

MAGNUM **E N E R G Y**



MMSA1012 Pure Sine Wave Inverter/Charger Owner's Manual

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Restrictions on Use

The MMSA1012 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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This entire manual is available for download—with many of the diagrams in color—on our website at:

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Model:	Serial Number:
<input type="checkbox"/> MMSA1012	WBG

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.
- No AC or DC disconnects are provided as an integral part of this inverter. Both AC and DC disconnects must be provided as part of the system installation.
- No overcurrent protection for the battery supply is provided as an integral part of this inverter. Overcurrent protection of the battery cables must be provided as part of the installation.

Safety Information

- 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 ALL INSTRUCTIONS

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 ou des suppléments 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.
- 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.

Safety Information

- 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.
- 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.

CONSERVER CES INSTRUCTIONS

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1.0 Introduction

Congratulations on your purchase of an MMSA1012 inverter/charger from Sensata Technologies. This product is designed to be powerful, yet simple to use, and will provide you with years of trouble-free use. Please read this chapter to familiarize yourself with the features and benefits of the MMSA1012 inverter/charger.

1.1 MMSA1012 Inverter/Charger

The MMSA1012 is a 1000-watt inverter/charger with a 50-amp, 4-stage PFC charger. The AC loads are connected to an on-board GFCI outlet, and the connection to the AC input for charging is provided by a standard 3 ft. plug-in power cord. Includes isolated input/output neutrals, and a 15' battery temperature sensor.



Figure 1-1, MMSA1012 Inverter/Charger

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. The MMSA1012 inverter/charger also takes alternating current 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 AC for powering your vehicle.
- **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 Advantages of a Pure Sine Wave Inverter

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

Modified sine wave inverters approximate a pure sine waveform and will run most appliances and electronics without any problems.

The output of a pure sine wave inverter is equal to, or in many ways, better than the shorepower 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.

1.4 Appliances and Run Time

The MMSA1012 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 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 MMSA1012 inverter has a built-in safeguard that automatically protects your batteries from being over-discharged.

1.5 Standard Features and Benefits

The MMSA1012 inverter/charger converts 12-volt direct current (VDC) power from your battery to 120-volt alternating current (VAC) power. With the multi-stage battery charger feature, the incoming AC power is optimized using Power Factor Correction (PFC) technology to keep the inverter's battery bank fully charged. The MMSA1012 is designed to allow easy installation and use, and its die-cast aluminum baseplate ensures maximum durability and a cooler, more efficient operation.

The MMSA1012 inverter/charger is equipped with the following:

- Continuous 1000-watt output power and 50-amp charging at 45°C (113°F)
- Numerous protection features to provide peace-of-mind operation and safe 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)
- DC terminals with Anderson connectors for quick DC connection
- True RMS output voltage regulation to ensure the inverter will deliver the correct amount of power—within the DC input voltage range and the continuous output power level
- Quick connection accessory and remote ports—easily accepts several optional remote controls and the Battery Temp Sensor

1.5.1 External MMSA1012 Features

This section covers the many features available on the MMSA1012 inverter.

- 1 Power ON/OFF Switch & LED Status Indicators** – a momentary pushbutton switch that alternately turns the inverter on or off, and five LED status indicators (INV, BULK, ABSORB, FLOAT, and FAULT) for monitoring inverter and charger operation.
- 2 Auxiliary Output Circuit Breaker (AUX OUT)** – a 20-amp circuit breaker that provides overload protection for the aux DC output.
- 3 Input Circuit Breaker (AC IN)** – a 15-amp circuit breaker to protect the unit's internal wiring and pass-thru relay.
- 4 Output Circuit Breaker (AC OUT)** – a 15-amp circuit breaker to provide another layer of overload protection. This is not a branch circuit-rated breaker. Separate output breakers may be required on the output.
- 5 GFCI Outlet** – a Ground Fault Circuit Interrupter outlet (with test and reset capability).
- 6 Mounting Flanges (x4)** – two flanges on each side to secure the inverter to a shelf/wall.

Introduction

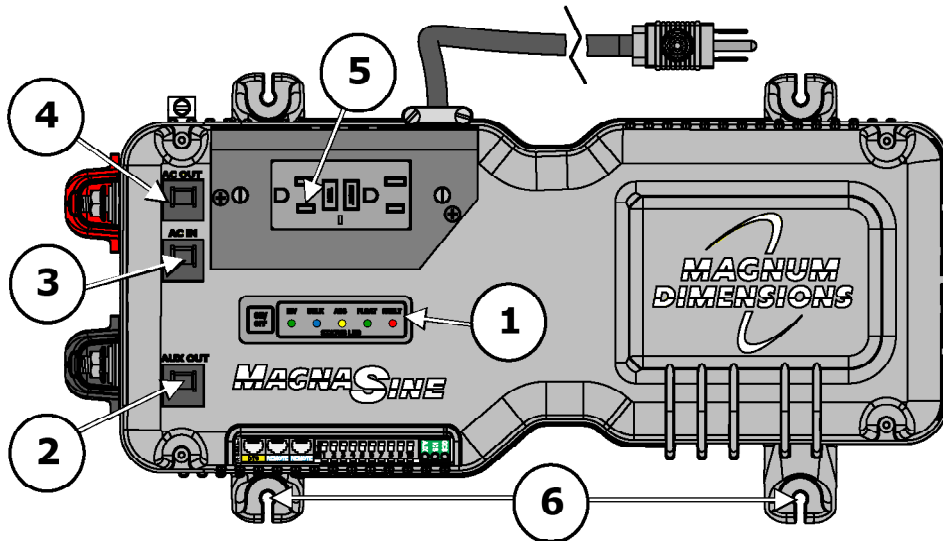


Figure 1-2, Top Side Features

- 7 AC Input Connection** – a strain relief clamp with a 3 ft. standard plug-in power cord to provide AC power to the inverter.
- 8 DC Ground Terminal** – a ground connection used to tie the exposed chassis of the inverter to earth ground, or to the vehicle's DC grounding system. Terminal accepts CU/AL conductors from #14 to #6 AWG (2.1 mm² to 13.3 mm²).

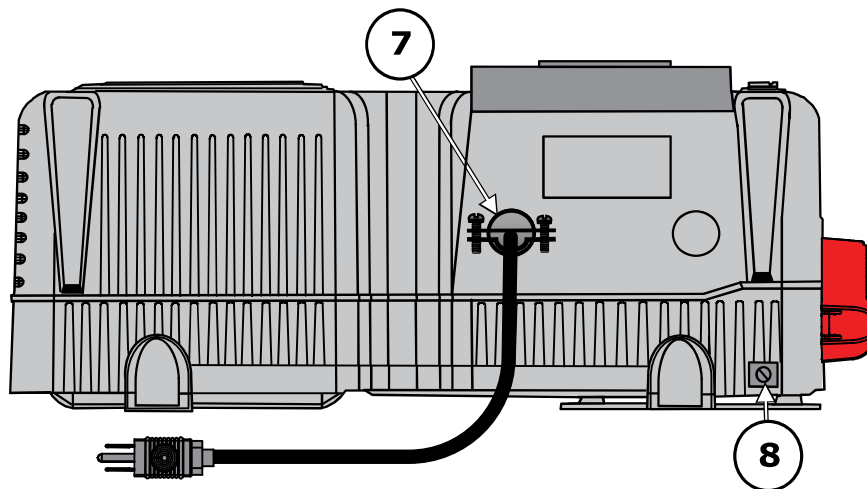


Figure 1-3, Left Side Features

Introduction

- 9 **Battery Temperature Sensor Connection** – a RJ11 port that accepts the supplied remote Battery Temp Sensor (BTS) cable.
- 10 **Remote Connections** – two RJ11 ports that allow two remote controls to be connected for adjusting/monitoring inverter and charger operation.
- 11 **Dual In-line Package (DIP) Switch** – 10 individual slide switches that are used to determine the MMSA inverter/charger’s operating parameters.
- 12 **3-Port Terminal Block** – three spring-loaded clip terminals to connect an optional 20-amp DC auxiliary device, a ignition control switch, and a ground remote control switch.

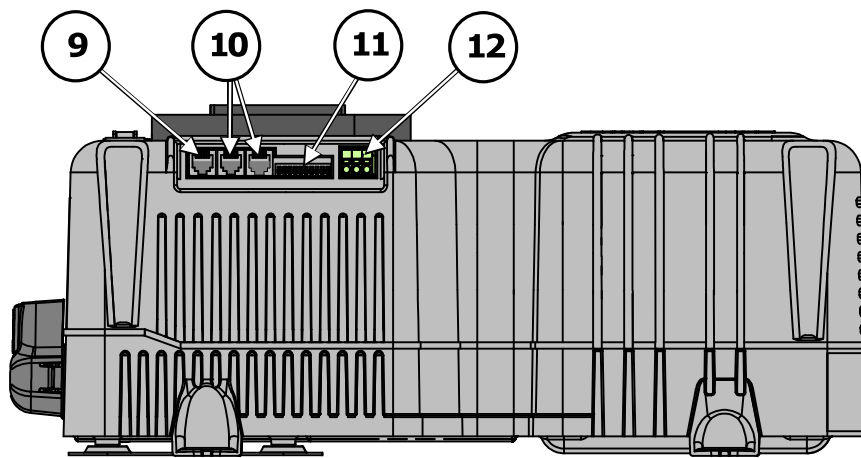


Figure 1-4, Right Side Features

- 13 **Exhaust Vent** – ventilation openings that allow heated air to be removed by the internal cooling fan.
- 14 **Model/Serial Number Label** – includes model/serial number and provides specifications and information on the inverter and charger.

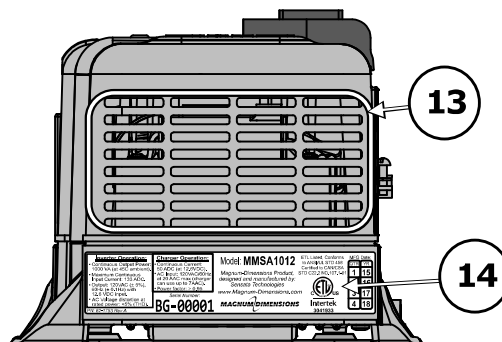


Figure 1-5, Back Side Features

Introduction

- 15 **Warning and Information Label** – provides pertinent information for safely using the inverter.
- 16 **Positive DC Terminal** – the inverter’s connection to the positive terminal on the battery bank. The MMSA1012 comes with one end of a red #2 AWG DC cable already connected to the inverter’s positive terminal (Figure 1-6), and the other end with an Anderson connector (SB175) attached (Figure 1-7).
- 17 **Negative DC Terminal** – the inverter’s connection to the negative terminal on the battery bank. The MMSA1012 comes with one end of a black #2 AWG DC cable already connected to the inverter’s negative terminal (Figure 1-6), and the other end with an Anderson connector (SB175) attached (Figure 1-7).
- 18 **Intake Vent** – ventilation openings to pull in air to help keep the inverter cool for peak performance.

