

TRISTAR MPPT™

Solar Charging System Controller

Installation, Operation and Maintenance Manual

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Solar Battery Charger

With

TrakStar™ Maximum Power Point Tracking Technology

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MODELS

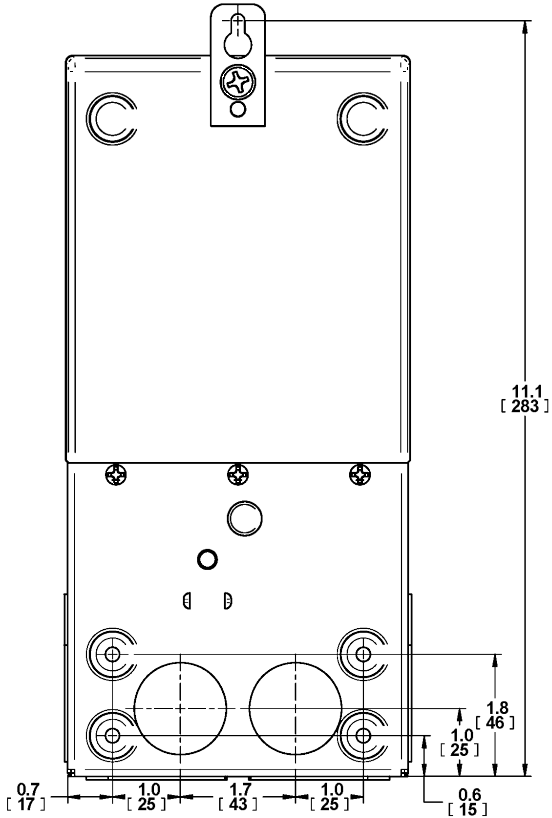
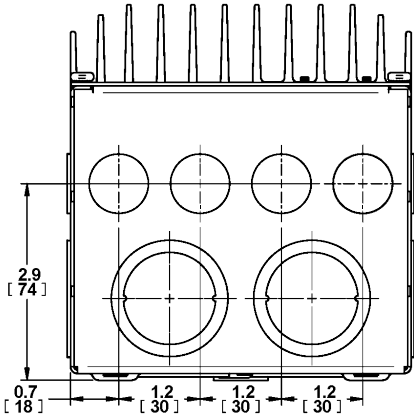
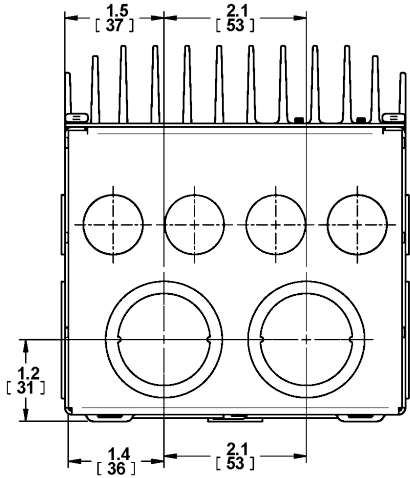
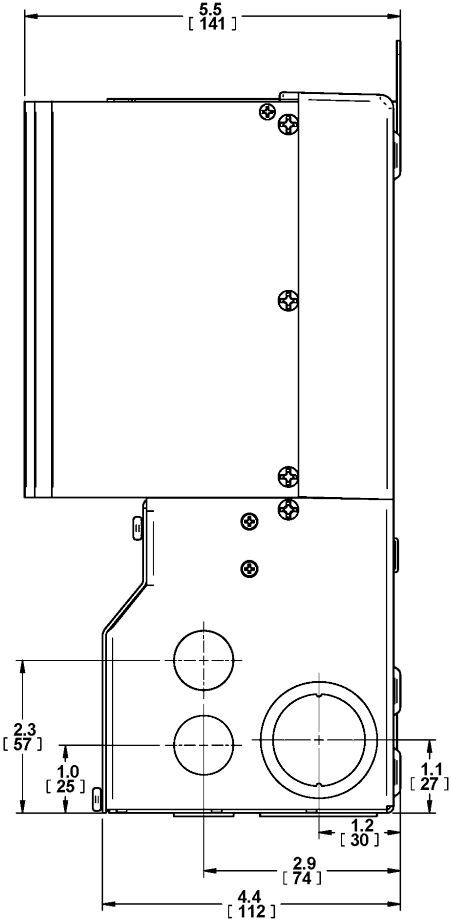
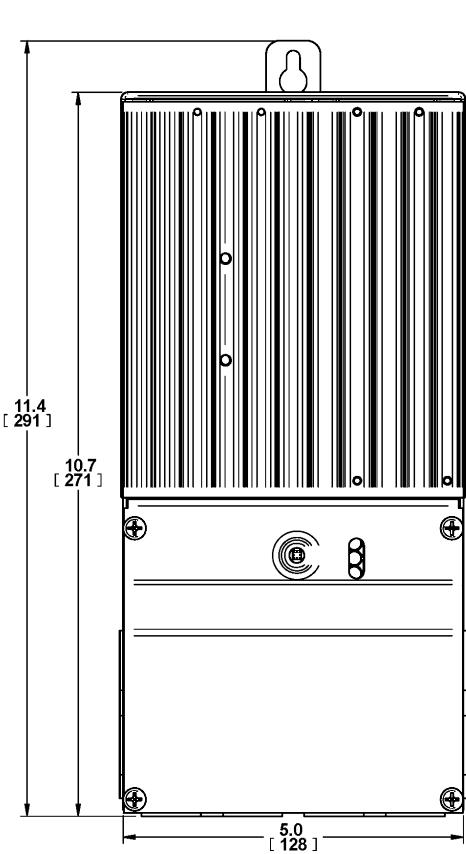
TS-MPPT-30

TS-MPPT-45

TS-MPPT-60



Dimensions in Inches [Millimeters]



1.0 Important Safety Instructions

SAVE THESE INSTRUCTIONS.

This manual contains important safety, installation and operating instructions for the TriStar MPPT 150V 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.



AVERTISSEMENT :

Indique une condition potentiellement dangereuse. Faites preuve d'une prudence extrême lors de la réalisation de cette tâche.



PRUDENCE :

Indique une procédure critique pour l'utilisation sûre et correcte du contrôleur.



REMARQUE :

Indique une procédure ou fonction importante pour l'utilisation sûre et correcte du contrôleur.

Safety Information

- Read all of the instructions and cautions in the manual before beginning installation.
- There are no user serviceable parts inside the TriStar MPPT 150V. Do not disassemble or attempt to repair the controller.



WARNING: RISK OF ELECTRICAL SHOCK.

NO POWER OR ACCESSORY TERMINALS ARE ELECTRICALLY ISOLATED FROM DC INPUT, AND MAY BE ENERGIZED WITH HAZARDOUS SOLAR VOLTAGE. UNDER CERTAIN FAULT CONDITIONS, BATTERY COULD BECOME OVER-CHARGED. TEST BETWEEN ALL TERMINALS AND GROUND BEFORE TOUCHING.

- External solar and battery disconnects are required.
- Disconnect all sources of power to the controller before installing or adjusting the TriStar MPPT 150V.
- There are no fuses or disconnects inside the TriStar MPPT 150V. Do not attempt to repair.

- This charge controller is to be connected to DC circuits only. These DC connections are identified by the symbol below:



Direct Current Symbol

The TriStar MPPT 150V controller must be installed by a qualified technician in accordance with the electrical regulations of the country where the product is installed. A means of disconnecting all power supply poles must be provided. These disconnects must be incorporated in the fixed wiring. A permanent, reliable earth ground must be established with connection to the wiring compartment ground terminal.

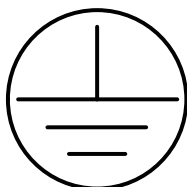
The grounding conductor must be secured against any accidental detachment. The knock-outs in the wiring compartment must protect wires with conduit or rubber rings.

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 TriStar MPPT 150V à l'intérieur. Empêchez l'exposition aux éléments et la pénétration d'eau dans le contrôleur.
- Installez le TriStar MPPT 150V dans un endroit qui empêche le contact occasionnel. Le dissipateur de chaleur peut devenir très chaud 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.
- 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.
- La borne de mise à la terre se trouve dans le compartiment de câblage et est identifiée par le symbole ci-dessous estampillé dans le boî:



- Servicing of batteries should be performed, or supervised, by personnel knowledgeable about batteries, and the proper safety precautions.
 - Be very careful when working with large lead-acid batteries. Wear eye protection and have fresh water available in case there is contact with the battery acid.
 - Remove watches, rings, jewelry and other metal objects before working with batteries.
 - Wear rubber gloves and boots
 - Use tools with insulated handles and avoid placing tools or metal objects on top of batteries.
 - Disconnect charging source prior to connecting or dis-connecting battery terminals.
 - Determine if battery is inadvertently grounded. If so, remove the source of contact with ground. Contact with any part of a grounded battery can result in electrical shock. The likelihood of such a shock can be reduced if battery grounds are removed during installation and maintenance (applicable to equipment and remote battery supplies not having a grounded supply circuit).
 - Carefully read the battery manufacturer's instructions before installing / connecting to, or removing batteries from, the TriStar MPPT.
 - Be very careful not to short circuit the cables connected to the battery.
 - Have someone nearby to assist in case of an accident.
 - Explosive battery gases can be present during charging. Be certain there is enough ventilation to release the gases.
 - Never smoke in the battery area.
 - If battery acid comes into contact with the skin, wash with soap and water. If the acid contacts the eye, flood with fresh water and get medical attention.
 - Be sure the battery electrolyte level is correct before starting charging. Do not attempt to charge a frozen battery.
 - Recycle the battery when it is replaced.
-
- Entretien des batteries devrait être effectué ou supervisé, par un personnel bien informé sur les piles et les précautions de sécurité appropriées.
 - Soyez très prudent quand vous travaillez avec des grandes batteries au plomb. Portez des lunettes de protection et ayez de l'eau fraîche à disposition en cas de contact avec l'électrolyte.
 - Enlevez les montres, bagues, bijoux et autres objets métalliques avant de travailler avec des piles.
 - Porter des bottes et des gants de caoutchouc
 - Utiliser des outils avec poignées isolantes et évitez de placer des outils ou des objets métalliques sur le dessus de batteries.
 - Débrancher la source de charge avant de brancher ou dis-reliant les bornes de la batterie.
 - Utilisez des outils isolés et évitez de placer des objets métalliques dans la zone de travail.
 - Déterminer si batterie repose par inadvertance. Dans l'affirmative, supprimer la source du contact avec le sol. Contact avec n'importe quelle partie d'une batterie mise à la terre peut entraîner un choc électrique. La probabilité d'un tel choc peut être réduite si des motifs de batterie sont supprimés pendant l'installation et maintentretien (applicable à l'équipement et les fournitures de pile de la télécommande n'ayant pas un circuit d'alimentation mise à la terre *).
 - Lisez attentivement les instructions du fabricant de la batterie avant d'installer / connexion à ou retrait des batteries du TriStar MPPT.
 - Veillez à ne pas court-circuiter les câbles connectés à la batterie.
 - Ayez une personne à proximité qui puisse aider en cas d'accident.

