



# MM Series Inverters

## Installation and Operation Guide

## Disclaimer of Liability

Since 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., this company does not assume responsibility and expressly disclaims liability for loss, damage or expense, whether direct, indirect, consequential or incidental, arising out of or 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.

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## 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** - Indicates a dangerous voltage or condition exists.



**Caution** - Indicates a critical step necessary for the safe installation and operation of the unit.



**Note** - Indicates an important statement.

### 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 shorepower.

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

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

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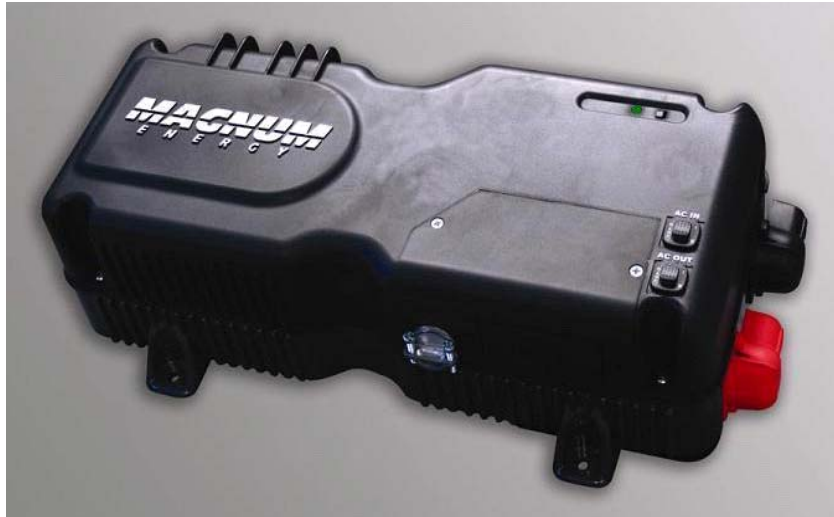
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## 1.0 Introduction

Congratulations on your purchase! The MM Series inverter from Magnum Energy, Inc. 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** - 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.

**MM612G** - 600 watt inverter with 7 amp AC transfer relay. The AC input is provided with a flexible cord and a GFCI outlet on the output for easy connection to your AC appliances; ready to use after connecting to your batteries. Features neutral-to-ground switching for Mobile applications.

**MM612AE** - 600 watt inverter/charger with 7 amp AC transfer relay and 30 amp, 4-stage PFC charger. AC input and output provided with pigtail wires to allow hardwiring to a main AC distribution panel and inverter sub-panel. Features common input/output neutrals for AE applications. Includes 15' battery temperature sensor.

**MM1212** - 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 inverter sub-panel. Features neutral-to-ground switching for Mobile applications. Includes 15' battery temperature sensor.

**MM1212AE** - 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 inverter sub-panel. Features common input/output neutrals for AE applications. Includes 15' battery temperature sensor.

## 1.0 Introduction

### 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 utility or generator power) and transforms it into direct current to recharge your batteries.

There are three modes of operation associated with this inverter:

**Inverter Mode:** Direct Current (DC) from the batteries is transformed into Alternating Current (AC) for powering your household electrical appliances.

**Transfer Mode:** Alternating Current (AC) is taken directly from utility power (or other AC sources) and passes through the inverter directly to your household appliances.

**Charger Mode** (not available on all models): The incoming AC from utility 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 and will run most appliances and electronics without any problems. These inverters are less expensive and, therefore, offer a viable alternative to more expensive pure sine inverters.

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 such 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.

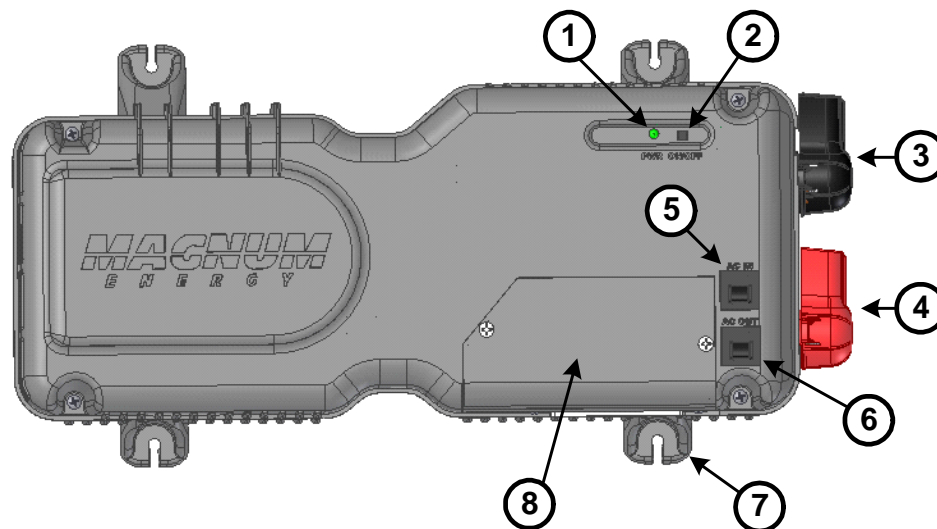


## Standard Features and Benefits

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 multistage 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.
- Equipped with numerous protection features to provide a safe and peace-of-mind operation.
- Unique 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) allows 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 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 continuous output power level.
- Quick connection accessory and remote ports - easily accepts several optional remote controls and the Battery Temperature Sensor.



*Figure 2, Top Side Features*

## 1.0 Introduction

**1, Inverter Status Indicator** - this green LED (Light Emitting Diode) 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.

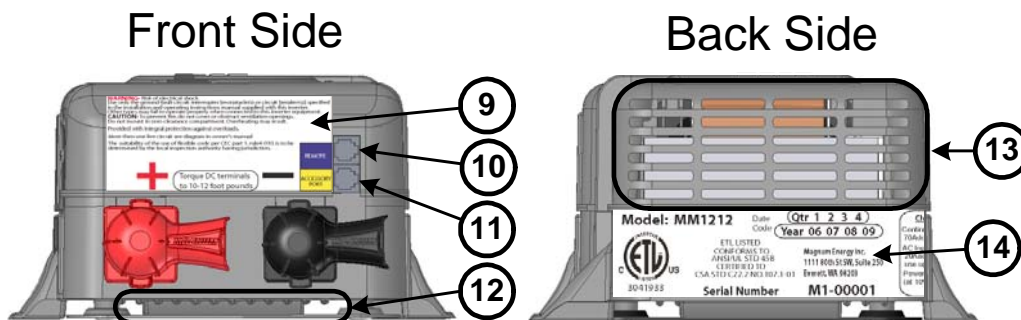
**4, Positive DC terminal (red)** - the inverter's connection to the positive terminal on the 12 VDC battery bank.

**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, unless you are using the GFCI outlet version.

**7, Mounting flanges (x4)** - used to secure the inverter to a shelf or 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 (available only models with the battery charger) to allow the Battery Temperature Sensor (BTS) to be connected. The BTS provides information that enables the multistage PFC battery charger to "fine tune" the battery charge voltages for better charging performance and longer battery life.

**12, Intake vent** - ventilation openings to pull in air to help keep the inverter cool for peak performance.

**13, Exhaust vent** - ventilation opening that allows 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 pages 28 and 29 for more information and the different models available.

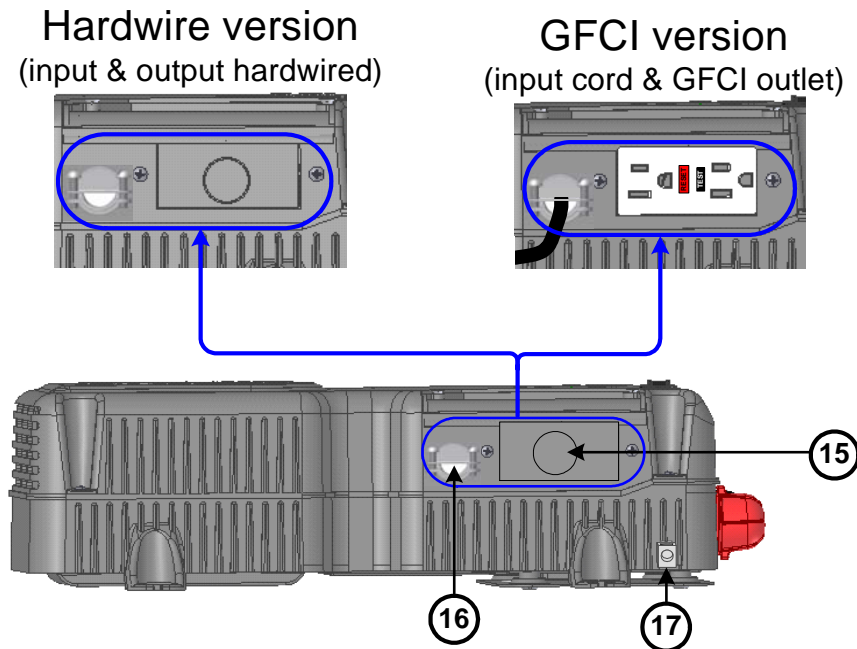


Figure 4, Bottom Side Features

**15, AC output connection -**

**Hardwire versions** - AC knockout (output) for hardwiring.

**GFCI versions** - provided with a Ground Fault Circuit-Interrupter outlet (with test and reset capability).

**16, AC input connection -**

**Hardwire versions** - AC knockout (input) for hardwiring.

**GFCI versions** - provided with a flexible AC input cord for direct connection to an AC outlet.

**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 setpoints based on temperature. If the temperature sensor is NOT installed and if the batteries are subjected to large temperature changes, the battery life may be shortened.

