device once. It is retained in non-volatile flash memory and is available even after the device is powered off/on. The routine stays in the device until a new routine is loaded or it is erased.
- This method of use is best for repeating the same task many times and that does not require the collecting of a lot of data.
- This method is good for a service center where many people want to perform the same battery management task over and over without having to worry about setting any configuration or test parameters. Users can just connect the battery and the session will operate and provide visual and audio indication as well as reporting results. Console can printed reports and graphs.
- Battery Console can be obtained from the website. [Download Battery Console](#) software. [Battery Console documentation](#) is available online.



Any routine currently loaded in the device, using Battery Console, will become active as soon as the power is switched on. However whenever BA500WIN is used, it will deactivate the currently loaded routine and put the device into direct control mode under the supervision of the BA500WIN program. The routine is not cleared when in BA500WIN mode. It is simply deactivated. It can easily be reactivated by closing BA500WIN and powering the device off/on. This way you can switch back and forth between using a loaded routine and BA500WIN without having to reload the routine. Routines are managed and loaded using the *Battery Console* application.

Advanced users who want the ultimate in control can write their own unique routines for the MC series using the *Battery Console* software from Battery Metric. By creating your own routine you have even greater flexibility to control the MC module. See [Battery Console documentation](#) for more information.

Take advantage of the powerful routing, looping and comparison functionality to meet any charge, discharge or special test function. With Battery Routines you have full control over the device's various resources to produce a unique App for a special test or application.

Use **Battery Console** software application to use unique battery test routines. This is great for setting up a special task in a production environment. Once the routine is created and loaded into the MC/LC device, production staff can easily use it without special training or knowledge. Great for commissioning batteries or packs or other routine quality or production requirements.

Note that when using Apps, the results from the last session are stored in the analyzer and can be retrieved even if the device is turned off/on. As long as a new session has not begun, you can always just open the *Battery Console* software to see the results from the last session. This means that you can take the MC device to a remote location, run a test session, then return back to display and print the results. Just ensure that you don't start a new session. When the App proceeds past the reset step to begin a new test session the previous session results are cleared to prepare the device for the new test session.

Updating MC Series Firmware

The MC series machines feature field upgradable firmware. This is the operating program that controls the basic operation of the machine. Note this is different from any Apps that you may load into the machine. The Apps are higher level software applications for a specific application. The firmware is the low level software that functions as the operating system for the machine.

The firmware version currently in use can be determined:

- BA500WIN: Menu/Analyzer/Details (F3)
- Battery Console: Menu/System/Configuration

Firmware updates are released from time to time. These updates add new features, improve performance and fix bugs. The latest version of the MC/LC series firmware can be found on the [downloads](#) page.

The F/W is installed using the [Firmware Manager](#) software program supplied with the analyzer or available as a download. For multi-channel systems upgrade each channel individually one at a time.



To upgrade the firmware follow these steps:

- Visit: www.batterymetric.com/downloads to get the latest firmware file: mcfwX_X.hex
- Save this hex file to your PC.
- Power off all MC series analyzers and start the Firmware Manager software program
- Press and hold the VEC switch, and at the same time turn on the power switch, to put the analyzer into update mode.
- With the channel selector arrows, switch to the channel assigned to the machine you are updating. You should now see that the Firmware Manager program has detected the MC machine and is showing the status as: *On-Line*. (Note the channel assignment may be different than BA500WIN or Battery Console. This procedure will not affect the channel assignments in those applications.)
- Select "Open Hex File" to open the firmware upgrade file you previously downloaded
- Click the *Load File* button to complete the update.
- For any other MC analyzers switch to the other channel and similarly load the new firmware.
- When completed, close the software and turn off the power switch off/on to exit update mode.

Calibration

Each MC series analyzer is factory calibrated and is supplied with a calibration certificate. If however you require calibration to a particular standard for your specific quality control procedures then you may choose to calibrate it yourself to your standard. BA500WIN includes software tools to allow you to calibrate the Voltage measurement, Voltage regulation, Current measurement & Current regulation. All calibration data, including factory calibration or your own user calibration data is stored in flash memory in the MC device. This calibration data then stays with the analyzer and is available even if the analyzer is moved to a different computer. Upgrading the firmware will not impact the stored calibration data in any way.

