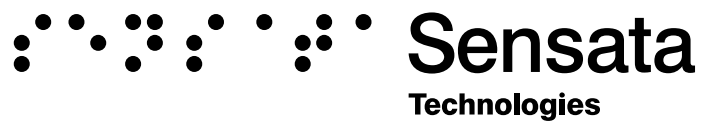




MMS Series Inverters/Chargers



Owner's Manual



Disclaimer of Liability

The use of this manual and the conditions or methods of installation, operation, use, and maintenance of the MMS Series inverter/charger are beyond the control of Sensata Technologies. 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 be in any way 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 MMS Series inverter/charger may only be used in life support devices or systems with the express written approval of Sensata. Failure of this inverter can reasonably be expected to cause the failure of that life support device or system, or to affect the safety or effectiveness of that device or system. If the MMS Series inverter fails, it is reasonable to assume that the health of the user or other persons may be endangered.

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Document Information

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This entire manual is available for download—with many of the diagrams in color—on our website at:

www.Magnum-Dimensions.com

Contact Information

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Sensata Technologies

Web: www.Magnum-Dimensions.com

Record the unit’s model and serial number in case you need to provide this information in the future.

Model:	Serial Number:
<input type="checkbox"/> MMS1012	WU1
<input type="checkbox"/> MMS1012-G	WU1

Safety Information

Safety Information

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.

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. DO NOT expose 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 through 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.
- Ensure all conductor insulation is of a type that is approved for the voltage, operation, temperature, and location of use.
- Use only copper wires with a minimum temp rating of 75°C (167°F).
- 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.

Safety Information

- 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 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 installation.

IMPORTANT BATTERY SAFETY INSTRUCTIONS

- Wear eye protection (safety glasses) when working with batteries.
- Remove all jewelry such as rings, watches, bracelets, etc., when installing or performing maintenance on the batteries.
- 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 (2.5 cm) 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 to 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.
- The converter/inverter is intended to recharge batteries. The battery that is connected to this product is only suitable if it complies with the given battery standard for that battery type and is provided with a battery management system that will monitor and control the electrical and thermal health of the battery during charging. When installing this converter/inverter, the battery is to be verified as in compliance with the applicable battery standard.

SAVE THESE INSTRUCTIONS

Safety Information

Information sur la sécurité

Afin de réduire les risques de choc électrique, d'incendie ou d'autres risques pour la sécurité, les symboles de sécurité suivants ont été placés tout au long de ce manuel pour indiquer les consignes de sécurité dangereuses et importantes.



AVERTISSEMENT: Ce symbole indique que le défaut de prendre une action spécifiée pourrait causer des dommages physiques à l'utilisateur.



ATTENTION: Ce symbole indique que le défaut de prendre une action spécifiée peut entraîner des dommages à l'équipement.



Info: Ce symbole indique une information qui met l'accent sur des points importants du texte principal.

CONSIGNES DE SÉCURITÉ IMPORTANTES

Ce manuel contient des consignes de sécurité importantes qui doivent être respectées pendant l'installation et l'utilisation de ce produit. Lisez toutes les instructions et informations de sécurité contenues dans ce manuel avant d'installer ou d'utiliser ce produit.

- Tous les travaux électriques doivent être effectués conformément aux codes électriques locaux, provinciaux et fédéraux.
- Ce produit est conçu pour l'installation à l'intérieur ou dans le compartiment. NE PAS exposer à la pluie, à la neige, à l'humidité ou à des liquides de tout type.
- Utilisez des outils isolés pour réduire les risques de choc électrique ou de court-circuit accidentel.
- Enlevez tous les bijoux (tels que bagues, montres, bracelets, etc.) lors de l'installation ou de la maintenance de l'onduleur.
- Débranchez toujours les piles ou la source d'énergie avant d'installer ou d'effectuer l'entretien sur l'onduleur. La puissance active peut être présente à plus d'un point, car un onduleur utilise les deux batteries et AC. La mise hors tension de l'onduleur peut ne pas réduire ce risque. Tant que l'alimentation CA est connectée, elle passera par l'onduleur indépendamment du réglage du commutateur ON/OFF.
- Vérifiez toujours le bon câblage avant le démarrage de l'onduleur.
- Ne pas faire fonctionner l'onduleur s'il a été endommagé.
- Ne démontez pas l'onduleur; Il n'y a pas de pièces réparables par l'utilisateur contenues dans ce produit. Si vous essayez de réparer l'appareil vous-même, vous risquez de provoquer un choc électrique. Les condensateurs internes restent chargés après la coupure de l'alimentation.
- Assurez-vous que tous les isolateurs de conducteurs sont approuvés pour la tension, le fonctionnement, la température et le lieu d'utilisation.

Safety Information

- Utilisez uniquement des fils de cuivre dont la température nominale minimale est de 75 ° C (167 ° F).
- Aucune déconnexion AC ou DC n'est fournie en tant que partie intégrante de cet onduleur. Les deux disjoncteurs AC et DC doivent être fournis dans le cadre de l'installation du système.
- Aucune protection contre les surintensités n'est fournie en tant que partie intégrante de cet onduleur. La protection contre les surintensités des câbles de la batterie doit être fournie dans le cadre de l'installation.
- Aucune protection contre les surintensités pour le câblage de sortie CA n'est fournie en tant que partie intégrante de cet onduleur. La protection contre les surintensités du câblage de sortie CA doit être fournie dans le cadre de l'installation.

CONSIGNES DE SÉCURITÉ IMPORTANTES

- Porter des lunettes de sécurité lorsque vous travaillez avec des piles.
- Retirez tous les bijoux tels que bagues, montres, bracelets, etc, lors de l'installation ou d'effectuer l'entretien sur les batteries.
- Ne jamais travailler seul. Toujours avoir quelqu'un près de vous lorsque vous travaillez autour des piles.
- Utilisez des techniques de levage appropriées lorsque vous travaillez avec des piles.
- N'utilisez jamais de piles usées ou non testées. Vérifiez chaque étiquette des piles pour l'âge, le type et le code de date pour s'assurer que toutes les piles sont identiques.
- Les batteries sont sensibles aux variations de température. Installez toujours les piles dans un environnement stable.
- Installez les piles dans un endroit bien ventilé. Les piles peuvent produire des gaz explosifs. Pour les installations de compartiment ou d'enceinte, évacuez toujours les piles vers l'extérieur.
- Prévoyez au moins 2,5 cm (1 po) d'espace entre les batteries pour assurer un refroidissement optimal.
- Ne jamais fumer à proximité des piles.
- Pour éviter une étincelle à la batterie et pour réduire les risques d'explosion, branchez toujours les câbles aux piles en premier. Connectez ensuite les câbles à l'onduleur.
- Utiliser des outils isolés en tout temps.
- Vérifiez toujours la polarité et la tension avant de connecter les piles au variateur.
- Pour réduire les risques d'incendie ou d'explosion, ne pas court-circuiter les piles.
- En cas d'exposition accidentelle à l'acide de la batterie, laver à fond avec de l'eau et du savon. En cas d'exposition aux yeux, les inonder pendant au moins 15 minutes avec de l'eau courante et consulter un médecin.
- Recyclez les vieilles batteries.

Safety Information

- Le convertisseur/onduleur est destiné à recharger les batteries. La batterie connectée à ce produit ne convient que si elle est conforme à la norme de batterie donnée pour ce type de batterie et est fournie avec un système de gestion de batterie qui surveillera et contrôlera la santé électrique et thermique de la batterie pendant la charge. Lors de l'installation de ce convertisseur/onduleur, la batterie doit être vérifiée comme étant conforme à la norme de batterie applicable.

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1.0 Introduction

Congratulations on your purchase of an MMS Series inverter/charger from Sensata Technologies. This product is designed especially for your small home or mobile application. Powerful, yet simple to use, this product will provide you with years of trouble-free use.

1.1 MMS Series Models

MMS1012 – a 1000 watt inverter/charger with a 50-amp, 4-stage Power Factor Correction (PFC) charger. The AC input and output are provided with pigtail wires to allow the inverter to be hard-wired to a main AC distribution panel and to an inverter sub-panel. Features isolated input/output neutrals for mobile applications. Includes a 15-foot battery temperature sensor.



Figure 1-1, MMS1012 Model Inverter/Charger

MMS1012-G – a 1000 watt inverter/charger with a 50-amp, 4-stage PFC charger. The AC input is provided by a standard 3-foot plug-in power cord, and the AC output is provided by a standard GFCI two plug outlet. Features isolated input/output neutrals for mobile applications. Includes a 15-foot battery temperature sensor.



Figure 1-2, MMS1012-G Model Inverter/Charger

Introduction

1.2 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 MMS Series models, it also takes alternating current (when connected to a generator or to shorepower) and transforms it into direct current to recharge your batteries.

The two modes of operation associated with this inverter/charger are referred to in this document as:

Inverter Mode: DC from the batteries is transformed into pure sine wave AC for powering your applications.

Standby Mode: The unit operates as a battery charger to convert incoming AC power into DC power to recharge the batteries while continuing to pass the incoming AC power directly to the inverter's output, to power any AC loads.

1.3 Pure Sine Wave vs Modified Sine Wave

Today's inverters come in two basic output waveforms: modified sine 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 wave inverters.

The output of a pure sine wave inverter is equal to, or in many cases, better than the utility power used in your home. Virtually any electronic device will operate from a pure sine wave inverter. Motors run cooler, microwaves usually cook faster, and clocks keep better time just to name a few examples. Without compromising quality or performance, the MMS Series inverter/chargers provide you with all of the advantages of a pure sine wave inverter at a much lower cost than many on the market.

1.4 Appliances and Run Time

The MMS Series inverter/charger can power a wide range of household appliances. 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.

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 MMS Series inverter/charger has a built-in safeguard that automatically protects your batteries from being over-discharged.

1.5 Standard Features and Benefits

The MMS Series inverter/charger converts 12 volts of direct current (VDC) power from your battery to 120 volts alternating current (VAC) power. The multi-stage battery charger optimizes incoming AC power 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 it ensures maximum durability and cooler, more efficient operation.

The inverter/charger provides the following:

- 1000 watts continuous at 25°C (77°F).
- 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 for batteries that are extremely low.
- Automatic 4-stage battery charger with power factor correction and temperature compensation—for optimum battery charging (using the temperature sensor).
- Modern and aesthetically pleasing design with a 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 temperature sensor.

Introduction

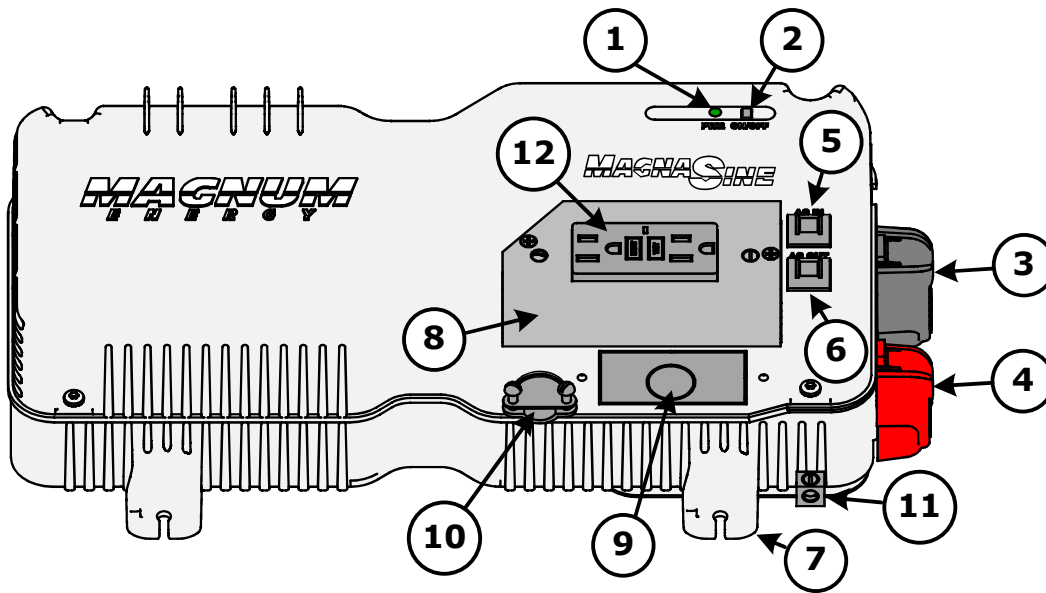
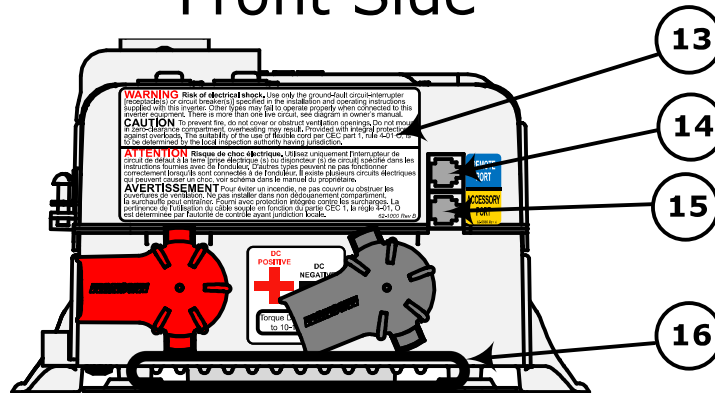


