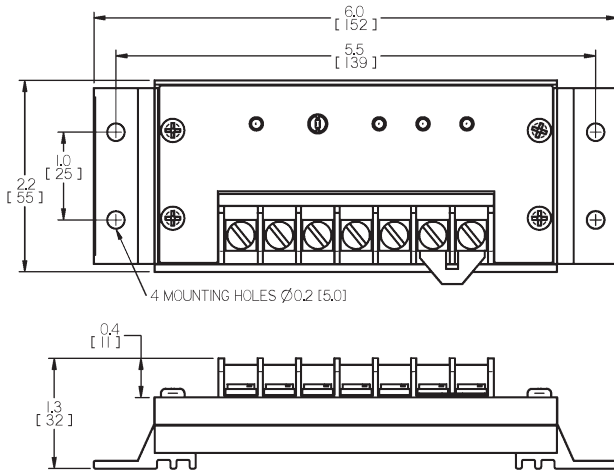


SunSaver Dimensions Inches [Millimeters]



Specification Summary

Ratings	SS-6/6L	SS-10/10L	SS-20L
System Voltage	12 V	12 or 24V	12 or 24V
Min. Battery Voltage	6 V	6 V	6 V
Max. Solar Voltage ¹	30 V	30 or 60V	30 or 60V
Max. Solar Current	6.5 A	10 A	20 A
Max. Load Current	6 A	10 A	20 A

See Section 7.0 for full technical specifications

1. Array voltage should never exceed maximum input voltage. Refer to the solar module documentation to determine the highest expected array Voc as defined by the lowest expected ambient temperature for the system location.

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1.0 IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS.

This manual contains important safety, installation and operating instructions for the SunSaver solar controller.

The following symbols are used throughout this manual to indicate potentially dangerous conditions or mark important safety instructions:



WARNING:
Indicates a potentially dangerous condition. Use extreme caution when performing this task.



CAUTION:
Indicates a critical procedure for safe and proper operation of the controller.



NOTE:
Indicates a procedure or function that is important for the safe and proper operation of the controller.

Safety Information

- Read all of the instructions and cautions in the manual before beginning installation.
- There are no user serviceable parts inside the SunSaver. Do not disassemble or attempt to repair the controller.
- Disconnect all sources of power to the controller before installing or adjusting the SunSaver.
- There are no fuses or disconnects inside the SunSaver. Do not attempt to repair.
- Install external fuses/breakers as required.



WARNING:
These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are qualified to do so.



WARNING:
EXPLOSION HAZARD - DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS.



CAUTION:
A BATTERY CAN PRESENT A RISK OF ELECTRICAL SHOCK, BURN FROM HIGH SHORT-CIRCUIT CURRENT, FIRE OR EXPLOSION FROM VENTED GASES. OBSERVE PROPER PRECAUTIONS



CAUTION:
To reduce the risk of fire, connect only to a circuit provided with a maximum branch-circuit overcurrent protection rating not to exceed the model current rating on page 2 and in accordance with the National Electrical Code, ANSI/NFPA 70.



CAUTION:
Unit has no battery removal protection. Disconnecting battery during charging may cause a brief spike in load voltage (above the 15V regulation limit) which may damage sensitive equipment.



NOTE:
PROPER DISPOSAL OF BATTERIES IS REQUIRED. REFER TO YOUR LOCAL CODES FOR DISPOSAL REQUIREMENTS

Informations de sécurité

- Lisez toutes les instructions et les avertissements figurant dans le manuel avant de commencer l'installation.
- Le SunSaver ne contient aucune pièce réparable par l'utilisateur. Ne démontez pas ni ne tentez de réparer le contrôleur.
- Déconnectez toutes les sources d'alimentation du contrôleur avant d'installer ou de régler le SunSaver.
- Le SunSaver ne contient aucun fusible ou interrupteur. Ne tentez pas de réparer.
- Installez des fusibles/coupe-circuits externes selon le besoin.



AVERTISSEMENT:

Ces instructions d'entretien sont exclusivement réservées à des techniciens qualifiés. Pour réduire le risque de choc électrique, ne réalisez aucun entretien autre que celui stipulé dans les instructions de fonctionnement, à moins que vous ne possédiez les qualifications nécessaires en la matière.



ATTENTION:

UNE BATTERIE PEUT PRÉSENTER UN RISQUE ÉLEVÉ DE CHOC ÉLECTRIQUE, DE BRÛLURES SUITE À UN COURANT DE COURT-CIRCUIT ÉLEVÉ, À UN INCENDIE OU À UNE EXPLOSION PROVENANT DE GAZ REJETÉS DANS L'AIR. VEUILLEZ PRENDRE LES PRÉCAUTIONS NÉCESSAIRES.



AVERTISSEMENT:

RISQUE D'EXPLOSION. NE PAS DEBRANCHER TANT QUE LE CIRCUIT EST SOUS TENSION, A MOINS QU'IL NE S'AGISSE D'UN EMPLACEMENT NON DANGEREUX.



ATTENTION:

Pour diminuer le risque d'incendie, ne connectez l'alimentation qu'à un circuit équipé d'une protection maximum par dérivation contre les surintensités ne dépassant pas le courant nominal du modèle de la page 2, conformément à la norme du Code National de l'Électricité (NEC), ANSI/NFPA 70.



ATTENTION:

Unité bénéficiant d'aucune protection de retrait de batterie. Débrancher la batterie pendant la charge peut entraîner un bref pic de tension de charge (au-dessus du 15V limite de réglage) qui peuvent endommager les équipements sensibles.

Installation Safety Precautions



WARNING:

This unit is not provided with a GFDI device. This charge controller must be used with an external GFDI device as required by the Article 690 of the National Electrical Code for the installation location.

- Mount the SunSaver indoors. Prevent exposure to the elements and do not allow water to enter the controller.
- Install the SunSaver in a location that prevents casual contact. The SunSaver heatsink can become very hot during operation.
- Use insulated tools when working with batteries.
- Avoid wearing jewelry during installation.
- The battery bank must be comprised of batteries of same type, make, and age.
- Do not smoke in the vicinity of the battery bank.
- Mount the controller at least 3 ft (1 m) away from vented batteries unless separated by a barrier or located in a separate compartment.