At any time you may choose to restore the factory calibration data. Even if you re-calibrate you can always choose to revert back to the original factory calibration at any time. See the BA500WIN manual for more information on calibration.

If at any time you experience problems with no current flowing or erroneous voltage readings, try restoring the calibration values back to factory defaults.

Re-calibration is not normally required unless critical tests are being performed that requires the highest level of accuracy possible or as quality standards may dictate.

Battery Metric offers a [calibration service](#). Contact Battery Metric for details and pricing.

Using Multiple Channels

A major feature of the MS series system is the ability to expand the system by connecting any number of analyzers to meet requirements. The computer interface software system can accommodate up to 96 channels. In stand alone mode an unlimited number of channels can be used because each channel is a separate device. To add more channels simply connect additional MC modules to other USB ports on your computer. If your computer requires more USB ports, then simply use an inexpensive USB hub to add more USB ports. The USB hub does not need to be powered. When the software detects a device for the first time it will automatically assign a channel number. This channel number will persist each time the software is opened. If necessary they can be reassigned with the **Reassign Channel Numbers** control.

Each module can manage 1 battery or battery pack. Each analyzer is managed as a separate channel. This means you can load different profiles and have different types of batteries and sessions operating simultaneously. You can also mix and match different MC series models on the same computer. This can give you a variety of voltage and current capabilities.

The software automatically detects how many analyzer are connected to the system. There is no need to configure the software to specify your set up situation. The software has full control of all devices connected to the computer. Each channel can operate simultaneously and independently from the other channels. The software has channel selector controls to select and control a specific channel. When using BA500WIN you can also view data from all analyzers simultaneously with the Multi-Channel view. This is great for a production environment allowing you can see the status of 24 channels in a single window.

The MC series analyzers feature electrical isolation from the PC and earth ground. This means that each MC device can float at any potential required. This allows for multiple devices to be connected to the same battery string and operate independently at a higher or lower voltage in the battery. The minus (black) leads are not earth ground, so do not connect this lead to earth ground. Each black lead from each channel can be at slightly different potentials. In a multi-channel system, take care not to mix up the leads from different channels. Interchanging the by leads by mistake can result in inaccurate measurements and improper operation.

It is a good idea to mark each analyzer with a channel number. This will make it easier for the operator to identify which battery is on which channel when using the system. The software will recognize each channel individually and always assign the same channel number in software.

The MC series analyzers are compatible with the older BA500 series analyzers. Both machines types can work together on the same system. Older BA500 series analyzers cannot operate with Battery Console.

Battery Connection

Batteries can be connected to the MC series devices in either a 2 Wire or 4 Wire configuration. The following describes the difference and how and when to use each type of connection.

(A) - 2 Wire Configuration

With a 2 wire connection there is only 1 pair of leads that connect to the battery. Both are used to carry the current and measure the voltage. The current flowing through the 2 wires will cause a small voltage drop across the leads due to the very small lead resistance. At low current levels the error in voltage measurement and regulation is insignificant. This error will also have an insignificant effect on charging, discharging and capacity measurements. When using a 2 wire system there is a compensation factor (lead resistance) that can be used to adjust the voltage measurements based on the actual current measured. You can set this adjustment factor in BA500WIN. See Menu/Analyzer/Lead Resistance. A typical value to use for compensation (lead resistance) in a 2 wire setup is 100 m Ω . You can increase or decrease this 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. These voltage errors usually only become significant in a laboratory situation. If the voltage deviation is an issue in your application, you may want to consider the following when using a 2 wire battery connection.

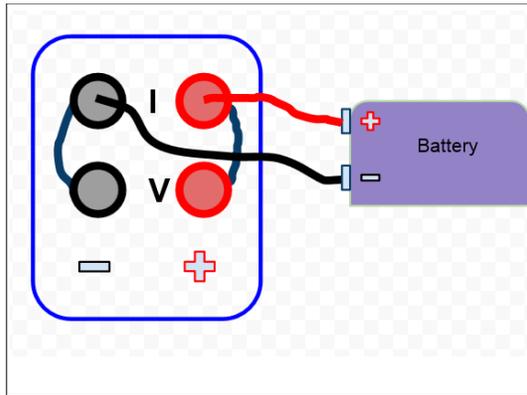
The amount of voltage deviation will depend on :

- The gauge of the wire used to connect the battery to the analyzer.
- The method used to connect the leads to the battery.
- The length of the leads.
- The current in effect at any given time.