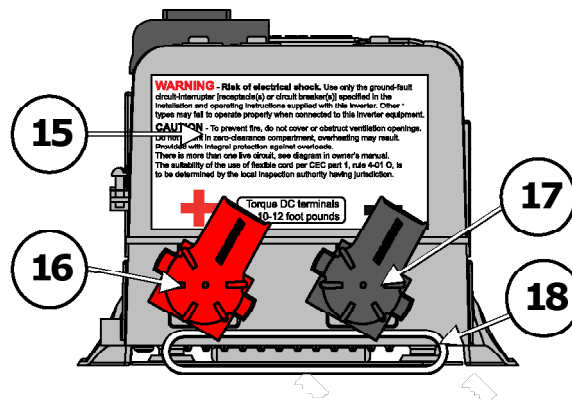


Figure 1-6, Front Side Features

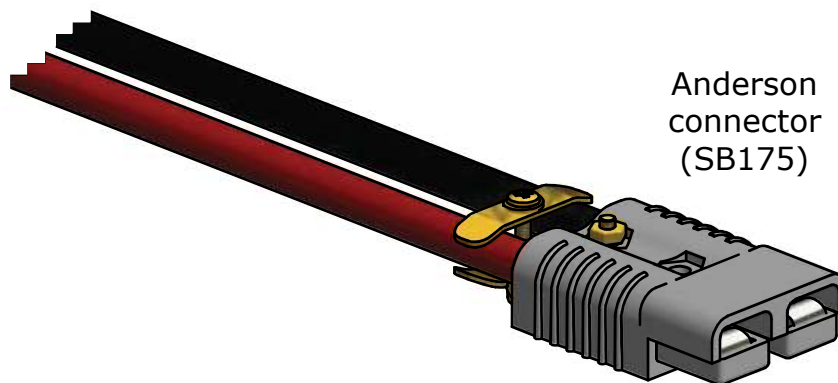


Figure 1-7, MMSA1012 Inverter’s Anderson Connector

1.5.2 Battery Temperature Sensor

A plug-in external Battery Temperature Sensor (BTS) is provided (Figure 1-8). 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, the battery life may be shortened.

The BTS cable comes with a RJ11 connector that plugs into the BTS port on the side of the inverter (Figure 1-4, Item 9). Refer to Figure 2-4 for installation instructions, and to Section 4.4 for information on the operation of the BTS.

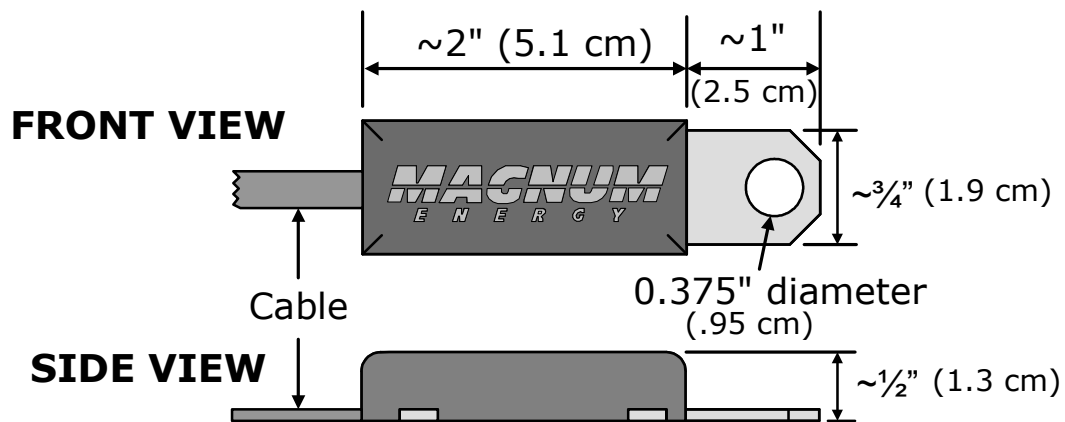


Figure 1-8, Battery Temperature Sensor (BTS)

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 safety information on pages ii-v before proceeding with the installation.

The basic system diagram shown in Figure 2-1 should be reviewed to assist you in planning and designing your installation. This drawing is not intended to override or to restrict any national or local electrical requirements. This drawing 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 MMSA1012 inverter from its shipping container and inspect all contents. Verify the following items are included:

- MMSA1012 inverter/charger
- Connected positive and negative battery cables with Anderson connector attached
- Battery Temperature Sensor
- MMSA1012 Owner's Manual
- Warning label

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

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.

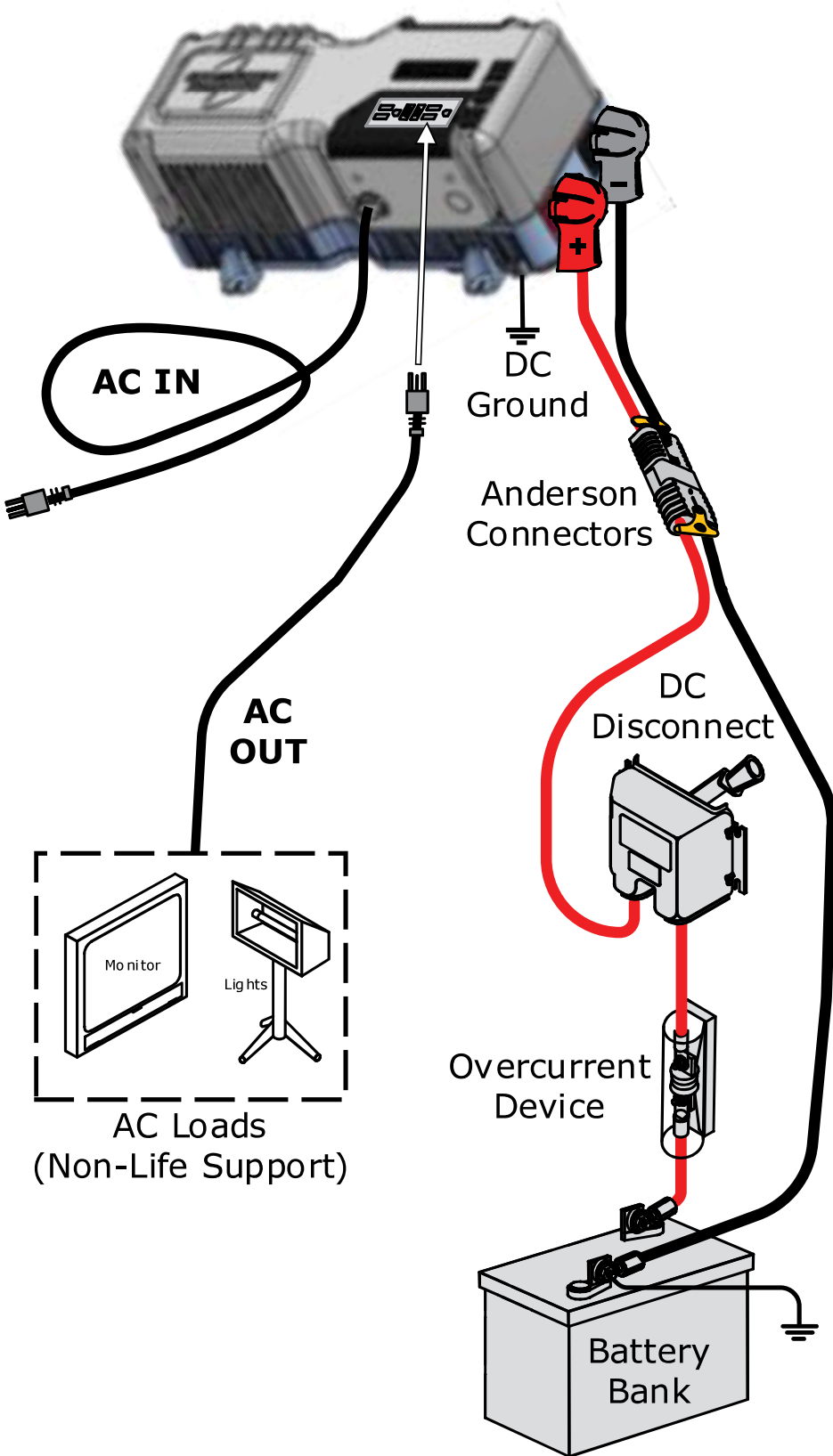


Figure 2-1, MMSA1012 Model Basic Installation Diagram

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.
- Maximum ambient temperature around the inverter must not exceed 113°F (45°C) to meet 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. This area also must be free from any risk of condensation, water, or any other liquid that can enter or fall on the inverter. The inverter uses stainless steel fasteners, plated copper 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 to any equipment that produces extreme heat. The ambient air temperature should be between -4°F and 140°F (-20°C to 60°C); realize that the inverter’s continuous output power and continuous charger current are rated at 113°F (45°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 and ensure there is enough space to allow heated air inside the inverter to escape. Provide as much clearance around the inverter’s intake and exhaust ventilation openings as possible (Figure 1-5, Item 13 and Figure 1-6, Item 18). 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 is recommended to allow cool air from the outside to flow into the inverter and heated air to exit away from the inverter and the enclosure.

Safe – Keep flammable/combustible materials (e.g., paper, cloth, plastic, etc.) that may be ignited by heat, sparks, or flames at a minimum distance of 2 feet (60 cm) away from the inverter. Do not install this inverter in an area that contains extremely flammable liquids like gasoline or propane, or in locations that require ignition-protected devices.

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 DC wiring connections as they will need to be checked and tightened periodically. See Figure 2-3 for the dimensions of the MMSA1012.

Mounting Orientation – To meet regulatory requirements, the MMSA1012 can only be mounted on a horizontal surface (right-side up or up-side down on a shelf/table) or vertical surface (right-side up on a wall/bulkhead), as shown in Figure 2-2. 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.

As 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. Once the inverter has been properly mounted, you can begin to wire the DC connections.