Figure 5, BTS

## 2.0 Installation

# 2.0 Installation

### Pre-Installation

Before installing the inverter, read the entire installation section to determine how you are going to install your MM. The more thorough you plan in the beginning, the better your inverter needs will be met.



**Note:** Installations should be performed by qualified personnel, such as a licensed or certified electrician. It is the installer's responsibility to determine which safety codes apply and to ensure that all applicable installation requirements are followed. Applicable installation codes vary depending on the specific location and application of the installation.



**Note:** Review the "Important Product Safety Information" on page ii and the "Important Battery Safety Instructions" on page iii before any installation.

The basic system diagram shown in Figure 6 should be reviewed to assist you in planning and designing your installation.

### Unpacking and Inspection

- Carefully remove the MM Series inverter from its shipping container and inspect all contents. Verify the following items are included:
  - The MM Inverter
  - Red and black DC terminal covers
  - AC access cover with two screws
  - Two 1/2" hex-head kee nuts (installed on the DC terminals).
  - Battery Temperature Sensor (battery charger models only)
  - MM Series Inverters, Installation and Operation Guide.

If items appear to be missing or damaged, contact your authorized Magnum Energy dealer or Magnum Energy.

- If at all possible, keep your shipping box. It will help protect your inverter from damage if it ever needs to be returned for service.
- Save your proof-of-purchase as a record of your ownership; it will also be needed if the unit should require in-warranty service.
- Record the unit's model and serial number in the front of this manual 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.

### MM Series Inverter

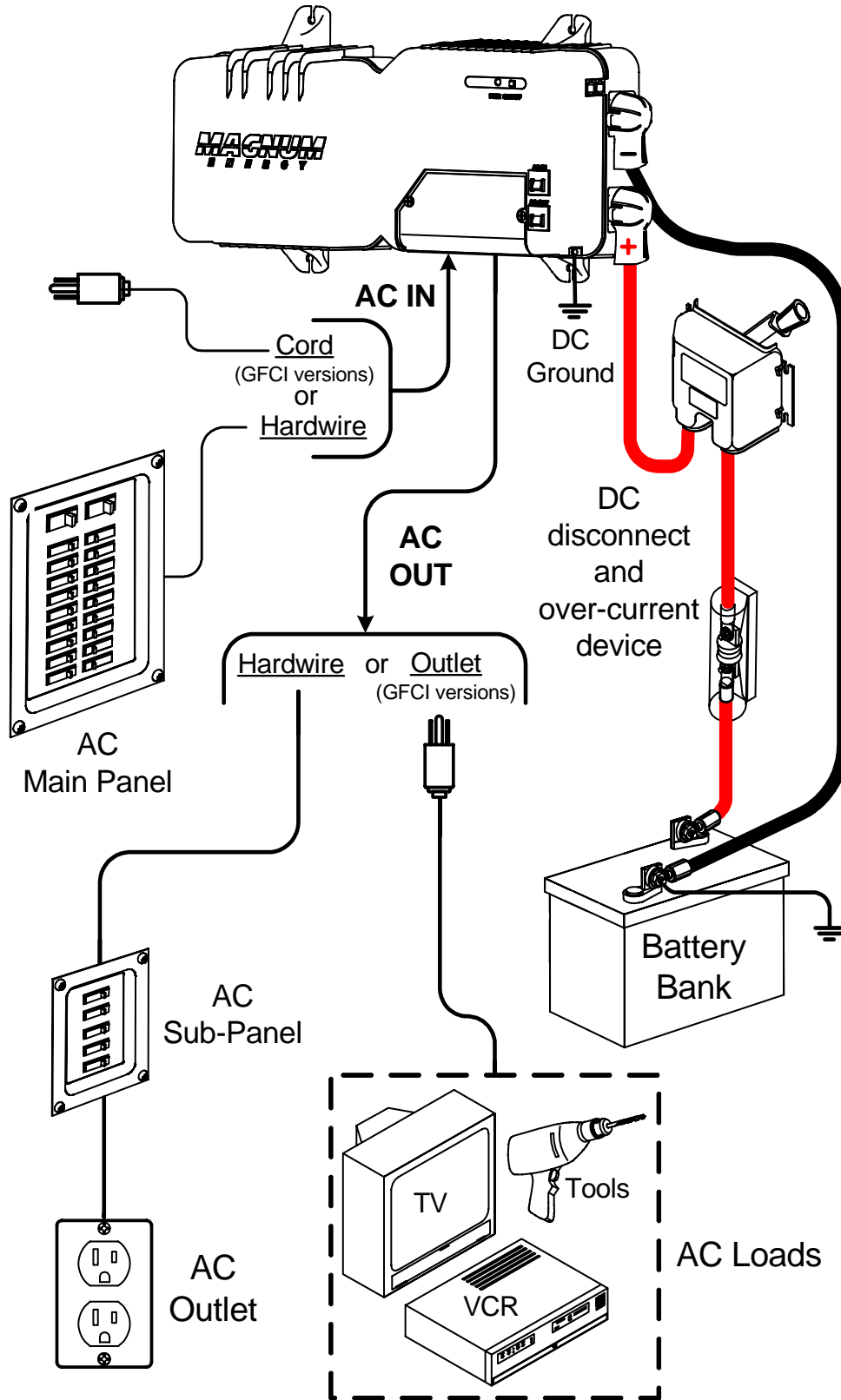


Figure 6, Basic Installation Diagram

## 2.0 Installation

### Locating and Mounting the inverter



#### Warnings:

- Do not mount the inverter near any flammable or combustible fluid or components.
- Provide adequate clearance and ventilation to the inverter
- Mount the inverter only on a “noncombustible” surface.
- Maximum ambient temperature around the inverter must not exceed 77° F (25° C) to meet power specifications.

The inverter should only be installed in a location that meets the following requirements:

**Clean and Dry** - The inverter should not be installed in an area that allows dust, fumes, insects or rodents to enter or block the inverter’s ventilation openings. This area also must be free from any risk of condensation, water or any other liquid that can enter or fall on the inverter. The inverter uses stainless steel fasteners, plated copper buss-bars, a power-coated aluminum base and the internal circuit boards are conformal coated all done to help fight the harmful effects of corrosive environments. However, the life of the inverter is uncertain if used in these type of environments, and inverter failure under these conditions is not covered under warranty.

**Cool** - The inverter should be protected from direct exposure to the sun or equipment that produces extreme heat. The ambient air temperature should be between 32° F (0° C) and 104° F (40° C); realize that the inverters output specifications are rated at 77° F (25° C), so the cooler the better within this range.

**Ventilated** - In order for the inverter to provide full output power and avoid overtemperature fault conditions; do not cover or block the inverters ventilation openings or install this inverter in an area with limited airflow. Allow as much clearance around the inverters intake and exhaust ventilation openings as possible, see items 12 and 13 in figure 3. At the minimum, an airspace clearance of 6” (15 cm) at the front and back and 3” (7.5 cm) everywhere else to provide adequate ventilation.

If installed in an enclosure, a fresh air intake opening must be provided directly to the front side (intake vent) and an exhaust opening on the back side (exhaust vent) of the inverter. This will allow cool air from the outside to flow into the inverter and heated air to exit from the inverter and out of the enclosure. When mounted in an enclosed compartment, airflow must be at least 59 cfm in order to maintain no more than a 68° F (20° C) rise in compartment temperature. Minimum clearances can be reduced if airflow is increased, but in no case should clearance around inverter be less than 2” (5 cm) on all sides.