- Power connections must remain tight to avoid excessive heating from a loose connection.
- Use properly sized conductors and circuit interrupters
- This charge controller is to be connected to DC circuits only. These DC connections are identified by the symbol below:



Direct Current Symbol

- Les connexions d'alimentation doivent rester serrées pour éviter une surchauffe excessive d'une connexion desserrée.
- Utilisez des conducteurs et des coupe-circuits de dimensions adaptées.
- Ce contrôleur de charge ne doit être connecté qu'à des circuits en courant continu. Ces connexions CC sont identifiées par le symbole ci-dessous:



Symbole courant continu

Précautions de sécurité d'installation



AVERTISSEMENT:

L'appareil n'est pas fourni avec un dispositif GFDI. Ce contrôleur de charge doit être utilisé avec un dispositif GFDI externe tel que requis par l'Article 690 du Code électrique national de l'emplacement de l'installation.

- Montez le SunSaver à l'intérieur. Empêchez l'exposition aux éléments et la pénétration d'eau dans le contrôleur.
- Installez le SunSaver dans un endroit qui empêche le contact occasionnel. Le dissipateur de chaleur SunSaver peut devenir très chaude pendant le fonctionnement
- Utilisez des outils isolés pour travailler avec les batteries.
- Évitez le port de bijoux pendant l'installation.
- Le groupe de batteries doit être constitué de batteries du même type, fabricant et âge.
- Ne fumez pas à proximité du groupe de batteries.
- Monter le régulateur au moins 3 pi (1 m) de batteries ventilés sauf séparées par une barrière ou situé dans un compartiment séparé.

2.0 GENERAL INFORMATION

2.1 Overview

Thank you for selecting the SunSaver solar charge controller. The SunSaver is an advanced PWM solar battery charger and load controller for stand-alone PV systems.

The SunSaver battery charging process has been optimized for long battery life and improved system performance. Self-diagnostics and electronic error protection prevent damage when installation mistakes or system faults occur.

Although the SunSaver is very simple to install and use, please take the time to read this operator's manual and become familiar with the controller.



NOTE: Product photos are only intended for use in general depiction, and for purposes of wiring illustration – refer to manual addendums and website declarations of conformity for exact certification listings.

2.2 Features

The features of the SunSaver are shown in Figure 1 below. An explanation of each feature is provided.

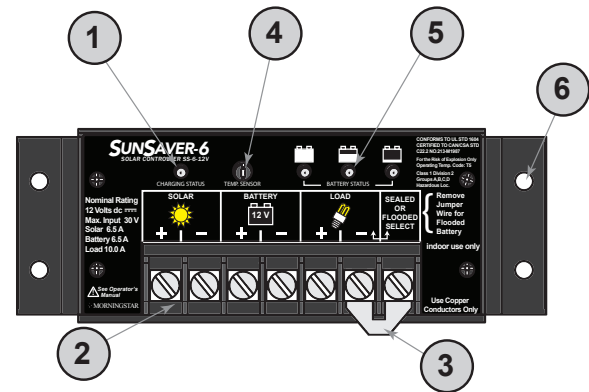


Figure 1. SunSaver features.

1 - Status LED

An LED indicator that shows charging status and also indicates when a solar input fault condition exists.

2 - Power Terminal Block

Power terminations for system Solar, Battery, and Load connections.

3 - Battery Select Jumper

A removable jumper to select the battery type.

4 - Local Temperature Sensor

Measures ambient temperature. Battery regulation is adjusted based on ambient temperature changes.

5 - Battery Status LEDs

Provides approximate battery *state-of-charge* indication and also indicates when a system or load fault condition exists.

6 - Mounting Holes

Four (4) mounting holes

2.3 Regulatory Information



NOTE:

This section contains important information for safety and regulatory requirements.

The SunSaver controller should be installed by a qualified technician according to the electrical regulations of the country in which the product will be installed.

SunSaver controllers comply with the following EMC standards:

- Immunity: EN61000-6-2:1999
- Emissions: EN55022:1994 with A1 and A3 Class B1
- Safety: EN60335-1 and EN60335-2-29 (battery chargers)

FCC REQUIREMENTS:

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by Morningstar for compliance could void the user's authority to operate the equipment.

NOTE:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for assistance.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

3.0 INSTALLATION INSTRUCTIONS

3.1 General Installation Notes

- Read through the entire installation section before beginning installation.
- Be very careful when working with batteries. Wear eye protection. Have fresh water available to wash and clean any contact with battery acid.
- Use insulated tools and avoid placing metal objects near the batteries.
- Explosive battery gases may be present during charging. Be certain there is sufficient ventilation to release the gases.
- Do not install in locations where water can enter the controller.
- Loose power connections and/or corroded wires may result in resistive connections that melt wire insulation, burn surrounding materials, or **even cause fire**. Ensure tight connections and use cable clamps to secure cables and prevent them from swaying in mobile applications.
- The SunSaver charging algorithm is compatible with lead-acid or NiCd batteries. ***NiMH, Li-ion, and other battery chemistries are not compatible with the SunSaver charging algorithm.***
- The SunSaver Battery connection may be wired to one battery or a bank of batteries. The following instructions refer to a single battery, but it is implied that the battery connection can be made to either one battery or a group of batteries in a battery bank.

Installation in Hazardous Locations

THIS EQUIPMENT IS ONLY SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A,B,C and D OR NON-HAZARDOUS LOCATIONS.



CAUTION:

For hazardous locations, device must be installed inside an appropriately type rated tool secured enclosure. Consult with local authority having jurisdiction for type rating required.



ATTENTION:

Pour les endroits dangereux, le dispositif doit être installé à l'intérieur un convenablement qualification de type outil sécurisé enceinte. Consultez les autorités locales compétentes pour la qualification de type requise.

3.2 User Selections

Select a Battery Type

The SunSaver provides a *Battery Select Jumper* to choose the battery type. See *Section 7.0 Technical Specifications* for detailed charging information for each battery type.

The battery select jumper is secured in the terminal block between terminal #6 and terminal #7 as shown in figure 2a. The second column in table 1 specifies whether the jumper should be removed or remain in place, depending on the desired battery type.

Battery Type	Battery Jumper	Absorption	Float	Equalize
Sealed	Inserted	14.10V	13.70V	N/A
Flooded/ AGM ¹	Removed	14.60V	13.70V	14.90V

1. Flooded/AGM absorption value effective with unit serial nos. 2038 0001 and higher

Table 1. Battery Type selection

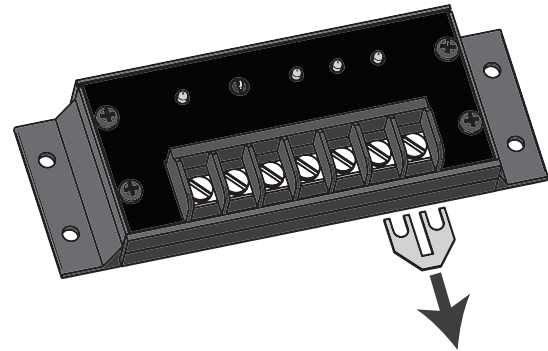


Figure 2a. Removing the Battery Select jumper.