2.0 Getting Started

2.1 Overview

Thank you for selecting the TriStar MPPT 150V solar charge controller with TrakStar™ MPPT Technology. The TriStar MPPT 150V (TS-MPPT) is an advanced maximum power point tracking solar battery charger. The controller features a smart tracking algorithm that finds and maintains operation at the solar array peak power point, maximizing energy harvest.

The TriStar MPPT 150V battery charging process has been optimized for long battery life and improved system performance. Self-diagnostics and electronic error protections prevent damage when installation mistakes or system faults occur. The controller also features eight (8) adjustable settings switches, several communication ports, and terminals for remote battery temperature and voltage measurement.

Please take the time to read this operator's manual and become familiar with the controller. This will help you make full use of the many advantages the TriStar MPPT 150V can provide for your PV system.

2.2 Versions and Ratings

There are three versions of TriStar MPPT 150V controller:

TriStar-MPPT-30

- maximum 30 amps continuous battery current
- 12, 24 and 48 Volt dc systems
- maximum 150 Volt dc solar input voltage
- RS-232 and MeterBus™ communication ports

TriStar-MPPT-45

- maximum 45 amps continuous battery current
- 12, 24 and 48 Volt dc systems
- maximum 150 Volt dc solar input voltage
- RS-232 and MeterBus™ communication ports

TriStar-MPPT-60

- maximum 60 amps continuous battery current
- 12, 24 and 48 Volt dc systems
- maximum 150 Volt dc solar input voltage
- RS-232, EIA-485, MeterBus™, and Ethernet communication ports

1 - Heatsink

Aluminum heatsink to dissipate controller heat

2 - Mounting Hanger

Keyhole slot for mounting

3 - Settings Switches

Eight (8) settings switches to configure operation of the TriStar MPPT 150V

4 - Battery Positive Terminal (red)

Power connection for Battery (+)

5 - Remote Temperature Sensor Terminals

Connection point for a Morningstar RTS (optional) to remotely monitor battery temperature

6 - LED Indicators

Three *state of charge* (SOC) LED indicators show charging status and controller faults

7 - MeterBus™ Port

RJ-11 socket for Morningstar MeterBus™ network connections

8 - Battery Voltage Sense Terminals

Terminals for battery voltage input provide accurate battery voltage measurement

9 - Ground Terminal

A chassis ground terminal for system grounding

10 - Ethernet Port

RJ-45 socket for LAN/internet connections (TS-MPPT-60 model only)

11 - Wiring Box with Conduit Knockouts

Termination points for wiring conduit and wire glands

12 - Wiring Box Cover

Sheet metal wiring box cover protects power connections

13 - Serial RS-232 Port

9-pin serial connector (female)

14 - EIA-485 Port

Four (4) position screw terminal for EIA-485 bus connections (TS-MPPT-60 model only)

15 - Solar Positive Terminal (yellow)

Power connection for Solar (+)

16 - Common Negative Power Terminals

Two (2) negative terminals for negative system cable termination

17 - Push-button Switch

Manually reset from an error or fault, also used to start/stop a manual equalization.

2.5 Optional Accessories

The following accessories are available for purchase separately from your authorized Morningstar dealer:

TriStar Digital Meter 2 / TriStar Remote Meter 2 (Models: TS-M-2 / TS-RM-2)

The TriStar Digital Meter mounts directly on the TS-MPPT controller, replacing the wiring box cover. The TriStar Remote Meter can be flush mounted in a wall or into a standard duplex (2-gang) electrical box. A 2 x 16 character display shows system operating information, error indications, and self-diagnostic information. Four (4) buttons make navigating the meter menus easy.

For systems where multiple TS-MPPT controllers are networked together, one (1) meter can display full system information. The TriStar meters connect to the RJ-11 MeterBus™ port on the TriStar-MPPT.

Meter Hub (HUB-1)

A Morningstar MeterBus™ network with multiple controllers requires a Meter Hub for electrical isolation. The HUB-1 allows communication between MeterBus™ compatible Morningstar products, including the TriStar MPPT 150V controller. DIN rail compatible. See section 5.2 for more details.

Relay Driver (RD-1)

The Relay Driver™ accessory enables the TriStar MPPT 150V to control external devices. Four (4) relay control ports can be configured (in various combinations) to perform the following tasks:

- generator control (2-, 3-, and 4-wire configurations)
- dry contacts for alarms and other signals
- advanced load control
- vent fan control
- DIN rail compatible or surface mount

For more information on the Relay Driver, visit our website at www.morningstarcorp.com or inquire with your local Morningstar dealer.

EIA-485 / RS-232 Communications Adapter (RSC-1)

Connect one or more TriStar MPPT 150V controllers to a PC or to other serial devices using the RSC-1 EIA-485 adapter. The adapter converts an RS-232 serial interface to EIA-485 compliant signals. An LED shows network activity and errors. DIN rail compatible.

3.0 Installation

3.1 General Information

The mounting location is important to the performance and operating life of the controller. The environment must be dry and protected from water ingress. If required, the controller may be installed in a ventilated enclosure with sufficient air flow. Never install the TriStar MPPT 150V in a sealed enclosure. The controller may be mounted in an enclosure with sealed batteries, but never with vented/flooded batteries. Battery fumes from vented batteries will corrode and destroy the TriStar MPPT 150V circuits.

Multiple TriStars can be installed in parallel on the same battery bank to achieve higher charging current. Additional parallel controllers can also be added in the future. Each TriStar MPPT 150V must have its own solar array.



WARNING: Installation must conform to all requirements of the US National Electrical Code and the Canadian Electrical Code.



AVERTISSEMENT: Installation doit être conforme à toutes les requirments US National Electrical Code et Code Canadien d'Electricité.



CAUTION: Equipment Damage or Risk of Explosion

Never install the TriStar MPPT 150V in an enclosure with vented/flooded batteries. Battery fumes are flammable and will corrode and destroy the TriStar MPPT 150V circuits.



CAUTION: Equipment Damage

When installing the TriStar MPPT 150V 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 TriStar MPPT 150V dans une enceinte avec des batteries à évent/à électrolyte liquide. Les vapeurs des batteries sont inflammables et corroderont et détruiront les circuits du TriStar MPPT 150V.



PRUDENCE : Endommagement de l'équipement

Assurez une ventilation suffisante en cas d'installation du TriStar MPPT 150V dans une enceinte. L'installation dans une enceinte hermétique entraîne une surchauffe et une réduction de la durée de vie du produit.

The installation is straight-forward, but it is important each step is done correctly and safely. A mistake can lead to dangerous voltage and current levels. Be sure to carefully follow each instruction in this section. Read all instructions first before beginning installation.

The installation instructions are for installation of a negative grounded system. National Electrical Code (NEC) requirements are noted on occasion for convenience, however the installer should have a complete understanding of NEC and UL requirements for photovoltaic installations.

3.2 Controller Installation

Step 1 - Remove the wiring box cover



CAUTION: Shock Hazard

Disconnect all power sources to the controller before removing the wiring box cover. Never remove the cover when voltage exists on any of the TriStar MPPT 150V power connections.



PRUDENCE : Risque de décharge électrique

Déconnectez toutes les sources d'alimentation du contrôleur avant d'enlever le couvercle du boîtier de câblage. Ne retirez jamais le couvercle en présence de tension sur une des connexions d'alimentation du TriStar MPPT.

Use a #2 Phillips screw driver to remove the four (4) screws that secure the wiring box cover as shown in figure 3-1 below.

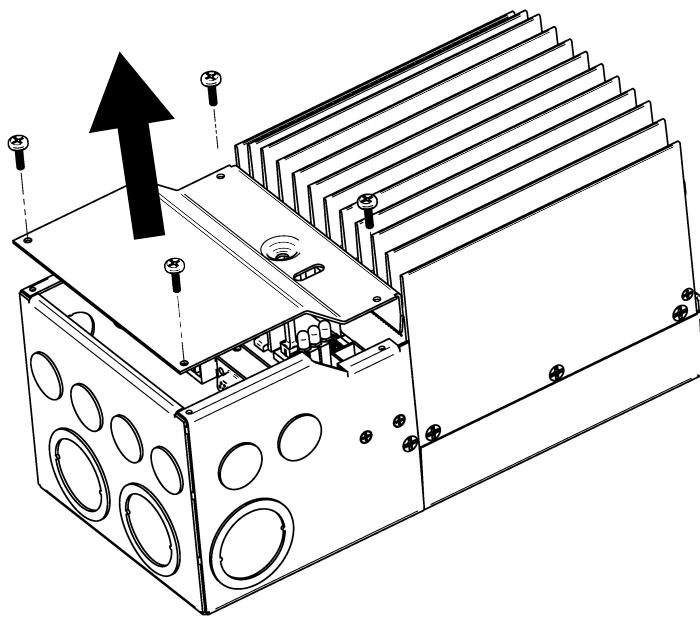


Figure 3-1. Remove the wiring box cover.

If a TriStar Digital Meter 2 display is installed, be sure to disconnect the RJ-11 cable.

Step 3 - Mount to a Vertical Surface



CAUTION: Risk of Burns

Install the TriStar MPPT 150V in a location that prevents casual contact. The TriStar MPPT 150V heatsink can become very hot during operation.