**Safe** - Keep any flammable/combustible material (i.e. paper, cloth, plastic, etc.) that may be ignited by heat, sparks or flames at a minimum distance of 2 feet (60 cm) away from the inverter.

Do not install this inverter in any area that contains extremely flammable liquids like gasoline or propane, or in locations that require ignition-protected devices.

## 2.0 Installation

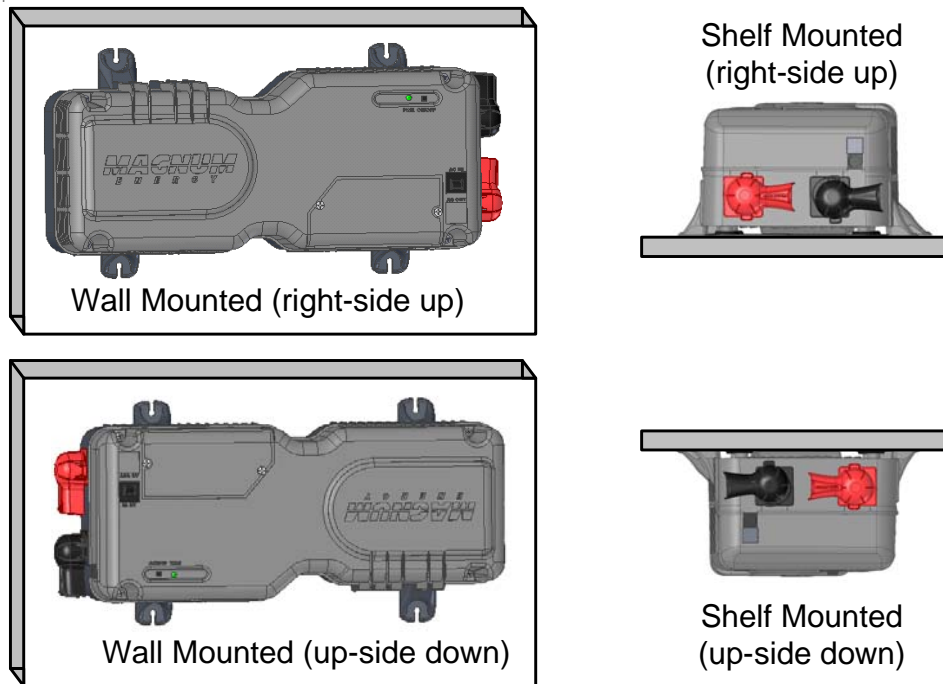
**Close to the battery bank** - As with any inverter, it should be located as close to the batteries as possible. Long DC wires tend to lose efficiency and reduce the overall performance of an inverter. However, the unit should not be installed in the same compartment as the batteries or mounted where it will be exposed to gases produced by the batteries. These gases are corrosive and will damage the inverter; also if these gases are not ventilated and if allowed to collect, they could ignite and cause an explosion.

**Accessible** - Do not block access to the inverter's remote control and accessory ports. Also allow enough room to access the AC and DC wiring connections, as they will need to be checked and tightened periodically. See figure 8 for the MM Series inverter dimensions.

**Mounting Orientation** - To meet regulatory requirements, the MM Series Inverter can only be mounted on a horizontal surface (shelf or table) or a vertical surface (wall or bulkhead) either right-side up or upside-down, as shown in figure 7. The inverter must be mounted on a "noncombustible" surface and this surface and the mounting hardware must be capable of supporting at least twice the weight of the inverter. After determining your mounting position, use the base of the inverter's chassis as a template to mark your mounting screw locations. Remove the inverter and drill pilot holes into the mounting surface.

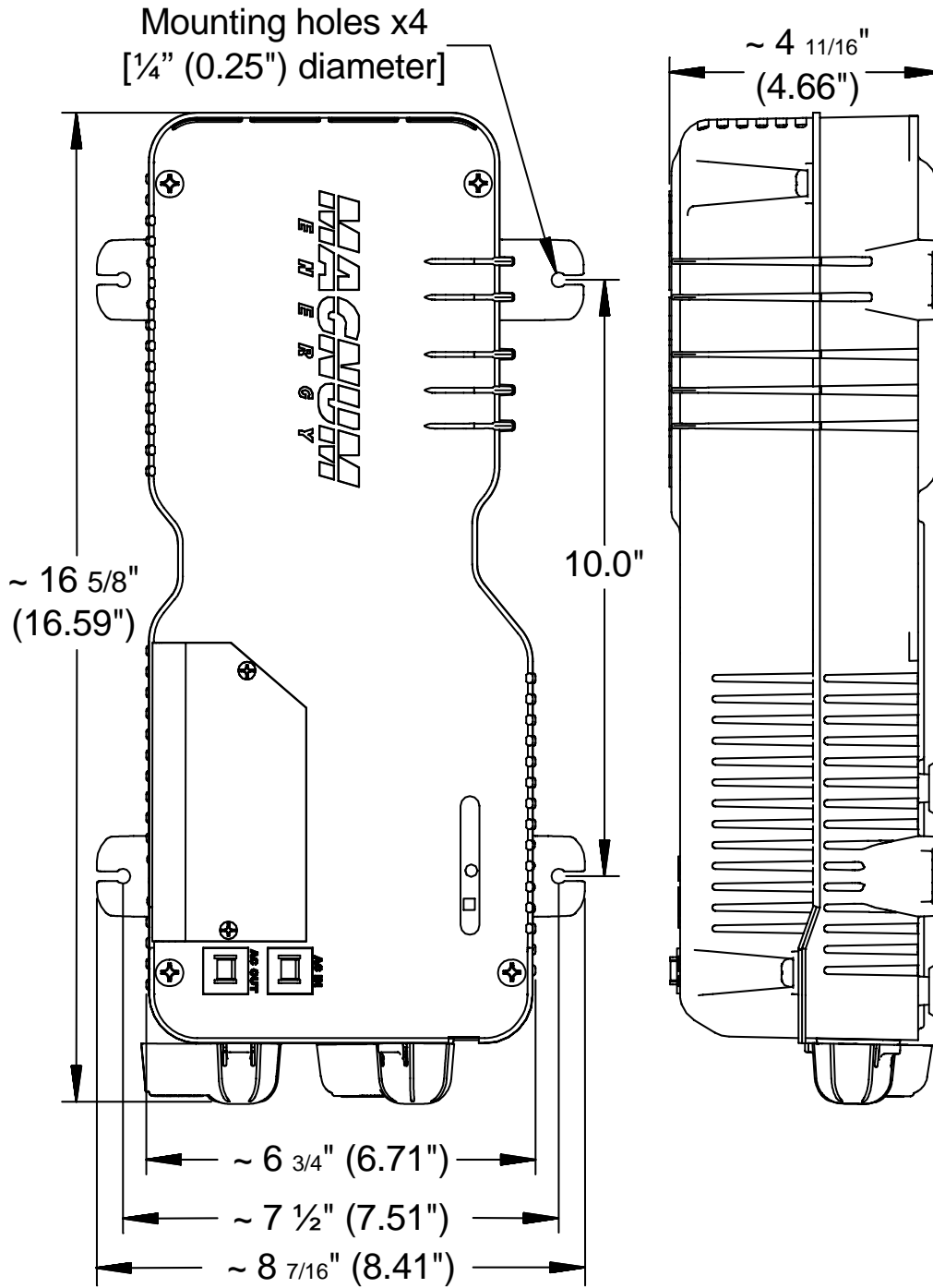
If this unit is used in a Mobile application, you may want to place flexible washers or bushings between the mounting surface and the inverter's mounting flanges to reduce vibration.

After the inverter has been properly mounted, proceed to the DC wiring section.



**Figure 7, Approved Mounting Orientations**

## 2.0 Installation



**Figure 8, MM Series Inverter Dimensions**



## Wiring Guidelines

- Before connecting any wires, determine all wire routes throughout the home or vehicle/boat both to and from the inverter.
- Conductors passing through walls, bulkheads or other structural members must be protected to minimize insulation damage such as chafing, which can be caused by vibration or constant rubbing.
- Always check for existing electrical, plumbing or other areas of potential damage prior to making cuts in structural surfaces, bulkheads or walls.
- Make sure all wires have a smooth bend radius and do not become kinked.
- Both AC and DC overcurrent protection must be provided as part of the installation.
- Do not attempt to use a vehicle metal frame in place of the DC negative connection or DC ground. The inverter requires a reliable negative and ground return path directly to the battery.
- DC wires and cables should be tied together with wire ties or electrical tape approximately every 6 inches. This helps improve the surge capability and reduces the effects of inductance, which improves the inverter waveform and reduces the wear of the inverter's filter capacitors.
- Use only copper wires with a minimum temperature rating of 75° C.
- To ensure the maximum performance from the inverter, all connections from the battery bank to the inverter should be minimized, the exception is the DC overcurrent disconnect in the positive line and a shunt in the negative line. Any other additional connection will contribute to additional voltage drops and these extra connections points may loosen during use.
- All wiring to the battery terminals should be checked periodically (once a month) for proper tightness. The torque requirement for the DC terminals is between 10 to 12 foot-pounds. If you don't have a torque wrench, ensure all DC terminals are tight and cannot move.
- Be aware that overtightening and misthreading the nuts on the DC terminals can cause the bolts to strip and snap/break off.