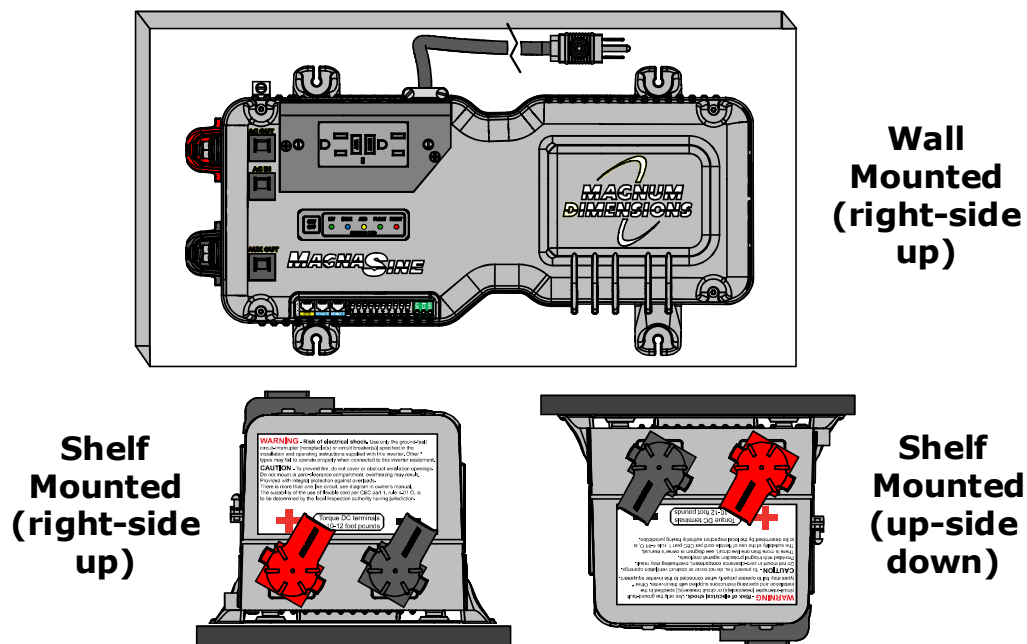


Figure 2-2, Approved Mounting Orientations

Installation

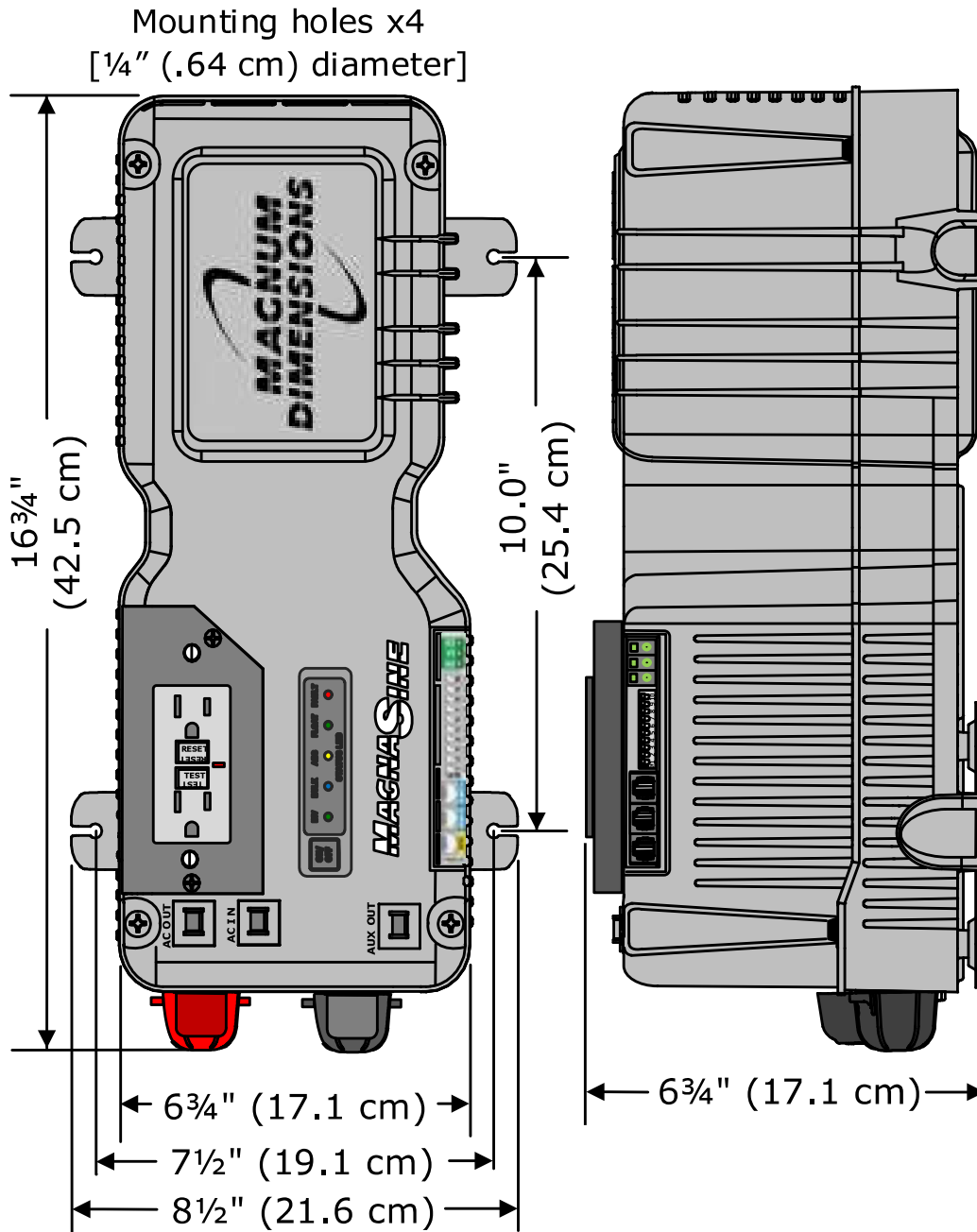


Figure 2-3, MMSA1012 Inverter Dimensions

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: 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.



CAUTION: DO NOT connect the battery cables to the inverter until all wiring is complete and the correct DC voltage and polarity have been verified.

Refer to Figure 2-4 when connecting the DC wires to the battery. Also, to ensure maximum performance 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 and disconnect, or the DC circuit breaker—required at the battery to protect the DC wiring—in the positive line. Any other additional connection will contribute to additional 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. Do not use the chassis in place of the battery negative connection to the inverter.

Installation

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. If the distance from the inverter to the battery bank is greater than 5 feet (152.4 cm), use the bottom part of this 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

		MMSA1012
Maximum Continuous Current¹		133 amps
DC Grounding Electrode Wire Size²		#6 AWG (13.3 mm ²)
Minimum DC Wire Size³ [75°C rating in free air]		#2 AWG (33.6 mm ²) [170 amps]
DC Fuse Size⁴		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)
	10 to 15 ft (3.0 to 4.6m) =	#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.

2.3.2 DC Overcurrent Protection

For safety reasons and to comply with electrical code regulations, DC overcurrent protection must be provided as part of the installation. The DC overcurrent protection device must be installed in the positive DC cable line, it can be a fuse or a circuit breaker and must be DC-rated. 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. The NEC requires both overcurrent protection and a disconnect switch.

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.

Because batteries can deliver thousands of amps in an instant during a short, 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 all the batteries in the 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 fuse size (coordinated with the DC wire size) recommended for your inverter.

2.3.3 DC Grounding

The MMSA1012 inverter should always be connected to a permanent, grounded wiring system. The idea is to connect the metallic chassis of the various enclosures together to have them at the same voltage potential, which reduces the possibility for electric shock. For the majority of installations, the inverter chassis and the negative battery conductor are connected to the system's ground bond via a safety-grounding conductor at only one point in the system. The grounding conductor for the DC system shall meet the sizing requirements specified in the NEC for the application, but must be no smaller than #8 AWG copper.

If installing in a vehicle, do not attempt to 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. If any non-factory installed appliances are onboard the vehicle, DO NOT ground them at safety ground. Only ground them at the negative bus of the DC load center (as applicable).

Installation

2.3.4 DC Cable Connections

Do not put anything between the battery cable ring lug and the battery post (see Figure 2-4). When connecting the battery cable, it should be placed directly against the battery post. Incorrectly installed hardware causes a high resistance connection which could lead to poor inverter performance, and may melt the cable and terminal connections. Torque from 10 to 12 ft-lbs.

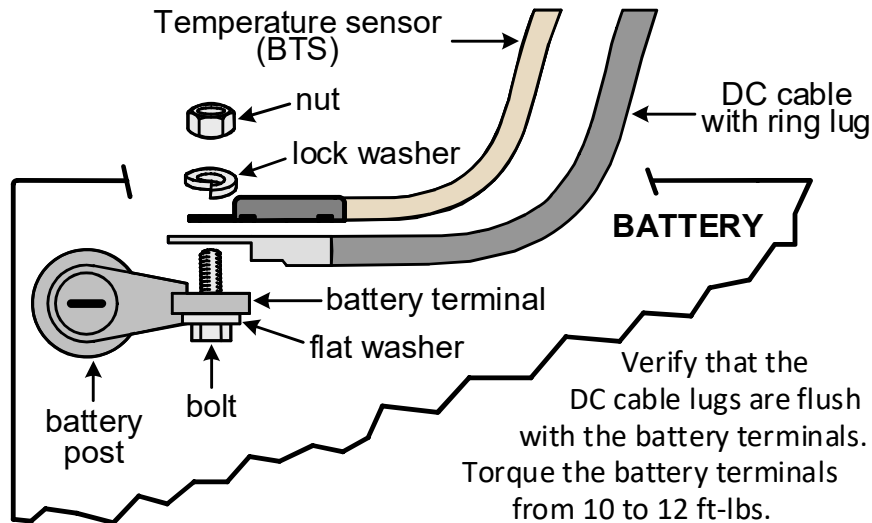


Figure 2-4, DC Cable to Battery Terminals

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 wiring complete, 2) the correct DC and AC overcurrent protection have been installed, and 3) the correct DC voltage and polarity have been verified.



Info: For optimum performance, a minimum battery bank of 200 AH 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 to provide 12 VDC (see Appendix B – Battery Information, for guidance on wiring batteries together). The interconnecting DC wires must be sized and rated exactly the same as those that are used between the battery bank and the inverter.

Place the batteries as close as practical to the inverter, preferably in an insulated and ventilated enclosure. Allow adequate space above the batteries to access the terminals and vent caps (as applicable). Allow $\geq 1"$ (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 (utility/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/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.

2.3.6.1 Wiring the Battery Bank to a MMSA1012 Inverter

Use the following information to safely connect the MMSA1012 inverter to your battery bank. Refer to Figure 2-1 before proceeding.

Inverter's DC Positive and Negative Wires

The MMSA1012 inverter comes with the positive and negative DC battery cables secured to the unit (and the red/black terminal covers in place). The DC cables have an attached Anderson connector.

Important: *You must supply a compatible Anderson connector (see Figure 1-7) for the battery bank cable side (per Figure 2-1).*

Installation

Battery Bank's DC Positive Wire

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



WARNING: DO NOT close the DC fuse/disconnect (or close the DC circuit breaker) to enable battery power to the inverter at this time. Wait for the **Functional Test**.

2. Connect a short wire (same rating as the DC wires) from one end of the fuse block to the positive terminal of the first battery string (see Figure B-3).
3. Connect another short wire (same rating as the DC wires) from the other end of the fuse block to one end of the DC disconnect.
4. Using a compatible Anderson connector (not supplied), route and connect its appropriately sized DC positive wire (RED) to the other end of the DC disconnect.

Battery Bank's DC Negative Wire

5. Route and connect the appropriately sized DC negative wire (BLACK) from the Anderson connector you supplied (Step 4) to the negative terminal of the last battery string. This ensures even charging and discharging across the entire battery bank.

DC Ground Wire

6. Route an appropriately sized DC grounding wire (GREEN or bare wire) from the inverter's DC Ground Terminal (Figure 1-3, Item 8) to a dedicated system ground. Torque to 45 in-lbs.

Battery Temperature Sensor

7. Connect the RJ11 connector end of the BTS to the BTS port (Figure 1-4, Item 9) on the inverter.
8. Connect the other end of the BTS to the negative terminal of the last battery string (place hardware per Figure 2-4).

Final Checks

- Connect the two Anderson connectors.
- Ensure the DC wire connections (on the battery terminals, fuse lugs/DC circuit breaker, and disconnect) are flush on the surface of the DC terminals, and the hardware (lock washer and nut) used to hold these connections in place are stacked correctly (see Figure 2-4).
- Verify all DC connections are torqued from 10 to 12 ft-lbs.
- Once the DC connections are completely wired and tested, coat the terminals with an approved anti-oxidizing spray.
- If batteries are in an enclosure, check the hold down brackets and all connections. Close and secure the battery enclosure.

2.4 Connecting to the 3-Port Terminal Block

The MMSA inverter/charger provides a 3-port terminal block on the right side of the unit (Figure 2-5) that can be used to connect an auxiliary DC load—(AUX), an ignition control switch—(ICS), and a ground control switch—(GCS). See also Figure 2-6.



Figure 2-5, MMSA1012's 3-Port Terminal Block

Aux DC Output (AUX)

The Aux Output port provides auxiliary DC power from the battery for small loads not exceeding 20 amps (e.g., an interior lamp, backup camera, etc.). Whenever +12V is applied to the ignition (ICS) input, an internal relay closes and provides battery voltage (up to 20 amps) on the auxiliary (AUX) DC output.



Info: The MMSA inverter/charger must be connected to the battery for the aux DC output to be available.

Ignition Control Switch (ICS)

With an ignition switch (a +12 VDC signal) wired to this port, the inverter automatically turns on (in turn disabling the inverter's ON/OFF switch and the remote's ON/OFF button—if connected). Refer to the Switch 2 section on pages 26-27 for information on setting up an ignition control switch for your system, and for other conditions and considerations that affect this feature.

Ground Control Switch (GCS)

With a ground switch wired to this port, you can automatically turn on the MMSA1012 inverter/charger (in turn disabling the inverter's ON/OFF switch and the remote's ON/OFF button—if connected). Refer to the Switch 3 section on page 27 for information on setting up a ground control switch for your system, and for other conditions and considerations that affect this feature.

2.5 Remotes and Remote Settings

Sensata Technologies offers several remotes that let you monitor the inverter/charger and enable you to switch the inverter on/off from a convenient location. Using cables with RJ11 connectors (included with purchase of remote), the remotes easily connect to either of the inverter's Remote ports (Figure 2-6).