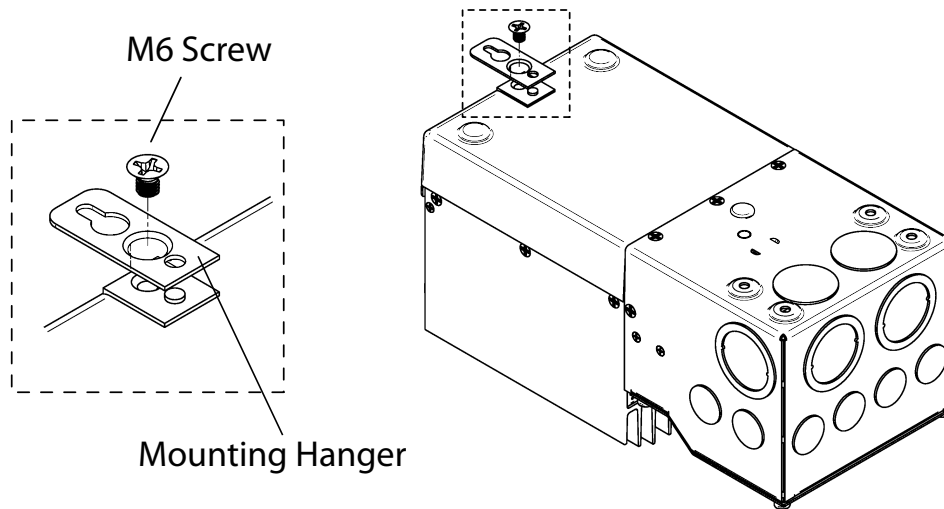


Figure 3-2. Attaching the mounting hanger

1. Attach the mounting hanger to the bottom of the TriStar MPPT 150V with the M6 screw provided as shown in figure 3-2.
2. Place the TriStar MPPT 150V on a vertical surface protected from direct sun, high temperatures, and water. The TriStar MPPT 150V requires at least 6" (150 mm) of clearance above and below and at least 1" (25 mm) on each side for proper air flow as shown in figure 3-3 below.

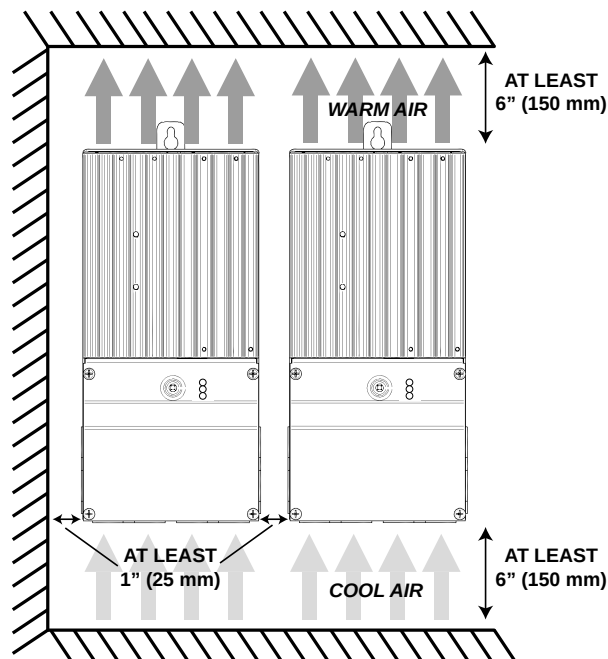


Figure 3-3. Required mounting clearance for air flow.

Switches 4, 5, & 6: Battery Charging Settings

It is important to select the battery type that matches the system battery to ensure proper charging and long battery life. Refer to the specifications provided by the battery manufacturer and choose a setting that best fits the recommended charging profile.

Settings Switches 4 - 5 - 6	Battery Type	Absorp. Stage (Volts)	Float Stage (Volts)	Equalize Stage (Volts)	Equalize Interval (Days)
off-off-off	1 - Gel	14.00	13.70		
off-off-on	2 - Sealed*	14.15	13.70	14.40	28
off-on-off	3 - Sealed*	14.30	13.70	14.60	28
off-on-on	4 - AGM/Flooded	14.40	13.70	15.10	28
on-off-off	5 - Flooded	14.60	13.50	15.30	28
on-off-on	6 - Flooded	14.70	13.50	15.40	28
on-on-off	7 - L-16	15.40	13.40	16.00	14
on-on-on	8 - Custom	Custom	Custom	Custom	Custom

* "Sealed" battery type includes gel and AGM batteries

All settings are for 12 Volt nominal systems. Multiply the charge voltage settings by 2 for 24 Volt systems or by 4 for 48 Volt systems. A description of each setting is provided below. See section 4.3 for full details on battery charging and a description of each of the settings in the battery charging table.

Battery Type - The most common battery type associated with the specified charging settings.

Absorption Stage - This stage limits input current so that the Absorption voltage is maintained. As the battery becomes more charged, the charging current continues to taper down until the battery is fully charged.

Float Stage - When the battery is fully charged, the charging voltage will be reduced to the Float voltage setting.

Equalize Stage - During an equalization cycle, the charging voltage will be held constant at the specified voltage setting.

Equalize Interval - The number of days between equalization charges when the controller is configured for automatic equalizations (settings switch 7).

Switch 7: Battery Equalization

Choose between manual and automatic battery equalization charging. In the manual equalization setting, an equalization will only occur when manually started with the push-button or when requested from the equalize menu on the TriStar meter. Automatic equalization will occur according to the battery program specified by settings switches 4, 5, & 6 in the previous step.

Step 5 - Remote Temperature Sensor

The included Remote Temperature Sensor (RTS) is recommended for effective temperature compensated charging. Connect the RTS to the 2-position terminal located between the battery (+) terminal lug and the LED stack (see figure 2-1). The RTS is supplied with 33 ft (10 m) of 22 AWG (0.34 mm²) cable. There is no polarity, so either wire (+ or -) can be connected to either screw terminal. The RTS cable may be pulled through conduit along with the power wires. Tighten the connector screws to 5 in-lb (0.56 Nm) of torque. Separate installation instructions are provided inside the RTS bag.



WARNING: Risk of Fire.

If no Remote Temperature Sensor (RTS) is connected, use the TriStar MPPT 150V within 3m (10 ft) of the batteries. Internal Temperature Compensation will be used if the RTS is not connected. Use of the RTS is strongly recommended.



AVERTISSEMENT: Risque d'incendie.

Si non Capteur de température distant (RTS) est connecté, utilisez le MPPT ProStar moins de 3m (10 pi) de les batteries. Compensation de la température interne sera utilisée si la RTS n'est pas connecté. Utilisation de la RTS est fortement recommandé.



CAUTION:

The TriStar MPPT 150V will not temperature compensate charging parameters if the RTS is not used.



CAUTION: Equipment Damage

Never place the temperature sensor inside a battery cell. Both the RTS and the battery will be damaged.



NOTE:

The RTS cable may be shortened if the full length is not needed. Be sure to reinstall the ferrite choke on the end of the RTS if a length of cable is removed. This choke ensures compliance with electromagnetic emissions standards.



PRUDENCE:

Le TriStar MPPT 150V ne compense pas la température des paramètres de charges si le RTS n'est pas utilisé.



PRUDENCE : Endommagement de l'équipement

Ne placez jamais la sonde de température dans un élément de batterie. Le RTS et la batterie seraient endommagés.



REMARQUE :

Le câble de RTS peut être raccourci si la totalité de la longueur n'est pas nécessaire. Assurez-vous de réinstaller la bobine en ferrite sur l'extrémité du RTS si une longueur de câble est enlevée. Cette bobine assure la conformité avec les normes d'émissions électromagnétiques.

Step 7 - Battery Voltage Sense

The voltage at the battery connection on the TriStar MPPT 150V may differ slightly from the voltage directly at the battery bank terminals due to connection and cable resistance. The *Battery Voltage Sense* connection enables the TriStar MPPT 150V to measure the battery terminal voltage precisely with small gauge wires that carry very little current, and thus have no voltage drop. Both battery voltage sense wires are connected to the TriStar at the 2-position terminal located between the push-button and the positive (+) terminal lug (see figure 2-1).

A battery voltage sense connection is not required to operate your TriStar MPPT 150V controller, but it is recommended for best performance. If a TriStar meter will be added to the controller, the battery voltage sense will ensure that the voltage and diagnostic displays are very accurate.

The voltage sense wires should be cut to length as required to connect the battery to the voltage sense terminal. The wire size can range from 16 to 24 AWG (1.0 to 0.25 mm²). A twisted pair cable is recommended but not required. Use UL rated 300 Volt conductors. The voltage sense wires may be pulled through conduit with the power conductors. Tighten the connector screws to 5 in-lb (0.56 Nm) of torque.

The maximum length allowed for each battery voltage sense wire is 98 ft (30 m).

Be careful to connect the battery positive (+) terminal to the voltage sense positive (+) terminal. No damage will occur if the polarity is reversed, but the controller cannot read a reversed sense voltage. Connecting the voltage sense wires to the RTS terminal will cause an alarm.

If a TriStar meter is installed, check the “TriStar Settings” to confirm the Voltage Sense and the RTS (if installed) are both present and detected by the controller. MSView™ PC software can also be used to confirm the voltage sense is working correctly.

Step 8 - Network Connections

Network connections allow the TriStar MPPT 150V to communicate with other controller or computers. A network can be as simple as one controller and one PC, or as complex as dozens of controllers monitored via the internet. Review section 5.0 for more information about networking and the connection(s) required for your system.



WARNING: Shock Hazard

Never route network cables in the same conduit as the power conductors.



WARNING: Shock Hazard

Only use 300 Volt UL rated communication cable.



AVERTISSEMENT : Risque de décharge électrique

N'acheminez jamais les câbles réseau dans le même conduit que les conducteurs d'alimentation.

RS-232 Connection

The serial RS-232 port is a standard 9-pin (DB9) female connector. A low-profile serial connector is recommended to save room in the wiring box.



NOTE:

The RS-232 and EIA-485 ports share hardware. Both ports cannot be used simultaneously.