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

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

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



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

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

This configuration is suitable for many applications.

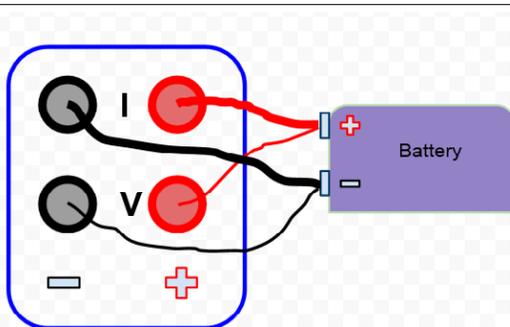
The 2 wire system is advantageous because it offers simplified wiring and less chance of the Vsense wires becoming disconnected. It is often the preferred method when the current is less than 2.5A. MC series analyzers with a current rating of 2A or less are supplied with a single pair of leads (banana jacks to alligator clips) because it is assumed the 2 wire connection will be used. For high current or voltage sensitive applications the 4 wire connection can be used.

(A) - 4 Wire Configuration

The higher current application the MC series 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 regulation regardless of the current.

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

The analyzer is shipped ready for a 2 wire connection and as such you will find two jumpers in place connecting the two minus (-) and two plus (+) 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 remove the 2 jumpers installed across the 2 POS and 2 NEG terminals respectively and use an extra pair of leads. Once you do this, the two terminals marked **I** will be the current carrying terminals and the 2 terminals marked **V** will be the voltage sense terminals.



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

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

Thermal Management

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 variable speed 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.

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

Charging The analyzer employs a linear charge regulator. As such the heat generated while regulating the charge current can be calculated as: **$P = (V_{ps} - V_{bat}) \times I_{reg}$**

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 become evident when charging low voltage batteries with a higher voltage analyzer at high current. In the event you experience an Overload situation while charging you will need to decrease the charge current or use a battery with a higher terminal voltage. If you experience an Overload situation while performing the charge calibration you will need to use a battery with a higher terminal voltage.

Discharging The heat generated during discharge can be calculated as: **$P = V_{bat} \times I_{reg}$**

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, **V_{ps}** is the DC voltage of the power supply, **V_{bat}** is the battery voltage at any given time, **I_{reg}** is the charge current in effect)

The battery console displays the analyzer's Internal temperature. This is the temperature inside the MC module and provides an indicator of the internal heat situation.

Front Panel Data Port

The MC series analyzer feature a front panel data port that provides additional methods of connection.

This connector is an eight position Molex™ connector that will mate with Molex housing 39-01-3085 using Molex 45750 series terminals

(8) – D1	(7) – Temp	(6) – Vsense +	(5) – Current +
(4) – D2	(3) – Gnd	(2) – Vsense –	(1) – Current –

Port Assignments

- (1) Current carrying negative (–) connection which is the same as binding post (I–)
- (2) Voltage Sense negative (–) connection the same as the binding post (V–)
- (3) Ground connection for digital I/O and/or thermistor
- (4) Special purpose digital I/O No 2 pin out. Can be configured as an output to control external circuitry or as an input to trigger step change events. Use Battery Console to setup digital I/O ports
- (5) Current carrying positive (+) connection which is the same as binding post (I+)
- (6) Voltage Sense positive (+) connection the same as the binding post (V+)
- (7) Temperature connection to thermistor. The MC device assumes a 10K ohm, NTC thermistor such as Vishay NTCLE100E3103HB0
- (8) Special purpose digital I/O No 1 pin out. Can be configured as an output to control external circuitry or as an input to trigger step change events. Use Battery Console to setup digital I/O ports

Optional Battery Pack Adapters

Contact Battery Metric to consult on battery test fixtures.

Smart fixtures are available that fixes certain critical charge and discharge parameters so that users cannot inadvertently apply improper test parameters.

Optional Thermistor Temperature probe and other accessories

Battery Metric supplies accessories such and temperature probes and other battery fixtures and holders. Contact Battery Metric to discuss your requirements.

The optional temperature 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 front panel data port. 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 front of the analyzer. This will allow temperature data to be continually recorded.

It is not necessary to use the temperature probe. This is an option for charge termination (e.g. TCO and dT/dt charge termination) and battery protection to prevent battery overheating.