Note: Only **one** remote control (e.g., MM-RC, ME-RC, or ME-ARC) can be connected to the inverter at any time. Only the MM-C monitor can be connected to the inverter with one of the remote controls.

MM-C (monitor only) – Provides three LED indicators (BULK, ABSORB, FLOAT) for charger status; comes with a 25' cable.

MM-RC – Provides six LED indicators for inverter and charger status, and includes a ON/OFF power switch; comes with a 25' cable.

ME-RC50/ME-ARC50 – Full feature remotes with backlit LCD display and LED indicators for inverter and charger status. Provide full menu access for easy selection and adjustment; come with a 50' cable. These remotes are used for many inverter models and have additional features that are not functional with the MMSA1012.

Do I need an optional ME-RC or ME-ARC remote?

An optional ME-RC50 or ME-ARC remote control provides additional settings not provided by the DIP switch settings. Review the following information and the adjustable settings in the remote owner's manual to determine if the inverter's (DIP switch) default settings (per Table 4-3) are adequate for your system needs.

Search Watts: This setting allows you to enable the power-saving Search mode circuitry and to adjust the power level at which the inverter will "wake up" and start inverting. This function is set to 5W ("wakes up" and inverts if loads exceed 5 watts) on the MMSA1012.

LBCO: This setting determines when the inverter turns off based on low battery voltage. This protects the batteries from over-discharge and the AC loads from unregulated power (brown-outs).

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

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

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

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

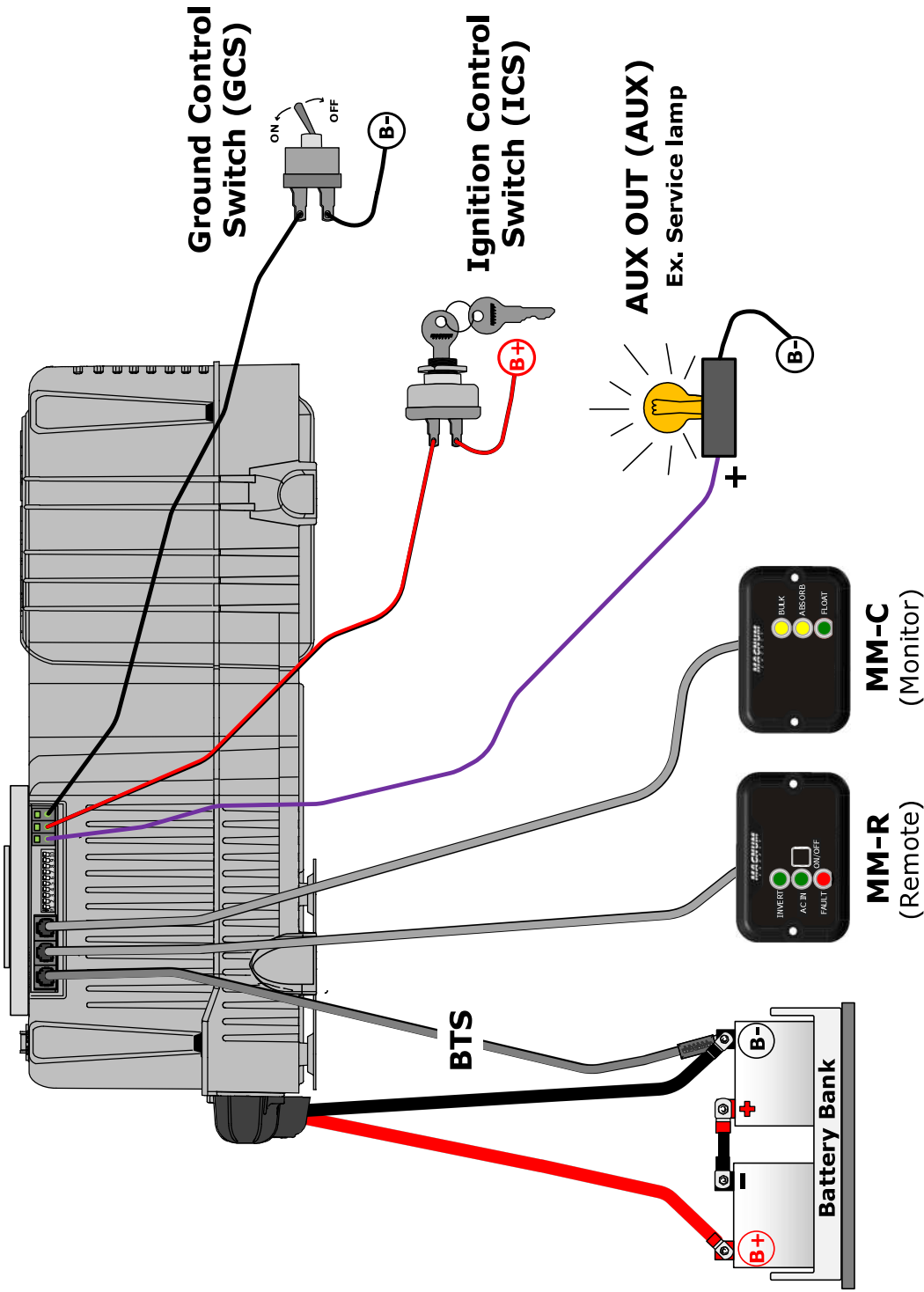


Figure 2-6, MMSA1012 Accessory Connections

Installation

2.6 GFCI Breakers

When installing a MMSA1012 inverter in an ambulance's wiring system, a ground fault circuit interruption breaker (GFCI) may be installed to protect some branch circuits powered by the inverter. In compliance with UL standards, Sensata has tested the following GFCI's and has found that they function properly when connected to the inverter's AC output (there are others on the market that will work as well): Leviton 8899-A, N7899, GFNT1 and GNNT2; Hubbel GF520EMBKA, GFRST15xx and GFRST20xx; and Cooper VGF15W Series.



WARNING: Risk of electric shock. Use only ground-fault circuit interrupters (receptacles or circuit breakers) that are compatible with your MMSA inverter. Some types may fail to operate properly when connected to this inverter equipment.



WARNING: Ground Fault Circuit Interrupters (GFCIs) shall be installed in the recreational vehicle's wiring system to protect all branch circuits.

2.7 Inverter Warning Label

The warning label (Figure 2-7) 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 2-7, Warning Label

2.8 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 15 VDC at the batteries' positive and negative terminals.
2. Apply battery power to the inverter by switching the DC disconnect on (or close the DC circuit-breaker). The inverter remains off, but the LED status indicators go through a start-up test (see Section 4.1.1) to indicate that DC power has been connected and is ready to be turned on.
3. Prior to turning on the inverter, ensure all connected loads (e.g., medical devices) are switched off or disconnected from the AC outlets.
4. a) If a remote switch is connected, press the remote's ON/OFF switch to turn on the inverter.
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 inverter's INV LED status indicator is solid (not blinking)—indicating the inverter is providing AC power. If the LED is blinking, turn off Search mode (DIP Switch 4 in UP position).
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. Turn on or connect a load and verify it comes on. Continue to keep the load connected and turned on.
7. Press the remote's ON/OFF switch to turn the inverter off. If no remote switch is connected, press and release the inverter's ON/OFF power switch to turn the inverter off. The INV LED status indicator and the connected load should go off.
8. Apply AC power to the inverter's AC input. After the AC input power is qualified (approximately 15 seconds), the incoming AC power transfers through the inverter to the AC output and the connected load is powered. Verify one of the inverter's CHG LEDs illuminates and the connected load comes on.
9. Even though the connected load is on, the inverter is currently disabled/off. Press the remote's ON/OFF switch (or press and release the ON/OFF power switch on the inverter) to enable/turn-on the inverter.
10. Disconnect the incoming AC power to the inverter. Verify the connected load remains on—but now is powered by the inverter.

If the inverter passes all the steps, the inverter is ready for use.

If the inverter fails any steps, refer to the Troubleshooting section.

3.0 Setup

When the MMSA inverter/charger is not connected to a remote, the internal DIP switches (Figure 1-4, Item 11) are used to determine its operation.



Info: When the MMSA is connected and networked with a remote, the remote can be used to set up and/or control the MMSA1012's operation. Refer to your remote owner's manual for setup information.

3.1 Adjusting DIP Switch Settings

The DIP (Dual In-line Package) switch includes 10 individual slide switches that can be set to the UP or DOWN position (Figure 3-1). As a standalone inverter, the arrangement of the 10 switches determines the MMSA's operating parameters. The default setting (all DIP switches UP) is adequate for most installations, however you have the option to change some of the operating parameters. This section shows how to set the DIP switch and provides information on each switch setting's function. Use the DIP switch adjustments described below to configure your MMSA1012 inverter/charger.



CAUTION: The MMSA does not warn against or disallow incorrect DIP switch settings. Ensure the settings used to charge the batteries—the *Absorption Done Time* and *Battery Type* selections—are carefully checked against your battery's specifications. Incorrect settings may damage the battery or shorten battery life.



Info: When changing any DIP switch setting, ensure each switch is fully in the UP or DOWN position as needed. The switch settings can be changed at any time, even while the unit is operating. DIP switch changes become effective when initiated, and do not require power to the MMSA to be cycled on and off.

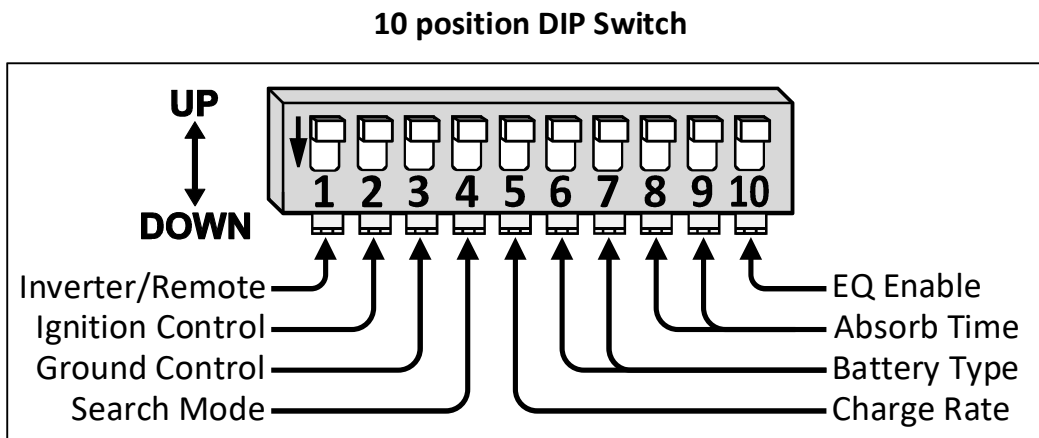


Figure 3-1, DIP Switch Summary

Switch 1: Use Inverter or Remote Settings

When a remote control is connected to the MMSA, DIP Switch 1 determines whether the MMSA uses the inverter's (DIP) settings or the connected remote's settings to set up and/or control the MMSA's operation.

If DIP Switch 1 is UP, the inverter runs on the DIP switch settings (See Table 4-3). If DIP Switch 1 is UP and a remote is connected, the inverter continues running on the DIP switch settings and ignores the remote settings—except for any settings not determined by any of the DIP switches.

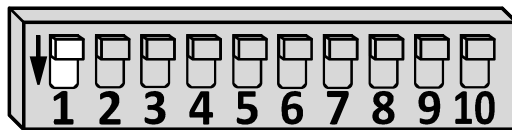
When DIP Switch 1 is DOWN and a remote control is connected to the MMSA, the settings from the remote are used instead of the DIP switch settings. **Note:** *The inverter continues to use the remote settings even if the remote is then disconnected—until power to the inverter is cycled, or DIP Switch 1 is set UP.*



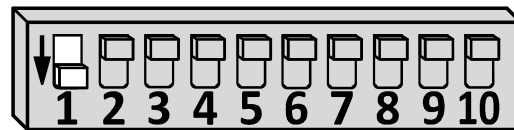
Info: If DIP Switch 1 is DOWN and a remote control is not connected or detected, the DIP switch settings will be used instead.