REMARQUE :

Les ports RS-232 et EIA-485 partagent le matériel. Ils ne peuvent pas être utilisés simultanément.

Ethernet Connection

The RJ-45 Ethernet jack features two (2) indicator LEDs for connection status and network traffic. Use CAT-5 or CAT-5e twisted pair cable and RJ-45 plugs. If possible, pull the network cable through conduit before crimping on the RJ-45 connectors. If using pre-assembled cables, take care not to damage the plugs when the cables are pulled through conduit.

MeterBus™ Connection

MeterBus™ networks use standard 4-wire or 6-wire RJ-11 telephone cables. If possible, pull the telephone cable through conduit before crimping on the RJ-11 connectors. If using pre-assembled cables, take care not to damage the plugs when the cables are pulled through conduit.

Y-cable Connections for EMC-1 Use

TS-MPPT-30 and TS-MPPT-45 units can be Ethernet connected using the EMC-1 accessory and an EMC-1 provided Y-cable. These models need to be connected to the EMC-1 with the Y-cable (DB-9 serial and RJ-11 plugs at the TS-MPPT) and an RJ-11 plug at the EMC-1.

Disconnects



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 NEC requires solar and battery fuses or DC breakers to be installed in the system. These protection devices are external to the TriStar MPPT 150V controller, and must be a maximum of 45 amps for the TS-MPPT-30, 70 amps for the TS-MPPT 45 and 90 amps for the TS-MPPT-60.

Maximum battery short-circuit current rating must be less than the interrupt current rating of the battery over-current protection device referenced above.



WARNING: Breakers and fuses may require lower ratings than referenced above, so as not to exceed any specific wire ampacity.



AVERTISSEMENT: Disjoncteurs et fusibles peuvent exiger des cotes inférieures que mentionnés ci-dessus de manière à ne pas pour dépasser n'importe quel fils particulier admissible.

Connect the Power Wires



WARNING: Shock Hazard

The solar PV array can produce open-circuit voltages in excess of 150 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 150 Vdc 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**

Be very certain that the solar connection is made with correct polarity. Turn on the solar array breaker/disconnect and measure the voltage on the open wires **BEFORE** connecting to the TriStar MPPT 150V. Disconnect the solar breaker/disconnect before wiring to the controller.

**AVERTISSEMENT : Risque d'endommagement**

Assurez-vous que la connexion solaire est effectuée avec la polarité correcte. Activez le coupe-circuit/interrupteur de réseau solaire et mesure la tension sur les câbles ouverts **AVANT** la connexion au TriStar MPPT 150V. Déconnectez le coupe-circuit/interrupteur solaire avant le câblage sur le contrôleur.

6. Connect the Solar + (positive) wire to the Solar + terminal on the TriStar MPPT 150V. The Solar + terminal has a yellow cover.
7. Connect the Solar - (negative) wire to one of the Common Negative terminals on the TriStar MPPT 150V.

Torque all four (4) power terminals to 50 in-lbs (5.65 Nm)

Power-up**WARNING: Risk of Damage**

Connecting the solar array to the battery terminal will permanently damage the TriStar MPPT 150V.

**WARNING: Risk of Damage**

Connecting the solar array or battery connection with reverse polarity will permanently damage the TriStar MPPT 150V.

**AVERTISSEMENT : Risque d'endommagement**

La connexion du réseau solaire sur la borne de la batterie endommagera le TriStar MPPT 150V de façon permanente.

**AVERTISSEMENT : Risque d'endommagement**

La connexion du réseau solaire ou la connexion de la batterie avec une polarité inversée endommagera le TriStar MPPT 150V de façon permanente.

- Confirm that the Solar and Battery polarities are correct.
- Turn the battery disconnect switch on first. Observe that the LEDs indicate a successful start-up. (LEDs blink Green - Yellow - Red in one cycle)
- Note that a battery must be connected to the TriStar MPPT 150V to start and operate the controller. The controller will not operate only from solar input.
- Turn the solar disconnect on. If the solar array is in full sunlight, the TriStar MPPT 150V will begin charging. If an optional TriStar Meter is installed, charging current will be reported along with charging state.

4.0 Operation

The TriStar MPPT 150V operation is fully automatic. After installation is completed, there are few operator tasks to perform. However, the operator should be familiar with the operation and care of the TriStar MPPT 150V as described in this section.

4.1 TrakStar™ MPPT Technology

The TriStar MPPT 150V utilizes Morningstar's TrakStar™ Maximum Power Point Tracking (MPPT) technology to extract maximum power from the solar array. The tracking algorithm is fully automatic and does not require user adjustment. TrakStar™ technology tracks the array *maximum power point* as it varies with weather conditions, ensuring that maximum power is harvested from the array throughout the course of the day.

Current Boost

Under most conditions, TrakStar™ MPPT technology will “boost” the solar charge current. For example, a system may have 36 Amps of solar current flowing into the TS-MPPT and 44 Amps of charge current flowing out to the battery. The TriStar MPPT 150V does not create current! Rest assured that the power into the TriStar MPPT 150V is the same as the power out of the TriStar MPPT 150V. Since power is the product of voltage and current (Volts x Amps), the following is true*:

- (1) Power Into the TriStar MPPT 150V = Power Out of the TriStar MPPT 150V
- (2) Volts In x Amps In = Volts Out x Amps Out

* assuming 100% efficiency. Losses in wiring and conversion exist.

If the solar module's *maximum power voltage* (V_{mp}) is greater than the battery voltage, it follows that the battery current must be proportionally greater than the solar input current so that input and output power are balanced. The greater the difference between the V_{mp} and battery voltage, the greater the current boost. Current boost can be substantial in systems where the solar array is of a higher nominal voltage than the battery as described in the next section.

High Voltage Strings and Grid-Tie Modules

Another benefit of TrakStar™ MPPT technology is the ability to charge batteries with solar arrays of higher nominal voltages. For example, a 12 volt battery bank may be charged with a 12, 24, 36, or 48 volt nominal off-grid solar array. Grid-tie solar modules may also be used as long as the solar array *open circuit voltage* (V_{oc}) rating will not exceed the TriStar MPPT 150V 150 Volt maximum input voltage rating at worst-case (coldest) module temperature. The solar module documentation should provide V_{oc} vs. temperature data.

Higher solar input voltage results in lower solar input current for a given input power. High voltage solar input strings allow for smaller gauge solar wiring. This is especially helpful and economical for systems with long wiring runs between the controller and the solar array.

4.2 Battery Charging Information

4-Stage Charging

The TriStar MPPT 150V has a 4-stage battery charging algorithm for rapid, efficient, and safe battery charging. Figure 4-2 shows the sequence of the stages.

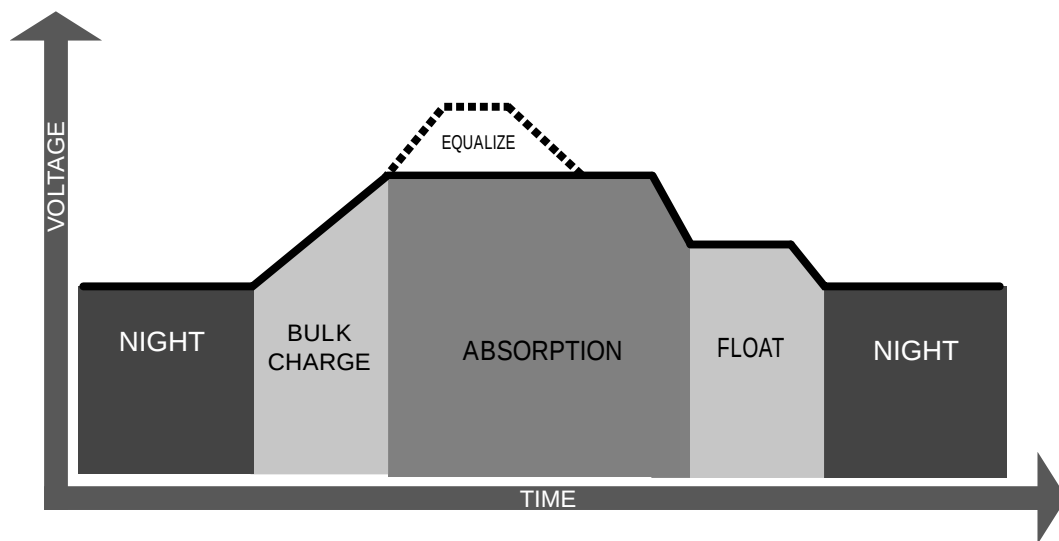


Figure 4-2. TriStar MPPT 150V Charging Algorithm

Bulk Charge Stage

In Bulk charging stage, the battery is not at 100% state of charge and battery voltage has not yet charged to the Absorption voltage set-point. The controller will deliver 100% of available solar power to recharge the battery.

Absorption Stage

When the battery has recharged to the Absorption voltage set-point, constant-voltage regulation is used to maintain battery voltage at the Absorption set-point. This prevents heating and excessive battery gassing. The battery is allowed to come to full state of charge at the Absorption voltage set-point. The green SOC LED will blink once per second during Absorption charging.

The battery must remain in the Absorption charging stage for a cumulative 120 - 150 minutes, depending on battery type, before transition to the Float stage will occur. However, Absorption time will be extended by 30 minutes if the battery discharges below 12.5 Volts (25 Volts @24 V, 50 Volts @48 V) the previous night.

The Absorption set-point is temperature compensated if the RTS is connected; otherwise, voltages set-points are based on the reference of 25°C.

Certain battery types benefit from a periodic boost charge to stir the electrolyte, level the cell voltages, and complete the chemical reactions. Equalize charging raises the battery voltage above the standard absorption voltage so that the electrolyte gasses. The green SOC LED will blink rapidly two (2) times per second during equalization charging.

The duration of the equalize charge is determined by the selected battery type. See table 4-1 in this section for more details. The *Equalization Time* is defined as time spent at the equalize set-point. If there is insufficient charge current to reach the equalization voltage, the equalization will terminate after an additional 60 minutes to avoid over gassing or heating the battery. If the battery requires more time in equalization, an equalize can be requested using the TriStar Meter or push-button to continue for one or more additional equalization cycles.