Figure 1-3, Top and Left Side Features

- 1. Inverter Status Indicator** – a green LED that illuminates to provide information on the inverter’s operation.
- 2. ON/OFF Switch** – a momentary pushbutton switch that turns the inverter on or off.
- 3. Negative DC Terminal (black)** – the inverter’s connection to the negative terminal on the battery bank.
- 4. Positive DC Terminal (red)** – the inverter’s connection to the positive terminal on the battery bank.
- 5. Input Circuit Breaker** – a circuit breaker that protects the unit’s internal wiring and pass-thru relay.
- 6. Output Circuit Breaker** – a circuit breaker that provides another layer of overload protection. Not a branch circuit-rated breaker. Separate AC output breakers may be required on the output.
- 7. Mounting Flanges (x4)** – secure the inverter to shelf/wall.
- 8. AC Wiring Compartment** - provides access for all AC input and output connections on the inverter.
- 9. AC Output Connection** – AC knockout for hardwiring AC output.
- 10. AC Input Connection** – a strain relief clamp for hardwiring AC input. *On the MMS1012-G model, the strain relief comes with an attached flexible AC input power cord.*
- 11. DC Ground Terminal** – a connection that is used to tie the exposed chassis of the inverter to the DC grounding system. Accepts CU/AL conductors from #14 AWG (2.1 mm²) to #6 AWG (13.3 mm²).
- 12. GFCI Outlet** – Ground Fault Circuit Interrupter outlet (with test and reset capability). *MMS1012-G models only.*

Front Side



NOTE: MMS1012-G model shown, MMS1012 model has identical front side and back side features.

Back Side

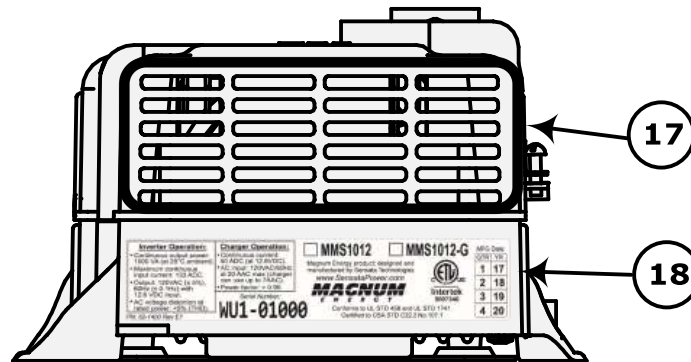


Figure 1-4, Front and Back Side Features

- 13. Warning and Information Label** – provides pertinent information for safely using the inverter.
- 14. REMOTE Port Connection** – a RJ11 connector that allows an optional remote control to be connected.
- 15. ACCESSORY PORT Connection** – a RJ11 connector to allow the Battery Temperature Sensor (BTS) or MMS accessories (e.g., MM-DCLD, MM-ISA) to be connected.
- 16. Intake Vent** – ventilation openings to pull in air to keep the inverter cool for peak performance.
- 17. Exhaust Vent** – ventilation openings that allow heated air to be removed by the internal cooling fan.
- 18. Model/Serial Number Label** – includes model/serial number and provides specifications and information on the inverter and charger. See the *MMS Series Specifications* (Table 5-1) for more information and the different models available.

Introduction

1.5.1 Battery Temperature Sensor

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 charger's 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, battery life may be shortened. See Section 3.2 for more information on the BTS.

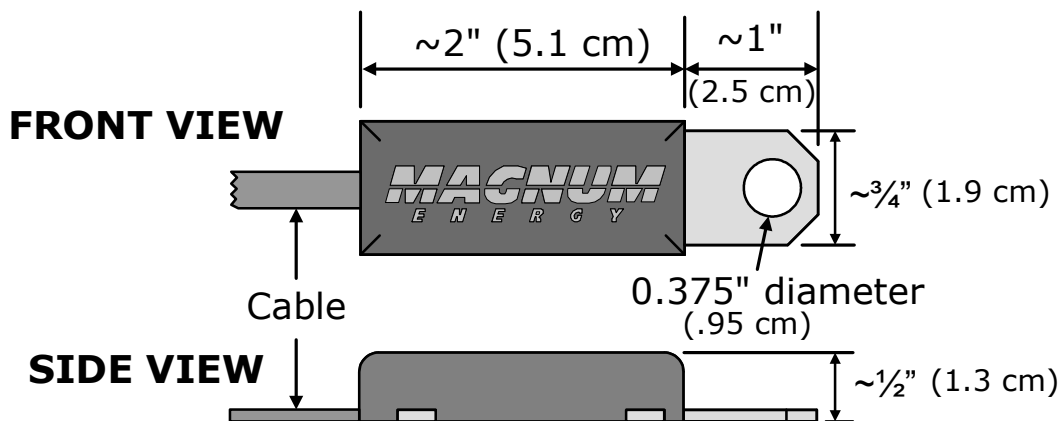


Figure 1-5, Battery Temperature Sensor (BTS)

2.0 Installation

2.1 Pre-Installation

Before installing the inverter, read the entire Installation section. The more thorough you plan in the beginning, the better your inverter needs will be met.



WARNING: 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.



Info: Review the Important Product Safety Information and Important Battery Safety Instructions on pages ii-v before proceeding with the installation.

The basic system diagrams shown in Figures 2-1 and 2-2 should be reviewed to assist you in planning and designing your installation. These drawings are not intended to override or to restrict any national or local electrical requirements. These drawings should not be the determining factor as to whether the installation is compliant, which is the responsibility of the installer/electrician and the on-site inspector.

2.1.1 Unpacking and Inspection

Carefully remove the MMS inverter/charger from its shipping container and inspect all contents. Verify the following items are included:

- MMS Series inverter/charger
- Red and black DC terminal covers
- AC access cover with two screws
- Two 5/16-18 hex-head kee nuts (installed on the DC terminals)
- Battery Temperature Sensor (BTS)
- Warning Label
- MMS Series Owner's Manual

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.

Installation

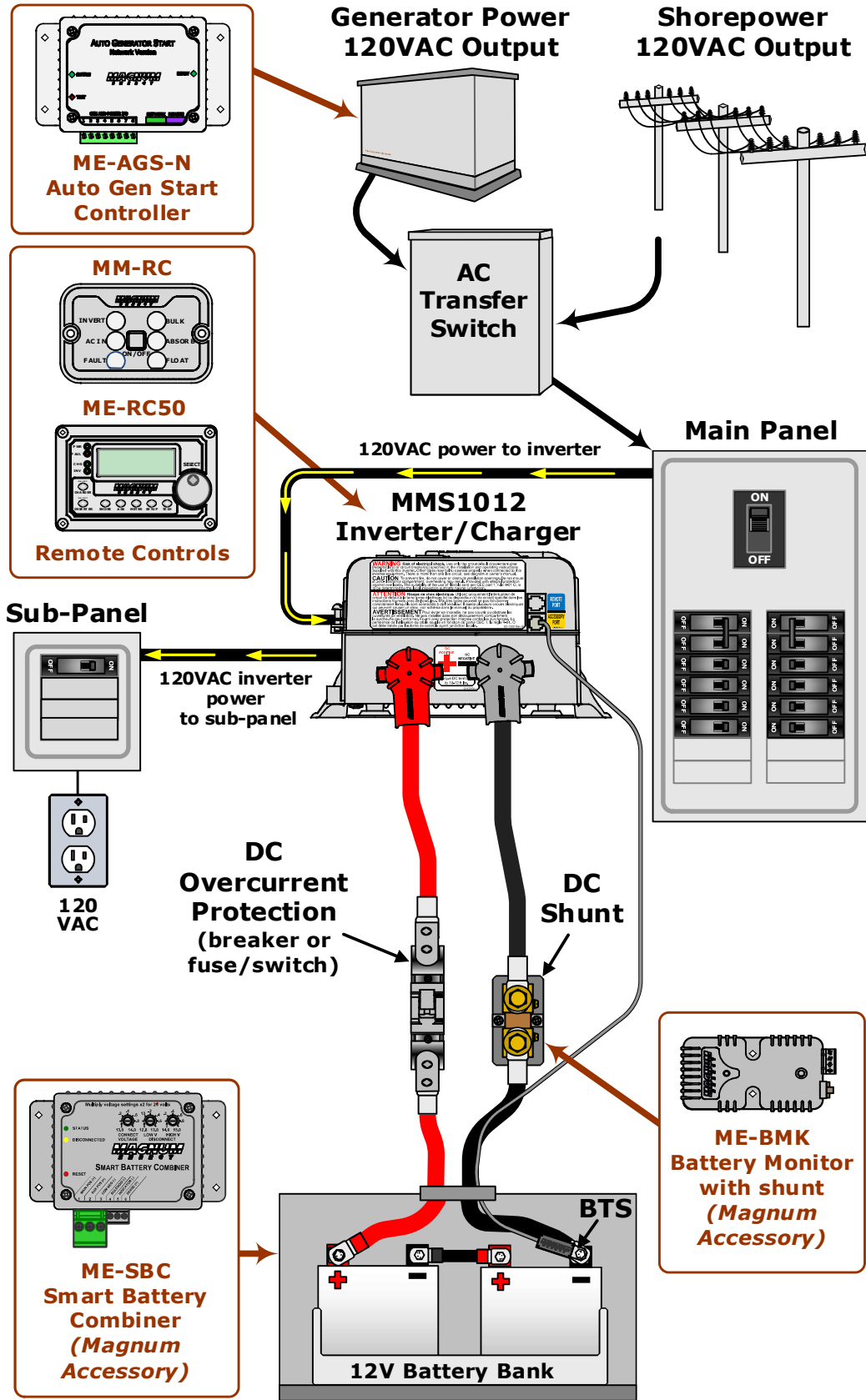


Figure 2-1, MMS102 Model Basic Installation Diagram

Installation

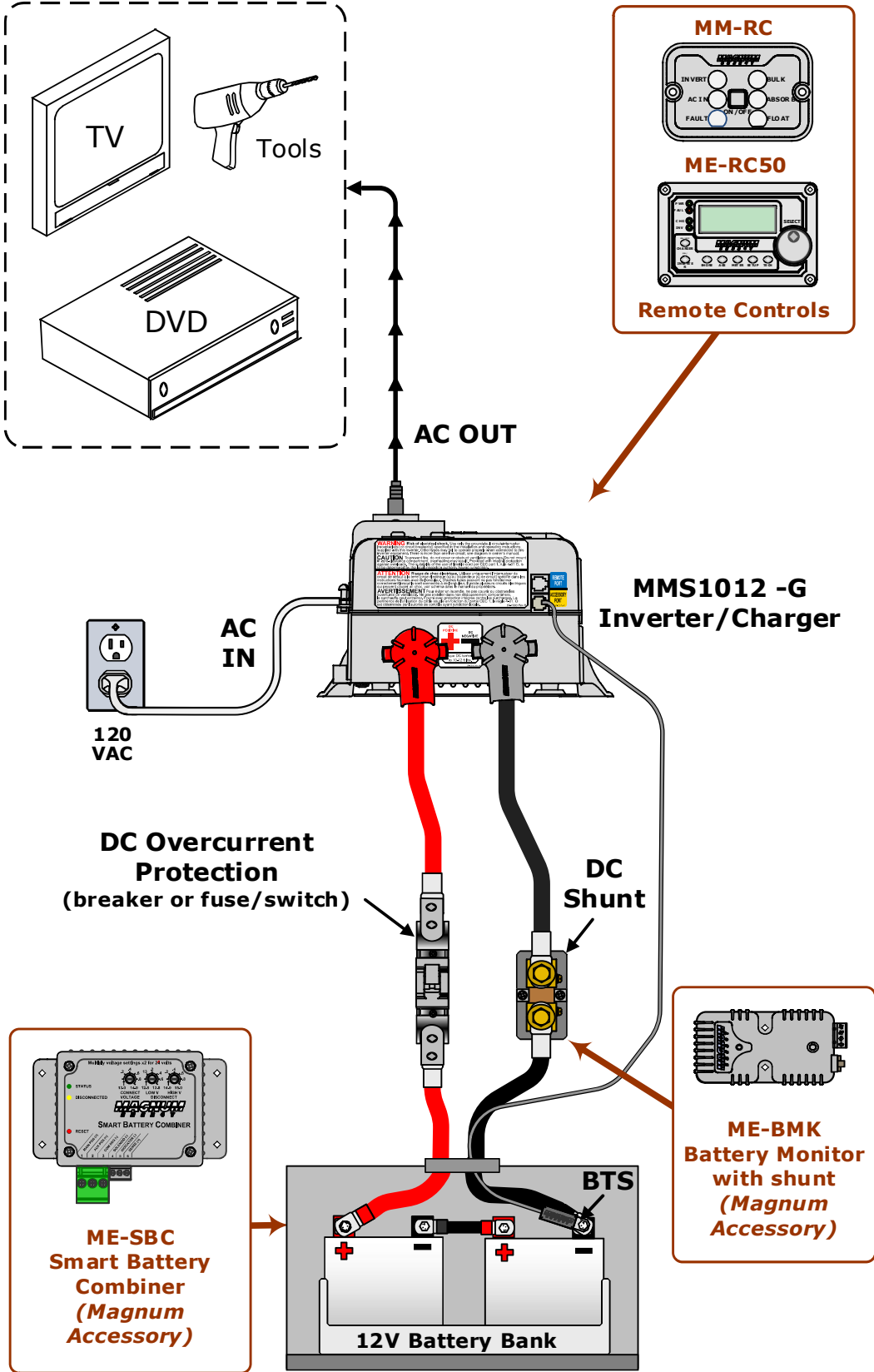


Figure 2-2, MMS1012-G Model Basic Installation Diagram

2.2 Locating and Mounting the Inverter



WARNINGS:

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

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

Clean and Dry – The inverter is rated for indoor use only. It should not be installed in an area that allows dust, fumes, insects, or rodents to enter or block the inverter’s ventilation openings. The 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 busbars, and a power-coated aluminum base. Also, the internal circuit boards are conformal coated. The above measures are undertaken to help fight the harmful effects of corrosive environments. However, the life of the inverter is uncertain if used in any of these types 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 any equipment that produces extreme heat. The ambient air temperature should be between 32°F (0°C) and 104°F (40°C); keep in mind that the inverter’s continuous output power 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 over-temperature fault conditions, do not cover or block the inverter’s ventilation openings or install this inverter in an area with limited airflow. Allow as much clearance around the inverter’s intake and exhaust ventilation openings as possible (see Figure 1-4, Items 16 & 17). At the minimum, allow an airspace clearance of 3” (7.5 cm) on all sides 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.

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



WARNING: The MMS inverter/charger should not be installed in any location that requires ignition-protected equipment. To prevent fire or explosion, do not install in any area with extremely flammable liquids like gasoline or propane; or, in an area that contains connections between components of a fuel system.

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 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. Refer to Figures 2-4 and 2-5 for the specific dimensions of the two MMS Series models.

Mounting Orientation – To meet regulatory requirements, the MMS Series inverter/charger 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 2-3. The inverter must be mounted on a non-combustible surface, and this surface and the mounting hardware must be capable of supporting at least twice the weight of the inverter. After determining the mounting position, use the base of the inverter's chassis as a template to mark the mounting screw locations on 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.

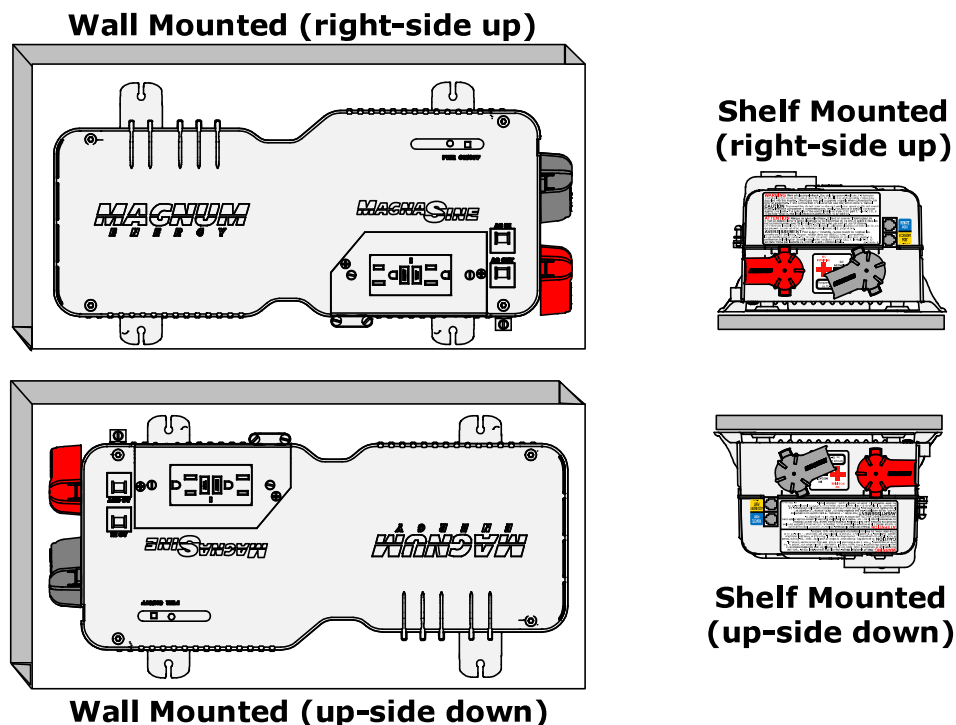


Figure 2-3, Approved MMS1012 (-G) Mounting Orientations

Installation

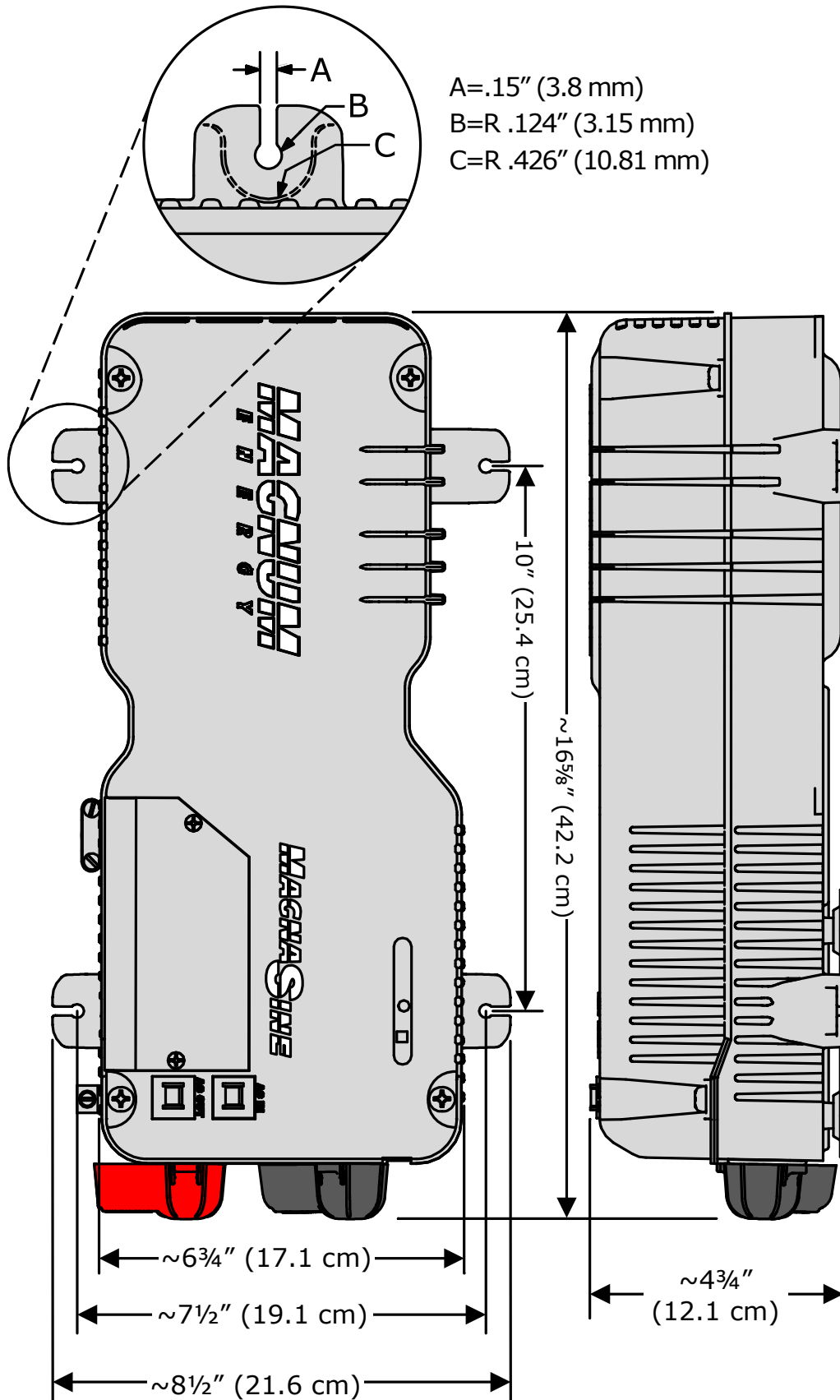


Figure 2-4, MMS1012 Model Dimensions

Installation

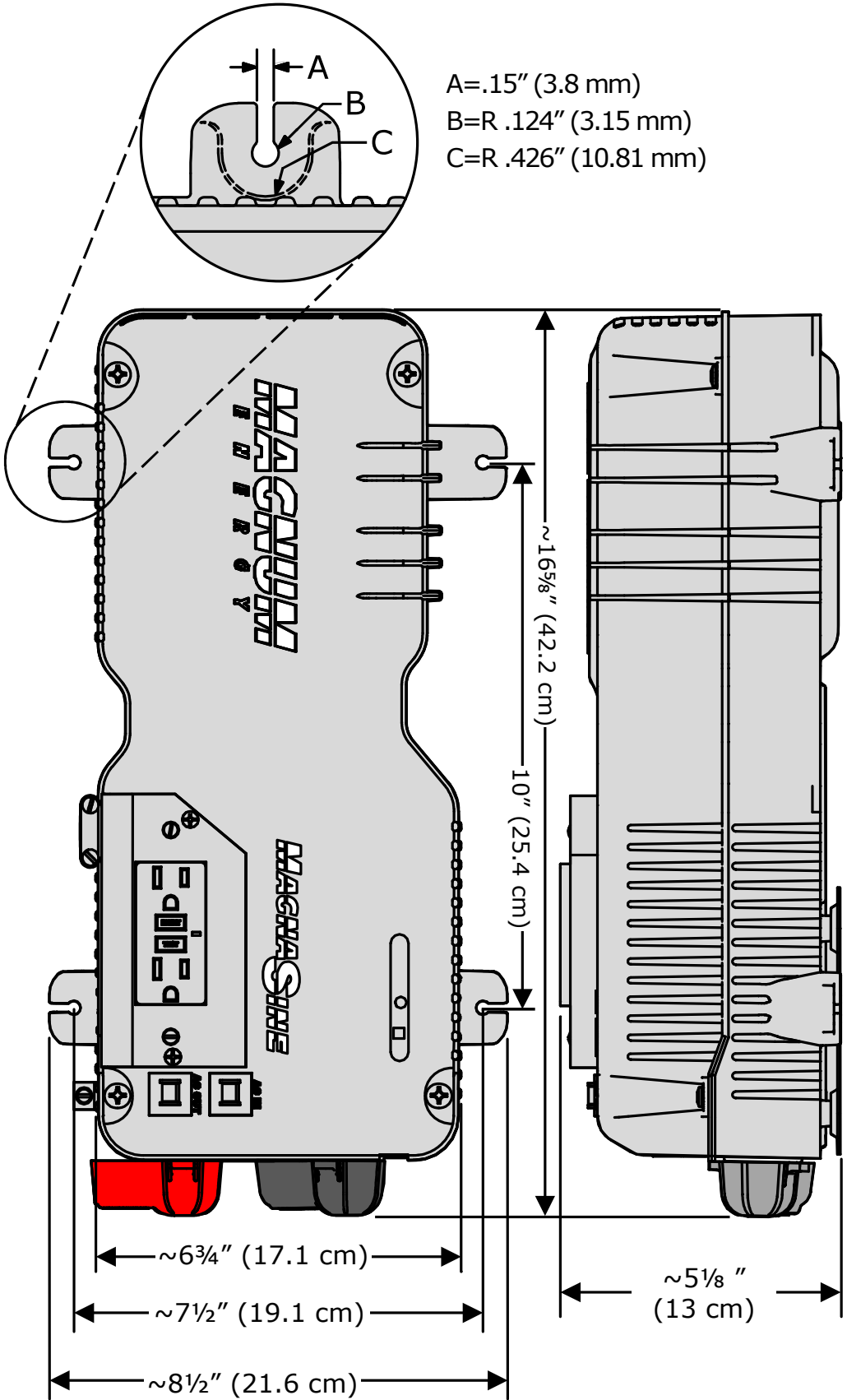


Figure 2-5, MMS1012-G Model Dimensions

Installation

2.3 DC Wiring

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



WARNING: Even though DC voltage can be regarded as "low voltage", significant hazards may be present, particularly from short circuits of the battery system.