Info: If a remote is connected and DIP Switch 1 is in the DOWN position, the settings from the remote control override all DIP switch settings except for Switches 2, 3, and 10—which are still active with a remote connected.



Use DIP Switch Settings
(UP)



Use Remote Settings
(DOWN)

Switch 2: Ignition Control Switch (ICS)

In certain installations it may be desirable to automatically turn on loads connected to the inverter (e.g., backup camera) when a +12VDC signal is supplied to the ICS terminal (Figure 1-4, Item 12)—such as when turning on an ignition switch. The position of the Ignition Control Switch (DIP Switch 2) determines if a +12VDC signal connected to the ICS terminal causes the MMSA inverter to automatically turn on—and the ON/OFF switch on the inverter (and remote control, if connected) to be disabled.

If DIP Switch 2 is UP (ignition control disabled), a +12VDC signal connected to the ICS terminal is ignored and has no effect on turning the inverter on/off, and the inverter's ON/OFF switch (and remote control, if connected) can be used to turn the inverter on and off.

If this DIP switch is DOWN (ignition control enabled), the inverter is forced on and cannot be turned off when a +12VDC signal is connected to the ICS terminal; and is forced off and cannot be turned on when the +12VDC signal is removed.

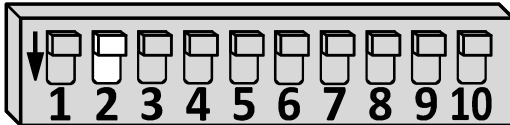
Setup



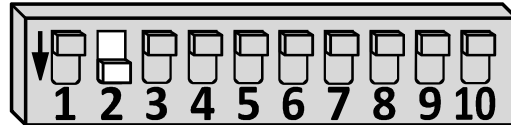
Info: If the inverter is on, supplying a +12VDC signal to the ICS terminal causes the 20A aux DC output voltage to be available on its output terminal—even if the ignition control switch is disabled (i.e., DIP Switch 2 is UP).



Info: If DIP Switches 2 & 3 are both enabled (DOWN), then both signals (+12VDC and ground) must be connected to their appropriate terminals for the inverter to be forced on; and when one or both signals are removed, the inverter is forced off.



Ignition Control Disabled
(UP)



Ignition Control Enabled
(DOWN)

Switch 3: Ground Control Switch (GCS)

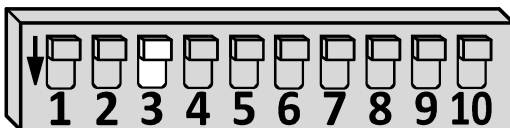
The position of the Ground Control Switch (DIP Switch 3) determines if a ground connection supplied to the GCS terminal (Figure 1-4, Item 12) causes the MMSA inverter to automatically come on—and the ON/OFF switch on the inverter (and remote control, if connected) to be disabled.

If DIP Switch 3 is UP (ground control disabled), a ground connection to the GCS terminal is ignored and has no effect on turning the inverter on or off, and the switch on the inverter (and remote control, if connected) can be used to turn the inverter on and off.

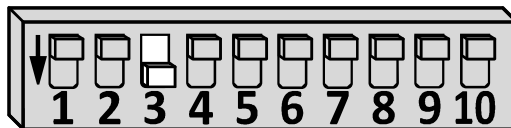
If DIP Switch 3 is DOWN (ground control enabled), a ground connection to the GCS terminal forces the inverter to come on and disables the switch on the inverter (and remote control, if connected). This means the inverter cannot be turned off when ground is connected to the GCS terminal; and when ground is removed, the inverter is forced off and cannot be turned on.



Info: If DIP Switches 2 & 3 are both enabled (DOWN), then both signals (+12VDC and ground) must be connected to their appropriate terminals for the inverter to be forced on; and when one or both signals are removed, the inverter is forced off.



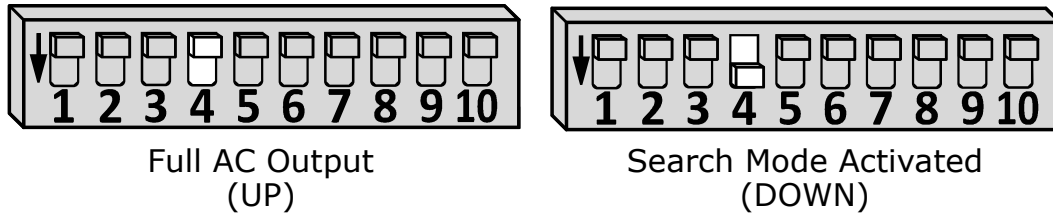
Ground Control Disabled
(UP)



Ground Control Enabled
(DOWN)

Switch 4: Search Mode

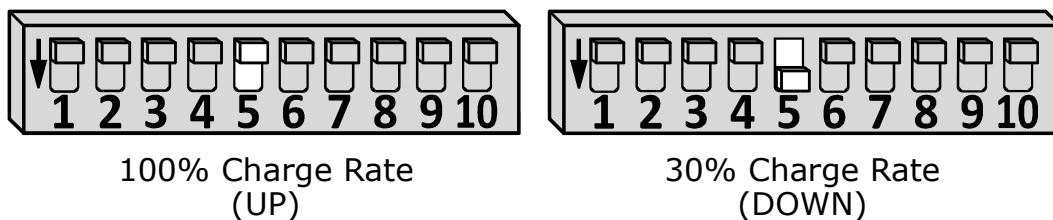
The position of DIP Switch 4 allows you to enable the power-saving Search mode circuitry. Normally, the inverter is providing full AC voltage to the loads (DIP Switch 4 is UP). When Switch 4 is set DOWN, the Search mode feature is activated. When Search mode is active, the inverter sends out pulses—consuming very little energy from the battery—until the power level of the loads on the inverter are above 5 watts, causing the inverter to “wake up” and start providing full AC output.

**Switch 5: Charge Rate**

The DIP Switch 5 setting determines the maximum current allowed to charge the batteries during Bulk, Absorption, Float, and Equalize charging. The two selections are provided as a percentage of the inverter/charger’s maximum charging capability. Refer to the label on the back side of the inverter (or Table 6-1) to determine the inverter’s 100% (or maximum) charge rate.

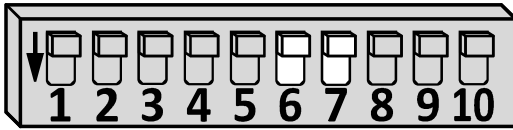
With DIP Switch 5 set UP (100% Charge Rate), the charger can deliver 100% of the available charging capability of the inverter. With DIP Switch 5 set DOWN (30% Charge Rate), the charge rate will be limited to 30% of the maximum charging capability of the inverter. This 30% setting is provided to help prevent battery overheating caused by charging at too high a charge rate.

Example: The maximum charge rate of your inverter/charger is 50 amps. When the DIP switch is set DOWN, the charge rate is limited to 15 amps (15 amps = 30% of 50 amps).

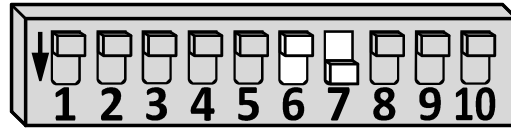
**Switches 6 & 7 Battery Type**

Switches 6 & 7 are used to select the battery type—which determines the battery charge profile and ensures the batteries are receiving the proper charge voltage. Select the battery type that matches your system’s battery bank chemistry, or refer to Table 3-1 to determine the specific charge voltage to use based on the battery type selected.

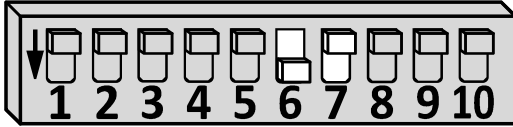
Setup



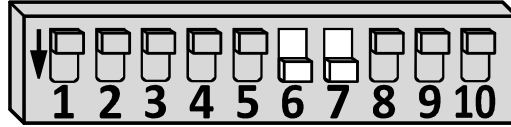
Flooded



AGM 1



GEL



AGM 2



Info: Voltages shown in Table 3-1 are based on the Battery Temperature Sensor (BTS) being disconnected, or at a temperature of 77°F (25°C). If the BTS is connected, the charge voltage changes based on the temperature around the BTS—to ensure the batteries receive the correct charge voltage even if they become cold or hot (see Section 1.5.2).

Table 3-1, Battery Type to Charge Voltages

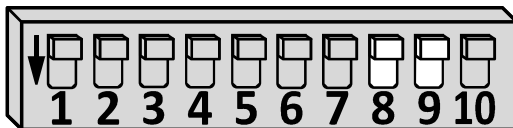
Battery Type	Absorption Voltage	Float Voltage	Equalization Voltage	Equalization Time
Flooded	14.6 VDC	13.4 VDC	15.5 VDC	2.0 Hours
GEL	14.1 VDC	13.6 VDC	Not Allowed	Not Applicable
AGM 1 ¹	14.3 VDC	13.1 VDC	15.5 VDC	2.0 Hours
AGM 2 ²	14.5 VDC	13.5 VDC	Not Allowed	Not Applicable

Note 1: Specifications for Concord (Lifeline Series) AGM batteries.

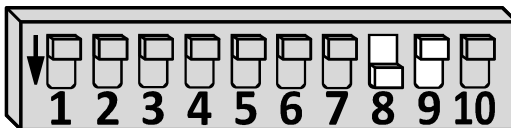
Note 2: Specifications for East Penn, Deka, Discover and Trojan AGM batteries.

Switches 8 & 9: Absorb Time

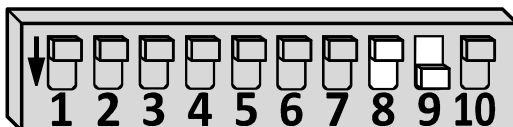
DIP Switches 8 & 9 determine the absorption charge time of the MMSA inverter/charger. Four (4) time periods are provided to determine how long the charger is in the Absorb Charge stage—holding the batteries at the *Absorb Voltage* setting.



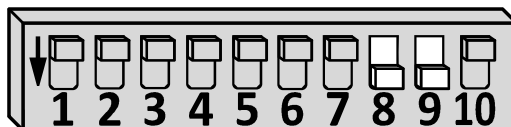
60 Minutes



120 Minutes



90 Minutes



150 Minutes

Switch 10: EQ Enable

The position of DIP switch 10 allows an Equalize (EQ) charge to be started or stopped by the inverter. An EQ charge can be started by setting DIP switch DOWN or by using a connected remote. When an EQ charge starts, the position of DIP Switch 1 determines if the EQ charge settings (EQ voltage and time period) are dictated by the inverter settings or by the connected remote. Once the EQ charge has started, it will automatically stop once the EQ charge is complete, or it can be manually be stopped by setting DIP Switch 10 to UP, or by disabling Equalize from the remote—if connected.



Info: Once DIP switch 10 has been set DOWN, it must be cycled (i.e., set UP then DOWN) to start another EQ charge using DIP switch 10.



Info: EQ charge is only permitted if the Battery Type selection allows, and the charger is in Float charge or Full charge mode.



Info: Charge LED's (BULK, ABSORB, and FLOAT) each come on in sequence to indicate the charger is equalizing.

DIP Switch 1 UP (use inverter settings): When DIP Switch 1 is UP and an EQ charge is started, the charger uses the inverter's battery type selection to determine the EQ voltage and time period. To EQ charge, ensure the charger is in the Float Charge or Full Charge stage, and then set DIP Switch 10 to DOWN. The EQ charge begins (if Battery Type selection allows—see Table 3-1) and continues for 2 hours, and then automatically stops and returns to Float charging.