The Equalize set-point is temperature compensated if the RTS is connected; otherwise, voltages set-points are based on the reference of 25°C.

When to Equalize

The ideal frequency of equalizations depends on the battery type (lead-calcium, lead-antimony, etc.), the depth of discharging, battery age, temperature, and other factors. One very broad guide is to equalize flooded batteries every 1 to 3 months or every 5 to 10 deep discharges. Some batteries, such as the L-16 group, will need more frequent equalizations.

The difference between the highest cell and lowest cell in a battery can also indicate the need for an equalization. Either the specific gravity or the cell voltage can be measured. The battery manufacturer can recommend the specific gravity or voltage values for your particular battery.

Why Equalize?

Routine equalization cycles are often vital to the performance and life of a battery - particularly in a solar system. During battery discharge, sulfuric acid is consumed and soft lead sulfate crystals form on the plates. If the battery remains in a partially discharged condition, the soft crystals will turn into hard crystals over time. This process, called "lead sulfation," causes the crystals to become harder over time and more difficult to convert back to soft active materials.

Sulfation from chronic undercharging of the battery is the leading cause of battery failures in solar charging systems. In addition to reducing the battery capacity, sulfate build-up is the most common cause of buckling plates and cracked grids. Deep cycle batteries are particularly susceptible to lead sulfation.

Normal charging of the battery can convert the sulfate back to the soft active material if the battery is fully recharged. However, a solar charged battery is seldom completely recharged, so the soft lead sulfate crystals harden over a period of time. Only a long controlled overcharge, or equalization, at a higher voltage can reverse the hardening of sulfate crystals.

The TriStar MPPT 150V provides seven (7) standard battery charging settings that are selectable with the settings DIP switches (see Figure 4.1 above). These standard charging settings are suitable for lead-acid batteries ranging from sealed (gel, AGM, maintenance-free) to Flooded and L-16 cells. In addition, an 8th charging setting provides for custom set-points using MSView™ PC software.

Shared Settings	Value	Units
Absorption Extension Voltage	12.50	Volts
Absorption Extension Time	Absorption Time + 30	minutes
Float Exit Timeout	60	minutes
Float Cancel Voltage	12.30	Volts
Equalize Timeout	Equalize Time + 60	minutes
Temperature Compensation Coefficient*	- 5	millivolts / °C / cell

* 25°C reference

Table 4-2. Battery settings that are shared between all battery types

The shared settings in Table 4-2 above are common to all battery types. The following illustrations graphically explain the shared settings.

Absorption Extension

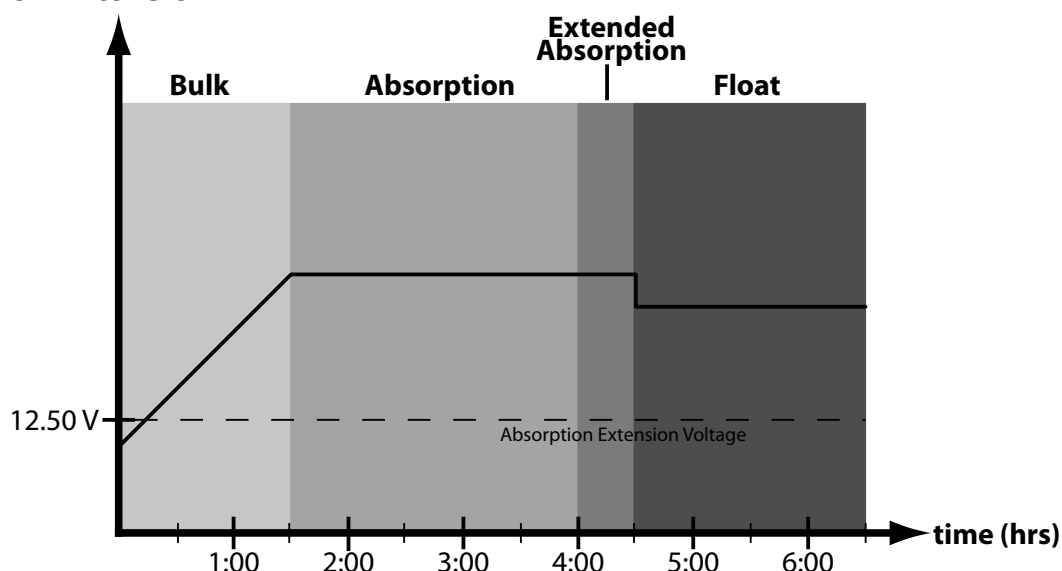


Figure 4-3. Absorption extension charging profile.

If battery voltage discharges below 12.50 Volts (25.00 Volts @ 24 V, 50 Volts @ 48 V) the previous night, Absorption charging will be extended on the next charge cycle as shown in figure 4-3 above. 30 minutes will be added to the normal Absorption duration.

Equalize Time-out

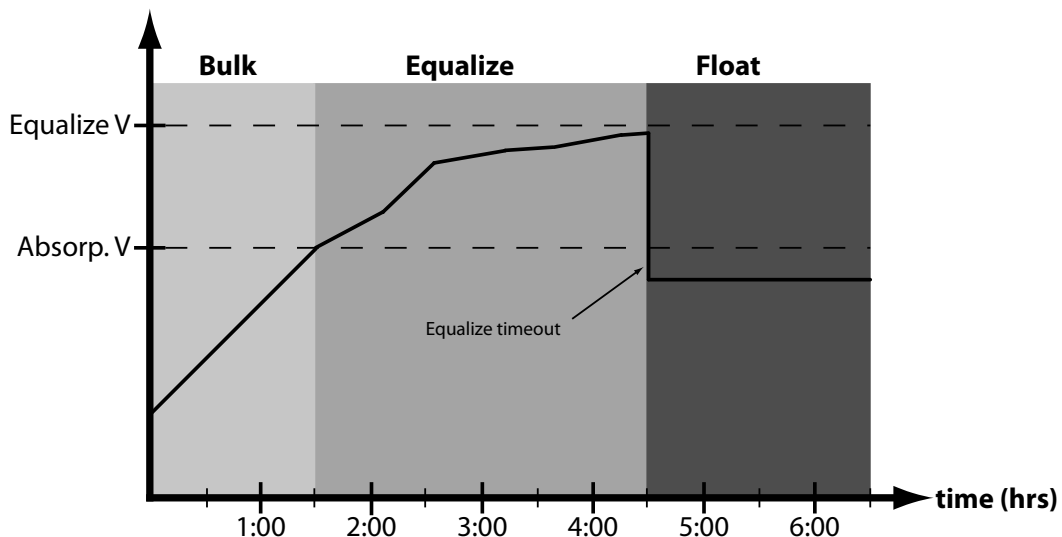


Figure 4-6. Equalize timeout charging profile

The charging profile in figure 4-6 shows an *Equalize Timeout* event. The timeout timer begins as soon as battery voltage exceeds the Absorption voltage setpoint. If there is insufficient charging current or system loads are too large, the battery voltage may not reach the Equalize setpoint. Equalize Timeout is a safety feature that prevents high battery voltage for extended periods of time which may damage the battery.

Temperature Compensation

All charging settings are based on 25°C (77°F). If the battery temperature varies by 5°C, the charging setting will change by 0.15 Volts for a 12 Volt battery. This is a substantial change in the charging of the battery, and the use of the Remote Temperature Sensor (RTS) is recommended to adjust charging to the actual battery temperature.

The need for temperature compensation depends on the temperature variations, battery type, how the system is used, and other factors. If the battery appears to be gassing too much or not charging enough, the RTS can be added at any time after the system has been installed. See Section 2.3 - Step 4 for installation instructions.

Battery Sense

Voltage drops are unavoidable in power cables that carry current, including the TriStar MPPT 150V battery cables. If Battery Sense wires are not used, the controller must use the voltage reading at the battery power terminals for regulation. Due to voltage drops in the battery cables, the battery power connection voltage will be higher than the actual battery bank voltage while charging the battery.

Two sense wires, sized from 1.0 to 0.25 mm² (16 to 24 AWG), can be used for battery voltage sense. Because these wires carry no current, the voltage at the TriStar will be identical to the battery voltage. A 2-position terminal is used for the battery sense connection.

Generally accepted wiring practice is to limit voltage drops between the charger and the battery to 2%. Even properly sized wiring with 2% drop can result in a 0.29 Volt drop for 14.4V charging (or 1.15 Volt for a 48 Volt nominal system). Voltage drops will cause some undercharging of

**REMARQUE :**

Avec plusieurs contrôleurs TriStar MPPT 150V sur un réseau MeterBus™, initialisez une compensation de batteries à l'aide de l'outil de mesure TriStar afin de synchroniser tous les contrôleurs.

Note that if two or more TriStar MPPT 150V controllers are charging in parallel, each controller may attempt to equalize on a different day. Systems with multiple controllers should only equalize manually to ensure synchronization between controllers.

4.4 LED Indications

Valuable information can be provided by the three LEDs visible through the front cover. Although there are many different LED indications, they have similar patterns to make it easier to interpret each LED display. Consider as three groups of indications: General Transitions // Battery Status // Faults & Alarms.

LED Display Explanation

G = green LED is lit

Y - R = yellow LED is lit, then red LED is lit alone

G / Y = green and yellow are both lit at the same time

G / Y - R = green & yellow both lit, then red is lit alone

Sequencing LED patterns (faults) repeat until the fault is cleared

General Transitions

- | | |
|--------------------------------|--|
| • Controller start-up | G - Y - R (one cycle) |
| • Equalize start request | G / Y / R - G / Y / R - G - G |
| • Equalize cancelled | G / Y / R - G / Y / R - R - R |
| • Battery service is required* | all three LEDs blinking until service is reset |

**battery service notification is only enabled in custom settings, or when any custom edit is programmed*

Battery Status

- | | |
|---------------------------|---|
| • General state-of-charge | See battery SOC LED indications below |
| • Absorption state | G blinking (½ second on / ½ second off) |
| • Equalization state | G fast blink (2.5 times per second) |
| • Float state | G slow blink (1 second on / 1 second off) |

Faults & Alarms

diagnostics that report Fault and Alarm conditions as they occur.

