



MM Series Inverters



Owner's Manual

Disclaimer of Liability

The use of this manual and the conditions or methods of installation, operation, use, and maintenance of the MM Series Inverter are beyond the control of Magnum Energy, Inc. Therefore, this company assumes no responsibility and expressly disclaims any liability for loss, damage, or expense whether direct, indirect, consequential, or incidental that may arise out of or in anyway connected with such installation, operation, use, or maintenance.

Due to continuous improvements and product updates, the images shown in this manual may not exactly match the unit purchased.

Restrictions on Use

The MM Series Inverter shall not be used in connection with life support systems, life saving or other medical equipment or devices. Use of this particular equipment is at your own risk.

Contact Information

Magnum Energy, Inc.

2211 West Casino Rd.

Everett, WA 98204

Phone: (425) 353-8833/Fax: (425) 353-8390

Web: www.magnumenergy.com

Record the unit's model and serial number in case you need to provide this information in the future. It is much easier to record this information now, instead of trying to gather it after the unit has been installed.	
Model:	Serial Number:
<input type="checkbox"/> MM612	L1
<input type="checkbox"/> MM1212	M1

Conventions Used in this Manual

Safety symbols

To reduce the risk of electrical shock, fire, or other safety hazard, the following safety symbols have been placed throughout this manual to indicate dangerous and important safety instructions.



WARNING: This symbol indicates that failure to take a specified action could result in physical harm to the user.



CAUTION: This symbol indicates that failure to take a specified action could result in damage to the equipment.



Info: This symbol indicates information that emphasizes or supplements important points of the main text.

Terminology

AC source or External AC power - refers to Alternating Current (AC) provided by the utility electric power grid or from a generator. In some applications this is referred to as shore power.

AE application - typically refers to using the inverter in an system that uses Alternative Energy (e.g., solar, wind, or hydro). This term is also used to refer to inverters used in a home, office, or a cabin installation.

Mobile application - refers to inverters used in a Recreation Vehicle (RV), boat, or a truck installation.

IMPORTANT PRODUCT SAFETY INSTRUCTIONS

This manual contains important safety instructions that must be followed during the installation and operation of this product. Read all instructions and safety information contained in this manual before installing or using this product.

- All electrical work must be performed in accordance with local, state, and federal electrical codes.
- This product is designed for indoor/compartment installation. It must not be exposed to rain, snow, moisture, or liquids of any type.
- Use insulated tools to reduce the chance of electrical shock or accidental short circuits.
- Remove all jewelry such as rings, watches, bracelets, etc., when installing or performing maintenance on the inverter.
- Always disconnect the batteries or energy source prior to installing or performing maintenance on the inverter. Live power may be present at more than one point since an inverter utilizes both batteries and AC. Turning off the inverter may not reduce this risk. As long as AC power is connected, it will pass thru the inverter regardless of the ON/OFF power switch setting.
- Always verify proper wiring prior to starting the inverter.
- Do not operate the inverter if it has been damaged.
- Do not dismantle the inverter; there are no user-serviceable parts contained in this product. Attempting to service the unit yourself could cause electrical shock. Internal capacitors remain charged after all power is disconnected.
- No AC or DC disconnects are provided as an integral part of this inverter. Both AC and DC disconnects must be provided as part of the system installation.
- No overcurrent protection for the battery supply is provided as an integral part of this inverter. Overcurrent protection of the battery cables must be provided as part of the system installation.
- No overcurrent protection for the AC output wiring is provided as an integral part of this inverter. Overcurrent protection of the AC output wiring must be provided as part of the system installation.

SAVE THESE INSTRUCTIONS

IMPORTANT BATTERY SAFETY INSTRUCTIONS

- Wear eye protection such as safety glasses when working with batteries.
- Remove all jewelry such as rings, watches, bracelets, etc., when installing or performing maintenance on the inverter.
- Never work alone. Always have someone near you when working around batteries.
- Use proper lifting techniques when working with batteries.
- Never use old or untested batteries. Check each battery's label for age, type, and date code to ensure all batteries are identical.
- Batteries are sensitive to changes in temperature. Always install batteries in a stable environment.
- Install batteries in a well ventilated area. Batteries can produce explosive gasses. For compartment or enclosure installations, always vent batteries to the outside.
- Provide at least one inch of air space between batteries to provide optimum cooling.
- Never smoke when in the vicinity of batteries.
- To prevent a spark at the battery and reduce the chance of explosion, always connect the cables to the batteries first. Then connect the cables to the inverter.
- Use insulated tools at all times.
- Always verify proper polarity and voltage before connecting the batteries to the inverter.
- To reduce the chance of fire or explosion, do not short-circuit the batteries.
- In the event of accidental exposure to battery acid, wash thoroughly with soap and water. In the event of exposure to the eyes, flood them for at least 15 minutes with running water and seek immediate medical attention.
- Recycle old batteries.

SAVE THESE INSTRUCTIONS

1.0 Introduction

Congratulations on your purchase of an MM Series inverter from Magnum Energy, Inc. This product is designed to be powerful, yet simple to use, and provide you with years of trouble-free use.

Please read this chapter to familiarize yourself with the features and benefits of your particular MM Series model.



Figure 1, MM Series Inverter

MM Series Models

MM612 - a 600 watt inverter with 7 amp AC transfer relay. The AC input and output are provided with pigtail wires to allow hardwiring to an AC distribution panel. Features neutral-to-ground switching for mobile applications.

MM1212 - a 1200 watt inverter/charger with 12 amp AC transfer relay and 70 amp, 4-stage PFC charger. The AC input and output are provided with pigtail wires to allow hardwiring to a main AC distribution panel and an inverter sub-panel. Features neutral-to-ground switching for mobile applications. Includes a 15' battery temperature sensor.

How an Inverter/Charger Works

An inverter takes direct current (DC) from your batteries and turns it into alternating current (AC), like you use at home. With MM Series models that have the battery charger feature, it also takes alternating current (when connected to a generator or to shore power) and transforms it into direct current to recharge your batteries.

There are three modes of operation associated with this inverter:

Inverter Mode: DC from the batteries is transformed into AC for powering your boat or RV accessories.

Transfer Mode: AC is taken directly from shore power (or other AC sources) and passes through the inverter directly to your RV or boat accessories.

Charger Mode (not available on all models): The incoming AC from shore power (or other AC sources) is converted to DC to recharge the batteries connected to the inverter.