CAUTION: Ensure the DC overcurrent protection device (i.e., Fuse or circuit breaker) is DC rated and is correctly sized according to the ampacity of the DC cables being used. This means the overcurrent protection device is required to open before the cable reaches its maximum current carrying capability, thereby preventing a fire.



CAUTION: The inverter is NOT reverse polarity protected—which means if the negative and positive battery voltage is connected to the inverter backwards, the inverter will likely be damaged. Use a voltmeter to verify the correct polarity BEFORE connecting the DC wires.

When connecting the DC wires, consider the following:

- The DC positive and negative cables connected to the inverter from the battery bank should be tied together with wire ties/straps or electrical tape approximately every 6 inches (15.3 cm). 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.
- The battery bank voltage MUST be between 9.0-17.0 volts for the inverter to operate. If the voltage exceeds 17.0 volts, the inverter may be damaged.
- To ensure the maximum performance from the inverter, all connections from the battery bank to the inverter should be minimized. The exceptions are the DC fuse or the DC circuit breaker—required in the positive line to protect the DC wiring. Any additional connections may contribute to voltage drops, and these extra connection points may loosen during use.
- A brief spark or arc may occur when connecting the battery cables to the inverter DC terminals; this is normal and due to the inverter's internal capacitors being charged.
- Before routing the wiring, color code the DC cables/wires to the battery bank with colored tape or heat shrink tubing: RED for positive (+); WHITE for negative (-); and GREEN (or bare copper) for DC ground, to avoid polarity problems.
- A cable should be connected directly from the inverter negative terminal to the battery negative connection; this ensures the inverter has a reliable return path directly to the battery.

2.3.1 DC Wire Sizing

It is important to use the correct DC wire to achieve maximum efficiency from the system and to reduce fire hazards associated with overheating. Use Table 2-1 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 5 feet (1.5 m), use the bottom part of that table 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 to 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.

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 2-1, Recommended DC Wire/Overcurrent Device

		Inverter Model	
		MMS1012	MMS1012-G
Maximum Continuous Current¹		133 amps	133 amps
DC Grounding Electrode Wire Size²		#6 AWG (13.3 mm ²)	#6 AWG (13.3 mm ²)
Minimum DC Wire Size³ (75°C rating in free air)		#2 AWG (33.6 mm ²) [170 amps]	#2 AWG (33.6 mm ²) [170 amps]
DC Fuse Size⁴		150 amps with time delay	150 amps with time delay
▼ ▼			
Increased size for longer distance	5 to 10 ft (1.5 to 3.0 m) =	#2 AWG (33.6 mm ²)	#2 AWG (33.6 mm ²)
	10 to 15 ft (3.0 to 4.6m) =	#1 AWG (42.4 mm ²)	#1 AWG (42.4 mm ²)

Note¹ – Maximum Continuous Current is based on the inverter's continuous power rating at the lowest input voltage with an inefficiency factor.

Note² – Per the NEC, the DC grounding electrode conductor can be a #6 AWG (13.3 mm²) conductor if that is the only connection to the grounding electrode and that grounding electrode is a pipe, rod, or plate electrode.

Note³ – Wire size is based on the requirements needed to increase efficiency and reduce stress to the inverter.

Note⁴ – The 'DC Fuse Size' in this table is the minimum recommended fuse size for the inverter. This fuse is matched with the 'Minimum DC Wire Size' to ensure the current rating of the fuse does not exceed the ampacity of the wire. If a larger fuse is used, ensure the ampacity of the DC wire is sized correctly.

Installation

2.3.2 DC Overcurrent Protection

For safety and to comply with NEC (National Electrical Code) 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 (with a disconnect switch*) or a 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.

Batteries can deliver thousands of amps in an instant during a short. Therefore, you are required to install a DC-rated fuse (or circuit breaker) that has a interrupt current rating (known as Amps Interrupting Current, or AIC) that can withstand the short-circuit current without explosion or damage. If a fuse is used as an overcurrent device, a Class-T type or equivalent is highly recommended when used with inverters. A Class-T fuse is rated for DC operation, can handle very high short-circuit currents (up to 100,000 amps), and has a time delay that allows for momentary current surges from the inverter without opening the fuse. In some installations, if the combined short-circuit current of the battery bank is determined to be 2,700 amps or less, then an ANL type of fuse may be used—if in doubt, use a Class-T fuse. See Table 2-1 for the DC overcurrent device (coordinated with the DC wire size) recommended for your inverter.

**Electrical systems in mobile installations typically do not require using a DC disconnect, although an overcurrent protection device is still required. These installations also do not normally use conduit, so the fuse must be installed in the ungrounded conductor within 18 inches (45.7 cm) of the battery—to protect the DC wiring system.*



Info: If this inverter is installed in a Marine installation, an overcurrent protection device is not required to be installed in the ungrounded DC conductor within 7" of the charger. This is because the battery charger in this inverter is 'self-limiting', (refer to ABYC regulation 31.5.2.4.4.1).

2.3.3 DC Grounding

The MMS should always be connected to a permanent, grounded wiring system. The idea is to connect the metallic chassis of all 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 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 2-1).

If installing in a vehicle, do not use the vehicle's metal frame in place of the negative connection or DC ground. The inverter requires a reliable negative and ground return path directly to the battery.

2.3.4 DC Cable Connections

When connecting the DC cable to the battery or the inverter, stack the hardware in the correct order to prevent high resistance connections from heating up and cause the connections to melt. Stack the hardware per Figures 2-6 & 2-7, and tighten the connections from 10 to 12 ft-lbs (13.6 to 16.3 N m).



CAUTION: Do not put anything between the DC cable ring lug and the battery terminal post or the inverter’s DC terminal. If antioxidant grease/spray is used, apply it after all connections have been made and properly tightened.



Info: 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.

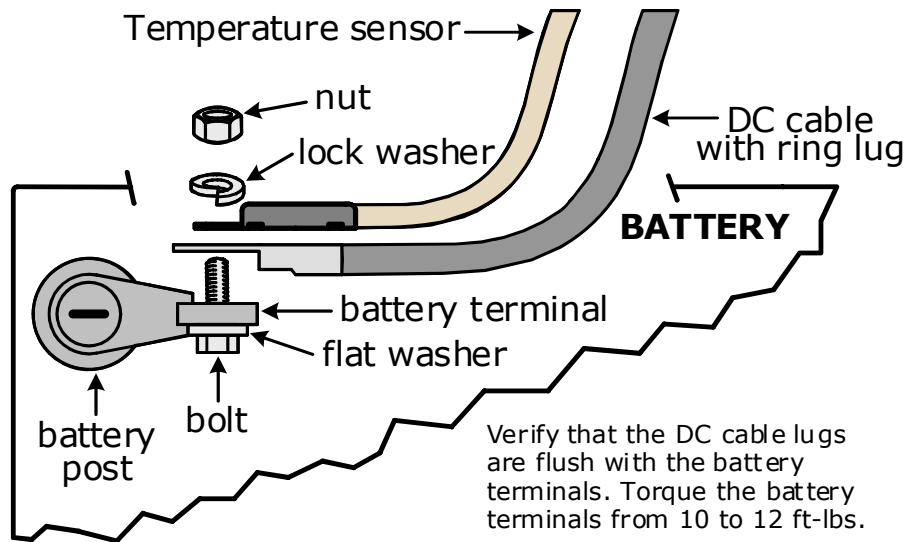


Figure 2-6, DC Cable to Battery Terminals

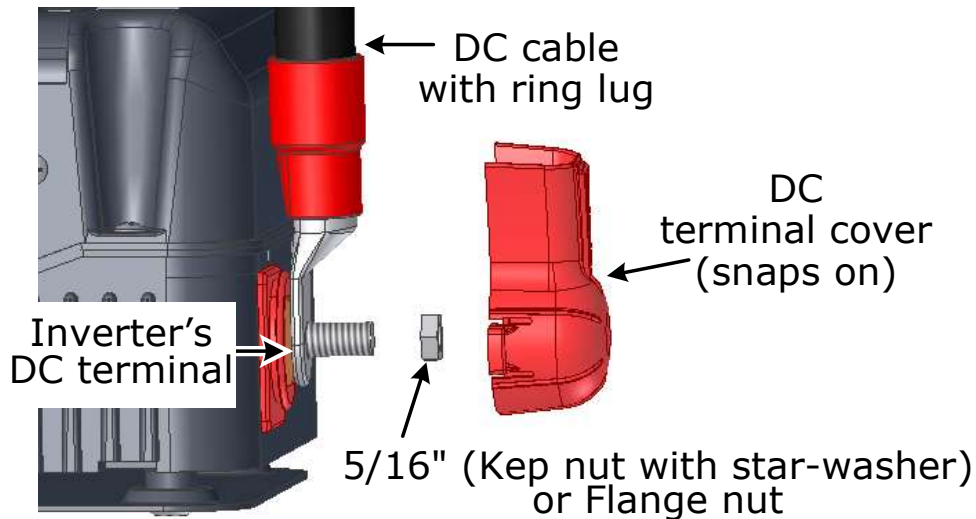


Figure 2-7, DC Cable to Inverter's DC Terminals

2.3.5 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.



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



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



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



Info: 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.

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 (see *Appendix A – 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" (2.5 cm) of space between the batteries to provide good air flow. DO NOT mount the batteries directly under the inverter.

2.3.6 Inverter to Battery Bank Wiring



WARNING: Ensure all sources of DC power (i.e., batteries) and AC power (shorepower or AC generator) are de-energized (i.e., breakers opened, fuses removed) before proceeding.



CAUTION: The 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 (+), and BLACK for negative (-) to avoid polarity confusion.



Info: 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 1-3, Item 11) to a dedicated system ground. Recommended tightening torque is 45 in-lbs (5.2 N m).

DC Negative Wire

Route an appropriately sized DC negative wire (BLACK) from the negative terminal of the last battery string to the inverter's negative terminal (see Figure 2-8 for reference).

Battery Temperature Sensor

Connect the RJ11 connector end of the BTS to the ACCESSORY PORT (see Figure 1-4, Item 15) on the inverter. Connect the other end of the BTS to the negative terminal of the last battery string (in same place as the DC negative wire above—see Figure 2-8); refer to Figure 2-6 for the correct hardware placement.

Installation

DC Positive Wire

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



WARNING: DO NOT close the DC fuse/DC disconnect (or close the DC circuit breaker) to enable 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 wire (same rating as the DC wires) to one end of the fuse block and the other end of this wire to the positive terminal of the first battery string (see Figure 2-8). This is essential to ensure even charging and discharging across the entire battery bank.

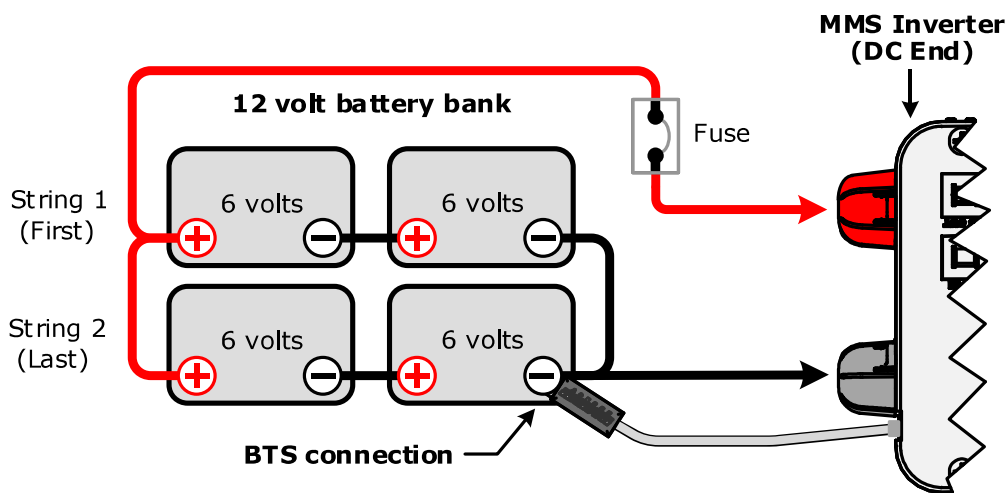
Ensure the DC wire connections (to batteries, inverter, and fuse lugs/DC circuit breaker) are flush on the surface of the DC terminals, and the hardware (lock washer and nut) used to hold these connections are stacked correctly (see Figures 2-6 and 2-7).