Choose Regulation Method (optional)

Choose between *Pulse Width Modulation (PWM)* charging or *Slow Switching* charging. PWM charging is the default regulation method and is the method recommended for most systems.

Slow Switching regulation should only be selected if noise or interference exists in the system due to PWM charging. This regulation method limits the switching frequency to 10 Hz (maximum), which can eliminate noise issues in some systems.

PWM charging is selected by default. To enable *Slow Switching* regulation do the following:

1. Remove all four screws that secure the faceplate on the SunSaver. See Figure 2b.
2. Gently pry the faceplate off the SunSaver. Occasionally, epoxy encapsulant will cause the faceplate to stick. Use a small flat-head screw driver to separate the faceplate from the SunSaver body. See Figure 2c.
3. A loop of wire protrudes from the epoxy. Cut the loop with wire clippers to switch the regulation method to Slow Switching. See Figure 2d.
4. Tape the cut ends with electrical tape to prevent contact with the faceplate.
5. Replace the faceplate and secure with the four screws.

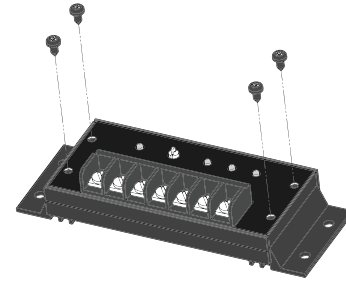


Figure 2b. Remove faceplate screws.

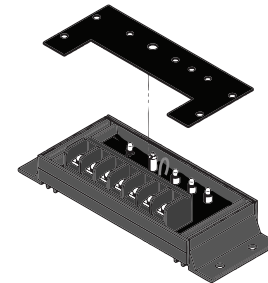


Figure 2c. Remove faceplate.

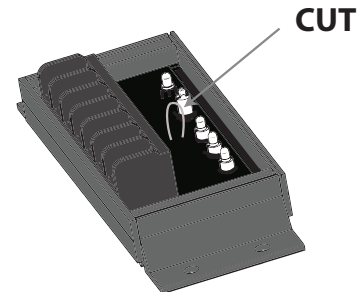


Figure 2d. Cut the Regulation Select wire loop.

3.3 Mounting



CAUTION: *Equipment Damage or Risk of Explosion*
Never install the SunSaver in an enclosure with vented/flooded batteries. Battery fumes are flammable and will corrode and destroy the SunSaver circuits.



CAUTION: *Equipment Damage*
When installing the SunSaver in an enclosure, ensure sufficient ventilation. Installation in a sealed enclosure will lead to over-heating and a decreased product lifetime.



PRUDENCE: *Endommagement de l'équipement ou risque d'explosion*
N'installez jamais le SunSaver dans une enceinte avec des batteries à électrolyte liquide. Les vapeurs des batteries sont inflammables et corroderont et détruiront les circuits du SunSaver.



PRUDENCE: *Endommagement de l'équipement*
Assurez une ventilation suffisante en cas d'installation du SunSaver dans une enceinte. L'installation dans une enceinte hermétique entraîne une surchauffe et une réduction de la durée de vie du produit.

Step 1: Choose Mounting Location

Locate the SunSaver on a vertical surface protected from direct sun, high temperatures, and water. The unit should be located in the same ambient temperature as the battery. Locate the controller within 10 ft (3 M) of the battery bank. Mounting the controller on a horizontal surface does not provide optimal airflow and could lead to overheating.

Step 2: Check for Clearance

Place the SunSaver in the location where it will be mounted. Verify that there is sufficient room to run wires and that there is ample room above and below the controller for air flow.

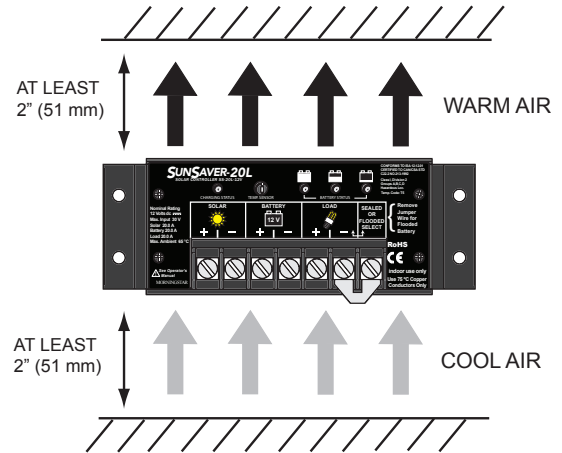


Figure 3. Mounting and cooling.

Step 3: Mark Holes

Use a pencil or pen to mark the four (4) mounting hole locations on the mounting surface.

Step 4: Drill Holes

Remove the controller and drill 3/32" (2.5 mm) holes in the marked locations.

Step 5: Secure Controller

Place the controller on the surface and align the mounting holes with the drilled holes in step 4. Secure the controller in place using mounting screws (not included).

3.4 Wiring



NOTE: A recommended connection order has been provided for maximum safety during installation. When disconnecting, solar input must be removed first before disconnecting battery. See caution below.



NOTE: The SunSaver is a negative ground controller. Any one negative conductor can be earth grounded as required. Grounding is recommended, but not required for correct operation.



NOTE: To comply with the NEC, the SunSaver must be installed using wiring methods in accordance with Article 690 of the latest edition of the National Electric Code, NFPA 70.



NOTE: The total current draw of all system loads connected to the SunSaver LOAD terminals cannot exceed the controller's load current rating.



NOTE: For mobile applications, be sure to secure all wiring. Use cable clamps to prevent cables from swaying when the vehicle is in motion. Unsecured cables create loose and resistive connections which may lead to excessive heating and/or fire.



WARNING: EXPLOSION HAZARD - DO NOT DISCONNECT WHILE CIRCUIT IS LIVE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS.



AVERTISSEMENT: RISQUE D'EXPLOSION. NE PAS DEBRANCHER TANT QUE LE CIRCUIT EST SOUS TENSION, A MOINS QU'IL NE S'AGISSE D'UN EMPLACEMENT NON DANGEREUX.