What Appliances will run from a Modified Sine Inverter

Today's inverters come in two basic output waveforms: modified sine (which is actually a modified square wave) and pure sine wave. Modified sine wave inverters approximate a pure sine waveform.

The output of a modified sine wave inverter will run most electronic and household items including but not limited to TV, VCR, satellite dish receiver, computers, and printers. Some devices such as rechargeable power supplies for phones, drills, and other like devices may not run or be damaged by modified sine wave inverters.

Appliances and Run Time

The MM Series inverter can power a wide range of household appliances including small motors, clocks, and other electrical devices. As with any appliance using batteries for power, there is a certain length of time that it can run – this is called "run time". Actual run time depends on several variables including the size and the type of appliance, the type of batteries installed in your application, as well as the battery's capacity and age. Other factors such as the battery's state of charge and temperature can also affect the length of time your appliances can run.

Appliances such as TVs, VCRs, stereos, computers, and lights can all be successfully powered by your inverter. Depending on your inverter capacity, larger electrical appliances such as coffee pots and hair dryers can be used for short durations. However, loads that are used for longer periods such as stoves or water heaters can quickly drain your batteries and are not recommended for inverter applications.

All electrical appliances are rated by the amount of power they consume. The rating is printed on the product's nameplate label, usually located on its chassis near the AC power cord. Even though it is difficult to calculate exactly how long an inverter will run a particular appliance, the best advice is trial and error. Your MM Series inverter has a built-in safeguard that automatically protects your batteries from being over-discharged.

Standard Features and Benefits

The MM Series inverter converts 12 Volts Direct Current (VDC) power from your battery to 120 Volts Alternating Current (VAC) power. On models with the multi-stage battery charger feature, the incoming AC power is optimized using Power Factor Correction (PFC) technology to keep the inverter's battery bank fully charged. This inverter is designed to allow easy installation and use and with its die-cast aluminum baseplate, which ensures maximum durability and cooler more efficient operation.

The inverter is equipped with the following features:

- 600 or 1200 watts continuous (depending on model) at 25° Celsius.
- Numerous protection features to provide a safe and peace-of-mind operation.
- AC transfer switch circuitry; allowing incoming AC power to continue to pass-thru to power loads even if the inverter is off.
- Dead battery charging (battery charger models) for charging batteries that are extremely low.
- Automatic 4-stage battery charger with power factor correction and temperature compensation – for optimum battery charging (models with battery charger and using the temperature sensor).
- Modern and aesthetically pleasing design with large AC wiring compartment (provides easy access to AC wiring for simple and quick connections) and 360° DC connection terminals with color-coded insulating covers.
- True RMS output voltage regulation to ensure the inverter will deliver the correct amount of power – within the DC input voltage range and the continuous output power level.
- Quick connection accessory and remote ports – easily accepts several optional remote controls and the Battery Temp. Sensor.

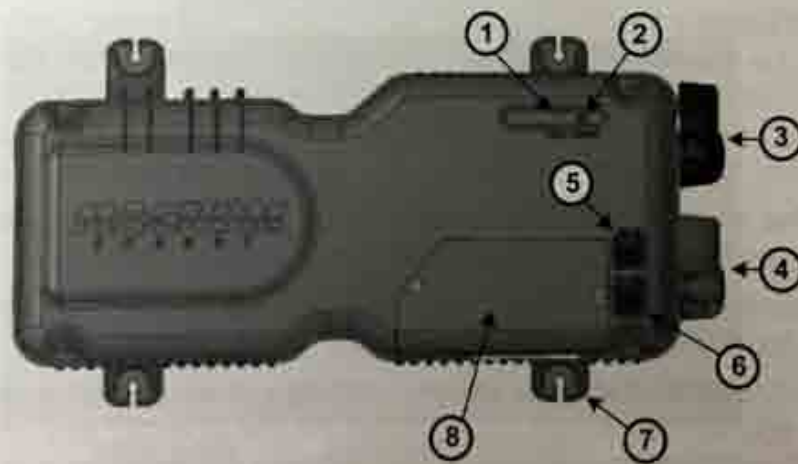


Figure 2, Top Side Features

1.0 Introduction

1. **Inverter Status Indicator** - this green light emitting diode (LED) illuminates to provide information on the inverter's operation.
2. **Power switch** - momentary push button switch that turns the inverter On or Off.
3. **Negative DC terminal (black)** - the inverter's connection to the negative terminal on the 12 VDC battery bank.
4. **Positive DC terminal (red)** - the inverter's connection to the positive terminal on the 12 VDC battery bank.
5. **Input circuit breaker** - this circuit breaker protects the unit's internal wiring and pass-thru relay.
6. **Output circuit breaker** - this circuit breaker provides another layer of overload protection. This is not a branch-circuit rated breaker. Separate AC output breakers are required on the output.
7. **Mounting flanges (x4)** - used to secure the inverter to shelf/wall.
8. **AC Wiring Compartment** - provides access for all AC input and output connections on the inverter.

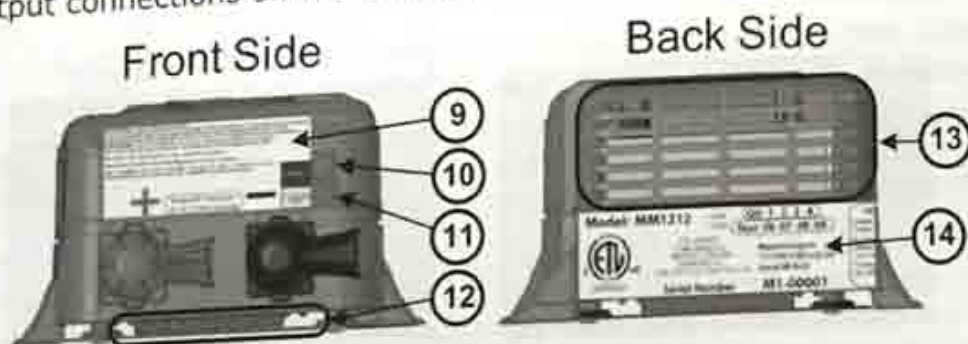


Figure 3, Front and Back Side Features

9. **Warning and information label** - provides pertinent information for safely using the inverter.
10. **REMOTE port connection** - a RJ11 connector that allows an optional remote control to be connected.
11. **ACCESSORY PORT connection** - a RJ11 connector (only available for models with the battery charger) to allow the Battery Temperature Sensor (BTS) or MM accessories (e.g., MM-DCLD) to be connected. The BTS provides information that enables the multi-stage PFC battery charger to "fine tune" the battery charge voltages.
12. **Intake vent** - ventilation openings to pull in air to help keep the inverter cool for peak performance.
13. **Exhaust vent** - ventilation openings that allow heated air to be removed by the internal cooling fan.
14. **Model/Serial Number label** - includes model/serial number and provides specifications and information on the inverter and charger. See the **Specifications** on page 28 for more information and the different models available.