## DC Wiring

This section describes the inverter's required DC wire sizes and the recommended disconnect/overcurrent protection and how to make the DC connections to the inverter and the battery bank.

### DC Wire Sizing and Overcurrent Protection

It is important to use the correct DC wire to achieve maximum efficiency from the system and reduce fire hazards associated with overheating. See Table 1 to select the minimum DC wire size needed based on your inverter model. If the distance from the inverter to the battery bank is greater than 3 feet, use Table 2 to help determine the minimum recommended cable sizes for longer distances. Always keep your wire runs as short as practical to help prevent low voltage shutdowns and keep the DC breaker from nuisance tripping (or open fuses) because of increased current draw. Undersized cables can also lower the inverter's peak output voltage as well as reduce its ability to surge heavy loads.

## 2.0 Installation



**Note:** The DC wires must be color coded with colored tape or heat shrink tubing: RED for positive (+); BLACK for negative (-); and GREEN for DC ground.

The DC wires must have soldered and crimped lugs, crimped copper compression lugs, or aluminum mechanical lugs. Soldered connections alone are not acceptable for this application.

**Table 1, Recommended DC Wire/Overcurrent Device**

	Inverter Model	
	MM612	MM1212
Full Load DC Input Current	60 amps	125 amps
Maximum DC Input Current	125 amps	175 amps
Minimum Wire Size	# 4 AWG	# 1 AWG
Maximum DC Overcurrent Device*	125 amps	200 amps
DC Ground Wire Size	# 6 AWG	# 6 AWG

\*Based on NEC, NFPA 70, Table 310-17, for 75° C single-insulated cables in free air

If the inverter is expected to operate at a distance greater than three feet from the battery bank, the DC wire will need to be increased to overcome the increase in resistance which affects the performance of the inverter. Continue to use the overcurrent device and DC ground wire previously determined from Table 1 and then refer to Table 2 to determine the minimum DC wire size you need for various distances based on your inverter model.

**Table 2, DC Wire Size For Increased Distance**

	Minimum recommended DC wire size (one way)			
	3 ft or less	3 to 5 ft	5 to 10 ft	10 to 15 ft
MM612	#4 AWG	#2 AWG	#1/0 AWG	#2/0 AWG
MM1212	# 1 AWG	#1/0 AWG	#2/0 AWG	not recommended

### **DC Overcurrent Protection**

For safety and to comply with electrical code regulations, you must install a DC overcurrent protection device in the positive DC cable line to protect your DC cables. This DC overcurrent device must be DC rated and can be a fuse or circuit-breaker. It must be correctly sized according to the size of DC cables being used, which means it is required to open before the cable reaches its maximum current carrying capability, thereby preventing a fire. See Table 1 to select the DC overcurrent device needed based on the minimum wire size according to your inverter model.

For electrical systems in AE applications, the NEC (National Electrical Code) requires an overcurrent protection device. Mobile installations typically do not require using a DC disconnect, although an overcurrent protection device is still required. Because the DC disconnect is not required, a fuse is usually used as the overcurrent device in these installations. These installations also do not normally use conduit, so the fuse must be installed in the ungrounded conductor (usually the positive DC cable line) within 18 inches of the battery to protect the DC wiring system.

If using a fuse, we recommend using a class-T type or equivalent. This fuse type is rated for DC operation, can handle the high short-circuit currents and allow for momentary current surges from the inverter without opening.

### **DC Grounding**

The inverter/charger should always be connected to a permanent, grounded wiring system. The idea is to connect the metallic chassis of the various enclosures together to have them at the same voltage potential, which reduces the possibility for electric shock. For the majority of installations, the inverter chassis and the negative battery conductor are connected to the system's ground bond via a safety-grounding conductor (bare wire or green insulated wire) at only one point in the system. Per the NEC, the size for the grounding conductor is usually based on the size of the overcurrent device used in the DC system. Refer to Table 1 to select the DC ground wire needed based on the overcurrent device used for your inverter model,

If using this inverter in a vehicle, DO NOT connect the battery negative (-) cable to the vehicle's safety ground. Connect it only to the inverter's negative battery terminal. If there are any non-factory installed DC appliances on board the vehicle, DO NOT ground them at the safety ground. Ground them only at the negative buss of the DC load center (as applicable).

## 2.0 Installation

### DC Cable Connections

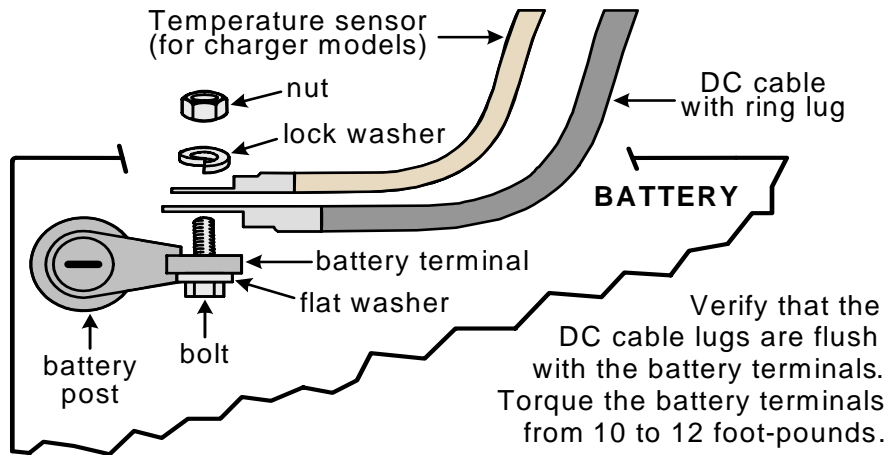
When connecting the DC cable to the battery or inverter DC terminals, the hardware should be installed in the correct order to prevent high resistance connections which will heat-up and could cause the connections to melt. Follow figure 9 and 10 to stack the hardware correctly. Tighten the terminal connections from 10 to 12 foot pounds.



**Caution:** Do not put anything between the DC cable ring lug and the battery terminal post or inverter's DC terminal. If antioxidant grease or spray is used, apply it after all the connections have been made and are properly tighten.



**Caution:** Overtightening or misthreading the nuts on the DC terminals will cause the bolts to strip and snap/break-off.

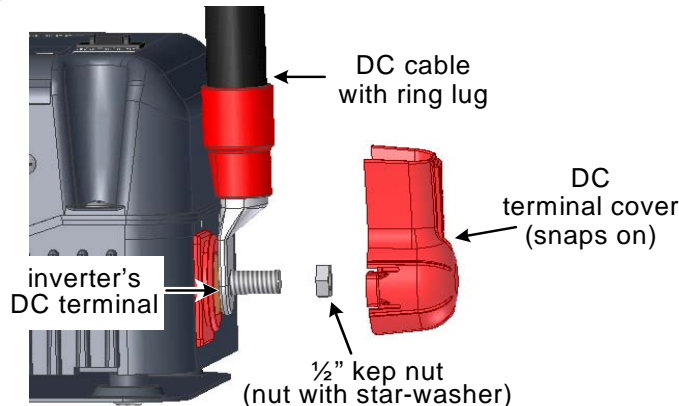


**Figure 9, DC Cable to Battery Terminals**



**Caution:** The inverter is NOT reverse polarity protected (negative and positive connected backwards). You must verify the correct voltage polarity BEFORE connecting the DC wires or damage may occur.

Crimped and sealed copper ring terminal lugs with a 5/16" hole should be used to connect the DC wires to the inverter's DC terminals.



**Figure 10, DC Cable to Inverter's DC Terminals**

## Battery Bank Wiring



**Warning:** Lethal currents will be present if the positive and negative cables attached to the battery bank touch each other. During the installation and wiring process, ensure the cable ends are insulated or covered to prevent touching/shorting the cables.