CAUTION: Unit has no battery removal protection. Disconnecting battery during charging may cause a brief spike in load voltage (above the 15V regulation limit) which may damage sensitive equipment.



ATTENTION:

Unité bénéficie d'aucune protection de retrait de batterie. Débrancher la batterie pendant la charge peut entraîner un bref pic de tension de charge (au-dessus du 15V limite de règlement) qui peuvent endommager les équipement sensibles.

Step 1: Load Wiring

The SunSaver load output connection will provide battery voltage to system loads such as lights, pumps, motors, and electronic devices. See *Section 4.3 Load Control Information* for more details about load control.

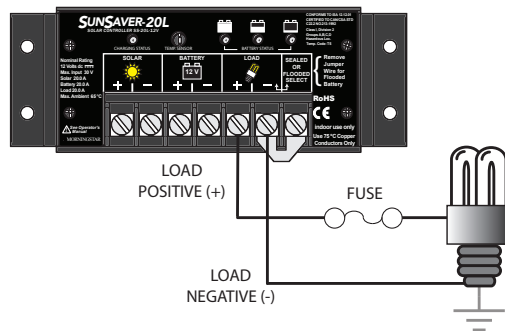


Figure 4. Load wiring.

Connect load positive (+) and negative (-) load wires to the system load(s) or load distribution panel as shown in figure 4. Refer to the wire gauge chart on page 30 of this manual for correct wire size. Use 75 °C copper wire.

If required, the negative load connection may be earth grounded. Use appropriate gauge wire and proper grounding methods for the installation site.

An in-line fuse holder should be wired in series in the load positive (+) wire as shown. DO NOT INSERT A FUSE AT THIS TIME. A circuit breaker may be used in lieu of a fuse. Keep the breaker in the open (disconnected) position at this time.

If wiring the load connection to a distribution panel, each load circuit should be fused separately. The total load draw should not exceed the the SunSaver's maximum load rating.

Step 2: Battery Wiring



WARNING: Shock Hazard
Fuses, circuit breakers, and disconnect switches should never open grounded system conductors. Only GFDI devices are permitted to disconnect grounded conductors.



AVERTISSEMENT: Risque de décharge électrique
Les fusibles, coupe-circuits et interrupteurs ne doivent jamais ouvrir les conducteurs du système mis à la terre. Seuls les dispositifs GFDI sont autorisés à déconnecter les conducteurs reliés mis à la terre.

The nominal battery voltage must match the SunSaver voltage rating. For 12V SunSaver models, only a 12V battery may be used. Connect only 24V batteries (or two 12V batteries in series) to 24V SunSaver models.

Before connecting the battery, measure the battery voltage. Battery voltage must be greater than 6 volts to power the SunSaver (12V or 24V models).

Connect the battery to the SunSaver. Refer to the wire gauge chart on page 43 of this manual for correct wire size. Use 75 °C copper wire.

If required, the negative battery connection may be earth grounded. Use appropriate gauge wire and proper grounding methods for the installation site.

Wire an in-line fuse holder no more than 6 inches (150

mm) from the battery positive terminal. DO NOT INSERT A FUSE AT THIS TIME. A circuit breaker may be used in lieu of a fuse. Keep the breaker in the open (disconnected) position at this time.



CAUTION: Unit has no battery removal protection.
Disconnecting battery during charging may cause a brief spike in load voltage (above the 15V regulation limit) which may damage sensitive equipment.



ATTENTION:
Unité bénéficie d'aucune protection de retrait de batterie. Débrancher la batterie pendant la charge peut entraîner un bref pic de tension de charge (au-dessus du 15V limite de règlement) qui peuvent endommager les équipement sensibles.



NOTE:
Battery circuit fuse / breaker not included. Fuse must be purchased separately.

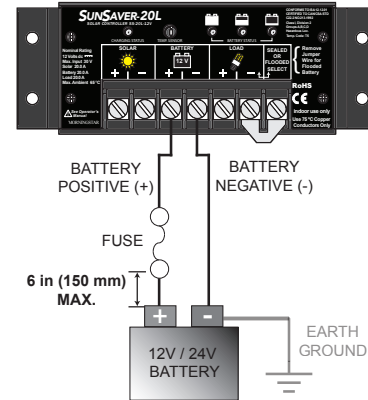


Figure 5. Battery wiring.

Step 3: Solar Wiring



WARNING: Shock Hazard

The solar PV array can produce open-circuit voltages in excess of 40 Vdc when in sunlight. Verify that the solar input breaker or disconnect has been opened (disconnected) before installing the system wires.



AVERTISSEMENT: Risque de décharge électrique

Le réseau PV solaire peut produire des tensions de circuit ouvert supérieures à 40 V cc à la lumière du soleil. Vérifiez que le coupe-circuit ou l'interrupteur d'entrée solaire a été ouvert (déconnexion) avant d'installer les câbles du système.



WARNING: Risk of Damage

Connecting the solar array to the battery terminal will permanently damage the SunSaver.



AVERTISSEMENT : Risque d'endommagement

La connexion du réseau solaire sur la borne de la batterie endommagera le SunSaver de façon permanente.

The nominal solar module voltage must match the SunSaver voltage rating. For 12V SunSaver models, only a 12 V nominal solar module having a maximum open circuit voltage of 30V may be used. Connect only 24V nominal solar modules (or two 12V arrays in series) to 24V SunSaver models. The maximum open circuit voltage of the 24V array must be less than 60V.

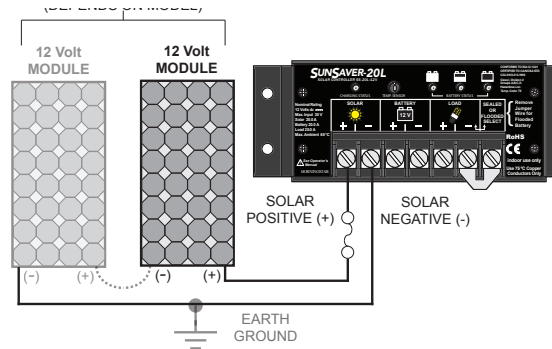


Figure 6. Solar input wiring.



NOTE:

Higher voltage PV modules designed for on-grid PV applications should not be used with the SunSaver or any PWM controller. Only use high voltage modules with maximum power point tracking (MPPT) controllers.