Figure 4, Left Side Features

- 15. **AC output connection** - AC knockout (output) for hardwiring.
- 16. **AC input connection** - AC knockout (input) for hardwiring.
- 17. **DC Ground terminal** - this connection is used to tie the exposed chassis of the inverter to the DC grounding system. This terminal accepts CU/AL conductors from #14 AWG to #6 AWG.

Battery Temperature Sensor (Battery Charger Models Only)

A plug-in external Battery Temperature Sensor (BTS) is provided for units with the battery charger feature. When installed, the BTS automatically adjusts the battery chargers BULK, ABSORB, and FLOAT voltage set-points based on temperature for better charging performance and longer battery life. If the temperature sensor is NOT installed and the batteries are subjected to large temperature changes, the battery life may be shortened.

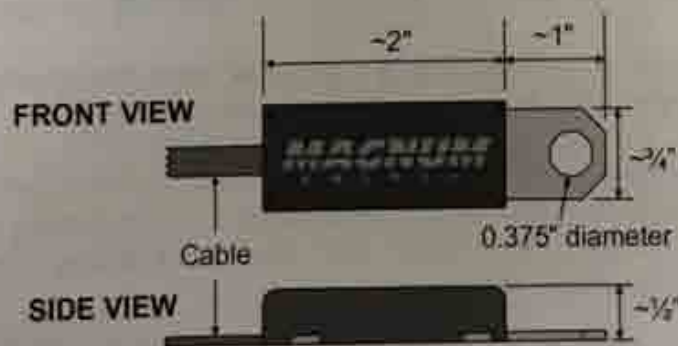


Figure 5, Battery Temperature Sensor

3.0 Operation

Operating Modes

The MM Series inverter has two normal modes of operation; Invert Mode, which powers your loads using the batteries, and Transfer Mode, which powers your loads from the incoming AC power (i.e., shore power or a generator). This inverter also has extensive protection circuitry and will go into the Protection Mode under certain fault conditions.

Invert Mode

In Invert Mode, the inverter supplies AC power to your appliances by inverting the DC power from the battery. The amount of time the inverter can provide power is directly related to the capacity of the battery (or battery bank).

Transfer Mode

The inverter will automatically go into Transfer Mode whenever an external AC source is connected and allowed to pass through to power your AC loads. While in Transfer Mode, the AC input is continually monitored to ensure it remains between 80 VAC (determined by the 'Adj VAC dropout' setting) and 140 VAC. The status LED indicator will be on (Transfer Mode), or blink off every four seconds (battery charging) to indicate that the inverter is passing the input AC power to the output and monitoring the AC input. Whenever AC power is disconnected or falls below the 80 VAC threshold, the inverter automatically transfers back to the Invert Mode with minimum interruption to your appliances – as long as the inverter is enabled (turned on).



Info: You must use the ME-RC remote to adjust the VAC dropout setting – which in turn determines the VAC dropout threshold.

Transfer time - When the AC power falls below the VAC dropout threshold voltage (80 VAC, default setting), the relay transfers from Transfer Mode to Invert Mode in about 16 milliseconds. While the MM Series is not designed as a computer UPS system, this transfer time is usually fast enough to hold them up. However, the VAC dropout setting has an effect on the ability of the loads to transfer without resetting. The lower this setting, the longer the effective transfer will be and therefore, the higher the probability for the output loads to reset. This occurs because the incoming AC voltage is allowed to fall to a level that is so low, that when the transfer does occur (in addition to the relay transfer time), the voltage from the inverter's output has already fallen to a low enough level to reset the loads.

The disadvantage of a higher VAC dropout setting is that smaller generators (or large generators with an unstable output) may nuisance transfer. This commonly happens when powering loads that are larger than the generator can handle – causing the generator's output to constantly fall below the inverter's VAC dropout threshold.

When switching from Invert Mode to Transfer Mode, the inverter waits approximately 15 seconds to ensure the grid is stable (or the generator is up to speed) and then makes the transfer in approximately 8 milliseconds.

Protection Mode

The inverter is protected against five fault conditions, and in normal usage it will be rare to see any. If there is a situation the inverter can't handle, then it will shut down and attempt to protect itself, the battery bank, and your appliances. If there is a condition that causes one of the following five faults to be enabled, refer to the Troubleshooting section to diagnose and clear the fault.

- **Low Battery** - Whenever the battery voltage falls to a low level (10 VDC, default setting) for more than one minute, the inverter will shut down to protect the batteries from being over-discharged.
- **High Battery** - In the event the battery voltage exceeds a high voltage level (15.5 VDC), the inverter will automatically shut down — along with all connected loads — to protect the loads from un-regulated AC output voltage.
- **Overload** - While inverting, the AC and DC sides are monitoring the current levels. In the event of a short-circuit or overload condition, the inverter will shut down.
- **Over-temperature** - If internal power components begin to exceed their safe operating temperature level, the inverter will shut down to protect itself from damage.
- **Internal Fault** - The inverter continually monitors several internal components and the processor communications. If a condition occurs that does not allow proper internal operation, the inverter will shut down to protect itself and the connected loads.

Charge Mode (not available on all models)

Some MM Series models are equipped with a multi-stage battery charger feature. This includes an automatic 4-stage charging process: Bulk, Absorb, Float and Full Charge; and a manual charge stage: Equalization (the ME-RC50 is required to enable Equalization charge). The automatic 4-stage charge process provides complete recharging and monitoring of the batteries without damage due to overcharging.