**Note:** DO NOT connect the DC wires from the battery bank to the inverter until 1) all DC and AC wiring is complete, 2) the correct DC and AC overcurrent protection has been installed and 3) the correct DC voltage and polarity have been verified.



**Note:** For optimum performance, a minimum battery bank of 200 AHr is recommended.

Depending upon the type of batteries you use in the installation (6 or 12 VDC), the batteries must be wired in series, parallel or series-parallel to provide 12 VDC (see Appendix B - Battery Information, for guidance on wiring batteries together). The interconnecting DC wires must be sized and rated exactly the same as those that are used between the battery bank and the inverter.

Place the batteries as close as practical to the inverter, preferably in an insulated and ventilated enclosure. Allow adequate space above the batteries to access the terminals and vent caps (as applicable). Also allow at least 1" of space between the batteries to provide good air flow. DO NOT mount the batteries directly under the inverter.



**Note:** To ensure the best performance from your inverter system, do not use old or untested batteries. Batteries should be of the same size, type, rating and age.



**Caution:** Install batteries in a well ventilated area. Batteries can produce explosive gasses. For compartment or enclosure installations, always vent batteries to the outside.

## Inverter to Battery Bank Wiring



**Warning:** Ensure all sources of DC power (i.e. batteries, solar, wind or hydro) and AC power (utility/shore power or AC generator) are de-energized (i.e. breakers opened, fuses removed) before proceeding.



**Caution:** Inverter is NOT reverse polarity protected, if this happens the inverter will be damaged and will not be covered under warranty. Before connecting the DC wires from the batteries to the inverter, verify the correct battery voltage and polarity using a voltmeter. If the positive terminal of the battery is connected to the negative terminal of the inverter and vice versa, severe damage will result. If necessary, color code the cables with colored tape or heat shrink tubing: RED for positive (+); BLACK for negative (-) to avoid polarity confusion.

## 2.0 Installation



**Note:** The DC overcurrent device (i.e. fuse or circuit breaker) must be placed in the positive (RED) DC cable line between the inverter's positive DC terminal and the battery's positive terminal (RED); as close to the battery as possible.

### DC Ground Wire

Route an appropriately sized DC grounding wire (GREEN or bare wire) from the inverter's DC ground terminal (see figure 4, item 17) to a dedicated system ground. Recommended tightening torque is 45 in. lbs.

### DC Negative Wire

Route an appropriately sized DC negative wire (BLACK) from the negative terminal of the first battery string to the inverter's negative terminal (see figure 16 for reference).

### Battery Temperature Sensor (Battery charger models only)

Connect the RJ11 connector end of the BTS to the ACCESSORY PORT (see figure 3, item 11) on the inverter. Connect the ring lug end to the negative terminal of the first battery string (same place as the negative DC wire to the inverter's negative terminal); refer to figure 9 for the correct hardware placement.

### DC Positive Wire

Mount the DC fuse block and disconnect (or circuit breaker assembly) as near as practical to the batteries and remove the fuse (or open the circuit breaker).



**Warning:** DO NOT close the DC fuse/DC disconnect (or close the DC circuit breaker) to put battery power to the inverter at this time. This will occur in the **Functional Test** after the installation is complete.

Route and connect an appropriately sized DC positive wire (RED) from the DC fuse block (or circuit breaker assembly) to the inverter's positive DC terminal.

Connect a short wire (same rating as the DC wires) to one end of the fuse block and the other end of the short wire to the positive terminal of the last battery string (see figure 16 for reference). This is essential to ensure even charging and discharging across the entire battery bank.

Ensure the DC wire connections (on the batteries, inverter and fuse lugs/DC circuit breaker) are flush on the surface of the DC terminal's and the hardware (lock washer and nut) used to hold these connections are stacked correctly (see figures 9 and 10)

Verify all DC connections are torqued from 10 to 12 foot pounds.

Once the DC connections are completely wired and tested, coat the terminals with an approved anti-oxidizing spray.

Press on the red and black terminal covers to the inverter's DC connectors to secure them in place.

If the batteries are in an enclosure, perform a final check of the hold down brackets and all connections. Close and secure the battery enclosure.

## AC Wiring

This section describes the required AC wire size and overcurrent protection needed if you have the “hardwire” versions. It also provides information on how to make the AC connections.



**Warning:** All wiring should be performed by a qualified person or a licensed electrician following all local/NEC codes.

### Neutral to Safety Ground Bonding

The NEC (National Electric Code) provides the standards for safely wiring Mobile (RV, Boat or Truck) and AE (Houses, Cabin, or Office) installations in the United States. This wiring standard requires the AC source, such as the utility feed in your home, an inverter or a generator, to have the neutral conductor tied to ground. These standards also require that the AC neutral be connected to safety ground (often called a “bond”) in only one place at any time.

The fundamental difference between using an inverter in a Mobile application or in a AE application is how the neutral is grounded in the AC system.

In AE installations, the neutrals are connected together and are always connected to safety ground at the main AC panel, never at the inverter. However, in Mobile installations, there may be multiple AC sources (i.e. utility/shore power, generator or inverter), which means there may be the potential of having multiple neutral to ground connections.

When using the MM Series in a AE application, you must use the “AE” versions, which require the main service panel to provide the neutral-to-ground bond for the entire electrical system. All other models of the MM Series (non “AE” versions) provide an internal relay that connects the neutral to ground while inverting and automatically opens the neutral to ground bond when connected to the incoming AC source; these other models are designed to be used in a Mobile applications.

### AC Wiring Connections

For all “hardwired” inverter models, the AC input and output wiring is performed in the AC wiring compartment. This compartment is located on the top panel (see figure 2, item 8). If installed, remove the two Phillips screws on the cover to access the AC wiring compartment and locate the inverter’s AC wiring. There is a label located in the AC access compartment which gives information on which wires are used for the AC input and output. You can also refer to Table 3 to match the inverter’s AC wires to the appropriate AC wire connection.

**Table 3, Wire Color to AC Wire Connection**

	Wire color (label)	Wire connection
<b>AC IN</b>	Black (HOT IN)	Hot In
	White (NEUT IN)	Neutral In
<b>AC OUT</b>	Red (HOT OUT)	Hot Out
	White with black stripe (NEUT OUT)	Neutral Out
<b>AC Ground</b>	Green (GROUND)	AC IN and AC OUT Ground

## 2.0 Installation

The AC wires inside the AC compartment are #16 AWG with a temperature rating of 105° C, all AC connections should be made using an approved connector for your application (i.e. split bolt, twist-on wire connectors, etc.). Ensure the wire connectors used are rated for the size and number of wires you are connecting.

After connecting the wires together, gently pull on the wires to ensure they are securely held together. In a proper connection, no bare wire should be exposed.



**Note:** Per UL certification, nonmetallic-sheathed cable (i.e. Romex™) or a SO flexible cord with listed strain relief's are allowed to be used to connect to the inverter; conduit connections are not allowed.

After all AC wiring in the inverter is complete, prior to reattaching the AC access cover, review all AC wiring to ensure all connections are correct and secure.

### AC Wire Size and Overcurrent Protection

The AC input and output wiring must be sized per the NEC and local electrical safety code requirements to ensure the wires ability to safely handle the inverter's maximum load current. After determining the proper AC wire sizes, the inverter's AC input (unless you are using a flexible cord) and output wires are required to be protected against overcurrent and have a means to disconnect the AC circuits.

Overcurrent protection must be provided by fuses or circuit-breakers and must be properly sized and rated for the wire they are protecting and the appliances being powered.

An external disconnect device is required for both the AC input and AC output wiring. Most inverter's that are "hardwired" use a service/distribution panel wired to the inverter's input (main panel) and a dedicated panel between the inverter's output wiring and the AC loads (sub-panel). These systems use the circuit breakers provided in the panels as the overcurrent protection and the AC disconnect. If fuses are used, then separate AC disconnect switches will be needed.

Based on information from the NEC, Table 4 provides the minimum AC wire size and the suggested breaker size based on the inverter's model. However, larger wire size may be required because of voltage drop. The AC wire sizes provided in this table assume using only copper wire and a temperature rating of 75° C or higher. A minimum of #14 AWG is required for all AC wiring.