Connect the solar module(s) to the SunSaver. Refer to the wire gauge chart on page 30 of this manual for correct wire size. Use 75 °C copper wire.

If required, the negative solar connection may be earth grounded. Use appropriate gauge wire and proper grounding methods for the installation site.

Step 4: Confirm Wiring

Re-check the wiring in steps 1 through 3. Confirm correct polarity at each connection. Verify that all seven (7) SunSaver power terminals are tightened.

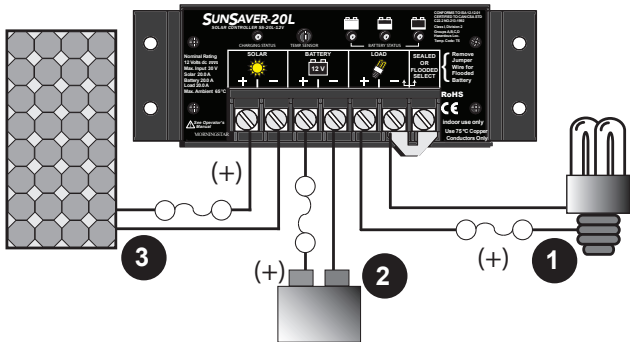


Figure 7. System Wiring Review.

Step 5: Install the Terminal Cover

The terminal cover prevents contact with the power terminals when energized. ***If local code and regulations require certification, terminal cover must be installed; otherwise, terminal cover use is optional.***

Begin by removing the two (2) lower faceplate screws as shown in figure 8a. Set the screws aside.

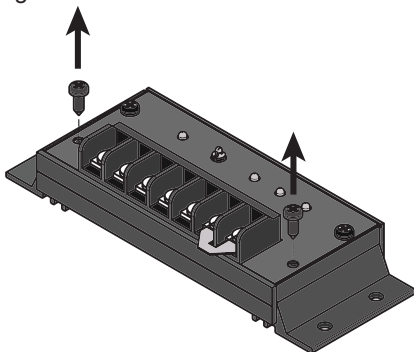


Figure 8a. Remove 2 faceplate screws.

Next, place the terminal cover over the terminal block as shown in Figure 8b. The cover mounting holes should align with the two (2) faceplate screw holes.

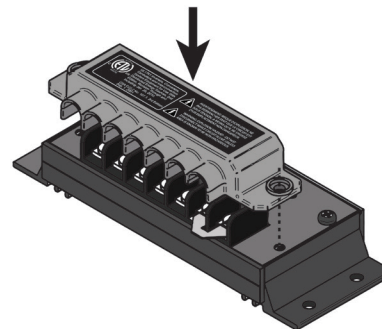


Figure 8b. Place the Terminal Block Cover.

Last, secure the terminal cover with the two (2) screws included with the cover.

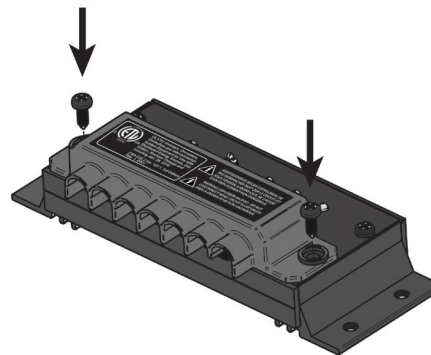


Figure 8c. Secure the Terminal Block Cover with 2 screws.

Step 6: Install Fuses or Close Breakers

Install a properly sized DC-rated fuse in each fuse holder in the following order:

1. Load circuit
2. Battery circuit
3. Solar circuit

Refer to the fuse table on page 46 for appropriate fuse sizes

If using circuit breakers, close the load breaker first followed by the battery breaker, then the solar breaker.

Step 7: Confirm Power-up

The SunSaver should begin the power-up LED sequence when battery power is applied. Observe that the Battery Status LEDs blink in sequence one time.

If the SunSaver does not power up or a flashing LED error sequence exists, refer to *Section 5.0 Troubleshooting*.

4.0 OPERATION

4.1 LED Indications

STATUS LED

The Status LED indicates charging status and any existing solar input error conditions. The Status LED is on when charging during the day and off at night. The Status LED will flash red whenever an error condition(s) exists. Table 2 lists the Status LED indications.

Color	Indication	Operating State
None	Off (with heartbeat ¹)	Night
Green	On Solid (with heartbeat ²)	Charging
Red	Flashing	Error
Red	On Solid (with heartbeat ²)	Critical Error

¹ Status LED heartbeat indication flickers ON briefly every 5 seconds

² Status LED heartbeat indication flickers OFF briefly every 5 seconds

Table 2. Status LED definitions

For more information on Status LED errors, see *Section 5.1 Error Indications*.

BATTERY SOC LEDS

Three (3) battery “state-of-charge” (SOC) LEDs indicate the level of charge on the battery. The SOC indication is based only on battery voltage setpoints, which only provides an approximation of the actual state-of-charge of the battery. Table 3 lists the SOC LED indications.

SOC LED	Indication	Battery Status	Load Status
Green	Fast Flashing (2 Flash / sec)	Full Battery: Equalize Charge	Load On
Green	Med. Flashing (1 Flash / sec)	Full Battery: Absorption Charge	Load On
Green	Slow Flashing (1 Flash / 2 sec)	Full Battery: Float Charge	Load On
Green	On solid	Battery Nearly Full	Load On
Yellow	On solid	Battery Half Full	Load On
Red	Flashing (1 Flash / sec)	Battery Low	LVD Warning (Load On)
Red	On solid	Battery Empty	LVD (Load Off)
None	No LEDS On	Battery Missing	Load Off

Table 3. Battery SOC LED definitions



NOTE:

An error condition exists if multiple Battery SOC LEDs are flashing. See Section 5.1 Error Indications for more information.

4.2 Battery Charging Information

The SunSaver has a 4-stage battery charging algorithm for rapid, efficient, and safe battery charging. Figure 9 shows the sequence of the stages.

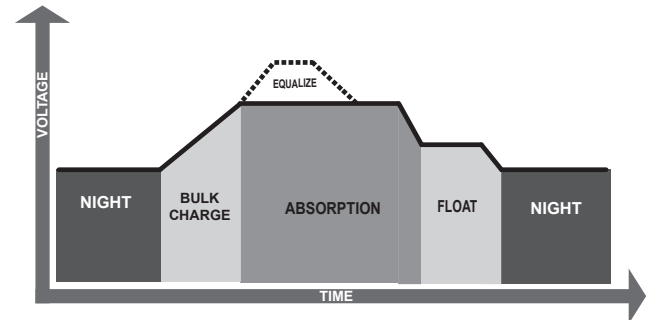


Figure 9. SunSaver charging algorithm.