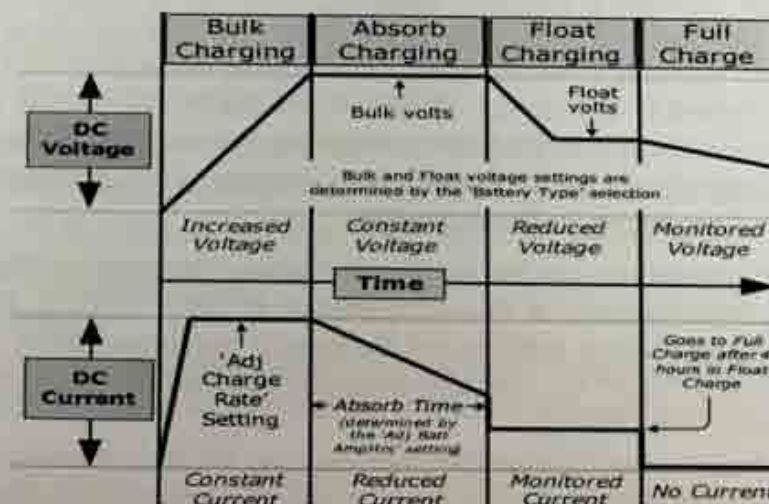


Figure 12, Automatic 4-Stage Charging Graph

3.0 Operation

When an AC source (shore power or generator) is connected to an inverter that has a battery charger, the inverter will monitor the AC input for acceptable voltage. Once the inverter has accepted the AC input, the AC transfer relay will close and Charge Mode will begin. Once in Charge Mode, the DC voltage will be monitored to determine how to charge. If the DC voltage is ≤ 12.9 VDC, the charger will go to bulk charging. If the DC voltage is > 12.9 VDC, the charger will skip the initial Bulk/Absorb Charging stages and go directly to float charging.

While charging, the unit may go into **Charger Back-off** protection which automatically reduces the charge current to the batteries. This is caused by: 1. The internal temperature is too hot – the charger automatically reduces the charge rate to maintain temperature; or, 2. The AC input voltage falls below 85 VAC – the charger reduces the charge current to zero to help stabilize the incoming AC voltage.

The Charge Mode provides up to four separate charging stages: Bulk Charging, Absorb Charging, Float Charging and Full Charge.

Bulk Charging; This is the initial stage of charging. While bulk charging, the charger supplies the battery with constant current. The charger will remain in bulk charge until 14.6 VDC* is achieved (determined by the Battery Type selection**).

Absorb Charging; This is the second charging stage and begins after the bulk voltage has been reached. Absorb charging provides the batteries with a constant voltage and reduces the DC charging current in order to maintain the bulk voltage setting. The absorb charging time is 120 minutes (determined by the Battery AmpHrs selection**).

Float Charging; The third charging stage occurs at the end of the absorb charging time. While float charging (also known as a maintenance charge), the batteries are kept fully charged and ready if needed by the inverter. In this stage, the charge voltage is reduced to 13.4 VDC* (determined by the Battery Type selection**) which can maintain the batteries indefinitely.

Full Charge (Battery Saver™ mode); The fourth stage occurs after four hours in the Float Charging stage. The Full Charge stage maintains the batteries without overcharging, preventing excessive loss of water in flooded batteries or drying out of GEL/AGM batteries. In this stage, the charger is turned off and begins monitoring the battery voltage; if the battery voltage drops to 12.9 VDC, the charger will automatically initiate another four hours in float charge.

* These voltage settings are based on the Battery Temperature Sensor (BTS) being disconnected, or at a temperature of 77° F (25° C). If the BTS is installed, these voltage settings will increase if the temperature around the BTS is below 77° F (25° C), and decrease if the temperature around the BTS is higher than 77° F (25° C).

** The MM Series uses changeable settings (see Table 5, Inverter Default Settings) that are adequate for most installations. However, if you determine that some of your operating parameters need to be changed, the ME-RC50 remote control can be purchased to allow changes to those settings.

Start-up

ON/OFF Switch - Turning the inverter ON and OFF is controlled by a momentary switch on the front of the inverter (see Figure 2, Item 2). When the inverter is connected to the batteries, or when its automatic protection circuit has turned the inverter off, the ON/OFF switch will need to be pressed to start the unit. Once the inverter has been turned on, pressing the ON/OFF switch alternately turns the unit on and off.



Info: The ON/OFF control switch is a small momentary switch which functions by lightly pressing and releasing.

Status Indicator - The status indicator is a green LED that provides information on the operational mode of the inverter. Watch the status indicator (see Figure 2, Item 1) for at least 10 seconds to verify or determine the operational condition from the information below.

Normal Operation

- Off - The inverter is off. There is no AC power from inverter, shore, or generator at the inverter's output terminals.
- On (solid) - The inverter is in Transfer Mode. The external AC power (utility power or generator) connected to the inverter's input is passing to the inverter's output to power the AC loads.
- Blinks on once every second - The inverter is on and using energy from the battery. The inverter is either providing full power to the loads connected to the inverter, or it's in Search Mode and ready to supply AC power to the loads connected to the inverter.

Protection Mode

There are five fault conditions that will cause the inverter to shut down; Low Battery, High Battery, Over-temperature, AC Overload, and Internal faults. If your inverter has shut down, monitor the status indicator and count the number of blinks that occur every four seconds to determine the particular reason for the shutdown. Once you have determined the reason for the shutdown, refer to the Troubleshooting section to help diagnose/clear the fault condition.

- Blinks on 1 time every four seconds - Low Battery fault.
- Blinks on 2 times every four seconds - High Battery fault.
- Blinks on 3 times every four seconds - Over-temperature fault.
- Blinks on 4 times every four seconds - AC Overload fault.
- Blinks on 5 times every four seconds - Internal fault.

Charge Mode

Some units are equipped with the internal battery charger - with this option the green LED status indicator provides additional information;

- Blinks off every four seconds - The unit is charging the batteries connected to the inverter.

Factory Default Settings

Your MM Series inverter uses default settings that are adequate for most installations. However, if you determine that some of your operating parameters need to be changed, the optional ME-RC50 remote allows you to control the operation and to customize the programming parameters of the inverter and/or charger.

Table 5, Inverter Default Settings

Function	Default Settings
Search Watts	NA (MM612), 5W (MM1212)
LowBatCutOut	10.0 VDC
Battery AmpHrs	400 AmpHrs (Absorb Time = 120 minutes)
Battery Type	Flooded - Liquid Lead Acid (Bulk = 14.6 VDC, Float = 13.4 VDC)
Charge Rate	100%
VAC dropout	80VAC

To help you determine if you need the ME-RC50 remote*, information on the settings that can be changed is provided below. The settings once programmed are saved in non-volatile memory and will be preserved until changed – even if DC power to the inverter is lost (the ME-RC50 must always be connected).