Faults are events or conditions that require the TriStar MPPT 150V to cease operation. A Fault usually occurs when a limit such as voltage, current, or temperature has been surpassed. Fault conditions are indicated with unique LED sequences and are also displayed on the TriStar Meter.

Alarms are events or conditions that may require the TriStar MPPT 150V to modify operation. Alarms are commonly used to alert the user that the controller is nearing a specific voltage, current, or temperature limit. Alarm conditions are only displayed on the TriStar Meter.

Some basic fault conditions are reviewed below:

Protections

Solar Overload

The TriStar MPPT 150V will limit battery current to the *Maximum Battery Current* rating. An over-sized solar array will not operate at peak power. The solar array should be less than the TriStar MPPT 150V *Nominal Maximum Input Power* rating for optimal performance. See section 8.0 for more information.

Solar Short Circuit

The TriStar MPPT 150V will disconnect the solar input if a short circuit is detected in the solar wiring. Charging automatically resumes when the short is cleared. No LED indication.

Solar High Input Voltage

Solar input current will be limited as the array open circuit voltage approaches the 150 Volt maximum input voltage limit.

Very Low Battery Voltage

If battery discharges below ~7 Volts the controller will go into brownout and shut down. When the battery voltage rises above the 8 Volt minimum operating voltage, the controller will restart.

Faults

Remote Temperature Sensor Failure (G - R sequencing, with constant yellow)

If a fault in the RTS (such as a short circuit, open circuit, loose terminal) occurs after the RTS has been working, the LED's will indicate a failure. However, if the controller is restarted with a failed RTS, the controller may not detect that the RTS is connected, and the LEDs will not indicate a problem. A TriStar meter or the PC software can be used to determine if an RTS is detected and working properly.

Battery Voltage Sense Failure (G - R sequencing, with constant yellow)

If a fault in the battery sense connection (such as a short circuit, open circuit or loose terminal) occurs after the battery sense has been working, the LEDs will indicate a failure. If the control-

Alarms

High Temperature Current Limit

The TriStar MPPT 150V will limit the solar input current if the heatsink temperature exceeds safe limits. Solar charge current will be tapered back (to 0 amps if needed) to reduce the heatsink temperature. The TriStar MPPT 150V is designed to operate at full rated current at the maximum ambient temperature. This alarm indicates that there is insufficient airflow and that the heatsink temperature is approaching unsafe limits. If the controller frequently reports this alarm condition, corrective action must be taken to provide better air flow or to relocate the controller to a cooler spot.

High Input Voltage Current Limit

The TriStar MPPT 150V will limit the solar input current as the solar array Voc approaches the maximum input voltage rating. The array Voc should never exceed the 150 Volt maximum input voltage. See the array voltage derating graph in Section 8.0.

Current Limit

The array power exceeds the rating of the controller. This alarm indicates that the TriStar MPPT 150V is limiting battery current to the maximum current rating.

RTS Open

The Remote Temperature Sensor is not connected to the controller. Use of the RTS is recommended for proper battery charging.

Heatsink Temperature Sensor Open / Shorted

The heatsink temperature sensor is damaged. Return the controller to an authorized Morningstar dealer for service.

Battery Sense Out of Range / Disconnected

A battery sense wire is disconnected. Inspect the battery sense connections. This alarm is set when the voltage at the battery sense voltage differs by more than 5 volts from the voltage at the battery terminals.

Uncalibrated

The controller was not factory calibrated. Return the controller to an authorized Morningstar dealer for service.

Schedule	Maintenance Items
2 weeks after installation	Re-tighten power terminal connections to specified torque values.
3 months after installation	Re-tighten power terminal connections to specified torque values.
Monthly or After Each Equalization	Inspect the battery bank. Look for cracked or bulging cases, and corroded terminals. For wet cell (flooded type) batteries, make sure the water level is correct. Wet cell water levels should be checked monthly or according to the manufacturer's recommendations.
Annually	Clean the heatsink fins with a clean, dry rag. Inspect all wiring for damage or fraying. Inspect for nesting insects. Re-tighten all wiring terminal connections to specified torque values. Inspect the system earth grounding for all components. Verify all grounding conductors are appropriately secured to earth ground.

Table 4-6. Maintenance Schedule

5.2 Morningstar MeterBus™

Morningstar's proprietary MeterBus™ protocol allows communication between compatible Morningstar products. Use a MeterBus™ network to to:

- display net system data for multiple TriStar / TriStar MPPT 150V systems**
- communicate with a TriStar Digital Meter 2 or TriStar Remote Meter 2
- communicate with a Relay Driver or other compatible Morningstar accessories (see section 2.5 for more details)

***A Morningstar MeterBus Hub (HUB-1) and either a TriStar Digital Meter 2 (TS-M-2) or TriStar Remote Meter 2 (TS-RM-2) are required, not included.*

A MeterBus Hub (model: HUB-1) is required for MeterBus networks containing multiple TriStar MPPT 150V controllers. The ports on the hub are electrically isolated to prevent damage in the event of broken grounds or voltage differences between controllers. Figure 5-1 below shows an example MeterBus™ network with two (2) TriStar MPPT 150V controllers and a TriStar Remote Meter 2 (TS-RM2).

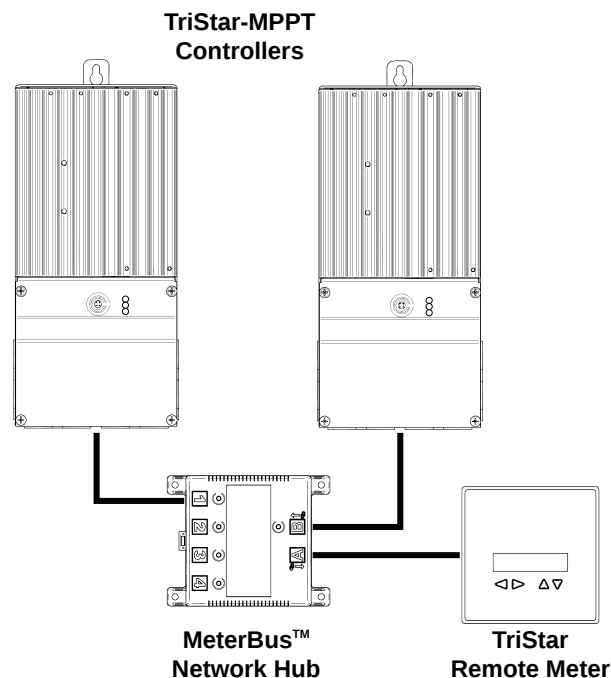


Figure 5-1. An example MeterBus network.

Up to five (5) controllers can be networked together with a single hub. Multiple hubs can be daisy-chained together to allow networks of up to 14 controllers and a meter. Refer to the HUB-1 and TriStar Meter manuals for more information about Morningstar MeterBus™ networking.

Serial Port Settings

Adjust the serial port settings as follows:

- 9600 BAUD
- 8 data bits
- 1 or 2 stop bits
- no parity

The serial RS-232 connection provides a direct connection between a TriStar MPPT 150V and a PC (or other serial device). **Firmware updates can only be programmed through the RS-232 connection.** The serial connection is not typically used for multi-controller networking. However, networking is possible using a USB hub and USB-Serial cables. For more information, refer to the “Morningstar Communications Document” on our website at:

www.morningstarcorp.com

5.5 Ethernet

**NOTE:**

Ethernet is only available on the TS-MPPT-60 model.

**CAUTION: Risk of Tampering**

The TS-MPPT does not feature built-in network security. It is the responsibility of the user or network administrator to place the TS-MPPT behind a network firewall to prevent unauthorized access.

**PRUDENCE : Risque de tentative d'altération**

Le TS-MPPT ne comporte pas de sécurité réseau intégrée. Il incombe à l'utilisateur ou à l'administrateur du réseau de placer le TS-MPPT derrière un pare-feu réseau afin d'empêcher l'accès non autorisé.

The Ethernet port supports HTTP, MODBUS TCP/IP™, SMTP, and SNMP protocols to provide a fully web-enabled interface between the TriStar MPPT 150V and a LAN/WAN network or the internet. Some of the many features the Ethernet connection provides include:

- program custom settings with MSView™ PC software
- monitor the controller from a web browser
- modify controller settings from a web browser
- log and monitor the system with MSView™ PC software anywhere on the internet
- create custom web pages to show system data
- send an email or text message if a fault, alarm, or user-defined event occurs
- monitor and receive messages on an SNMP network

This section provides a summary of each of the features. For detailed information about Ethernet connectivity and networking, refer to the “Morningstar Communications Document” on our web-site at:

[HTTP://www.morningstarcorp.com/](http://www.morningstarcorp.com/)

Network Information

Connect to the TriStar MPPT 150V via an Ethernet network (LAN/WAN) or connect the controller directly to a PC using an ethernet cross-over cable. Use CAT-5 or CAT-5e twisted pair Ethernet cables with RJ-45 connectors. A network diagram for both scenarios is shown in figure 5-3 below.

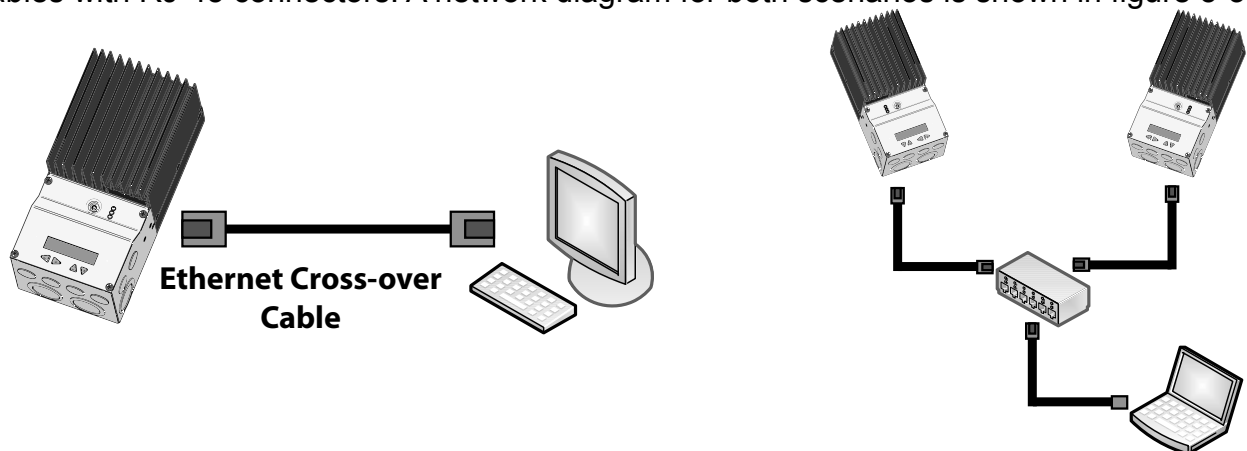


Figure 5-3. Ethernet network diagrams.