Bulk Charge

In this stage, the battery voltage has not yet reached absorption voltage and 100% of available solar power is used to recharge the battery.

Absorption

When the battery has recharged to the Absorption voltage setpoint, constant-voltage regulation is used to prevent heating and excessive battery gassing.

Float

After the battery is fully charged the SunSaver reduces the battery voltage to a float charge which is sometimes called a *trickle charge*.

Depending on battery history, the battery remains in the

absorption stage for 3 or 4 hours before transitioning to the float stage.

Equalize (flooded battery type only)

The SunSaver will equalize a flooded battery for three (3) hours every 28 days. Equalize charging raises the battery voltage above the standard absorption voltage so that the electrolyte gases. This process prevents electrolyte stratification and equalizes the individual cell voltages within the battery.



WARNING: Risk of Explosion
Equalizing vented batteries produces explosive gases. The battery bank must be properly ventilated.



CAUTION: Equipment Damage
Excessive overcharging and gassing too vigorously can damage the battery plates and cause shedding of active material from the plates. An equalization that is too high or for too long can be damaging. Review the requirements for the particular battery being used in your system.



AVERTISSEMENT: Risque d'explosion
Les batteries à évent et compensation produisent des gaz explosifs. Le groupe de batteries doit être correctement ventilé.



ATTENTION: Endommagement de l'équipement
Une surcharge excessive et un dégagement gazeux trop vigoureux peuvent endommager les plaques de batteries et provoquer l'élimination du matériau actif des plaques. Une compensation trop élevée ou trop longue peut provoquer des dégâts. Examinez les exigences pour la batterie particulière utilisée dans votre système.

Dead Battery Charging

The SunSaver has a special charging function to recover batteries that have discharged too low. If the terminal voltage of the battery is greater than 1 Volt, the SunSaver

will detect the battery and provide approximately 85% of available charge current until the battery reaches the minimum operating voltage of the controller. When the battery has recharged to the minimum operating voltage of the SunSaver, 100% of available charge current will flow to the battery and normal operation will resume.

4.3 Load Control Information

The primary purpose of the load control function is to disconnect system loads when the battery has discharged to a low state-of-charge and reconnect system loads when the battery is sufficiently recharged. System loads may be lights, pumps, motors, DC appliances, and other electronic devices. The total current draw of all loads must not exceed the SunSaver maximum load rating.



NOTE:
Do not wire an AC inverter of any size to the load terminals of the SunSaver. Damage to the load control circuit may result. Connect inverters directly to the battery or battery bank.

Load Control Settings

Load control is fully automatic. The load will be disconnected and reconnected based upon the Low Voltage Disconnect (LVD) and Low Voltage Reconnect (LVR) voltage thresholds. The LVD and LVR thresholds are listed in the back of the manual.

LVD Warning

As the battery discharges the *Battery Status* LEDs will transition from green to yellow and then from yellow to flashing red. The flashing red indication is a warning that a low voltage disconnect event will occur soon. The amount of time between a green SOC indication and load disconnect

will depend on many factors including:

- rate of discharge (amount of load draw)
- capacity of the battery
- health of the battery
- LVD set-point

If the battery discharges to the LVD set-point the load will disconnect and a solid red Battery Status LED indication will be displayed.

General Load Control Notes

- Only SS-6L/10L/20L models provide load control.
- Regulated voltage due to temperature compensation is limited to a maximum of 15V (30V @ 24V nominal). This protects certain DC loads that may be damaged by high regulated input voltage.
- The load connection is NOT a regulated voltage output. The load terminal voltage is approximately the same as battery voltage unless the controller is in LVD condition (load turned off).
- Do not wire multiple SunSaver load outputs together in parallel to power DC loads with a current draw greater than the lowest rated controller's maximum load rating. Equal current sharing cannot be guaranteed and an over-load condition will likely occur on one or more controllers.
- Exercise caution when connecting loads with specific polarity to a live load circuit. A reverse polarity connection may damage the load. Always re-check load connections before applying power.
- The SunSaver will go straight to LVD on start-up if the battery voltage is at or below 11.7V / 23.4V.

4.4 Protections

Solar Overload

(Charging Status LED: Red flashing) If the solar current exceeds the maximum solar rating, the SunSaver will stop charging until the solar current returns to within its operational rating. See *Section 7.0 Technical Specifications* for more information.

Load Overload

(Battery Status LEDs: G&R - Y sequencing) If the load current exceeds the maximum load current rating, the SunSaver will disconnect the load.

The SunSaver will attempt to reconnect the load two (2) times approximately 10 seconds apart. If the overload remains after the first two (2) attempts, the fault must be cleared by removing and reapplying power.

Solar Short Circuit

(Charging Status LED: off) Solar input power wires are short-circuited. Charging automatically resumes when the short is cleared.

Load Short Circuit

(Battery Status LEDs: G&R - Y sequencing) Fully protected against load wiring short-circuits. After two (2) automatic load reconnect attempts (10 seconds apart), the fault must be cleared by removing and reapplying power.

PV Reverse Polarity

(Charge Status LED: off) Fully protected against reverse solar connection. No damage to the controller will result. Correct the mistake to resume normal operation.

Battery Reverse Polarity

(No LED indication) Fully protected against reverse battery connection. No damage to the controller will result. Correct the mistake to resume normal operation.

Damaged Local Temperature Sensor

(Battery Status LED: R - Y - G sequencing, Charge Status LED: R on solid) The local ambient temperature sensor is short-circuited or damaged. Charging stops to avoid over- or under-charging. This is a critical error. Contact your authorized Morningstar dealer for service.

Damaged Internal Temperature Sensor

(Battery Status LED: R - Y - G sequencing, Charge Status LED: R on solid) The internal heatsink temperature sensor is damaged. This is a critical error. Contact your authorized Morningstar dealer for service.

High Temperature

(Battery Status LED: R - Y sequencing) The heatsink temperature has exceeded 85 °C and the solar and load is disconnected. The SunSaver will automatically reconnect when the heatsink cools to 80 °C.

High Voltage Disconnect

(Battery Status LED: R - G sequencing) The battery voltage has exceeded the controller's maximum regulation limit. The solar and load will be disconnected until the battery voltage decreases to the SunSaver's High Voltage Reconnect threshold. See *Section 7.0 Technical Specifications* for more information.