Search Watts: This setting allows you to enable the power-saving Search Mode circuitry and to adjust the power level at which the inverter will "wake up" and start inverting. This function is not available on the MM612 model and is adjusted to 5W ("wakes up" and inverts if loads exceed 5 watts) on the MM1212.

LBCO: This setting determines when the inverter will turn off based on low battery voltage (inverter turns off automatically after battery voltage has been below this setting for more than one minute). This protects the batteries from over-discharge and the AC loads from unregulated power (brown-outs).

Battery AmpHrs: This setting allows the user to input the battery bank size in amp hours, which provides information to the charger on how long to charge the batteries in the Absorb Charging stage.

Battery Type: Sets the type of batteries being used in the system which provides information to the charger to determine what voltage level to charge the batteries.

Charge Rate: This setting uses a percentage of the charger's max. output to determine the output charge rate. This setting can be used to limit the amount of current that the charger can use (leaving more current available to power loads); or, to ensure small battery banks are not overheated because of a charge rate that is too high.

VAC Dropout: Sets the min. AC voltage that can be present on the AC input before the unit transfers from Transfer Mode to Invert Mode. This protects the AC loads from utility outages and brown-outs.

* Visit our website (www.magnumenergy.com) for more information.

4.0 Troubleshooting

The MM Series Inverter is a fairly simple device to troubleshoot. There are only two active circuits (AC and DC) as well as a charging circuit in some of the models. The following chart is designed to help you quickly pinpoint the most common inverter and charger faults.

Table 6, Troubleshooting Guide

Symptom	Possible cause	Recommended Solution
Low Battery Voltage (the status indicator blinks on <u>1 time</u> every 4 secs)	The battery voltage level has dropped below the Low Battery Cut Out (LBCO) set-point for more than one minute (10.0VDC = LBCO default setting).	Battery voltage is too low. Check fuses/circuit-breakers and cable connections. Check battery voltage at the inverter's terminals. Your batteries may need to be charged; this fault condition will automatically clear when the battery voltage exceeds 12.5VDC.
High Battery Voltage (the status indicator blinks on <u>2 times</u> every 4 secs)	The battery voltage is above 15.5 VDC. The inverter automatically resets and resumes operation when the battery voltage drops below 15.5 VDC.	This condition usually occurs only when an additional charging source (alternator, solar panels or other external charging sources) is used to charge the battery bank. Reduce or turn off any other charger to the inverter batteries to allow the voltage level to drop.
Over-temperature condition (the status indicator blinks on <u>3 times</u> every 4 secs)	The internal temperature of the inverter has risen above acceptable limits; caused by loads too great for the inverter to operate continuously, or by lack of ventilation to the inverter. When the unit has cooled, it will automatically reset and resume operation.	Reduce the number of electrical loads that you are operating; this will avoid a repeat Overtemp shutdown if the cause was too many loads for the ambient conditions. Check ventilation around the inverter; ensure cool air is available to pass-thru the inverter.
AC Overload (the status indicator blinks on <u>4 times</u> every 4 secs)	The inverter has turned off because the connected loads are larger than the inverter's output capacity or the output wires are shorted.	Reduce the AC loads connected to the inverter or remove all AC output wiring and restart the inverter.
Internal fault (the status indicator blinks on <u>5 times</u> every 4 secs)	This fault occurs when an internal fault is detected.	To clear this fault, an inverter reset is required. Remove DC power to the inverter or press and hold down the power switch on the inverter for 15 seconds (until the green Status LED comes on). If this fault does not clear, the unit will need to be serviced.
Inverter's status light is off.	Inverter is switched OFF or there is no DC voltage (battery) connected to inverter.	Switch the inverter ON. Connect a battery with correct voltage to the inverter.
AC input won't connect (AC IN on remote blinks)	The incoming AC voltage will not be accepted if it is below the VAC Dropout setting (80VAC = VAC Dropout default setting).	Check the incoming AC voltage to the input of the inverter; ensure it is present and above the VAC dropout level.
Appliances turn off and on; or there is low AC output power.	Loose AC output connections.	Tighten AC output connections.
	Loose / corroded battery cables.	Clean and tighten all cables.
	Low batteries.	Recharge or replace batteries.
Inverter AC output voltage is too low or too high when using an AC voltmeter.	Wrong type of voltmeter used (will display 90 VAC to 130 VAC depending on the battery voltage).	Most meters are made to read Average AC voltage. The AC output of the MM is a "modified" waveform which requires using a "true" RMS voltmeter to correctly read the output voltage.
While charging, the DC charge voltage is higher or lower than expected.	If the Battery Temperature Sensor is installed, it will increase or decrease the DC voltage level depending on temperature around the battery sensor.	This is normal.

5.0 Specifications

Table 7, MM Series Specifications

MODEL	MM612	MM1212
Inverter Specifications		
Input DC voltage range	9 to 15.5 Vdc	
Output voltage AC	120 VRMS +/- 5%	
Output frequency	60 Hz +/- .004%	
1msec peak surge current	27A	42A
100msec peak surge current	11A	23 A
5 sec surge power	1100W	2100W
10 sec surge power	1050W	1900W
30 sec surge power	1000W	1750W
5 min surge power	950W	1450W
30 min surge power	675W	1375W
Continuous output power	600 VA	1200 VA
Input DC current (at 12.6Vdc)	60A	125A
Inverter efficiency (maximum)	95%	
Transfer time	16 msecs	
AC transfer capability	7A	12A
Search mode	3W	5W
No load (120 VAC output - typical)	10W	18W
Output AC waveform type	Modified Sine Wave	
Charger Specifications	NA	Standard
Continuous charger current (at 12.6Vdc)	NA	70 ADC
Charger efficiency (maximum)	NA	88%
Power factor (10% to 100% charge)	NA	> 0.95
Input current for rated charger output	NA	9 AAC
Temperature compensation	NA	Yes, with BTS
General Features and Capabilities		
Protection circuitry	Low/High Battery, Over-temp & Overload	
Corrosion protection	PCB's conformal coated, powder coated chassis	
Output circuit breaker	7A switchable	12A switchable
Input circuit breaker	8A	20A
Internal cooling	Yes, 0 to 59 cfm variable speed	
Optional remotes available	MM-R or ME-RC50	MM-RC or ME-RC50
UL listing	ETL to UL/cUL458, CSA C22.2 #107.1-01	
Environmental Specifications		
Operating temperature	-20° C to +60° C (-4° F to 140° F)	
Non-operating temperature	-40° C to +70° C (-40° F to 158° F)	
Operating humidity	0 to 95% RH non-condensing	
Physical Specifications		
Dimensions (L x W x H)	16.6"x 8.4"x 4.7" (42cm x 21cm x 12cm)	
Mounting	Shelf or wall (top or bottom up)	
Weight	16 lbs. (7.3 kg)	22 lbs. (10 kg)

Specifications @ 25° C - Subject to change without notice

Appendix A - Remote Control and Monitoring

There are several remotes that let you monitor and switch the inverter on/off from a convenient location. Using the supplied cable with RJ11 connectors, they connect easily to the REMOTE port located on the front side of the MM Series (see Figure 3, Item 10).