Verify DC connections torqued from 10 to 12 ft-lbs (13.6 to 16.3 N m).

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

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

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



Note: Above applies only in systems with more than one battery string.

Figure 2-8, Battery String Connections

2.4 AC Wiring (MMS1012 model only)

This section describes the MMS1012's required AC wire size and overcurrent protection, and provides info on making AC connections.



Info: This AC Wiring section does not apply to the MMS1012-G model. The MMS1012-G model comes wired from the factory with a power cord for the AC input and dual outlets on top of the inverter for the AC output.



WARNING: All wiring should be done by a qualified person or a licensed electrician following local/NEC codes.

2.4.1 Pre-AC Wiring Requirements



CAUTION: Before attempting any AC wiring, review the safety information at the beginning of this manual and listed below:

- Ensure all conductor insulation is of a type that is approved for the voltage, operation, temperature, and location of use.
- AC wiring must be no less than #12 AWG (3.3 mm²) gauge copper wire on input and #14 AWG (2.1 mm²) on output; and the wire must be approved for the application (i.e., residential, RV, or marine wiring).
- DO NOT connect the inverter's AC output to an AC power source. This could cause severe damage to the inverter and is not covered under warranty.
- Use only copper wires with a minimum temp rating of 75°C (167°F).
- Wire sizes recommended in this manual are based on the ampacities given in Table 310.17 (in free air) of the National Electrical Code. ANSI/NFPA 70, for 75°C (167°F) copper wire based on an ambient temperature of 30°C (86°F).

Note: The term "in free air" is defined by the NEC as not encased in conduit or raceway.



WARNING: To reduce the risk of fire, do not connect this inverter to an AC load center (circuit breaker panel) having multi-wire branch circuits connected.

2.4.2 AC Wire Size and Overcurrent Protection

The AC wiring must be sized per NEC and local electrical safety code requirements to ensure the wire's ability to safely handle the inverter's maximum load current. After determining the proper wire size, the inverter's AC input and output wires must be protected against overcurrent conditions and have a means to disconnect the AC circuits. All inverter AC input/output wiring must be protected by an overcurrent protection device, which can be a fuse or circuit-breaker. These devices must be properly sized and rated for the wire they are protecting and the appliances being powered.

Installation

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 2-2 provides the minimum AC wire size and the suggested breaker size based on inverter model. However, a 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 (167°F) or higher.

Table 2-2, 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
MMS1012	20 amps	#12 AWG (3.3 mm ²)	20 amps	15 amps	#14 AWG (2.1 mm ²)	15 amps
MMS1012-G	15 amps	#14 AWG (2.1 mm ²)	15 amps	15 amps	#14 AWG (2.1 mm ²)	15 amps

2.4.3 Ground-Fault Circuit Interruption (GFCI) Breakers

In compliance with UL standards, Sensata has tested some GFCIs to ensure they function properly when connected to the inverter's AC output. See WARNING below.



WARNING: Risk of electric shock. Use only the following GFCIs [receptacles or circuit breaker(s)]: Leviton 8899-A, N7899, GFNT1 and GNNT2; Hubbell GF520EMBKA, GFRST15xx and GFRST20xx; and Cooper VGF15W Series. Other types may fail to operate properly when connected to this inverter.



CAUTION: GFCIs shall be installed in the recreational vehicle's wiring system to protect all branch circuits.

Table 2-3, Wire Color to AC Wire Connection

	Wire Color (label)	Wire Connection
AC IN	Black (HOT IN)	Hot In
	White (NEU IN)	Neutral In
AC OUT	Red (HOT OUT)	Hot Out
	White with black stripe (NEU OUT)	Neutral Out
AC Ground	Green (GROUND)	AC IN & AC OUT Ground

2.4.4 AC Wiring Connections

For the MMS1012 model, the AC input and output wiring is performed in the AC wiring compartment. This compartment is accessed via the top panel (Figure 1-3, Item 8). If the panel cover is 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 AC input and output (see also Figure 2-9). You can also refer to Table 2-3 to match the inverter's AC wires to the appropriate AC wire connection.

The AC wires inside the AC compartment are #16 AWG (1.3 mm²) with a temperature rating of 105°C (221°F). All AC connections should be made using an approved connector for your application (e.g., split bolt, twist-on wire connectors, etc.). Ensure the wire connectors used are rated for the size and number of wires you are connecting.



Info: Per UL certification, non-metallic sheathed cable (i.e., Romex™) or an SO flexible cord with listed strain reliefs are allowed to be used to connect to the inverter; conduit connections are not allowed.



Info: The inverter's Neutral In and Neutral Out wires are electrically isolated from each other while inverting. However, these same input and output neutrals are connected together while charging.

2.4.5 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 the strain relief clamp on the AC input opening (Figure 1-3, Item 10). See Table 2-2 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 then separate the three wires and strip about 3/4" (1.9 cm) of insulation from each wire.
3. Using approved AC wire connectors, connect the incoming Hot In, Neutral In, and Ground wires to the MMS1012's AC wires colored black (HOT IN), white (NEU IN), and green (AC GROUND) respectively.
4. After making the AC input connections, gently pull on the wires to ensure they are securely held together and no bare wire is exposed, and then secure the AC input cable by tightening the strain relief clamp.

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

Installation

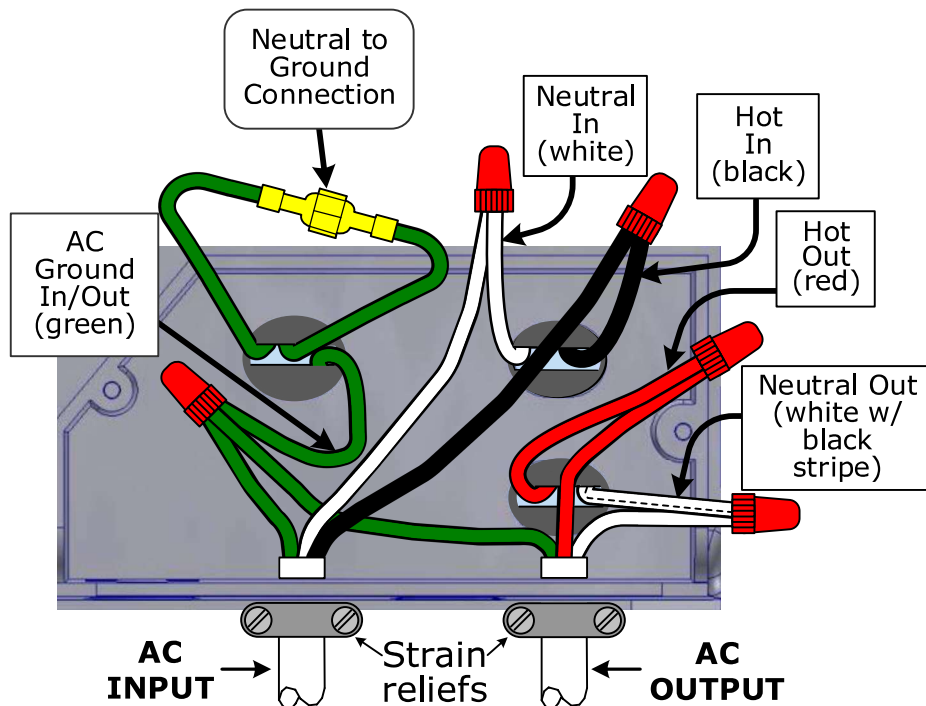


Figure 2-9, AC Wiring Connections (MMS1012 model)

2.4.6 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.



Info: When using the MMS Series inverter in an RV application—under certain conditions and provided that the wire is properly sized for the protecting breaker—RVIA wiring standards will permit the breaker in the main distribution panel and/or the supplemental breakers on the inverter to provide adequate protection for the AC output wiring. For more information on these requirements, refer to the RVIA (www.rvia.org).

To hardwire the AC output of the MMS Series inverter:

1. Remove the 1/2" knockout on the AC Output Connection (Figure 1-3, Item 9)—use a utility knife to cut thru the round slot.
2. Discard this knockout and install a 1/2" strain relief in the AC Output opening. You may need to file the opening edge for proper fit.
3. Run a 2-conductor plus ground cable through the strain relief in the AC OUT opening. Refer to Table 2-2 for the minimum wire size and the overcurrent protection required for the AC output wiring.
4. Remove about two inches (5.1 cm) of the insulating jacket from the AC cable, and then separate the three wires and strip about 3/4" (1.9 cm) of insulation from each wire.

5. Using approved AC wire connectors, connect the outgoing Hot Out, Neutral Out, and AC Ground wires to the inverter's AC wires colored red (HOT OUT), white with black stripe (NEU OUT), and green (AC GROUND) respectively.
6. After making the AC output connections, gently pull on the wires to ensure they are securely held together and no bare wire is exposed, and then secure the AC output cable by tightening the strain relief.
7. Connect the outgoing AC wires to either:
 - a) an AC load sub-panel equipped with overcurrent protection (e.g., circuit breakers), or
 - b) directly to the circuit (if following RVIA requirements that permit using breakers from the main distribution panel or the breakers on the inverter under certain conditions).

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

2.5 Grounding Inverters

The MMS Series inverter/chargers should always be connected to a permanent, grounded wiring system—which limits the risk of electrical shock, reduces radio frequency noise from the inverter, and minimizes excessive surge voltages induced by lightning.

2.5.1 Neutral to Safety Ground Bonding

The standards for safely wiring residential (home or office), RV/truck, and marine installations in the United States require the neutral and safety ground to be connected at the AC source; whether it is the utility feed in your home, an inverter, or a generator. This is to establish a specification that maximizes the possibility that a circuit breaker will activate if a hot wire-to-ground fault occurs. These standards also require that the AC neutral be connected to safety ground (often called a "bond") in one, and only one, place at any time. The single bond is established in order to make the electrical panel's neutral line safe, by connecting it to ground. Without this bond, the neutral can have up to 60 VAC with respect to ground. On the other hand, if more than one bond is established, currents can circulate between neutral and ground and cause "ground-loop" currents. These ground-loops can trip GFCIs, cause an electric shock hazard, and may be the reason for other annoying side effects.

In applications where you are using an inverter as one of your AC sources along with another AC source (i.e., utility power or generator), there is the potential of having multiple connections (bonds) between neutral and ground. Therefore, you must ensure that the inverter does not also connect the neutral-to-ground while the other AC source is actively powering the inverter loads. This can be prevented if your inverter is equipped with automatic neutral-to-ground switching.

Installation



WARNING: In most electrical systems, the neutral-to-ground bond is located in the main utility service entrance panel. Remove any bond downstream from the inverter to prevent multiple bonds. If there is an inverter sub-panel—separate from a main electrical panel—it should have a removable wire that allows the neutral bus to be unbonded from the ground busbar.

The MMS Series has automatic neutral-to-ground switching to specifically work in multiple source or mobile (i.e., truck/RV/boat) applications. The MMS inverter/charger uses an internal relay that automatically connects the AC neutral output terminal to the vehicle/boat's ground while inverting (Inverter mode) to provide the neutral-to-ground bond; as shown in Figure 2-10. However, when an external AC source (i.e., shorepower or a generator) is connected, another neutral-to-ground connection is introduced in the system. When the MMS1012 is connected to this external AC source and goes into Standby mode, the internal relay automatically opens the neutral-to-ground connection as shown in Figure 2-11. This design keeps two neutral-to-ground connections from occurring at the same time, thereby preventing an electrical shock hazard between the vehicle/boat's neutral and the external AC source's neutral.