4.5 Inspection and Maintenance

The following inspections and maintenance tasks are recommended at least two times per year for best controller performance.

- Tighten all terminals. Inspect for loose, broken, or corroded connections.
- Verify that all wire clamps and tie-downs are secure.
- Check that the controller is mounted in a clean, protected environment; free of dirt, insects, nests, and corrosion.
- If applicable, check enclosure ventilation and air flow holes for obstructions.
- Verify LED indication is consistent with the present system conditions.

5.0 TROUBLESHOOTING

5.1 Error Indications

Status LED Error Indications

- | | |
|---------------------------------|------------------------|
| • Solar overload | Flashing Red |
| • High Voltage Disconnect | Flashing Red |
| • High Temperature Disconnect | Flashing Red |
| • Damaged local temp. sensor | Solid Red ¹ |
| • Damaged heatsink temp. sensor | Solid Red ¹ |
| • Damaged input MOSFETs | Solid Red ¹ |
| • Firmware Error | Solid Red ¹ |

1 - A heartbeat indication flickers the Status LED off briefly every 5 seconds. A solid red Status LED indicates that a critical fault has been detected. Critical faults typically indicate that the controller is damaged and requires service.

Battery Status LED Error Indications

- | | |
|-------------------------------|----------------------|
| • High Voltage Disconnect | R - G Sequencing |
| • High Temperature Disconnect | R - Y Sequencing |
| • External Wiring Error | R&G - Y Sequencing |
| • Load Overcurrent | R&G - Y Sequencing |
| • Load Short Circuit | R&G - Y Sequencing |
| • Self-test Error | R - Y - G Sequencing |

Note:

LED error indications can be interpreted as follows:

“R - G sequencing” means that the Red LED is on, then the Green LED is on, then Red LED is on....

“R&G - Y sequencing” means that both the Red LED and Green LED are on, then just the Yellow LED is on, then Red and Green LED are on....

5.2 Common Problems

Problem: No LED indications

Solution: With a multi-meter, check the voltage at the Battery terminals on the SunSaver and the Solar terminals on the SunSaver. The solar module must be in good sun and battery voltage must be at least 1 V to power the SunSaver and activate the dead battery charging function.

Problem: The SunSaver is not charging the battery.

Solution: If the Status LED is solid or flashing red, see *Section 5.1 Error Indications*. If the Status LED is off, measure the voltage across the Solar input terminals of the SunSaver. Input voltage must be greater than battery voltage. Check fuses and solar wiring connections. The solar module must be in full natural sunlight.

Problem: No load output.

Solution: If the battery status indication is Solid Red, the SunSaver is in the Low Voltage Disconnect (LVD) condition. The load will automatically switch on when the battery recharges to the Low Voltage Reconnect (LVR) threshold voltage. See the specifications in section 7.0 for LVD & LVR settings.

NOTE: If the SunSaver model is SS-6-12V or SS-10-12V (no load control feature), the controller may be damaged.

Full testing documentation is available on our website at:

<http://morningstarcorp.com/support>

6.0 WARRANTY AND CLAIM PROCEDURE

LIMITED WARRANTY Morningstar Solar Controllers and Inverters

All Morningstar Professional Series™ products, except the SureSine™ inverter, are warranted to be free from defects in materials and workmanship for a period of FIVE (5) years from the date of shipment to the original end user. Warranty on replaced units, or field-replaced components, will be limited only to the duration of the original product coverage.

Morningstar Essentials Series™, and SureSine™ inverter, products are warranted to be free from defects in materials and workmanship for a period of TWO (2) years from the date of shipment to the original end user. Warranty on replaced units, or field-replaced components, will be limited only to the duration of the original product coverage.

Morningstar will, at its option, repair or replace any such defective units.

WARRANTY EXCLUSIONS AND LIMITATIONS

This warranty does not apply under the following conditions:

- Damage by accident, negligence, abuse or improper use.
- PV or load currents exceeding the ratings of the product.
- Unauthorized product modification or attempted repair
- Damage occurring during shipment
- Damage results from acts of nature such as lightning and weather extremes

THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHERS, EXPRESS OR IMPLIED. MORNINGSTAR SPECIFICALLY DISCLAIMS ANY AND ALL IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. No Morningstar distributor, agent or employee is authorized to make any modification or extension to this warranty.

MORNINGSTAR IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DOWN-TIME, GOODWILL OR DAMAGE TO EQUIPMENT OR PROPERTY.

WARRANTY CLAIM PROCEDURE

1. Before proceeding, please refer to product manual, including troubleshooting section.
2. Contacting your authorized Morningstar distributor or dealer from whom you purchased the unit is the first step in the warranty process. Local dealers can often address warranty issues quickly.
3. If supplier is unable to address the issue, please contact Morningstar by e-mail (support@morningstarcorp.com) with:
 - (A) purchase location - business or company name - and date
 - (B) full model and serial numbers (SN is 8-digits on unit bar label)
 - (C) failure behavior, including LED indications
 - (D) array configuration, panel Pmax, Voc, Vmp, Isc, and battery voltage; these specifications are needed to receive assistance.
 - (E) multi-meter available (for field troubleshooting)
4. After warranty replacement has been approved and new unit(s) received, please return failed unit(s) using pre-paid shipping label, and follow any product specific instructions if requested by Morningstar Warranty Dept.
5. If instructed by Morningstar, after warranty replacement shipment has been received, return of failed unit(s) is required before further warranty replacements can be considered for the original or future cases.

NOTE: Please do not return units without an RMA or case number. Doing so will increase the time required to resolve your claim.

7.0 TECHNICAL SPECIFICATIONS

Electrical

Nominal system voltage	12 or 24 Vdc
Max. solar input voltage	30 or 60V
Max. solar current	6.5 or 10 or 20A
Battery voltage range	6 -15V or 6-30V
Self-consumption	< 8 mA
Voltage Accuracy	1.0 %
Transient Surge Protection	1500W per connection

Protections (Solar & Load): short circuit, over-current, reverse polarity, high temperature, high voltage

Battery Charging

Regulation Method	4 stage PWM
Temp. Compensation Coefficient	12 V: -30 mV / °C 24 V: -60 mV / °C (25°C reference)
Temp. Compensation Range	- 30°C to + 60°C
Temp. Compensated Set-points	Absorption Float Equalize

Battery Status LEDs

	Falling V	Rising V	
G to Y	12.1	13.1	Y to G
Y to Flash R	11.7	12.6	R to Y
Flash R to R	11.5		

Note: Multiply x2 for 24 Volt systems.