Depending on your inverter model, you can select one of the following remotes:

MM-R - Provides three LED indicators for inverter status and includes a remote ON/OFF switch; comes with 25' cable. This remote is for the MM Series inverter without the battery charger feature – the MM612 model (requires serial number L1-201 or higher).

MM-RC - Provides six LED indicators for inverter and charger status, includes a remote ON/OFF switch; comes with 25' cable. This remote is for the MM Series inverter with the battery charger feature – the MM1212 model.

ME-RC50 - Full feature remote with backlit LCD display and LED indicators for inverter and charger status. Provides full menu access for easy selection and adjustment; comes with 50' cable. The ME-RC50 is used for many inverter models and has additional features that are not functional with the MM Series inverter. However, it can be used with all MM Series inverter models (MM612 requires serial number L1-201 or higher).

Using the MM-R and MM-RC Remotes

The MM remotes perform the same function as the ON/OFF switch on the front of the MM Series inverter, and provides the status of the different operational modes of the inverter. The appropriate remote to use depends on whether your inverter includes the battery charger feature. For MM Series inverters that do not have the battery charger, the **MM-R** is the recommended remote; for MM Series inverters that do have the battery charger, the **MM-RC** is the recommended remote.



Figure 13, MM Remotes

ON/OFF Switch

The ON/OFF Switch is a momentary push-button switch that duplicates the ON/OFF switch on the inverter. This switch also allows additional changes to be made while in the Invert or Charge Mode.

When the inverter is first connected to the batteries, the inverter and remote go through an internal 10 seconds start-up test. After this test is completed, the ON/OFF switch can be pressed to turn on the inverter. Once the inverter has been turned on, momentarily pressing the ON/OFF switch alternately turns the inverter On/Standby and Off.

On models with the Search Mode function, the ON/OFF switch can be used to enable or disable the Search Mode. While in the Invert Mode, pressing and holding this switch for three seconds causes the Search Mode to alternate between Disabled (inverter always on – indicated by the INVERT LED indicator always on) and 5W (inverter is looking for at least a 5 watt load to turn on and start inverting – indicated by the INVERT LED indicator blinking once a second).

On models with the battery charger feature, this switch can also be used to put the charger in standby (disables the charger) so that all the incoming power can be used exclusively for the AC loads. To put the charger in standby, press and hold the ON/OFF switch for three seconds (you must be in the Charge Mode). When this happens, the charging indicators (BULK, ABSORB and FLOAT) will go off. To activate the charger, press and hold the ON/OFF switch for three seconds again. When the charger is again activated, one of the charging indicators will come on to show the current charge stage.



WARNING: When any external AC power is passing through the inverter and present on the output, pressing the ON/OFF switch will not remove this AC power on the inverter's output.

Monitoring the LED Indicators

MM-R and MM-RC Remotes

The three LED indicators on the left side of both the MM-R and MM-RC remotes (see Figure 13) will show you the operating status of the MM Series inverter. Monitor the indicators to determine the mode of operation:

INVERT (green) -

- On (solid)
 - and the **AC IN** LED indicator is Off. The inverter is On. It is using energy from the battery to supply AC power to the loads connected to the inverter.
 - and the **AC IN** LED indicator is On (solid). The inverter is in Standby. The external AC power (utility/shore power or generator) connected to the inverter's input is passing through the inverter to power the AC loads. The inverter will automatically turn on to power the AC loads if the external AC power is lost or disconnected.
- Blinks On (once every second) - The inverter is in Search Mode. The AC load is below 5 watts (Search Watts default setting).

Appendix A - Remote Control and Monitoring

- Off - The inverter is disabled. The inverter is not on or will not come on if AC power is lost or disconnected.

AC IN (green) -

- On (solid) - the external AC power (utility/shore power or generator) is connected to the inverter's input, and passing through the inverter to power the AC loads connected to the inverter's output.
- Blinking On (once every second) - the external AC power is detected on the inverter's input, but not actively being used. Either: 1. The AC input is being qualified (takes approximately 15 seconds); or, 2. The input AC voltage is low. Ensure the incoming AC voltage is above 90 volts (VAC dropout setting with the MM remote connected).
- Off - No external AC power is detected on the inverter's input.

FAULT (red) - Under normal operating conditions, the FAULT indicator will be off. If there is a fault condition, this indicator will blink differently for each specific fault to help troubleshoot the inverter. Monitor this indicator for at least 10 seconds, and count the number of blinks that occur every four seconds to determine the particular reason for the shutdown. Once you have determined and cleared the fault the inverter can be turned on. To help clear the fault condition, refer to the Troubleshooting section.

- Blinks On 1 time every 4 seconds - Low Battery Voltage; the battery voltage level has dropped below 10.0 VDC (LBCO default setting**). Your batteries need to be charged, this fault condition will automatically clear when the battery voltage exceeds 12.5 VDC.
- Blinks On 2 times every 4 seconds - High Battery Voltage; the battery voltage is above 15.5 VDC. Reduce or turn off the external charging source to bring the battery voltage down.
- Blinks On 3 times every 4 seconds - Over-temperature condition; The internal temperature of the inverter has risen above acceptable limits; caused by loads too great for the inverter to operate continuously, or by lack of ventilation to the inverter. When the unit has cooled, it will automatically reset and resume operation.
- Blinks On 4 times every 4 seconds - AC Overload; the inverter has turned off because the connected loads are larger than the inverter's output capacity, or there is a short on the output wiring. The inverter can be restarted after the AC loads are reduced or the wiring short has been removed. To restart the inverter, momentarily press the ON/OFF button on the inverter or remote.
- Blinks On 5 times every 4 seconds - Internal Fault; the inverter has turned off because it has detected an internal problem. To clear this fault, the inverter will need to be reset by: 1. Press and hold the ON/OFF switch on the inverter for 15 seconds (the status LED must begin to rapidly flash); or, 2. Disconnect all DC power to the inverter for at least 15 seconds, and then reconnect. After resetting the inverter, momentarily press the inverter's ON/OFF switch and verify the fault has cleared. If the internal fault remains, the inverter requires service at an authorized repair facility.