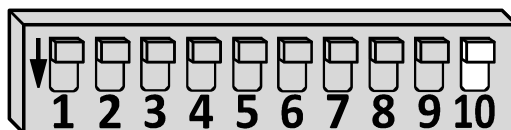


Info: If DIP switch 1 is UP and a remote is connected, the remote can be used to start an EQ charge, but the inverter's charge settings will continue to be used.

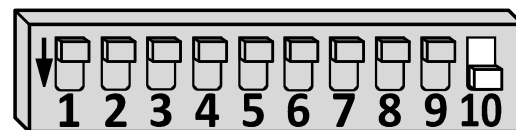


Info: When Equalize charging, the maximum current allowed to charge the batteries is set by the DIP Switch 5 (Charge Rate) setting.

DIP Switch 1 DOWN (use remote control settings): When DIP Switch 1 is DOWN and a remote control with the Equalize feature is connected, the Equalize charge settings from the remote control are used. To Equalize charge, ensure the charger is in the Float Charge or Full Charge stage, then start the EQ charge—either from the remote or by setting DIP Switch 10 to DOWN. The Equalize charge begins (if the remote's *Battery Type* selection allows) and uses the remote control settings to determine the Equalize voltage and time period.



Disable EQ Charge (UP)



Start EQ Charge (DOWN)

4.0 Operation

This section discusses the MMSA inverter/charger's ON/OFF switch and LED indicators, explains how the MMSA operates, provides information on the various remotes (and other accessories) that can be connected to the unit, and lists the inverter's/remote's default settings.

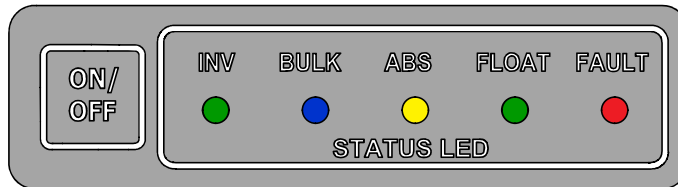


Figure 4-1, Top Panel Power Switch and LED Indicators

4.1 MMSA Top Panel Features

The top panel (Figure 4-1) is used to turn the MMSA on/off and to monitor its operational status. It is comprised of the following:

ON/OFF Pushbutton – The momentary pushbutton switch on the top of the inverter is used to turn the inverter on and off.

When the inverter is connected to the batteries—or when its automatic protection circuit has turned the inverter off—the ON/OFF pushbutton switch must be pressed to start the unit. Once the inverter has been turned on, pressing the ON/OFF switch alternately turns the unit off and on.



Info: The power ON/OFF pushbutton is a small momentary type switch which operates by lightly pressing and releasing.



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

Inverter Status LED Indicator – The inverter's status indicator (INV) is a green LED that provides information on the operational mode of the inverter. Watch the INV LED status indicator for at least 10 seconds to determine (or to verify) the inverter's operational condition—using the information below.

- *INV LED off* – The inverter is off. There is no AC power from the inverter, shore, or generator at the inverter's output terminals.
- *INV LED on (solid)* – The inverter is on and using energy from the battery. The inverter is providing full power to any loads connected to the inverter.

- *INV LED blinks once per second* – The inverter is connected to an external AC source (utility or generator power) and is in Standby mode. The inverter is ready to turn on and supply power to the loads if the external AC source is disconnected.
- *INV LED blinks twice per second (double blink)* – The inverter is in Search mode and is ready to supply AC power to the loads connected to the inverter—when a load greater than 5 watts is connected.

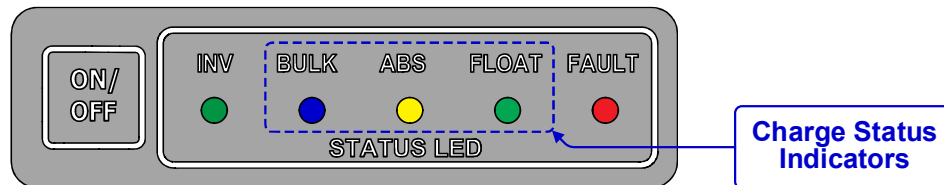


Figure 4-2, Charge Status Indicators

Charge Status LED Indicators – The at-a-glance charge LED’s (Figure 4-2) provide information on the inverter’s status while in Charge mode. Refer to Table 4-1 to identify the charger operation using these LED’s (BULK – blue; ABSORB – yellow; FLOAT – green).



Info: When one of the charge indicators is on, the external AC power (utility power or generator) that is connected to the inverter’s input is also passing through the inverter to power the AC loads on the inverter’s output.



Info: Whenever AC power (utility or generator) is present at the inverter’s AC input and is within the AC input limits (voltage and frequency), it connects and passes through the inverter—whether the inverter is on or off.

Table 4-1, Charge Status LED Indicators

BULK (blue)	ABSORB (yellow)	FLOAT (green)	Description
OFF	OFF	OFF	Charging Off – No external AC source is connected, there is a charger fault, or the unit was placed in Charger Standby using a connected remote.
ON	OFF	OFF	Bulk Charge Stage – Charger is delivering maximum current to the batteries. Charger remains in bulk charge until the absorb target voltage ¹ is achieved.
Blink (x1/sec) ³	OFF	OFF	Charger Back-off (in Bulk Charge mode) – Charger is in Charger Back-off ² , limiting charging current to the battery.

Operation

BULK (blue)	ABSORB (yellow)	FLOAT (green)	Description
OFF	ON	OFF	Absorb Charge Stage – Charger is in Constant Voltage stage and begins after the bulk voltage is reached. The DC charging current will taper down in order to maintain the battery at the absorb target voltage ¹ .
OFF	Blink (x1/sec) ³	OFF	Charger Back-off (in Absorb Charge mode) – Charger is in Charger Back-off ² , limiting charging current to the battery.
OFF	OFF	ON	Float Charge Stage (in Float Charge mode) – Float Charge occurs at end of absorb charging time—reduces the charge voltage to maintain the batteries at the float target voltage ¹ .
OFF	OFF	Blink (x1/sec) ³	Charger Back-off – Charger is in Float Charge mode and in Charger Back-off ² , limiting charging current to the battery.
OFF	OFF	Blink (x2/sec) ³	Full Charge Stage – Full Charge stage turns the charger off and monitors battery voltage to determine when to continue charging. After four hours in Float Charge mode, charger goes to Full Charge mode. If battery voltage drops to a low level (12.7 VDC), the charger automatically initiates another float charge.
1st ON	2nd ON	3rd ON	Equalize Charge Stage – Charger is in the Equalize Charge stage, regulating the current to maintain the battery at the equalize target voltage ¹ . Note: Each charge status LED indicator comes on quickly in sequence.

Note¹: Target Voltage – The temperature compensated voltage regulation set-point. The battery will be regulated to the voltage setting determined by the active charge stage (i.e., Absorb, Float, or Equalize) and the Battery Type DIP switch setting; and includes any voltage increase or decrease based on the temperature around the BTS.

Note²: Charger Back-off occurs if: 1. The FET or internal temperature is very hot (the charger reduces the charge rate to maintain temperature); or, 2. The AC input voltage has fallen below 85 VAC (the charger reduces the charge rate to help stabilize the incoming AC voltage).

Note³: There is a two-second pause between each blink sequence.
Example: Blink (x2 sec) means the LED blinks twice within a second and then is off for 2 seconds—this sequence continues while in this status.

Fault LED Indicator – Under normal operating conditions, the FAULT LED (red) indicator will be off. If there is a fault condition, this indicator illuminates to indicate that a fault condition has shut down the inverter. When the FAULT LED comes on, count the number of times it blinks (before turning off for two seconds) to determine the particular reason for the shutdown. Once you have identified and cleared the fault, the inverter can be turned on. To help clear the fault condition, refer to the Troubleshooting section.

- *Blinks x1, then off for 2 secs* – **Low Battery Voltage**; the battery voltage level has dropped below 10.0 VDC (LBCO default setting). Your batteries need to be charged. This fault condition automatically clears when the battery voltage exceeds 12.5 VDC.
- *Blinks x2, then off for 2 secs* – **High Battery Voltage**; the battery voltage is above 16.9 VDC. Reduce or turn off the external charging source to bring the battery voltage down.
- *Blinks x3, then off for 2 secs* – **Over-temperature Condition**; the internal inverter temperature is above acceptable limits. This may be 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 automatically resets and resumes operation.
- *Blinks x4, then off for 2 secs* – **AC Overload**; the inverter has turned off because the connected loads are larger than the inverter's output capacity, or there is a short on the output wiring. Restart the inverter once the AC loads are reduced or the wiring short has been removed. To restart the inverter, momentarily press the ON/OFF button on the inverter or remote.
- *Blinks x5, then off for 2 secs* – **Internal Fault**; the inverter has turned off because it has detected an internal problem. To clear this fault, the inverter needs to be reset: 1) Press and hold the inverter's ON/OFF switch for 10 seconds (inverter goes thru power-up test – see Section 4.1.1); or, 2) Disconnect all DC power to the inverter for at least 15 seconds, and then reconnect. After resetting the inverter, momentarily press the inverter's ON/OFF switch and verify the fault cleared. If the internal fault remains, the inverter requires service at an authorized repair facility.
- *Blinks x6, then off for 2 secs* – **High AC Volts**; this fault causes the AC input to be disabled because a very high AC voltage (>145 VAC) has been detected on the AC input. To clear this fault, remove all AC power from the inverter's AC input for at least 15 minutes. Ensure only 120 VAC power is connected to the inverter's AC input.

4.1.1 Power-up LED Test

When the inverter is first connected to the batteries, the inverter and remote go through a power-up LED test. This test verifies the inverter's LEDs by requiring all LEDs to come on in sequence from the first (INV) to the last (FAULT), and after all LEDs are on for 2 seconds they all turn off.

4.2 Operating Modes

The MMSA1012 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.

4.2.1 Inverter Mode

When the MMSA is first powered up, it defaults to the OFF mode. The inverter's momentary ON/OFF power switch 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 disabled. 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 twice.



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-MR, ME-RC, or ME-ARC remote display.

- **Inverting** – When a load greater than 5 watts is connected to the inverter output, the MMSA1012 "inverts" the DC power from the battery and supplies 120 VAC power to your sub-panel. The inverter's green LED is on solid 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.

4.2.2 Standby Mode

The MMSA1012 features an automatic transfer relay and an internal battery charger when operating in Standby mode. Standby mode begins whenever you plug the inverter's AC input into AC power (shorepower or generator). 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 MMSA1012 model is 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 waveshape to mirror the voltage waveshape). 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 the MMSA, 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 4-3). The Equalization stage 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 charge current to the batteries, because:

1. The internal temperature is too hot – the charger automatically reduces the charge rate to maintain temperature.
2. The AC input voltage falls < 85 VAC – the charger reduces the charge current to zero to help stabilize the incoming AC voltage.

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)* (per *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 60 minutes (per *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. This stage reduces battery gassing, minimizes watering requirements (flooded battery), 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)* (per *Battery Type* selection**)—maintain batteries indefinitely.

Full Charge (Battery Saver™ mode): The fourth stage occurs after four hours in the 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.