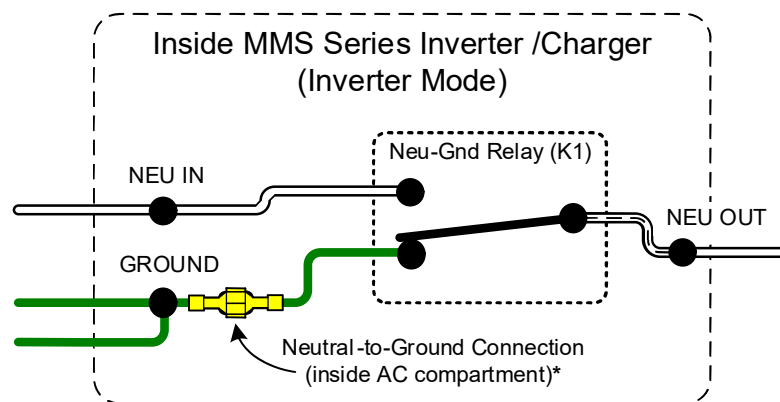


Figure 2-10, Neutral-to-Ground Connection (Inverter Mode)

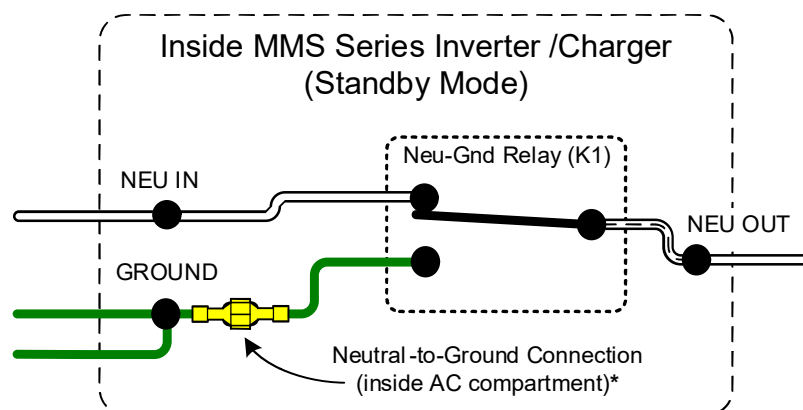


Figure 2-11, Neutral-to-Ground Connection (Standby Mode)

2.5.2 Disabling the Neutral-to-Ground Connection

The MMS1012 has an automatic neutral-to-ground switching feature. In installations that already have the neutral bonded to ground in the electrical panel (i.e., home/office installation), this feature must be disabled by disconnecting the neutral-to-ground connection. If you are not sure whether you must disable this feature, check your local code requirements. Follow the steps below to disable this feature.



Info: The ground connection from the inverter's AC and DC grounds should still be connected to the system ground, even if the neutral-to-ground connection has been disconnected.



WARNING: Fire and Shock Hazard—disconnect all AC and DC sources before working in the AC wiring compartment.

1. Locate and remove the AC access cover plate (Figure 1-3, Item 8) on the side of the MMS1012 inverter.
2. Inside the AC wiring compartment, locate the green wire with the insulated connector (Figure 2-12). This insulated connector connects the neutral and ground inside the inverter while inverting.
3. Pull the two ends of the insulated connector apart to separate the green wire; this will prevent the neutral and ground from connecting inside this inverter.
4. Move the two disconnected ends away from each other and push back out of the way. You must ensure that the two connector ends will not have any contact with any other wires within the AC compartment. You may want to use electrical tape to insulate the ends and secure them out of the way.

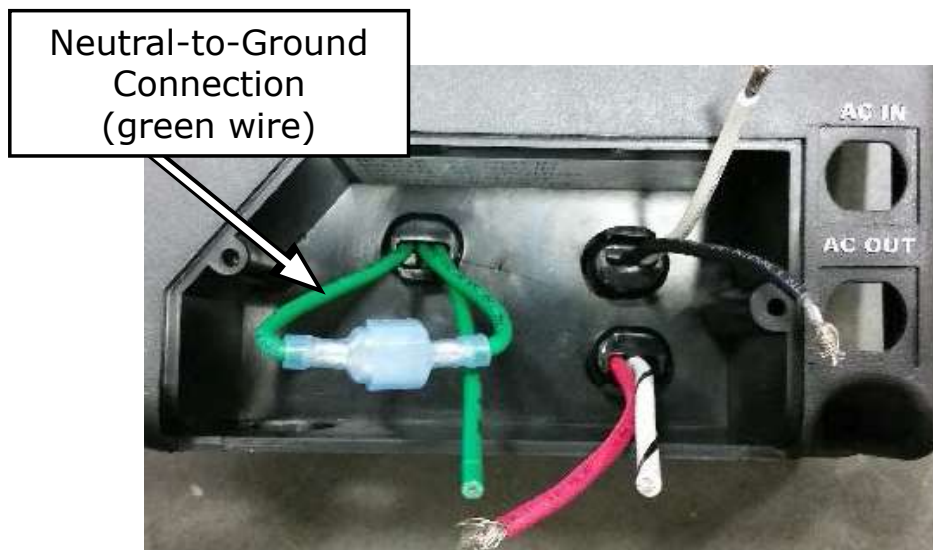


Figure 2-12, Disconnecting Neutral-to-Ground Connection

2.6 Inverter Warning Label

The warning label (Figure 2-13) is provided to inform all personnel that an inverter is installed in your electrical system. Affix this label in a clearly visible location at the electrical panel that is being powered by the inverter. This is necessary because it might be falsely assumed that the panel is no longer “hot” after AC power has been shut off—when in fact power may actually still be available due to the inverter automatically powering the panel.

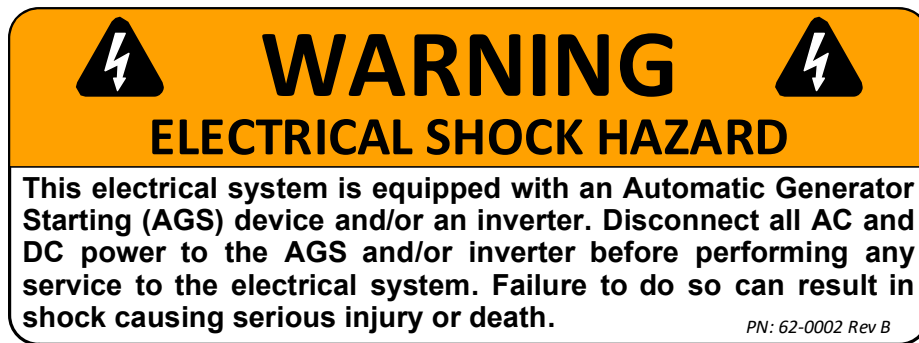


Figure 2-13, Warning Label

2.7 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’s operation.

1. Check the battery voltage and polarity before connecting the batteries to the inverter. Use a multimeter to verify 10 to 14 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 (e.g., appliances) are switched OFF or disconnected from the AC outlets.
 - a) If a remote switch is connected, press the ON/OFF switch to turn the inverter on.
 - b) If there is no remote switch connected, lightly press and release the inverter’s ON/OFF power 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.

4. Connect a 10-25 watt light bulb to the inverter output and verify it comes on and shines normally. DO NOT connect anything larger than a 25-watt light bulb until all wiring and voltages are confirmed to be correct.



Info: The inverter's AC output voltage will not be correct until a load greater than 5 watts (default setting) is connected to the inverter; or, Search mode is turned off with a remote display (MM-RC, ME-RC, or ME-ARC). A 10 to 25 watt bulb is used as it is a sufficient load to bring the inverter out of Search mode and up to full voltage.

5. Check the output voltage of the inverter by connecting a multimeter to the outlets powered by the inverter. Verify the voltage is 120 VAC +/- 5 VAC.
6. 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 power switch to turn the inverter off. The inverter's status indicator and the connected load should go off.
7. 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 light bulb. Verify that the inverter's status indicator and the connected light bulb come on.
8. Even though the connected light bulb is on, the inverter is currently disabled/off. Press the remote's ON/OFF switch (or press and release the ON/OFF power switch on the inverter) to enable/turn on the inverter.
9. Disconnect the incoming AC power to the inverter. Verify the light bulb 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

3.1 Operating Modes

The MMS Series inverter/charger has two normal operating routines. Inverter mode, which powers the loads using the batteries, and Standby mode, which transfers the incoming AC power (i.e., shorepower or a generator) to power the loads and to recharge the batteries. This inverter also includes an extensive protection circuitry that shuts down the inverter under certain fault conditions.

3.1.1 Inverter Mode

When the inverter is first powered up, it defaults to the OFF mode. The momentary ON/OFF power switch (Figure 3, Item 2) must be lightly pressed to turn the inverter ON. Subsequently pressing this switch alternately turns the inverter off and on.

- **Inverter OFF** – When the inverter is OFF, no power is used from the batteries to power the AC loads and the status LED will be OFF. If AC power from an external source (shorepower or generator) is connected and qualified on the inverter's AC input, this AC input power will pass through the inverter to power the AC loads. However, if this AC power is lost, the AC loads will no longer be powered because the inverter is OFF.

When the inverter is turned ON, it operates either by "Searching" or "Inverting", depending on the connected AC loads.

- **Searching** – When the inverter is first turned ON, the automatic Search feature is enabled. This feature is provided to conserve battery power when AC power is not required. In this mode, the inverter pulses the AC output looking for an AC load (i.e., electrical appliance). Whenever an AC load (greater than 5 watts) is turned on, the inverter recognizes the need for power and automatically starts inverting. When there is no load (or less than 5 watts) detected, the inverter automatically goes back into Search mode to minimize energy consumption from the battery bank. When the inverter is "Searching", the inverter's green LED flashes.



Info: The factory default value for the Search feature is 5 watts. It can be turned off or adjusted from 5 to 50 watts using the ME-RC50 remote display.

- **Inverting** – When a load greater than 5 watts is connected to the inverter output, the MMS Series "inverts" the DC power from the battery and supplies 120 VAC power to your sub-panel. The inverter's green LED flashes once every 2 seconds to indicate it is inverting. The amount of time the inverter can be inverting and providing power is directly related to the amount of AC loads that are connected and the capacity of the battery bank.

3.1.2 Standby Mode

The MMS Series features an automatic transfer relay and an internal battery charger when operating in Standby mode. Standby mode begins whenever AC power (shorepower or generator) is connected to the inverter's AC input. Once the AC voltage and frequency of the incoming AC power is within the AC input limits, an automatic AC transfer relay is activated. This transfer relay passes the incoming AC power through the inverter to power the AC loads on the inverter's output. This incoming power is also used to activate a powerful internal battery charger to keep the battery bank charged in case of a power failure.

Battery charging – The MMS Series models are equipped with an active Power Factor Corrected (PFC) multi-stage battery charger. The PFC feature is used to control the amount of power used to charge the batteries in order to obtain a power factor as close as possible to 1 (or unity). This causes the battery charger to look like a resistor to the line (forces the charge current wave-shape to mirror the voltage wave-shape). This feature maximizes the real power available from the AC power source (shorepower or generator), which translates into less power wasted and a greater charging capability than most chargers available today.

When an AC power source is connected to an inverter that has a battery charger, the inverter monitors the AC input for acceptable voltage. Once the inverter has accepted the AC input, the AC transfer relay will close and charging will begin. Once charging, the DC voltage is monitored to determine the charging stage. If the DC voltage is low (<12.9 VDC), the charger begins bulk charging. If the DC voltage is high (≥12.9 VDC), the charger skips the initial Bulk/Absorb Charging stages and goes directly to float charging.

The multi-stage charger can use up to five different charging stages to help monitor and keep the batteries healthy. The five stages include an automatic 4-stage charging process (Bulk, Absorb, Float, and Full Charge), and a manual Equalization (EQ) charge stage. The automatic 4-stage charge process provides complete recharging and monitoring of the batteries without damage due to overcharging (see Figure 3-1). The Equalization stage (requires the ME-RC50 remote) is used to stir up stratified electrolyte and reverse any battery plate sulfation that might have occurred.

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 <85 VAC – the charger reduces the charge current to zero to help stabilize the incoming AC voltage; or
3. FET temperature.

Operation

The automatic 4-stage charging process includes:

- **Bulk Charging:** This is the initial stage of charging. While bulk charging, the charger supplies the battery with constant current. The charger remains in bulk charge until the absorption charge voltage is achieved (14.6 VDC)*—as 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 absorb voltage setting. The absorb charging time is 120 minutes—as 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. The Float Charging stage reduces battery gassing, minimizes watering requirements (for flooded batteries), and ensures the batteries are maintained at optimum capacity. In this stage, the charge voltage is reduced to the float charge voltage (13.4 VDC)* —as determined by the Battery Type selection**—which can maintain the batteries indefinitely.
- **Full Charge (Battery Saver™ mode):** The fourth stage occurs after four hours of float charging. 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 low (≤ 12.7 VDC), the charger will automatically initiate another four hours in float charge.