MM-RC Remote Only

The MM-RC provides three additional charging LED indicators. Monitor these indicators for at least 10 seconds to determine the charger status.

BULK (yellow) -

- On (solid) - Bulk Charging; the charger is delivering maximum current to the batteries. The charger will remain in bulk charge until 14.6 VDC* is achieved (determined by the Battery Type selection**).
- Blinks On (1 time every 4 seconds) - Charger Back-off; the charger current is reduced. This occurs if: 1. The internal temperature is very hot (the charger reduces the charge rate to maintain temperature); or, 2. The AC input voltage has fallen below 85 VAC (the charger reduces the charge rate to help stabilize the incoming AC voltage).
- Off - charger is not in Bulk Charge mode.

ABSORB (yellow) -

- On (solid) - Absorb Charging; the charger is in constant voltage stage and begins after the bulk voltage has been reached. The DC charging current will taper down in order to maintain the bulk voltage setting. The absorb charging time is 120 minutes (per Battery AmpHrs selection**).
- Blinks On (1 time every 4 seconds) - Charger Back-off; the charger current is reduced. This occurs if: 1. The internal temperature is very hot (the charger reduces the charge rate to maintain temperature); or, 2. The AC input voltage has fallen below 85 VAC (the charger reduces the charge rate to help stabilize the incoming AC voltage).
- Off - charger is not in Absorption Charge mode.

FLOAT (green) -

- On (solid) - Float Charging; at the end of the absorb charging time, the charger reduces the charge voltage to maintain the batteries at 13.4* VDC (determined by the Battery Type selection**).
- Blinks On (1 time every 4 seconds) - Charger Back-off; the charger current is reduced. This occurs if: 1. The internal temperature is very hot (the charger reduces the charge rate to maintain temperature); or, 2. The AC input voltage has fallen below 85 VAC (the charger reduces the charge rate to help stabilize the incoming AC voltage).
- Blinks On (2 times every 4 seconds) - Full Charge; this mode monitors the battery voltage to determine when to continue charging. After four hours in the Float Charge mode, the charger turns off and goes to Full Charge mode. If the battery voltage drops to 12.9 VDC, the charger will automatically initiate another float charge.
- Off - charger is not in Float Charge mode.

* These voltage settings are based on the BTS being disconnected; if connected, these voltage settings will increase or decrease depending on temperature around the BTS - this ensures correct charging.

** These settings are preset in the inverter (see Table 5, Inverter Default Settings), but can be changed using the ME-RC50 remote.

Appendix B - Battery Information

Battery Bank Sizing

The size of the battery bank determines how long the inverter can power the AC loads without recharging. The larger the battery bank, the longer the run time. Size your battery bank to the system's AC load requirements and the length of time required to run the load from the batteries. In general, the battery bank should not be discharged more than 50%.

Battery Types

Batteries are available in different sizes, amp-hour ratings, voltage, and chemistries; they also come in liquid or gel, vented or non-vented, etc. They are also available for starting applications (such as an automobile starting battery) and deep discharge applications. Only the deep cycle types are recommended for inverter applications. Choose the batteries best suited for the inverter installation and cost. Use only the same battery type for all batteries in the bank. For best performance, all batteries should be from the same lot and date. This information is usually printed on a label located on the battery.

Battery Configuration

The battery bank must be wired to match the inverter's DC input voltage specifications (12 VDC). In addition, the batteries can be wired to provide additional run time. The various wiring configurations are:

Series Wiring

Wiring batteries in a series increases the total battery bank output voltage. A series connection combines each battery in a string until the voltage matches the inverter's DC requirement. Even though there are multiple batteries, the capacity remains the same. In the example below (Figure 14), two 6 VDC/200 Ahr batteries are combined into a single string – resulting in a 12 VDC/200 Ahr bank.

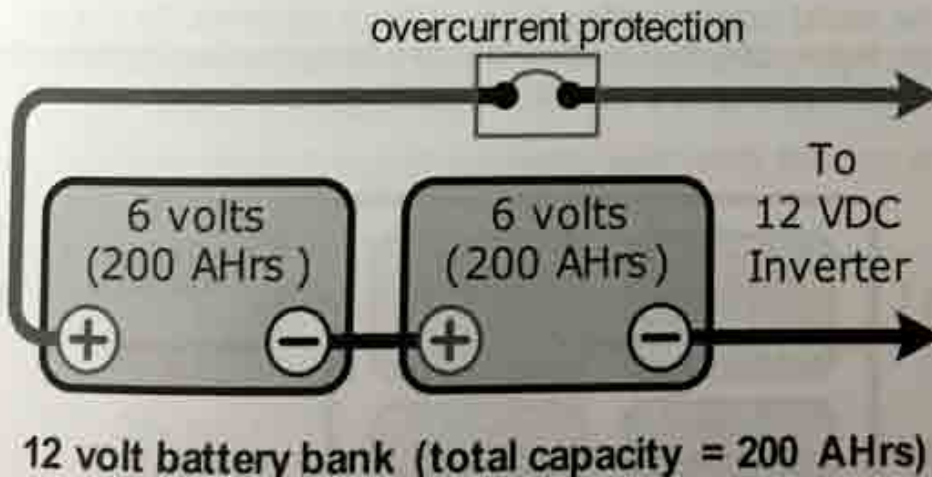


Figure 14, Series Battery Wiring

Parallel Wiring

Wiring the batteries in parallel increases the total run time the batteries can operate the AC loads. A parallel connection combines overall battery capacity by the number of batteries in the string. Even though there are multiple batteries, the voltage remains the same. In the example below (Figure 15), four 12 VDC/100 AHr batteries are combined into a single 12 VDC/400 AHr battery bank.