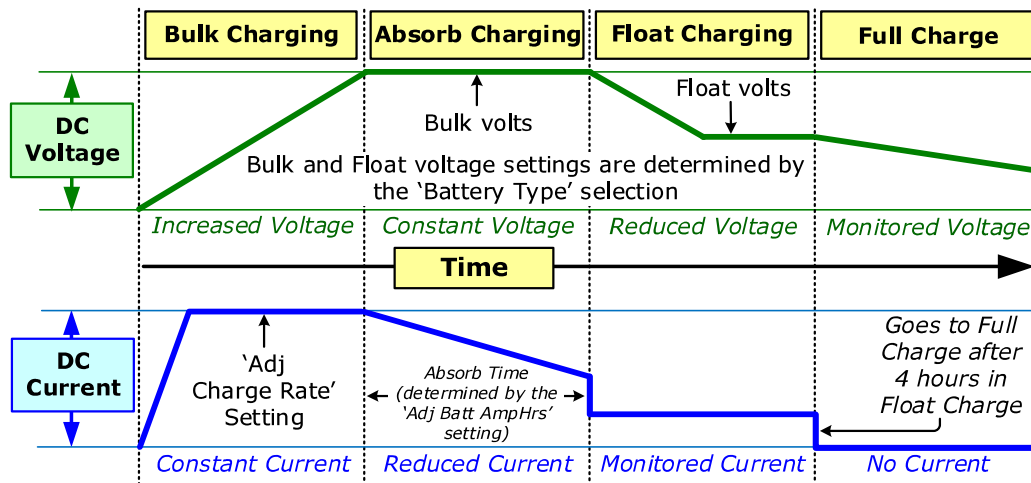


Figure 4-3, Automatic 4-Stage Charging Graph

* Voltage settings based on the Battery Temperature Sensor (BTS) being disconnected, or at a temperature of 77°F (25°C). If BTS is installed, these voltage settings increase if the temperature around the BTS is <77°F (25°C), and decrease if the temperature around the BTS is >77°F (25°C).

** The MMSA uses changeable settings (see Table 4-3) that are adequate for most installations. However, if some of your operating parameters need to be changed, the ME-MR, ME-RC, or ME-ARC remote control can be purchased to allow change to those settings.

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 MMSA1012 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-MR, ME-RC, or ME-ARC 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.

4.3 Protection Circuitry Operation

The inverter is protected against fault conditions, and in normal usage it will be rare to see any. 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. Refer also to the Troubleshooting section to diagnose and clear any of the fault conditions below.

- **Low Battery** – The inverter shuts down whenever the battery voltage falls to the Low Battery Cut Out (LBCO) level for over one minute to protect the batteries from being over-discharged. Once the inverter has reached the LBCO level and turned off, it 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 INV LED turns off when a low battery fault condition occurs. Refer to Table 4-2 to determine the LBCO and LBCI levels for your particular inverter model.

Operation

- **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 INV 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 4-2 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.
- **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.

Table 4-2, Inverter Battery Turn On/Off Levels

Inverter Battery Turn On/Off Levels	Inverter Model
	MMSA1012
HBCO	>16.9 VDC
HBCI	16.5 VDC
LBCI	≥12.5 VDC
LBCO (one minute delay)	10.0 VDC (9.0 - 12.2 VDC)*
LBCO (immediate)	8.5 VDC

* - Adjustable with ME-RC or ME-ARC remote controls.

4.4 Battery Temperature Sensor Operation

The plug-in Battery Temperature Sensor (BTS) is used to determine the 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 (Figure 2-6), 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 4-4 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 are not compensated and the battery maintains the charge it had at a temperature of 77°F (25°C). Without a BTS, the life of the batteries may be reduced if they are subjected to large temperature changes.



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

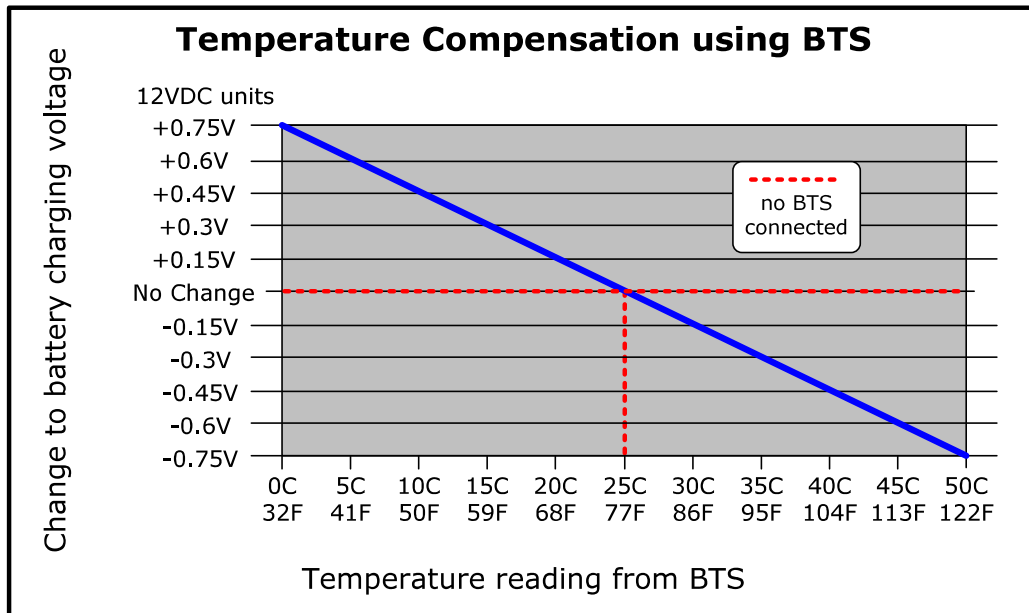


Figure 4-4, BTS Temperature to Voltage Change

4.5 Summary of Inverter/DIP Switch Settings

Your MMSA1012 inverter uses default settings (established by DIP switch positions) that are adequate for most installations. However, if you determine that some of your operating parameters need to be changed, Sensata offers several remotes (Section 2.5) that allow you to customize the programming parameters of the inverter/charger.

Table 4-3, MMSA Inverter/DIP Switch Settings

Function	Settings/Ranges
Inverter/Remote Settings (DIP Switch 1)	UP ¹ = Use Inverter Settings DOWN = Use Remote Settings
Ignition Control (DIP Switch 2)	UP ¹ = Ignition Control Disabled DOWN = Ignition Control Enabled
Ground Control (DIP Switch 3)	UP ¹ = Ground Control Disabled DOWN = Ground Control Enabled
Search Mode ² (DIP Switch 4)	UP ¹ = (Search off) Full AC Output DOWN = Search Mode Activated (5W)
Charge Rate ² (DIP Switch 5)	UP ¹ = 100% (50A) DOWN = 30% (15A)
Battery Type ² (DIP Switches 6 & 7)	Both UP ¹ = Flooded (Absorb = 14.6 VDC, Float = 13.4 VDC) Other DIP settings: AGM1, AGM2, and GEL
Absorb Time ² (DIP Switches 8 & 9)	Both UP ¹ = 60 Minutes Other DIP settings: 90, 120, & 150 minutes
EQ Enable ² (DIP Switch 10)	UP ¹ = EQ Charge Disabled DOWN = Start EQ Charge
LowBatCutOut ²	10.0 VDC ¹
VAC Dropout ²	80 VAC ¹

Note¹: Inverter and DIP switch default settings.

Note²: Optional ME-RC and ME-ARC remote controls provide additional settings for these functions.

5.0 Maintenance & Troubleshooting

The following information is provided to help you keep your MMSA1012 inverter/charger in optimum operational condition.

5.1 Recommended Inverter & Battery Care

The MMSA1012 inverter is designed to provide you with years of trouble-free service. Even though there are no user-serviceable parts, it is recommended that every six months you perform the following maintenance steps to ensure optimum performance and extend the life of your batteries.



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

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

5.1.1 Off-Season Storage

If placing a vehicle 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.

5.2 Troubleshooting

The MMSA1012 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 5-1 is designed to help you quickly identify the most common inverter and charger faults.

Maintenance & Troubleshooting

Table 5-1, Troubleshooting Guide

Symptom	Possible Cause	Recommended Solution
Low Battery Voltage (<i>status indicator blinks on 1 time every 3 secs</i>)	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 too low. Check fuses/ circuit-breakers and cable connections. Check battery voltage at inverter's terminals. Batteries may need to be charged—fault condition automatically clears when battery voltage exceeds 12.5 VDC.
High Battery Voltage (<i>status indicator blinks on 2 times every 3 secs</i>)	Battery voltage is above 16.9 VDC. Inverter automatically resets and resumes operation when the battery voltage drops below 16.5 VDC.	Generally, this condition only occurs 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 (<i>status indicator blinks on 3 times every 3 secs</i>)	Internal temperature of the inverter has risen above acceptable limits—loads too great for inverter to continuously operate or inadequate ventilation around inverter. Once unit has cooled, it automatically resets and resumes operation.	Reduce number of operating electrical loads—will avoid a repeat Overtemp shutdown if the cause was too many loads for ambient conditions.
		Check ventilation around the inverter, ensure cool air is available to pass through the inverter.
AC Overload (<i>status indicator blinks on 4 times every 3 secs</i>)	Inverter has turned off because connected loads are larger than the inverter's output capacity—or the output wires are shorted.	Reduce AC loads connected to inverter, or remove all AC output wiring and restart the inverter.

Maintenance & Troubleshooting

Troubleshooting Guide, Cont.

Symptom	Possible Cause	Recommended Solution
Internal fault (<i>status indicator blinks on 5 times every 3 secs</i>)	An internal fault detected.	To clear, perform a power reset by removing DC power to the inverter (see Section 5.3). If the fault does not clear, the unit will need to be serviced.
Inverter's INV status light is off	Inverter is switched OFF, or no DC voltage (battery) connected to inverter.	Switch inverter ON. Connect a battery with correct voltage to inverter.
AC input won't connect (CHG LED on remote blinks)	Incoming AC voltage not accepted if below VAC Dropout setting (80 VAC = default).	Check incoming AC voltage to inverter's input, ensure it is present and above the <i>VAC Dropout</i> setting.
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.
Low charging rate when connected to shore power.	Charge rate set too low.	Adjust <i>Charge Rate</i> or <i>SHORE</i> settings (on remote)
	Low AC voltage (<85 VAC).	Check AC input wiring.
Low charging rate when using a generator.	Generator output is too low to power both load and charger.	Reduce the load, increase the generator's RPMs.
		Check <i>SHORE</i> settings (if remote connected).
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 the temperature around the battery sensor.	This is normal; see Section 4.4 (Battery Temperature Sensor Operation) for more information.

5.3 Performing an Inverter Reset

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

1. Remove all AC power (i.e., shorepower) to the inverter.
2. Press and hold the inverter’s ON/OFF pushbutton for approximately 10 seconds, or until all LEDs come on in sequence from the first (INV) to the last (FAULT).
3. Release the ON/OFF pushbutton once all LEDs turn off.
Note: LEDs will cycle every 10 secs if the button is NOT released.
4. Press the ON/OFF pushbutton again to turn the inverter on.



Info: The ON/OFF pushbutton is a small momentary type switch which is operated by lightly pressing and releasing.

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

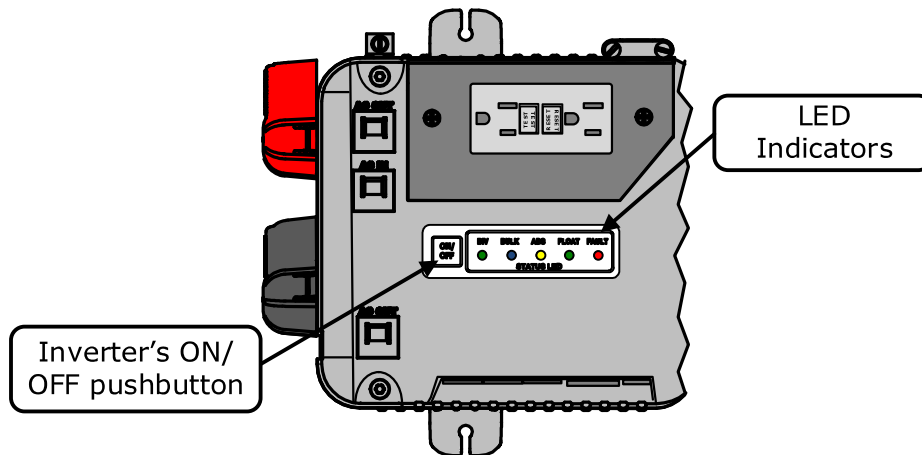


Figure 5-1, Resetting the Inverter

5.4 Performing a Power Reset

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

1. Remove all AC power (i.e., shorepower) to the inverter.
2. Open all the inverter DC disconnects (or disconnect the positive battery cable to the inverter).
3. Ensure the inverter and the remote are disconnected from all AC and DC power (the remote display will be blank).
4. 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 no DC disconnects in system, a momentary spark may occur when the positive battery cable is connected to the inverter’s terminal. This is normal and indicates the inverter’s internal capacitors are being charged.