Email & SMS Alerts

The email and SMS alerts feature sends notification to an email address or mobile phone if one of the following occurs:

- TriStar MPPT 150V self diagnostics fault condition
- TriStar MPPT 150V self diagnostics alarm condition
- User-defined event (e.g. battery voltage is less than 46 Volts)

Up to four email and SMS alerts can be configured from the network settings web page in the MSView TriStar MPPT 150V wizard.

View Logged Data

The TriStar MPPT 150V logs up to 200 days* of daily data. The controller always logs the standard values listed below. Using MSView, the controller can be configured to log additional optional values each day. The maximum number of days that can be stored decreases as the number of logged values increases.

Standard Values

- Minimum Battery Voltage
- Maximum Battery Voltage
- Daily Events (Equalize triggered, Entered Float, Alarm/Fault occurred, Controller Reset)
- Faults / Alarms - recorded only if a fault or alarm occurs that day

Optional Values

- Maximum Array Voltage
- Maximum Power Output
- Charge Amp-hours
- Charge Watt-hours
- Minimum/Maximum Battery Temperature
- Charge stage regulation timers for Absorption, Float, Equalize

** logging only standard values*

SNMP

For telecom and industrial applications that require SNMP monitoring of deployed systems, the TriStar MPPT 150V will behave as an SNMP agent and supports the following commands:

TRAP
GET
GETNEXT

A link to the agent *Management Information Base* file (*.MIB) is available on the TriStar MPPT 150V Live View *Network Settings* page.

**NOTE:**

For more in-depth testing and diagnosis, download the *TriStar MPPT 150V Testing Document* from the Support section on our website: www.morningstarcorp.com/

Network and Communication Issues

.....

Problem:

Cannot connect to the controller via RS-232

Solution:

Check the following:

- The RS-232 cable is straight-through, not a Null Modem (cross-over)
- If using a serial-USB adapter, verify that the adapter software is installed and a serial COM port has been mapped. Check the activity light on the USB adapter if it has one. If there is no activity, the wrong COM port has been chosen or there is a configuration issue with the adapter.
- The default MODBUS ID of the TriStar MPPT 150V is 1. Verify that the PC software is configured to communicate using the correct MODBUS ID.

Problem:

Cannot connect to the controller via EIA-485

Solution:

Check the following:

- The RS-232 port is not in use. The EIA-485 and RS-232 ports cannot be used simultaneously. Only one port can be used at a time.
- The RSC-1 adapter used to connect the PC to the EIA-485 network shows a green LED and pulses red when a connection is attempted. See the RSC-1 documentation for more information.
- Each controller or device on the EIA-485 network has been programmed with a unique MODBUS ID.
- A serial cross-over (Null Modem) cable is used for the connection between the PC and the Morningstar RSC-1 485 Adapter. A straight-through serial cable will not work.
- Power is supplied to the 4-wire bus on the Power/Ground lines. The bus requires voltage in the range: 8 - 16 Vdc.
- All bus connections are secure and each terminal is wired in parallel: line A to line A, line B to line B, etc.

Problem:

Cannot connect to the controller via Ethernet

Solution:

See the *TriStar MPPT 150V Networking Companion Document*, available on our website.

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@morn-ingstarcorp.com) with:
 - (A) purchase location -- business or company name
 - (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.

Battery Charging Status LEDs

LED Indication	Battery Charging Status
Green Flashing (fast) - 2.5 times per second	Equalize charging stage
Green Flashing - 1/2 sec on, 1/2 sec off	Absorption charging stage
Green Flashing (slow) - 1 sec on, 1 sec off	Float charging stage
Green	13.3 Volts $\leq$ Vbattery
Green & Yellow	13.0 Volts $\leq$ Vbattery < 13.3 Volts
Yellow	12.7 Volts $\leq$ Vbattery < 13.0 Volts
Yellow & Red	12.0 Volts $\leq$ Vbattery < 12.7 Volts
Red	Vbattery < 12.0 Volts

Mechanical

Dimensions:	(H) 291 mm / 11.44" (W) 130 mm / 5.12" (D) 142 mm / 5.58"
Product Weight:	4.14 kg / 9 lbs 2 oz
Shipping Weight (2 pcs/carton)	11.6 kg / 25 lbs 9oz
Power terminals:	
Minimum wire size:	2.5 mm ² / 14 AWG
Maximum wire size:	35 mm ² / 2 AWG
Recommended torque:	5.65 Nm / 50 in-lb
RTS / Sense terminals:	
Minimum wire size	0.25 mm ² / 24 AWG
Maximum wire size	1.0 mm ² / 16 AWG
Recommended torque	0.40 Nm / 3.5 in-lb
Knockouts (trade sizes):	M20 & 1/2", 1", 1 - 1/4"
Mounting:	Vertical surface

Environmental

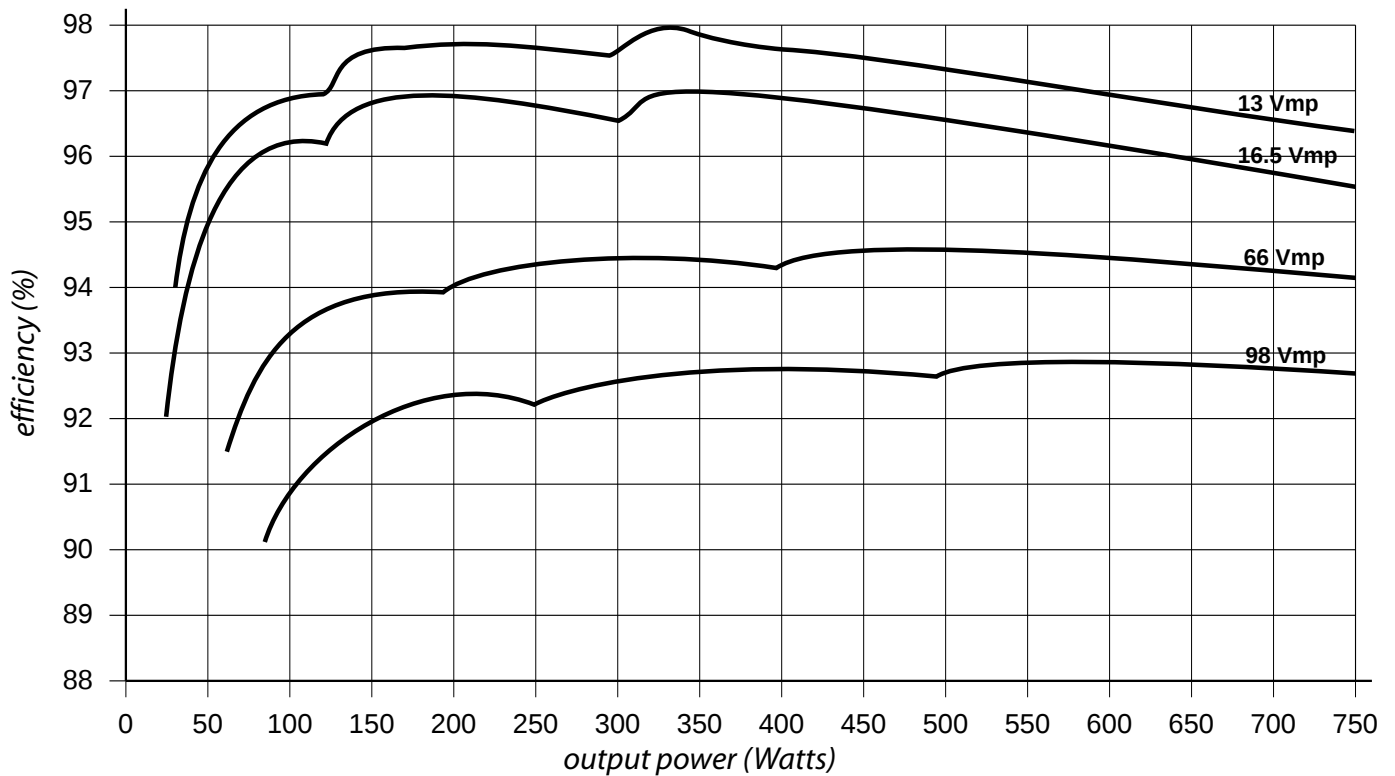
Operating Altitude	Below 2000 meters
Ambient Temperature Range	-40 °C to +45 °C
Storage Temperature	-55 °C to +85 °C
Humidity	100% N.C.
Enclosure	IP20
	Type 1 (indoor & vented)

Protections

Solar high voltage disconnect
Solar high voltage reconnect
Battery high voltage disconnect
Battery high voltage reconnect
High temperature disconnect
High temperature reconnect