Info: If the battery voltage falls to the re-bulk voltage (12.1 VDC) or lower, the unit will begin another bulk 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 MMS Series uses changeable settings (see Table 3-2, 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.*

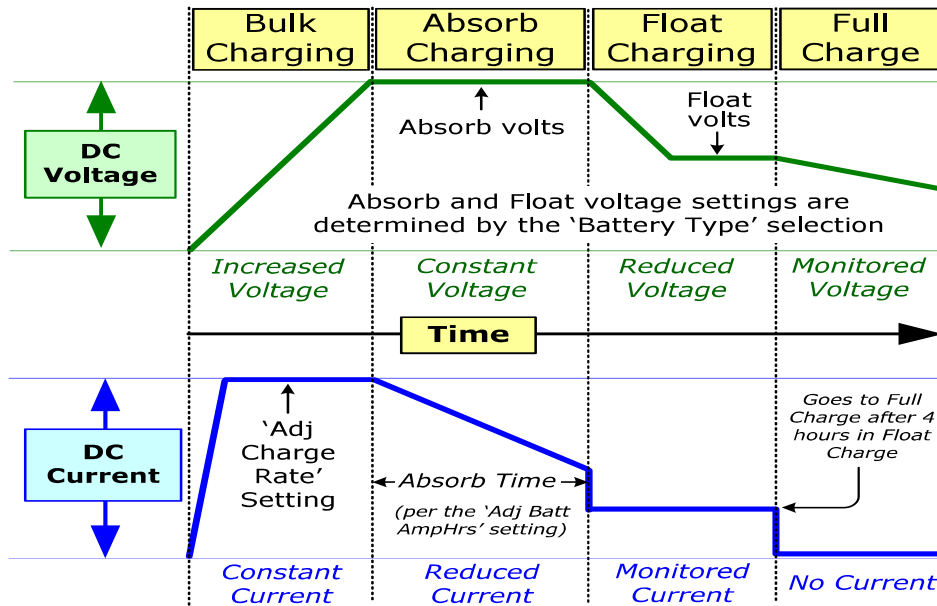


Figure 3-1, Automatic 4-Stage Charging Graph

Transfer time – While in Standby mode, the AC input is continually monitored. Whenever AC power falls below the VAC dropout voltage (80 VAC, default setting), the inverter automatically transfers back to Inverter mode with minimum interruption to your appliances—as long as the inverter is turned on. The transfer from Standby mode to Inverter mode averages approximately 16 milliseconds. While the MMS 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, the voltage on 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 voltage to constantly fall below the inverter’s input VAC dropout threshold.



Info: You must use the ME-RC50 or ME-ARC50 remote to adjust the VAC dropout setting—which in turn determines the VAC dropout threshold.



Info: When switching from Inverter mode to Standby mode, the inverter waits approximately 15 seconds to ensure the AC source is stable before transferring.

Operation

3.2 Battery Temperature Sensor Operation

The plug-in Battery Temperature Sensor (BTS) is used to determine the battery temperature around the batteries. This information allows the multi-stage battery charger to automatically adjust the battery charge voltages for optimum charging performance and longer battery life.

When the BTS is installed, if the temperature around the BTS is below 77°F (25°C) the absorb and float charge voltage increases. If the temperature around the BTS is higher than 77°F (25°C), the absorb and float charge voltage decreases. See Figure 3-2 to determine how much the charge voltage changes (increases or decreases) as the temperature reading of the BTS changes. For example, the nominal absorb charge voltage for a flooded battery at 77°F (25°C) is 14.6 VDC. If the battery temperature is 95°F (35°C), the absorb charge voltage would decrease to 14.3 VDC (14.6 VDC - 0.3 change).

If the temperature sensor is NOT installed, the charge voltages will not be compensated and the battery will maintain the charge it had at a temperature of 77°F (25°C). The life of the batteries may be reduced if they are subjected to large temperature changes when the BTS is not installed.



Info: When the BTS is connected, the battery charger uses a value of $-5\text{mV}/^\circ\text{C}/\text{Cell}$ from 0-50°C to change the charge voltage based on temperature.

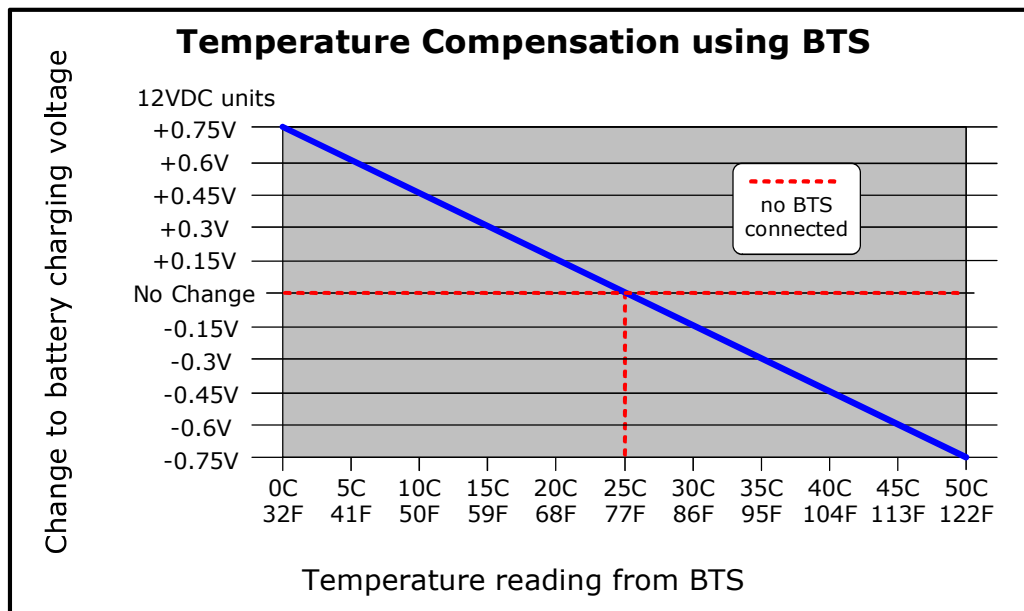


Figure 3-2, BTS Temperature to Charge Voltage Change

3.3 Protection Circuitry Operation

The inverter is protected against fault conditions, and in normal usage it will be rare to see any. However, if a condition occurs that is outside the inverter's normal operating parameters, then it will shut down and attempt to protect itself, the battery bank, and your AC loads. If there is a condition that causes the inverter to shut down, it may be one of the conditions listed below. Refer also to the Troubleshooting section to diagnose and clear the fault.

- **Low Battery** – The inverter will shut off whenever the battery voltage falls to the Low Battery Cut Out (LBCO) level to protect the batteries from being over-discharged. After the inverter has reached the LBCO level and turned off, the inverter will automatically restart after one of the following conditions:
 1. AC power is applied and the inverter begins operating as a battery charger.
 2. Battery voltage rises to the Low Battery Cut In (**LBCI**) level. The inverter's status LED turns off when a low battery fault condition occurs. Refer to Table 3-1 to determine the LBCO and LBCI levels for your particular inverter model.
- **High Battery** – In the event the battery voltage approaches the High Battery Cut Out (**HBCO**) level, the inverter will automatically shut down to prevent the inverter from supplying unregulated AC output voltage. The inverter's status LED turns off when a high battery fault condition occurs. The inverter will automatically restart when the battery falls to the High Battery Cut In (**HBCI**) level. Refer to Table 3-1 to determine the HBCO and HBCI levels for your particular inverter model.



Info: High battery voltage may be caused by excessive or unregulated voltage from solar panels or other external charging sources.

- **Overload** – During Inverter and Standby operation modes, the inverter monitors the DC and AC current levels. In the event of a short-circuit or an overload condition for more than a few seconds, the inverter will shut down. To start operating after this fault, the inverter would need to be restarted (turned back on) after the inverter's AC loads are reduced/removed.
- **Over-temperature** – If internal power components begin to exceed their safe operating temperature level, the inverter will shut down to protect itself from damage. The inverter's status LED turns off to indicate the over-temperature fault condition. The inverter will automatically restart after the units cools down.

Operation

- **Internal Fault** – The inverter continually monitors several internal components and the processor communications. If a condition occurs that doesn't allow proper internal operation, the inverter will shut down to protect itself and the connected loads. The inverter will need to be reset to start operating again.

Note: See Section 4.4 to reset the inverter.

Table 3-1, Inverter Battery Turn On/Off Levels

Inverter Battery Turn On/Off Levels	Inverter Model	
	MMS1012	MMS1012-G
HBCO	>15.8 VDC	>15.8 VDC
HBCI	15.5 VDC	15.5 VDC
LBCI	≥12.5 VDC	≥12.5 VDC
LBCO (one minute delay)	10.0 VDC	10.0 VDC
LBCO (immediate)	8.5 VDC	8.5 VDC

3.4 Inverter Startup

ON/OFF Switch – The MMS Series can be turned on and off by lightly pressing and releasing the ON/OFF switch on the front of the inverter. When the inverter is first 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 inverter on and off.



WARNING: The ON/OFF control switch does not turn on or off the charger feature. If AC power (utility or generator) is connected and qualified on the AC input, this AC power will also be available on the AC output and is not controlled by the ON/OFF switch.

Status LED Indicator – The status indicator is a green LED (Light Emitting Diode) that provides information on the operational mode of the inverter. Watch this indicator for at least 10 seconds to determine the inverter's operational condition from the information below:

Inverter Mode

Off – Indicates the inverter is off; there is no AC power from the inverter, shorepower, or generator at the inverter's output terminals.

- *Blinks On (once every second)* – The inverter is on and is 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 connected loads.

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. Refer to the Troubleshooting section to help diagnose/clear the fault condition.

- *Blinks on x1 every four seconds* – Low Battery fault.
- *Blinks on x2 every four seconds* – High Battery fault.
- *Blinks on x3 every four seconds* – Over-temperature fault.
- *Blinks on x4 every four seconds* – AC Overload fault.
- *Blinks on x5 every four seconds* – Internal fault.

Charge Mode

The green LED status indicator provides additional information:

- *Blinks off every four seconds* – The unit is charging the batteries connected to the inverter. The external AC power (shorepower or generator) connected to the inverter's input is passing through the inverter and is powering the AC loads connected to the inverter's output.

3.5 Factory Default Settings

The MMS Series inverter/charger uses default settings that are adequate for most installations (see Table 3-2). However, you can adjust these parameters using Sensata's optional ME-RC50 remote. The settings once programmed are saved in non-volatile memory and are preserved until changed—even if DC power to the inverter is lost and the ME-RC50 stays connected to the MMS Series inverter. The following adjustable settings in the ME-RC50 remote can help you determine if you need the ME-RC50 remote*.

01 Search Watts: This setting allows you to turn off the power-saving Search mode circuitry and to adjust the power level at which the inverter will “wake up” and start inverting.

02 Low Battery Cut Out: 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).

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

04 Battery Type: This setting identifies the type of batteries being used in the system. This provides information to the charger to determine what voltage level to use to charge the batteries.

Operation

05 Charge Rate: This setting can be used to turn off the charger, or 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.

06 VAC Dropout: Sets the minimum AC voltage that must be present on the AC input before the unit transfers from Standby mode to Inverter mode. This protects the AC loads from utility outages and brown-outs.

The ME-RC50 remote also provides the following features:

- allows you to enable an equalize charge for certain battery types
- displays the inverter/charger's operating status
- displays fault information for troubleshooting

Table 3-2, Inverter/Charger Default Settings

Function	Default Settings
Search Watts	5W
LowBatCutOut	10.0 VDC
Battery AmpHrs	400 AmpHrs (Absorb Time = 90 minutes)
Battery Type	Flooded - Liquid Lead Acid (Absorb = 14.6 VDC, Float = 13.4 VDC)
Charge Rate	100%
VAC Dropout	80VAC

The default settings in Table 3-2 are without a remote connected. If a remote is connected, the remote settings are saved in the inverter—even if the remote is disconnected—until all power to the inverter is removed.

4.0 Maintenance and Troubleshooting

The following information is provided to help you keep your MM Series inverter in optimum operational condition.

4.1 Recommended Inverter and Battery Care

The MMS Series inverter/charger is designed to provide you with years of trouble-free service. It is recommended that every 6 months you perform the following maintenance steps to ensure optimum performance and to extend the life of your batteries.



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

- Check batteries for cracks, leaks, or swelling – replace as needed.
- Use baking soda to clean and remove electrolyte spills or buildups.
- Check and tighten all battery hold-down clamps.
- Clean and tighten (10 to 12 ft-lbs, or 13.6 to 16.3 N m)) all DC terminals (battery and inverter) and connecting cables.
- Check/fill battery water levels (liquid lead acid batteries only).
- Check individual battery voltages (replace those that vary more than 0.3 VDC from each other).
- Check all cable runs for signs of chafing – replace as needed.
- Check the inverter's cooling vents – clean as necessary.