6.0 Specifications

Table 6-1, MMSA1012 Specifications

MODEL:	MMSA1012
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
Total Harmonic Distortion	<5%
1 msec surge current	38 AAC
100 msec surge current	21 AAC
5 sec surge power	1650W
30 sec surge power	1600W
5 min surge power	1250W
30 min surge power	1200W
Continuous power output @ 45°C	1000 VA
Max. continuous input current	133 ADC
Inverter efficiency (max)	87%
Transfer time (typical)	16 msecs
AC pass-thru capability	15A
Power Draw: Search mode	5W typical (with no remote)
Power Draw: ON (no load)	22W typical (with no remote)
Output AC waveform type	Pure Sine Wave
Charger Specifications	
Continuous output @ 45°C	50 ADC
Charger efficiency (maximum)	84%
Power factor	> 0.95
Input current @ rated output	7 AAC
Temperature compensation	Yes, with BTS
General Features and Capabilities	
Protection circuitry	Low/High Battery, Over-temp & Overload
Corrosion protection	PCB's conformal coated, powder coated chassis
AC Output	GFCI outlet
AC Input	3 ft cord
Output circuit breaker	15 AAC
Input circuit breaker	15 AAC
Internal cooling	Yes, 0 to 59 cfm variable speed
UL listing	ETL to UL/cUL458, CSA C22.2 #107.1-01
Environmental Specifications	
Operating temperature	-20° C to +60° C (-4° F to 140° F)
Non-operating temperature	-40° C to +70° C (-40° F to 158° F)
Operating humidity	0 to 95% RH non-condensing
Physical Specifications	
Dimensions (L x W x H)	16.6"x 8.4"x 6.75" (42.2 cm x 21.3 cm x 17.1 cm)
Mounting	Shelf or wall (top or bottom up)
Weight	24 lbs. (10.9 kg)
Shipping weight	25 lbs. (11.3 kg)

Specifications @ 45°C unless otherwise noted – Subject to change without notice

Appendix A – Optional Equipment & Accessories

The following components are available for use with the MMSA1012 inverter/charger. Some of these items are required depending upon the intended use of the inverter.

Smart Battery Combiner

The Smart Battery Combiner (ME-SBC™) is designed to monitor and charge a second battery using a portion of the current that is charging the main battery. The ME-SBC eliminates a significant voltage drop, and provides automatic turn-on and turn-off based on adjustable voltage set-points. This allows different batteries to be charged from a single charging source, and prevents overcharging/undercharging.

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 most 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

The 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 fuse.

Appendix B – Battery Information

B-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%.

B-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.

B-3 Battery Configuration

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

Series Wiring

Wiring batteries in a series increases the total battery bank output voltage. A series connection combines each battery in a string until the voltage matches the inverter's DC requirement. Even though there are multiple batteries, the capacity remains the same. In the example below (Figure B-1), two 6 VDC/200 AH batteries are combined into a single string—resulting in a 12 VDC/200 AH bank.

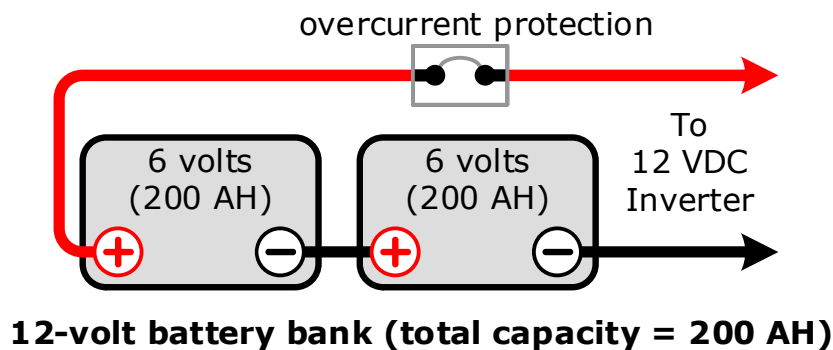


Figure B-1, Series Battery Wiring

Appendix B – Battery Information

Parallel Wiring

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

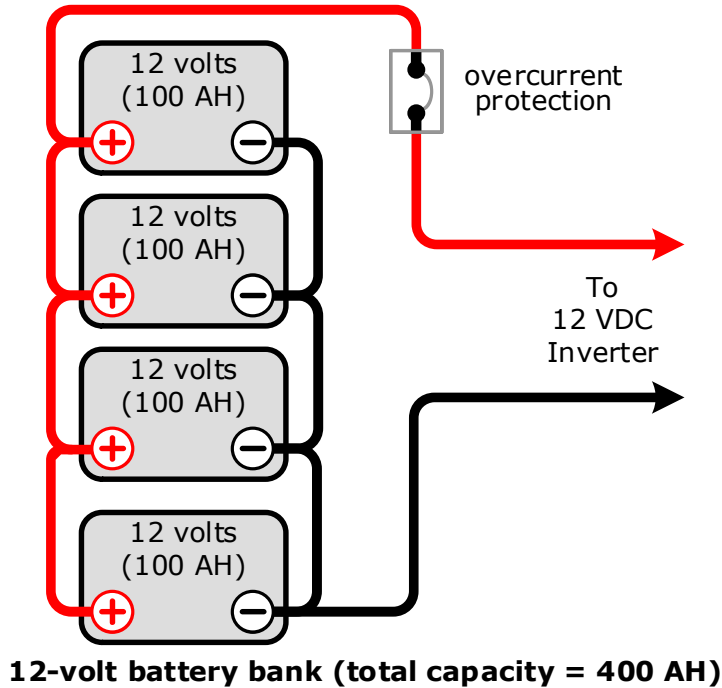


Figure B-2, Parallel Battery Wiring

Series-Parallel Wiring

A series-parallel configuration increases both voltage (to match inverter's DC requirements) and capacity (to increase run time for operating loads) using smaller, lower-voltage batteries. In example below (Figure B-3), four 6 VDC/200 AH batteries are combined into two strings resulting in a 12 VDC/400 AH battery bank.

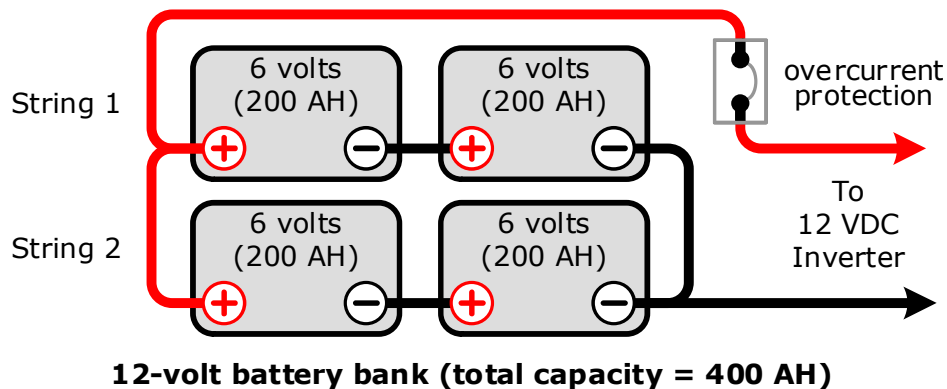


Figure B-3, Series-Parallel Battery Wiring

Appendix B – Battery Information

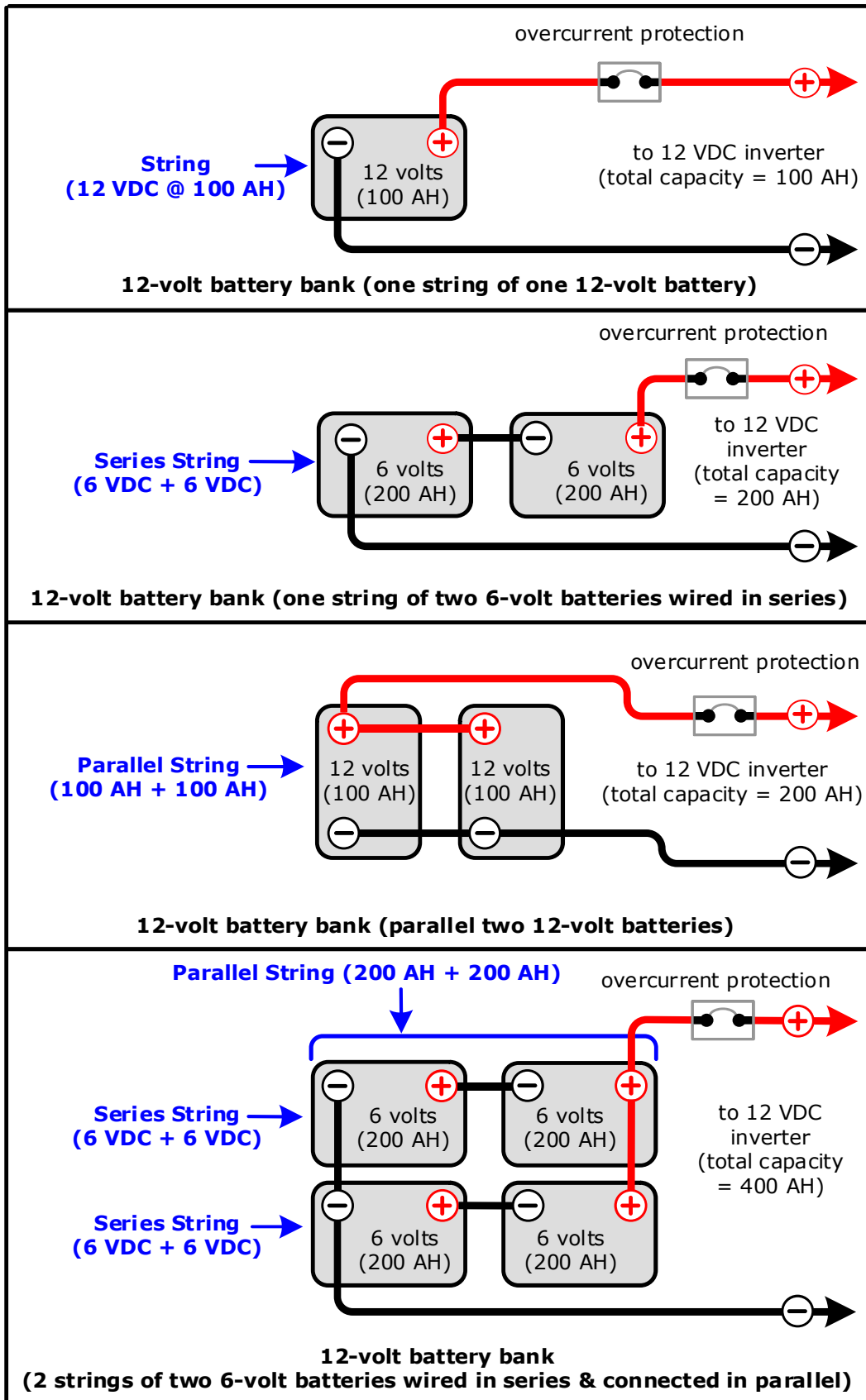


Figure B-4, Battery Bank Wiring Examples





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Magnum-Dimensions Products by:

Sensata Technologies Web:

www.Magnum-Dimensions.com