**Table 4, Minimum Wire Size to Circuit-breaker Size**

Inverter Model	AC Input			AC Output		
	Input Breaker	Minimum Wire Size	Suggested Breaker Size	Output Breaker	Minimum Wire Size	Suggested Breaker Size
MM612	7 amps	#14 AWG	10 amps	7 amps	#14 AWG	10 amps
MM612G	7 amps	#14 AWG	10 amps	7 amps	#14 AWG	10 amps
MM612AE	8 amps	#14 AWG	10 amps	7 amps	#14 AWG	10 amps
MM1212	16 amps	#12 AWG	20 amps	12 amps	#14 AWG	15 amps
MM1212AE	16 amps	#12 AWG	20 amps	12 amps	#14 AWG	15 amps



### AC Input Wiring

Your inverter has an AC transfer feature that passes the AC input power to the inverter's output. Connection to the AC input is made by hardwiring from a distribution panel as described below:

1. Run an appropriately sized 2-conductor plus ground cable (from the AC distribution panel) through a strain-relief on the AC IN opening. Refer to Table 4 for minimum wire size and overcurrent protection required for the AC input wiring.
2. Remove about two inches of the insulating jacket from the AC cable and separate the three wires and strip about 3/4" of insulation from each wire.
3. Using an approved AC wire connectors, connect the incoming Hot In, Neutral In and Ground wires to the MM Series AC wires colored black (HOT IN), white (NEU IN) and green (AC GROUND) respectively.
4. After making the AC input connections, secure the AC input cable by tightening the strain relief.

The AC input wiring in the inverter is complete, review all AC wiring to ensure all connections are correct and secure.

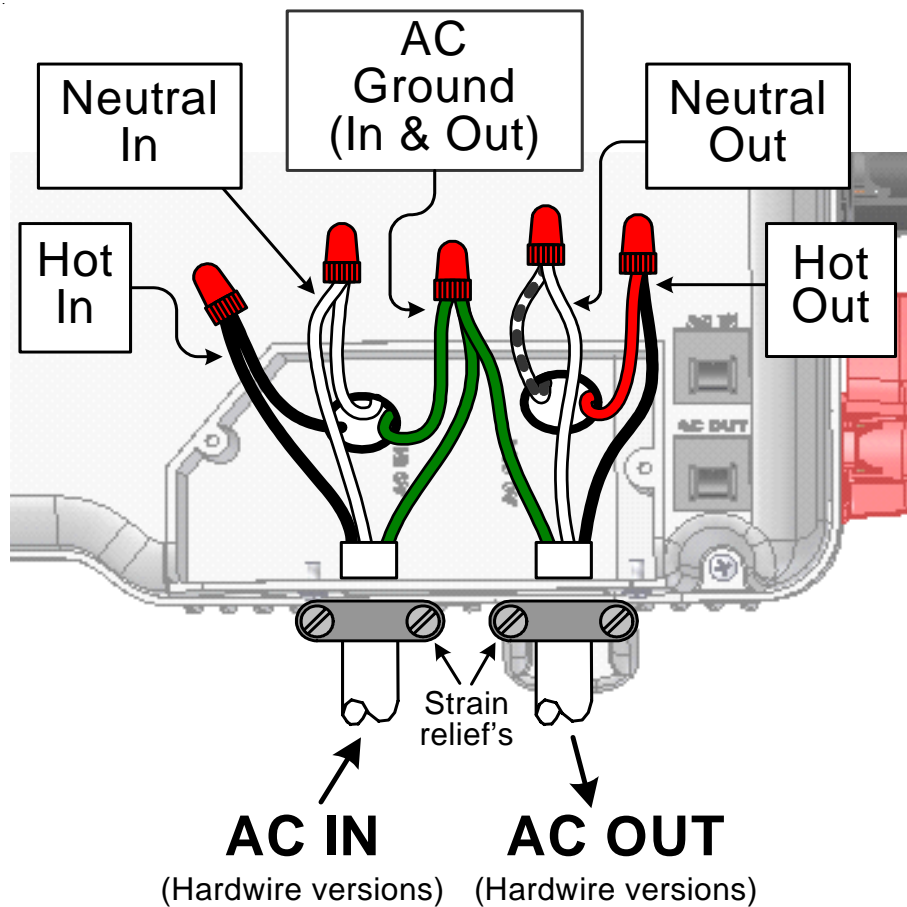


Figure 11, AC Wiring Connections

## 2.0 Installation

### AC Output Wiring



**Caution:** The inverter's AC output must never be connected to an AC power source. This will cause severe damage to the inverter and is not covered under warranty.

When hardwiring the output of the inverter, a cable will be need to be routed from the inverter's output to an AC distribution panel (i.e. sub-panel) that provides overcurrent protection to the loads powered by the inverter. Connect the AC output to this distribution panel as described below:

1. Remove the 1/2" knockout on the AC output connection (see figure 4, item 15) using a utility knife to cut through the round slot.
2. Discard this knockout and install a 1/2" strain-relief in the AC OUT opening; you may need to file the opening edge to insert the strain-relief.
3. Run a 2-conductor plus ground cable through the strain-relief on the AC OUT opening. Refer to Table 4 for minimum wire size and overcurrent protection required for the AC output wiring.
4. Remove about two inches of the insulating jacket from the AC cable and separate the three wires and strip about 3/4" of insulation from each wire.
5. Using approved AC wire connectors, connect the outgoing Hot Out, Neutral Out and AC Ground wires to the MM Series AC wires colored Red (HOT OUT), white with black stripe (NEU OUT) and green (AC GROUND) respectively. Gently pull on the wires to ensure they are securely held together and ensure no bare wire is exposed.
6. After making the AC output connections, secure the AC output cable by tightening the strain relief.
7. Connect the outgoing AC wires to an AC load panel equipped with overcurrent protection (i.e. circuit breakers).

The AC output wiring in the inverter should be complete, prior to reattaching the AC access cover, review all AC wiring to ensure all connections are correct and secure.

### Recommended Ground-Fault Circuit Interruption Breakers

If installing this inverter in the wiring system of a Mobile application (RV/Marine/Truck), a Ground-Fault Circuit-Interrupter (GFCI) must be installed to protect all branch circuit powered by this inverter. In addition, some electrical safety codes require GFCI's to be installed in AE Applications (Home/Cabin/Office). In compliance with UL standards, Magnum Energy has tested the following GFCI's and find that they function properly when connected to the inverter's AC output.

Shock Sentry™ #XGF15V-SP  
Leviton Smart Lock #8899-A  
Hubbel #GF520EMBKA



**Warning:** Risk of electric shock. Use only the Ground-Fault Circuit Interrupter [receptacles or circuit breaker(s)] specified in this manual. Other types may fail to operate properly when connected to this inverter.

## Functional Test

After all electrical connections to the inverter, batteries, AC source, and loads (using a sub-panel) have been completed; follow these steps to test the installation and the inverter operation.

1. Check the battery voltage and polarity before connecting the batteries to the inverter. Use a multimeter to verify 10 to 15 VDC at the batteries positive and negative terminals.
2. Apply battery power to the inverter by switching the DC disconnect on (or close the DC circuit-breaker). The inverter will remain OFF, but the green status indicator on the front of the inverter will quickly blink once to indicate that DC power has been connected and is ready to be turned on.
3. Prior to turning on the inverter, make sure all connected loads (i.e. appliances) are switched OFF or disconnected from the AC outlets.
4. a. If a remote switch is connected, press the ON/OFF switch to turn the inverter on.  
b. If there is not a remote switch connected, lightly press and release the inverter's ON/OFF switch - located on the top of the inverter - to turn the inverter on.

Verify the inverter's status indicator is blinking - indicating the inverter is providing AC power.

5. Check the output voltage of the inverter by connecting a true RMS multimeter to the outlets powered by the inverter. Verify the voltage is 120 VAC +/- 5 VAC. If not using a true RMS meter, the output AC voltage could indicate from 90 to 130 VAC.
  6. Turn on or connect a load to the outlets and verify it comes on. Continue to keep the load connected and turned on.
  7. Press the remote ON/OFF switch to turn the inverter off. If the remote is not used, press and release the inverter's ON/OFF switch to turn the inverter off. The inverter's status indicator and the connected load should go off.
  8. Apply AC power to the inverter's AC input. After the AC input power is qualified (approximately 15 seconds), the incoming AC power will transfer through the inverter to the inverter's AC output and power the connected load. Verify the inverter's status indicator and the connected load comes on.
  9. Even though the connected load is on, the inverter is currently disabled/off. Press the remote's ON/OFF switch (or press and release the ON/OFF switch on the inverter) to enable/turn-on the inverter.
  10. Disconnect the incoming AC power to the inverter. Verify the connected load remains on, but now is powered by the inverter.
- If the inverter passes all the steps, the inverter is ready for use. If the inverter fails any of the steps, refer to the Troubleshooting section.