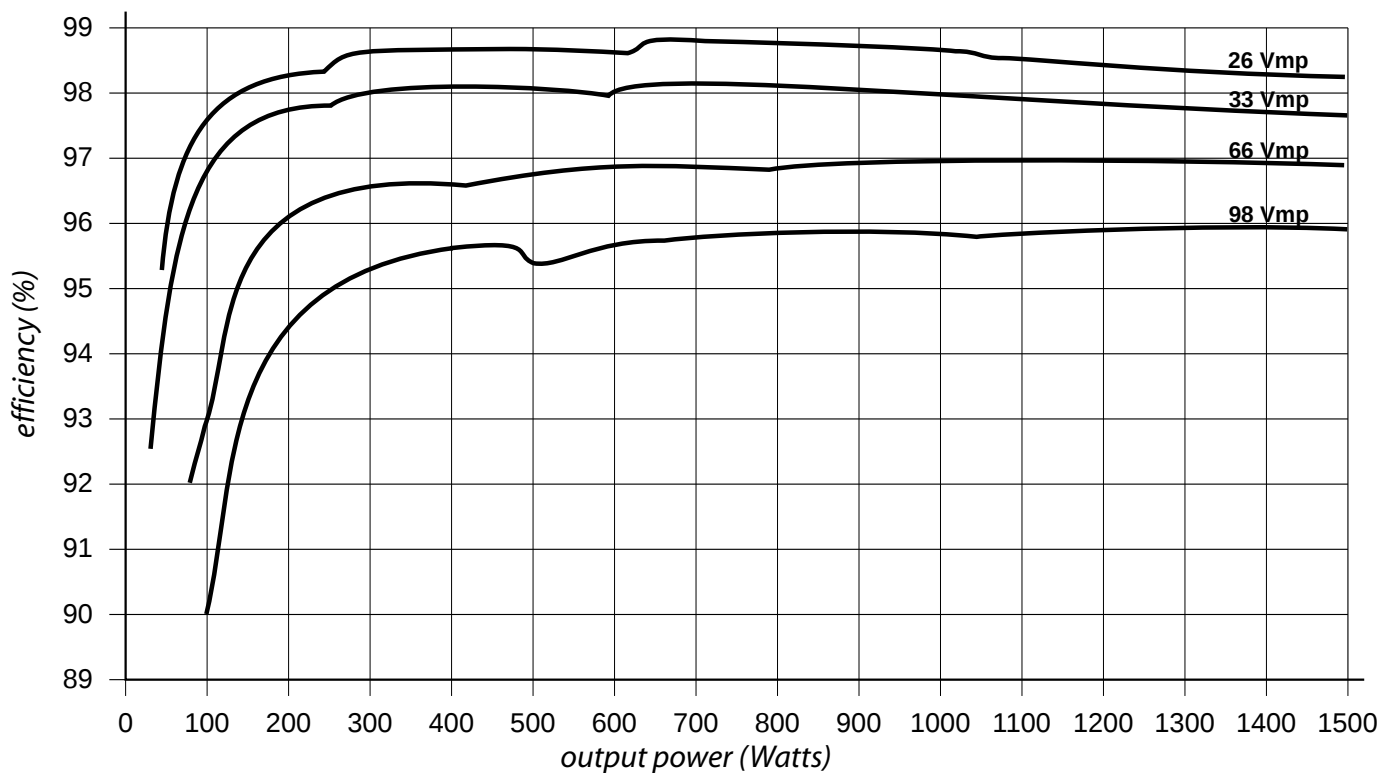
Efficiency

TriStar MPPT 12 Volt Efficiency



Battery @ 12.8 V, 25 C ambient, firmware ver. 08 or later

TriStar MPPT 24 Volt Efficiency



Battery @ 25.6 V, 25 C ambient, firmware ver. 08 or later

2% Voltage Drop Charts for 75°C Stranded Copper Wire

1-Way Wire Distance (feet), 12 Volt System

Wire Size (AWG)	60 Amps	55 Amps	50 Amps	45 Amps	40 Amps	35 Amps	30 Amps	25 Amps	20 Amps	15 Amps
2/0 **	22.4	24.4	26.9	29.9	33.6	38.4	44.8	53.8	67.2	89.6
1/0 **	17.8	19.4	21.3	23.7	26.6	30.4	35.5	42.6	53.3	71.0
2	11.2	12.2	13.4	14.9	16.8	19.1	22.3	26.8	33.5	44.7
4	7.0	7.7	8.4	9.4	10.6	12.1	14.1	16.9	21.1	28.1
6	4.4	4.8	5.3	5.9	6.6	7.6	8.8	10.6	13.2	17.7
8	2.8	3.0	3.3	3.7	4.2	4.8	5.6	6.7	8.4	11.1
10	1.7	1.9	2.1	2.3	2.6	3.0	3.5	4.2	5.2	7.0
12	1.1	1.2	1.3	1.5	1.6	1.9	2.2	2.6	3.3	4.4
14	0.7	0.8	0.8	0.9	1.0	1.2	1.4	1.7	2.1	2.8

Table 8-1. Maximum 1-way wire distance for 12 Volt systems, stranded copper, 2% voltage drop

1-Way Wire Distance (meters), 12 Volt System

Wire Size (mm²)	60 Amps	55 Amps	50 Amps	45 Amps	40 Amps	35 Amps	30 Amps	25 Amps	20 Amps	15 Amps
70 **	6.83	7.45	8.20	9.11	10.24	11.71	13.66	16.39	20.49	27.32
50 **	5.41	5.91	6.50	7.22	8.12	9.28	10.83	12.99	16.24	21.65
35	3.40	3.71	4.08	4.54	5.11	5.84	6.81	8.17	10.21	13.62
25	2.14	2.34	2.57	2.86	3.22	3.68	4.29	5.15	6.43	8.58
16	1.35	1.47	1.61	1.79	2.02	2.31	2.69	3.23	4.04	5.38
10	0.85	0.93	1.02	1.13	1.27	1.46	1.70	2.04	2.55	3.40
6	0.53	0.58	0.64	0.71	0.80	0.91	1.07	1.28	1.60	2.13
4	0.33	0.36	0.40	0.44	0.50	0.57	0.67	0.80	1.00	1.33
2.5	0.21	0.23	0.25	0.28	0.32	0.36	0.42	0.50	0.63	0.84

Table 8-2. Maximum 1-way wire distance for 12 Volt systems, solid copper, 2% voltage drop

** Wires sizes larger than 2 AWG (35 mm²) must be terminated at a splicer block located outside of the TriStar MPPT 150V wiring box. Use 2 AWG (35 mm²) or smaller wire to connect to the TriStar MPPT 150V to the splicer block.

Notes:

- The specified wire length is for a pair of conductors from the solar or battery source to the controller (1-way distance)
- For 24 volt systems, multiply the 1-way length in the table by 2.
- For 48 volt systems, multiply the 1-way length in the table by 4.
- Shaded cells in the table indicate that the current exceeds the ampacity of the wire for a given ambient temperature as defined in the following table:

Wire Ampacity* Key	
	Exceeds wire ampacity at 60°C ambient temperature
	Exceeds wire ampacity at 50°C ambient temperature
	Exceeds wire ampacity at 40°C ambient temperature
	Exceeds wire ampacity at 30°C ambient temperature

*Ampacity for not more than three current-carrying conductors in a raceway, cable, or earth (buried).

2% Voltage Drop Charts for 90°C Stranded Copper Wire

1-Way Wire Distance (feet), 12 Volt System

Wire Size (AWG)	60 Amps	55 Amps	50 Amps	45 Amps	40 Amps	35 Amps	30 Amps	25 Amps	20 Amps	15 Amps
2/0 **	22.4	24.4	26.9	29.9	33.6	38.4	44.8	53.8	67.2	89.6
1/0 **	17.8	19.4	21.3	23.7	26.6	30.4	35.5	42.6	53.3	71.0
2	11.2	12.2	13.4	14.9	16.8	19.1	22.3	26.8	33.5	44.7
4	7.0	7.7	8.4	9.4	10.6	12.1	14.1	16.9	21.1	28.1
6	4.4	4.8	5.3	5.9	6.6	7.6	8.8	10.6	13.2	17.7
8	2.8	3.0	3.3	3.7	4.2	4.8	5.6	6.7	8.4	11.1
10	1.7	1.9	2.1	2.3	2.6	3.0	3.5	4.2	5.2	7.0
12	1.1	1.2	1.3	1.5	1.6	1.9	2.2	2.6	3.3	4.4
14	0.7	0.8	0.8	0.9	1.0	1.2	1.4	1.7	2.1	2.8

Table 8-5. Maximum 1-way wire distance for 12 Volt systems, stranded copper, 2% voltage drop

1-Way Wire Distance (meters), 12 Volt System

Wire Size (mm²)	60 Amps	55 Amps	50 Amps	45 Amps	40 Amps	35 Amps	30 Amps	25 Amps	20 Amps	15 Amps
70 **	6.83	7.45	8.20	9.11	10.24	11.71	13.66	16.39	20.49	27.32
50 **	5.41	5.91	6.50	7.22	8.12	9.28	10.83	12.99	16.24	21.65
35	3.40	3.71	4.08	4.54	5.11	5.84	6.81	8.17	10.21	13.62
25	2.14	2.34	2.57	2.86	3.22	3.68	4.29	5.15	6.43	8.58
16	1.35	1.47	1.61	1.79	2.02	2.31	2.69	3.23	4.04	5.38
10	0.85	0.93	1.02	1.13	1.27	1.46	1.70	2.04	2.55	3.40
6	0.53	0.58	0.64	0.71	0.80	0.91	1.07	1.28	1.60	2.13
4	0.33	0.36	0.40	0.44	0.50	0.57	0.67	0.80	1.00	1.33
2.5	0.21	0.23	0.25	0.28	0.32	0.36	0.42	0.50	0.63	0.84

Table 8-6. Maximum 1-way wire distance for 12 Volt systems, stranded copper, 2% voltage drop

** Wires sizes larger than 2 AWG (35 mm²) must be terminated at a splicer block located outside of the TriStar MPPT 150V wiring box. Use 2 AWG (35 mm²) or smaller wire to connect to the TriStar MPPT 150V to the splicer block.

Notes:

- The specified wire length is for a pair of conductors from the solar or battery source to the controller (1-way distance)
- For 24 volt systems, multiply the 1-way length in the table by 2.
- For 48 volt systems, multiply the 1-way length in the table by 4.
- Shaded cells in the table indicate that the current exceeds the ampacity of the wire for a given ambient temperature as defined in the following table:

Wire Ampacity* Key	
	Exceeds wire ampacity at 60°C ambient temperature
	Exceeds wire ampacity at 50°C ambient temperature
	Exceeds wire ampacity at 40°C ambient temperature
	Exceeds wire ampacity at 30°C ambient temperature

*Ampacity for not more than three current-carrying conductors in a raceway, cable, or earth (buried).

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