Note: Only SunSavers with load control display the Flashing Red LED indication.

Battery Set-points (@ 25°C)

	Sealed 12 V or 24 V	Flooded/AGM 12 V or 24 V
Absorption Voltage ¹	14.1 V or 28.2 V	14.6 V or 29.2 V
Absorption Duration ²	3 hr	3 hr
Float Voltage	13.7 V or 27.4 V	13.7 V or 27.4 V
Equalize Voltage	none	14.9 V or 29.8 V
Equalize Duration	none	3 hrs
Equalize Calendar	none	28 days
Max. Regulation Voltage ³	15 V or 30 V	
Low Voltage Disconnect	11.5 V or 23.0 V	
Low Voltage Reconnect	12.6 V or 25.2 V	
High Voltage Disconnect	15.3 V or 30.6 V	
High Voltage Reconnect	14 V or 28 V	
Start-Up LVD	11.7 V or 23.4 V	
Instant LVD	10.0 V or 20.0 V	

1. Flooded/AGM absorption values effective with unit serial nos. 2038 0001 or higher
2. Based on typical PWM duty cycle, and depth of discharge - actual duration may vary
3. Not temperature compensated: 15V @ 12 V nominal, 30V @ 24 V nominal



NOTE: Temperature compensation increases regulation voltage in cold temperature. A 15 V (30 V @ 24 V nominal) maximum battery voltage limit prevents damage to sensitive DC loads.

Environmental

Ambient Temperature Range:

T4 Certified	-40°C to +60°C
T5 Certified	-40°C to +45°C
Storage temperature	-55°C to +80°C
Humidity	100% N.C.
Enclosure	IP10 (indoor)

For hazardous location-IECEX/ATEX applications, see the addendum - part no.MS-003243-EN - to this manual.

Mechanical

Power terminals wire size (max.)

Solid	#10 AWG / 5 mm ²
Multistrand	#10 AWG / 5 mm ²
Fine strand	#10 AWG / 5 mm ²
Terminal Diameter	0.210 in / 5.4 mm
Power terminals torque (max.)	10.6 in-lb / 1.2 Nm
Dimensions	See inside front cover
Weight (unpacked)	8 oz / 0.23 kg

Certifications

FOR CURRENT DETAILED CERTIFICATION LISTINGS, REFER TO:

<https://www.morningstarcorp.com/support/library>

Under, "Type", choose, "Declaration of Conformity (DOC)", to view list of product DOCs.

Tables

Fusing Chart

Wire Gauge (AWG)	Max. Fuse Size*
14	15 Amps
12	20 Amps
10	30 Amps

* per 2011 NEC NFPA 70, Article 240. For copper wire only.

* Refer to the wire charts on page 47 for appropriate wire size.

12 VOLT NOMINAL WIRE CHART

Amps	One-way Wire Distance (feet) Wire Gauge (AWG)					One-way Wire Distance (meters) Wire Gauge (mm ²)				
	14	12	10	8	6	2.0	3.0	5.0	8.0	13.0
2	70	112	180	287	456	21	32	53	85	139
4	35	56	90	143	228	10	16	26	42	69
6	24	38	60	96	152	7	10	17	28	46
8	18	28	45	72	114	5	8	13	21	34
10	14	23	36	57	91	4	6	10	17	27
12	12	19	30	48	76	3	5	8	14	23
14	10	16	26	41	65	3	4	7	12	19
16	9	14	23	36	57	3	4	7	10	17
18	8	13	20	32	51	2	3	6	9	15
20	7	11	18	29	46	2	3	5	8	13

3% Voltage drop, Annealed copper wire at 20°C

24 Volt Nominal Wire Chart

Amps	One-way Wire Distance (feet) Wire Gauge (AWG)					One-way Wire Distance (meters) Wire Gauge (mm ²)				
	14	12	10	8	6	2.0	3.0	5.0	8.0	13.0
2	140	224	360	574	912	42	64	107	171	278
4	70	112	180	286	456	21	32	53	85	139
6	48	76	120	191	304	14	21	35	57	92
8	36	56	90	144	228	10	16	26	42	69
10	29	45	72	115	182	8	12	21	34	55
12	24	38	60	96	152	7	10	17	28	46
14	20	32	51	82	130	6	9	15	24	39
16	18	28	45	72	114	5	8	13	21	34
18	16	25	40	64	101	4	7	11	19	30
20	14	23	36	57	91	4	6	10	17	27

3% Voltage drop, Annealed copper wire at 20°C



Specifications subject to change without notice.
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MS-001272 v4.0

SUNSAVER GEN 3 ADDENDUM TO OPERATOR'S MANUAL

Certifications



UL1741 INVERTERS, CONVERTERS, AND CONTROLLERS
AND INTERCONNECTION SYSTEM EQUIPMENT FOR USE
WITH DISTRIBUTED ENERGY SOURCES, SECOND EDITION,
REVISION THROUGH AND INCLUDING FEB 15, 2018
CSA C22.2#107.1 POWER CONVERSION EQUIPMENT
UL121201/CSA C22.2 #213 Non-incendive
Electrical Equipment for Use in Class I, Division 2
Hazardous (Classified) Locations, Groups A,B,C,D,
Temperature Group: T4, T5 (see product manual
environmental specifications)

EMC Directives

Immunity: EN 55024

Emissions: EN 55032

Hazardous Locations for IECEx/ATEX Applications

IECEX ETL 20.0060X

ITS20ATEX35891X

IECEX: Ex ec IIC TX Gc

ATEX:  II 3G Ex ec IIC TX Gc

T4: $-40^{\circ}\text{C} \leq T_{\text{amb}} \leq +60^{\circ}\text{C}$

T5: $-40^{\circ}\text{C} \leq T_{\text{amb}} \leq +45^{\circ}\text{C}$

Sunsaver Gen 3 must be verified with di-electric strength test specified by the relevant industrial standard.

The equipment must be placed inside an Ex-rated IP 54 enclosure in accordance with IEC 60079 series. A tool is required in order to access the equipment inside the enclosure.

Morningstar Corporation

8 Pheasant Run, Newtown, PA 18940 USA

10611 Iron Bridge Road, Ste. L, Jessup, MD 20794 USA

MS-003243-EN-4