## 3.0 Operation

# 3.0 Operation

## Operating Modes

The MM Series inverter has two normal modes of operation; 1. Invert Mode, which powers your loads using the batteries, and 2. Transfer Mode, which powers your loads from the incoming AC Power (i.e. utility 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 the Transfer Mode whenever an external AC source is connected and allowed to pass-thru to power your AC loads. While in the 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).

**Transfer time** - When the AC power falls below the VAC dropout threshold voltage (80 VAC, default setting), the relay transfers from Transfer Mode to the 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 inverters 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 generators output to constantly fall below the inverters VAC dropout threshold.

When switching from Invert Mode to the 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 unregulated 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 an 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 multistage 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.

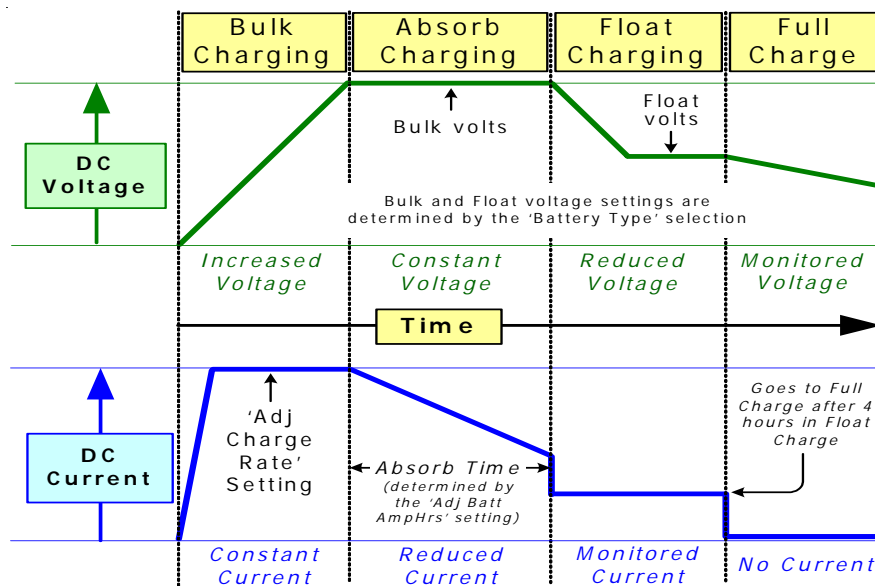


Figure 12, Automatic 4-Stage Charging Graph

### 3.0 Operation

When an AC source (utility power or generator) is connected to the inverter that has the battery charger, the inverter will begin to monitor the AC input for acceptable voltage. Once the inverter has accepted the AC input, the AC transfer relay will close and the Charge Mode will begin. After you are in the Charge Mode, the DC voltage will be monitored to determine how to charge. If the DC voltage is 12.9 VDC or less, the charger will go to Bulk Charging. If the DC voltage is greater than 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 controlled 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.



**Note:** If the battery voltage falls to 12.1 VDC or less, the unit will begin another Bulk charge.

\* These voltage settings are based on the Battery Temperature Sensor (BTS) 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.



**Note:** 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 (Light Emitting Diode) 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 inverter's 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 inverters input is passing to the inverters 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 1. Providing full power to the loads connected to the inverter; or 2. In Search Mode, 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 shutdown; Low Battery, High Battery, Over-temperature, AC Overload, and Internal faults. If your inverter has shutdown, 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.

### 3.0 Operation

#### 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 control can be used to make those changes. This 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 / MM612G), 5W (all other MM Series)
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 nonvolatile 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 and MM612G models and adjusted to 5W (“wakes up” and inverts if loads exceed 5 watts) on all other models.

**LBCO:** This setting determines when the inverter will turn off based on low battery voltage. The inverter turns off automatically after the 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 charge 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 maximum 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 minimum 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.

\* For information on the full range of settings for each function, refer to the ME-RC manual at our website ([www.magnumenergy.com](http://www.magnumenergy.com)).



## 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
<b>Low Battery Voltage (the status indicator blinks on 1 time every 4 secs)</b>	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.
<b>High Battery Voltage (the status indicator blinks on 2 times every 4 secs)</b>	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.
<b>Over-temperature condition (the status indicator blinks on 3 times every 4 secs)</b>	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.
<b>AC Overload (the status indicator blinks on 4 times every 4 secs)</b>	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.
<b>Internal fault (the status indicator blinks on 5 times every 4 secs)</b>	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.
<b>Inverter's status light is off.</b>	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.
<b>AC input won't connect (AC IN on remote blinks)</b>	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.
<b>Appliances turn off and on; or there is low AC output power.</b>	Loose AC output connections.	Tighten AC output connections.
	Loose / corroded battery cables.	Clean and tighten all cables.
	Low batteries.	Recharge or replace batteries.
<b>Inverter AC output voltage is too low or too high when using an AC voltmeter.</b>	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.
<b>While charging, the DC charge voltage is higher or lower than expected.</b>	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

### 5.0 Specifications

Table 7, MM600 Specifications

MODEL	MM612 / MM612G	MM612AE
<b>Inverter Specifications</b>		
Input DC voltage range	9 to 15.5 Vdc	
Output voltage AC	120 VRMS +/- 5%	
Output frequency	60 Hz +/- .005%	
1msec peak surge current	27A	
100msec peak surge current	11A	
5 sec surge power	1100W	
10 sec surge power	1050W	
30 sec surge power	1000W	
5 min surge power	950W	
30 min surge power	675W	
Continuous output power	600 VA	
Input DC current (at 12.6Vdc)	60A	
Inverter efficiency (maximum)	95%	
Transfer time	16 msec	
AC transfer capability	7A	
Search mode	NA	.33ADC
No load current (120 VAC output)	.77 ADC	
Output AC waveform type	Modified Sine Wave	
<b>Charger Specifications</b>	NA	Standard
Continuous charger current (at 12.6Vdc)	NA	30ADC
Charger efficiency (maximum)	NA	85%
Power factor (10% to 100% charge)	NA	> 0.95
Input current for rated charger output	NA	4 AAC
Temperature compensation	NA	Yes, with BTS
<b>General Features and Capabilities</b>		
Protection circuitry	Low/High Battery, Overtemp & Overload	
Corrosion protection	PCB's conformal coated, powder coated chassis	
Output circuit breaker	7A switchable	
Input circuit breaker	7A	8A
Internal cooling	Yes, 0 to 59 cfm variable speed	
AC output (Hardwire or GFCI)	MM612 = Hardwire, MM612G = GFCI Outlet	Hardwire
AC input (Hardwire or Cord)	MM612 = Hardwire, MM612G = Cord	Hardwire
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	NA
<b>Environmental Specifications</b>		
Operating temperature	-20° C to +60° C (-4° F to 140° F)	
Nonoperating temperature	-40° C to +70° C (-40° F to 158° F)	
Operating humidity	0 to 95% RH noncondensing	
<b>Physical Specifications</b>		
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	14 lbs. (6.4 kg)	
Specifications @ 25° C - Subject to change without notice		

**Table 8, MM1200 Specifications**

MODEL	MM1212	MM1212AE
<b>Inverter Specifications</b>		
Input DC voltage range	9 to 15.5 Vdc	
Output voltage AC	120 VRMS +/- 5%	
Output frequency	60 Hz +/- .005%	
1msec peak surge current	42A	
100msec peak surge current	23A	
5 sec surge power	2100W	
10 sec surge power	1900W	
30 sec surge power	1750W	
5 min surge power	1450W	
30 min surge power	1375W	
Continuous output power	1200 VA	
Input DC current (at 12.6Vdc)	125A	
Inverter efficiency (maximum)	95%	
Transfer time	16 msec	
AC transfer capability	12A	
Search mode	.4ADC	
No load current (120 VAC output)	1.3 ADC	
Output AC waveform type	Modified Sine Wave	
<b>Charger Specifications</b>	Standard	
Continuous charger current (at 12.6Vdc)	70ADC	
Charger efficiency (maximum)	88%	
Power factor (10% to 100% charge)	> 0.95	
Input current for rated charger output	9 AAC	
Temperature compensation	Yes, with Battery Temperature Sensor	
<b>General Features and Capabilities</b>		
Protection circuitry	Low/High Battery, Overtemp & Overload	
Corrosion protection	PCB's conformal coated, powder coated chassis	
Output circuit breaker	12A switchable	
Input circuit breaker	16A	
Internal cooling	Yes, 0 to 59 cfm variable speed	
AC output (Hardwire or GFCI)	Hardwire	
AC input (Hardwire or Cord)	Hardwire	
Optional remotes available	MM-RC or ME-RC50	
UL listing	ETL to UL/cUL458, CSA C22.2 #107.1-01	NA
<b>Environmental Specifications</b>		
Operating temperature	-20° C to +60° C (-4° F to 140° F)	
Nonoperating temperature	-40° C to +70° C (-40° F to 158° F)	
Operating humidity	0 to 95% RH noncondensing	
<b>Physical Specifications</b>		
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	20 lbs. (9 kg)	
Specifications @ 25° C - Subject to change without notice		

## Appendix A - Remote Control and Monitoring

### 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 MM Series inverters without the battery charger feature; such as the MM612 (requires serial number L1-201 or higher) or MM612G models.