4.2 Off-Season Storage

When placing a vehicle 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 shorepower (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.

4.3 Troubleshooting

The MMS Series inverter/charger is a fairly simple device to troubleshoot. There are only two active circuits (AC and DC), as well as a charging circuit. Table 4-1 is designed to help you quickly pinpoint the most common inverter and charger faults.

Table 4-1, Troubleshooting Guide

Symptom	Possible Cause	Recommended Solution
Low Battery Voltage (the status indicator blinks x1/4 secs)	The battery voltage level has dropped below the Low Battery Cut Out (LBCO) set-point for more than one minute (10.0 VDC = 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 12.5 VDC.
High Battery Voltage (the status indicator blinks x2/4 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 x3/4 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 Over-temp 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.

Maintenance and Troubleshooting

Table 4-1, Troubleshooting Guide (Cont.)

Symptom	Possible Cause	Recommended Solution
AC Overload (the status indicator blinks x4/4 secs)	The inverter has turned off because the connected loads are larger than the inverters 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 x5/4 secs)	This fault occurs when an internal fault is detected.	To clear this fault, an inverter reset is required. Remove all AC and DC power to the inverter, or press and hold down the power switch on the inverter for 15 seconds (till 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 = default setting).	Check incoming AC voltage to 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.
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 temp around the battery sensor.	This is normal; see Section 4.4 (Battery Temperature Sensor Operation) for more information.

4.4 Resetting the Inverter

Under some fault conditions (e.g., an internal fault), the inverter will need to be reset using the procedures below.

4.4.1 Performing an Inverter Reset (i.e., soft reset)

To perform an inverter reset (also known as a “soft reset”):

1. Remove all AC power (i.e., shorepower or gen) to the inverter.
2. Press and hold the ON/OFF switch (see Figure 4-1) for approximately fifteen (15) seconds until the Inverter Status Indicator LED comes on and flashes rapidly.
3. Once the rapid flashing has begun, release the ON/OFF switch. The Status LED will go off after the pushbutton is released.
4. After the inverter reset is completed, press the ON/OFF switch to turn the inverter on.

If the inverter reset fails, perform a power reset using the procedure below. In either case, if an internal fault does not clear, the inverter will require repair at an Authorized Service Center (ASC).



Info: The ON/OFF switch is a small momentary pushbutton that operates by lightly pressing and releasing. Do not apply too much force when pushing or the switch might break.

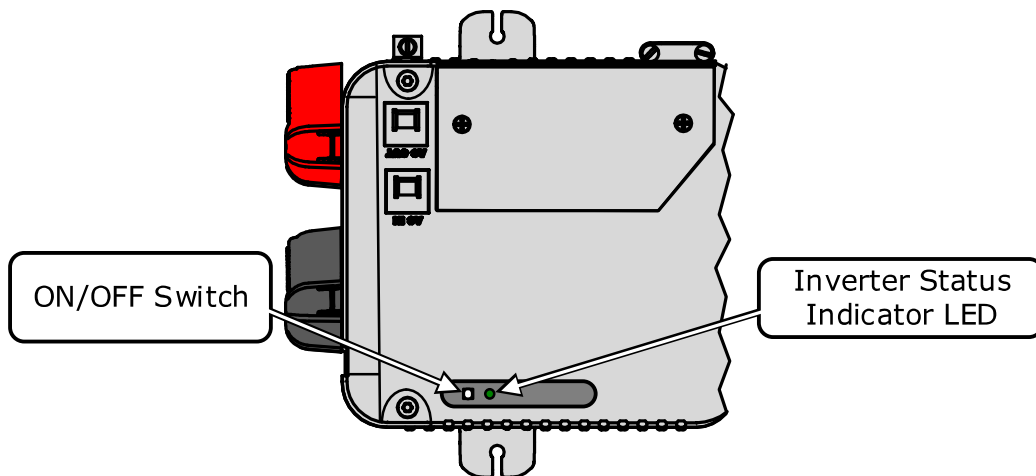


Figure 4-1, Performing an Inverter Reset

4.4.2 Performing a Power Reset (i.e., hard reset)

To perform a power reset (also known as a “hard reset”):

1. Open the inverter’s positive DC disconnect (or disconnect the positive battery cable to the inverter).
2. Ensure the inverter and the remote are disconnected from all AC and DC power.
3. After the inverter has been disconnected from all power for 30 seconds, reconnect the inverter DC disconnects (or reconnect the positive battery cable) and resume operation.



Info: If DC disconnects are not used, there may be a momentary spark when the positive battery cable is connected to the inverter. This is normal and indicates that the inverter’s internal capacitors are being charged.

5.0 Specifications

Table 5-1, MMS Series Specifications

MODEL	MMS1012	MMS1012-G
Inverter Specifications		
Input battery voltage	9 to 17 VDC	
Nominal AC output voltage	120 VAC +/- 5%	
Output frequency and accuracy	60 Hz +/- 0.1 Hz	
1msec surge current	38 AAC	
100msec surge current	21 AAC	
5 sec surge power (real watts)	1750	
30 sec surge power (real watts)	1600	
5 min surge power (real watts)	1200	
30 min surge power (real watts)	1050	
Continuous power output @ 25°C	1000 VA	
Max. continuous input current	133 ADC	
Inverter efficiency (peak)	0.87	
Transfer time	16 msec	
AC transfer capability	15A	
Search mode (typical)	5 watts	
No load (120VAC output, typical)	19 watts	
Output Waveform	Pure Sine Wave	
Charger Specifications		
Continuous output at 25°C	50 ADC	
Charger efficiency	84%	
Power factor	> 0.95	
Input current at rated output	7 AAC	
Battery temp compensation	Yes, 15 ft Battery Temp Sensor standard	
General Features and Capabilities		
Protection circuitry	Low/High Battery, Over-temp & Overload	
Corrosion protection	PCB's conformal coated, powder coated chassis	
AC Output	Hardwire	GFCI outlet
AC Input	Hardwire	3 ft cord
Output circuit breaker	15A	
Input circuit breaker	20 AAC	15 AAC
Internal cooling	Yes, 0 to 59 cfm variable speed	
Optional remotes available	MM-RC or ME-RC50	
UL listing	ETL listed to UL458 & UL1741, CSA C22.2 #107.1, meets KKK-A-1822E std.	
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 (no vents facing downward)	
Weight	23 lbs. (10.4 kg)	
Shipping weight	25 lbs. (11.3 kg)	

Specifications @ 25°C – Subject to change without notice

Appendix A – Battery Information

A-1 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%.

A-2 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.

A-3 Battery Configurations

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 A-1), two 6 VDC/200 AHr batteries are combined into a single string—resulting in a 12 VDC/200 AHr bank.

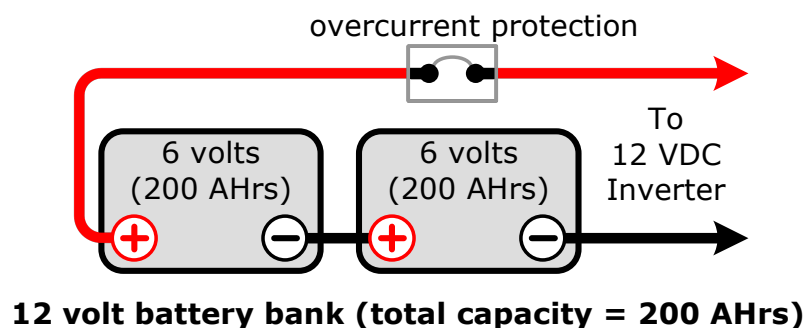
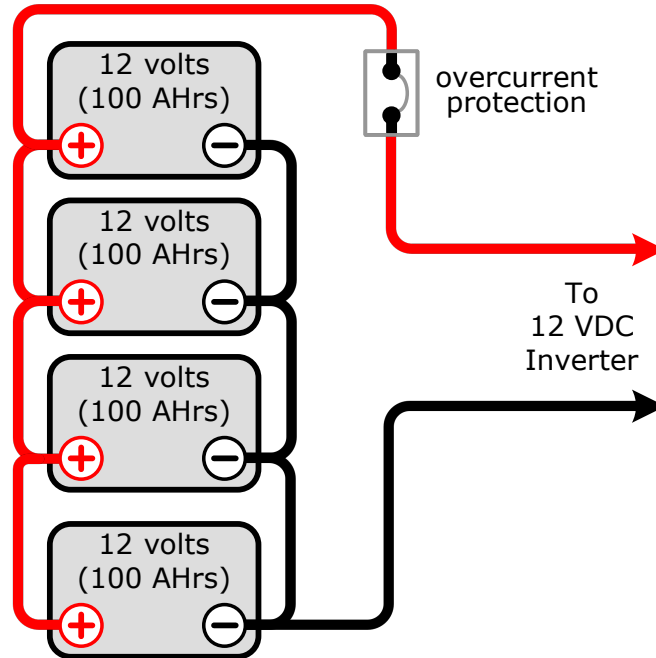


Figure A-1, Series Battery Wiring

Appendix A – Battery Information

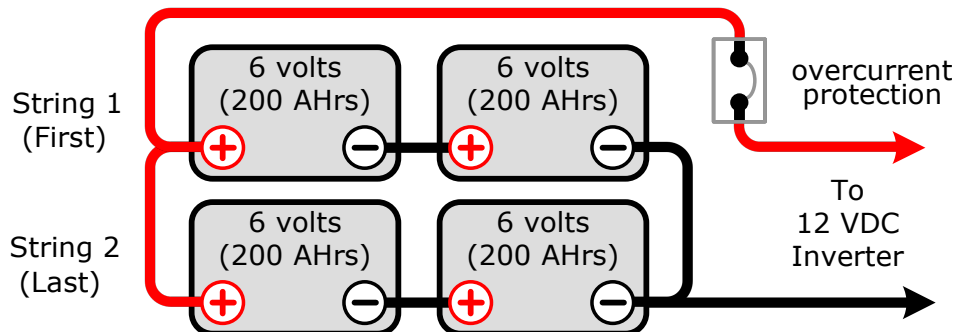
- **Parallel Wiring** – When batteries are wired in parallel, the total run time the batteries can operate the AC loads (i.e., amp-hr capacity) increases. A parallel connection combines overall battery capacity by the number of batteries in the string. Even though there are multiple batteries, the voltage remains the same. In the example below (Figure A-2), four 12 VDC/100 Ahr batteries are combined into a single 12 VDC/400 Ahr battery bank.



12 volt battery bank (total capacity = 400 AHrs)

Figure A-2, 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 A-3), four 6 VDC/200 Ahr batteries are combined into two strings resulting in a 12 VDC/400 Ahr battery bank.



12 volt battery bank (total capacity = 400 AHrs)

Figure A-3, Series-Parallel Battery Wiring

Appendix B – Remotes and Optional Equipment

B-1 Remote Controls

There are several remotes that enable you to monitor and switch the inverter on/off from a convenient location. The remotes connect to the REMOTE port located on the front side of the MMS Series inverter (see Figure 1-4, Item 14).

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

- **MM-RC** – Provides six LED indicators for identifying inverter and charger status, and includes a remote ON/OFF switch (with 25' cable).
- **ME-RC50** – Full feature remote with backlit LCD display and LED indicators for identifying 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.

B-2 Optional Equipment and Accessories

The following components are available for use with MM Series inverters. Some of these items are required—depending upon the intended use of the inverter.

Auto Generator Start Controller

The ME-AGS-N Automatic Generator Start controller (Network version) is designed to automatically start your generator based on low battery condition or high temperature. It works with 12, 24, and 48-volt battery banks and includes a 4-position DIP (Dual In-line Package) switch which provides the ability to change the relay timing configurations to allow compatibility with a wider range of generators.

Battery Monitor Kit

The ME-BMK Battery Monitor Kit is a single battery bank amp-hour meter that monitors the condition of the battery and provides information to let you know how much energy you have available and to plan your electrical usage to ensure the battery is not being over-discharged. The ME-BMK-NS version does not include a DC shunt—order the ME-BMK to receive a 500A/50mv DC shunt.

Fuse Block/Fuses

Fuse/Fuse-blocks are used to protect the battery bank, inverter, and cables from damage caused by DC short circuits and overloads. They include a slow-blow fuse with mounting block and protective cover. The 125 and 200-amp models use an ANL type fuse and the 300 and 400-amp models use a Class-T type fuse.

DC Load Disconnect

The MM-DCLD (DC Load Disconnect) pigtail adapter is designed to provide a means to DISABLE the inverter function when a 12-volt DC signal is removed.

Ignition Switch Activate

The MM-ISA (Ignition Switch Activate) is a pigtail adapter designed to ENABLE the inverter function when a 12-volt DC signal is supplied.







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