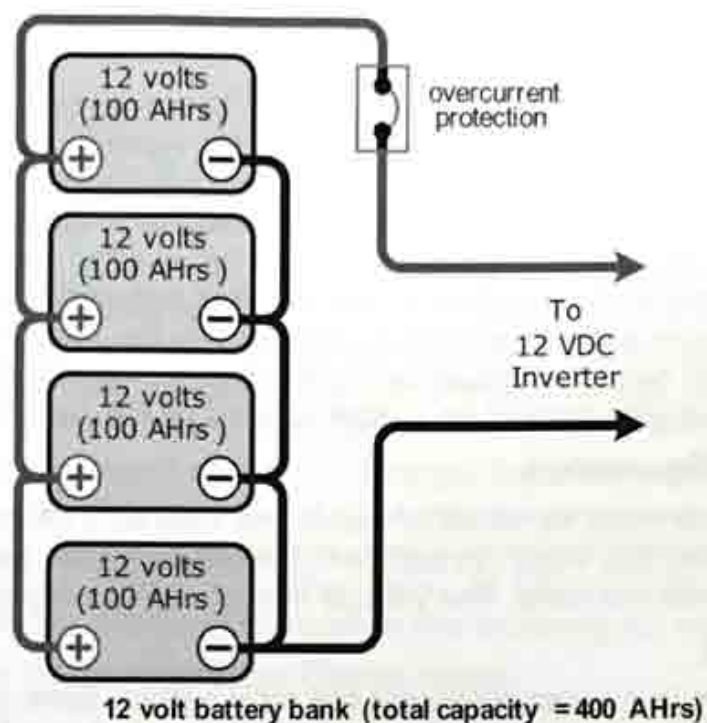


Figure 15, Parallel Battery Wiring

Series-Parallel Wiring

A series-parallel configuration increases both voltage (to match the inverter's DC requirements) and capacity (to increase run time for operating the loads) using smaller, lower-voltage batteries. In the example below (Figure 16), four 6 VDC/200 AHr batteries are combined into two strings resulting in a 12 VDC/400 AHr battery bank.

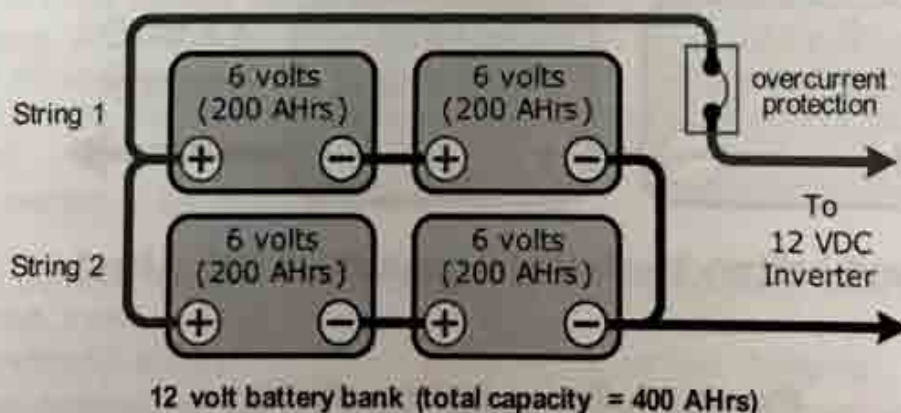


Figure 16, Series-Parallel Battery Wiring

Appendix C - Preventive Maintenance

Recommended Inverter and Battery Care

The MM Series Inverter is designed to provide you with years of trouble-free service. Even though there are no user-serviceable parts, it is recommended that every 6 months you perform the following maintenance steps to ensure optimum performance and extend the life of your batteries.



WARNING: Prior to performing these checks, switch both the AC and DC circuits OFF.

- Visually inspect batteries for cracks, leaks, or swelling – replace if necessary.
- Use baking soda to clean and remove any electrolyte spills or buildups.
- Check and tighten all battery hold down clamps.
- Clean and tighten (10 to 12 foot-pounds) all DC terminals (battery and inverter) and connecting cables.
- Check and fill battery water levels (Liquid Lead Acid batteries only).
- Check individual battery voltages (replace those that vary more than 0.3 VDC of each other).
- Check all cable runs for signs of chafing – replace if necessary.
- Check the inverter's cooling vents – clean as necessary.

RV/Marine Off-Season Storage

When placing your coach or boat into seasonal storage, it is recommended that you perform the following to ensure the system is properly shut down (or properly configured for seasonal storage). This is especially important for maintaining the batteries.

- Perform the recommended maintenance steps noted above.
- Fully charge the batteries.
- Connect shore power (if available) and verify that the breaker to the battery charger is switched ON.
- Verify the inverter is switched OFF.
- Switch OFF all unnecessary AC and DC loads.

Appendix D - Warranty/Service Information

24 Month Limited Warranty

Magnum Energy, Inc., warrants the MM Series Inverter to be free from defects in material and workmanship that result in product failure during normal usage, according to the following terms and conditions:

1. The limited warranty for the product extends for 24 months beginning from the product's original date of purchase.
2. The limited warranty extends to the original purchaser of the product and is not assignable or transferable to any subsequent purchaser.
3. During the limited warranty period, Magnum Energy will repair or replace (with factory new or rebuilt replacement items) at Magnum Energy's option any defective parts, or any parts that will not properly operate for their intended use - if such repair or replacement is needed because of product malfunction or failure during normal usage. The limited warranty does not cover defects in appearance (cosmetic or decorative), or any structural or non-operative parts. Magnum Energy's limit of liability under the limited warranty shall be the actual cash value of the product at the time the original purchaser returns the product for repair, determined by the price paid by the original purchaser. Magnum Energy shall not be liable for any other losses or damages.
4. Upon request from Magnum Energy, the original purchaser must prove the product's original date of purchase by a dated bill of sale, itemized receipt.
5. The original purchaser shall return the product prepaid to Magnum Energy in Everett, WA. After the completion of service under this limited warranty, Magnum Energy will return the product prepaid to the original purchaser via a Magnum selected non-expedited surface freight within the contiguous United States and Canada; this excludes Alaska and Hawaii.
6. If Magnum repairs or replaces a product, its warranty continues for the remaining portion of the original warranty period or 90 days from the date of the return shipment to the original purchaser, whichever is greater. All replaced products and parts removed from repaired products become the property of Magnum Energy.
7. This limited warranty is voided if:
 - the product has been modified without authorization
 - the serial number has been altered or removed
 - the product has been damaged through abuse, neglect, accident, high voltage, or corrosion
 - the product was not installed and operated according to the owner's manual

BEFORE RETURNING ANY UNIT, CONTACT MAGNUM ENERGY FOR A RETURN MATERIAL AUTHORIZATION (RMA) NUMBER.