**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 MM Series inverters with the battery charger feature; such as the MM612AE, MM1212 or MM1212AE models.

**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. Can be used with all MM Series inverter models (MM612 requires serial number L1-201 or higher).

#### Using the MM Remotes

The MM remotes performs the same function as the ON/OFF switch on the front of the MM Series inverter and provides 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.

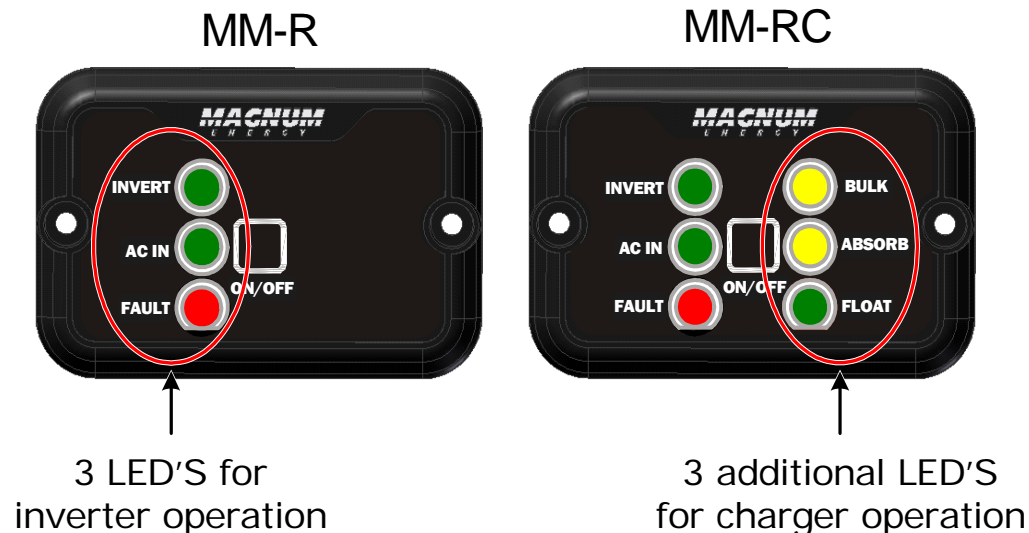


Figure 13, MM Remotes

## Appendix A - Remote Control and Monitoring

### 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 (the 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 these indicators to determine the inverter's mode of operation:

**INVERT** (green) -

- On (solid)
  - and **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 **AC IN** LED indicator is On (solid) - The inverter is in Standby. The external AC power (Utility or generator) connected to the inverters 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).
- Off - The inverter is disabled. The inverter is not on or will not come on if AC power is lost or disconnected.

## Appendix A - Remote Control and Monitoring

### **AC IN** (green) -

- On (solid) - the external AC power (Utility or generator) is connected to the inverters 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 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 inverters ON/OFF switch and verify the fault has cleared. If the Internal Fault remains, the inverter requires service at an authorized repair facility.

## Appendix A - Remote Control and Monitoring

### MM-RC Remote Only

The MM-RC provides three additional charging LED indicators to provide information on the operation of the battery charger. 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; 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 start to taper down in order to maintain the Bulk voltage setting. The Absorb Charging time is 120 minutes (determined by the Battery AmpHrs selection\*\*).
- Blinks On (1 time every 4 seconds) - Charger Back-off; 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; 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 by the ME-RC50 remote.

## Appendix B - Battery Information

# Appendix B - Battery Information

### Battery Bank Sizing

The size of the battery bank determines how long you want the inverter to power the AC loads without recharging. The larger the battery bank, the longer the run time. Size your battery bank to the systems AC load requirements and length of time required to run from the batteries. In general, the battery bank should not be discharged more than 50%. Additional DC charging devices such as solar, wind, hydro, etc. can provide longer run times by recharging the batteries in the absence of AC utility or generator power.

### Battery Types

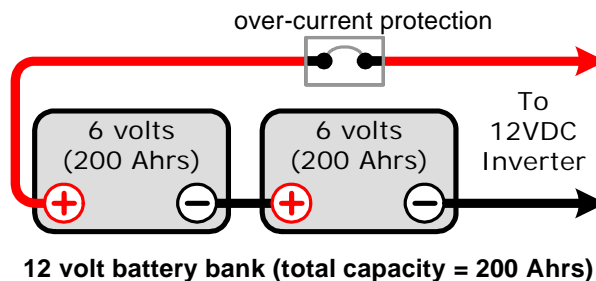
Batteries are available in different sizes, amp-hour ratings, voltage, liquid or gel, vented or non-vented, chemistries, etc. They are also available for starting applications (such as an automobile starting battery) and deep discharge applications. Only the deep cycle types are recommended for inverter 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 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.



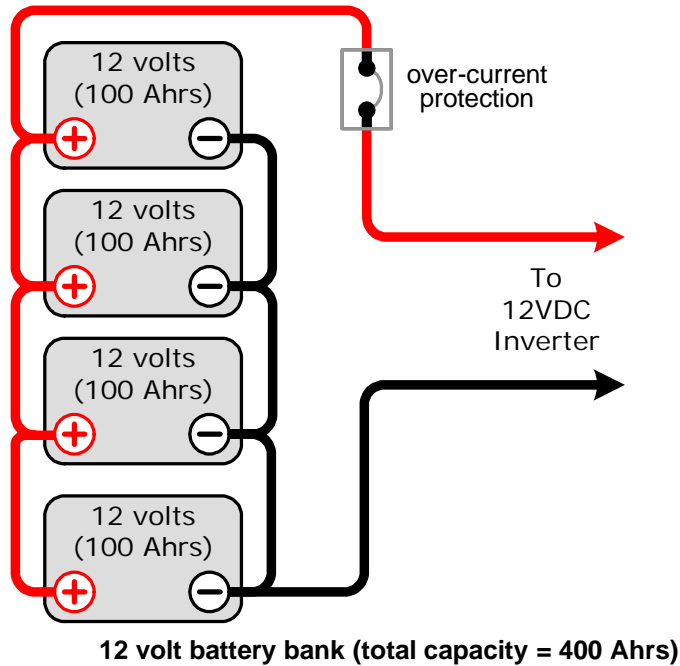
*Figure 14, Series Battery Wiring*



## Appendix B - Battery Information

### Parallel Wiring

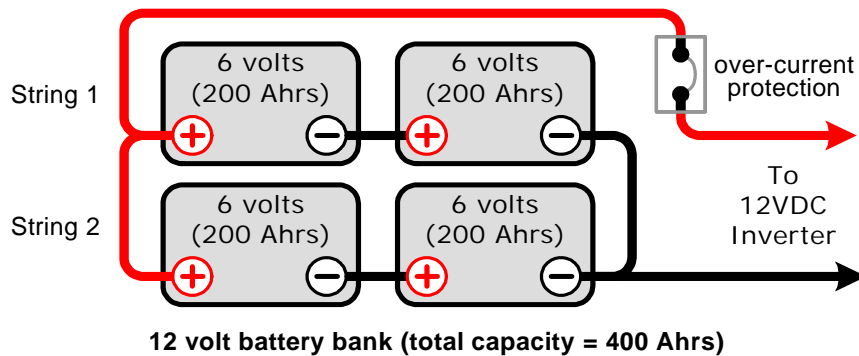
Wiring the batteries in parallel increases the total run time the batteries can operate the AC loads. A parallel connection combines overall battery capacity by the number of batteries in the string. Even though there are multiple batteries, the voltage remains the same. In the example below (figure 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

# 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 the 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 the coach or boat into seasonal storage, it is recommended that you perform the following to ensure the system is properly shutdown (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 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 at Magnum Energy's option, any defective parts, or any parts that will not properly operate for their intended use with factory new or rebuilt replacement items 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, decorative or structural parts or any 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.**



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