



IMPORTANT:

The TriStar Controller is designed to operate as a solar charge controller, a load or lighting controller, **OR** a diversion controller — one mode at a time and no combined-mode operation.

Specifications:

	TS-45	TS-60	TS-60M
Battery Voltage	12 Vdc, 24 Vdc, or 48 Vdc		
Maximum Solar Input Voltage ²	12 V Nominal Array Voc 24 V Nominal Array Voc 48 V Nominal Array Voc		
Maximum Current (Solar or Load)	45 A	60 A	
Maximum Current (Diversion)	30 A	40 A	
Battery Operating Voltage	9-68 V		
Battery Types Supported	Flooded, Sealed		

² See the Morningstar PV String Calculator at: <https://www.morningstarcorp.com/support/>

Wire Sizes and Torque Requirements:



IMPORTANT:

Refer to Section 2.0, *Installation*, in the TriStar-PWM manual, for all details on installation requirements. System design must comply with any applicable electrical code and regulations.

	MINIMUM WIRE SIZES AND TORQUE REQUIREMENTS		
	Battery or Load Terminals		Ground Terminal
	Rated for 75°C	Rated for 90°C	
TriStar-PWM-45	#6 AWG (16 mm ²)	#8 AWG (10 mm ²)	#10 AWG (5 mm ²)
TriStar-PWM-60/M	#4 AWG (25 mm ²)	#6 AWG (16 mm ²)	#8 AWG (8 mm ²)
Torque	50 in-lbs. (5.56 Nm)		
Maximum Length	See Table 2.3-6a in the TriStar PWM Installation Manual for Maximum 1-way Wire Distance.		

Fuses and Circuit Breakers:

- Circuit Breakers or fuses are required in the positive cable for Battery, Solar, DC Load, or Diversion Load connections.
- Solar connections require a PV Ground Fault Disconnect.
- A fuse is required in the positive cable for the Voltage Sense connections.
- **Fuse or breaker sizing must be based on required wire ampacity.**
- If using a fuse, do NOT insert the fuse in the fuse-holder until after all the other connections have been completed.

Contact Information:

Technical Support: morningstarcorp.com/support
Phone: 1-215-321-4457



WARNING: Hazardous Voltage

The TriStar charge controller must be installed by a **qualified** technician in accordance with the electrical regulations of the country of installation.



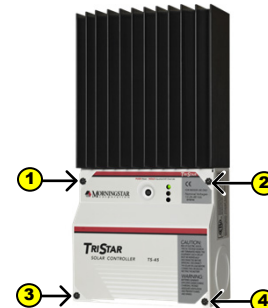
WARNING: Hazardous Voltage

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.

Accessing the wiring terminals:

To Access the Wiring Terminals:

1. Remove the 4 screws and star washers from the faceplate.
2. Lift the faceplate away from the base.



To Replace the Faceplate:

1. Align it with the base.
2. Replace the 4 screws and locking washers.
3. Hand tighten, careful not to over-tighten.



TRISTAR™

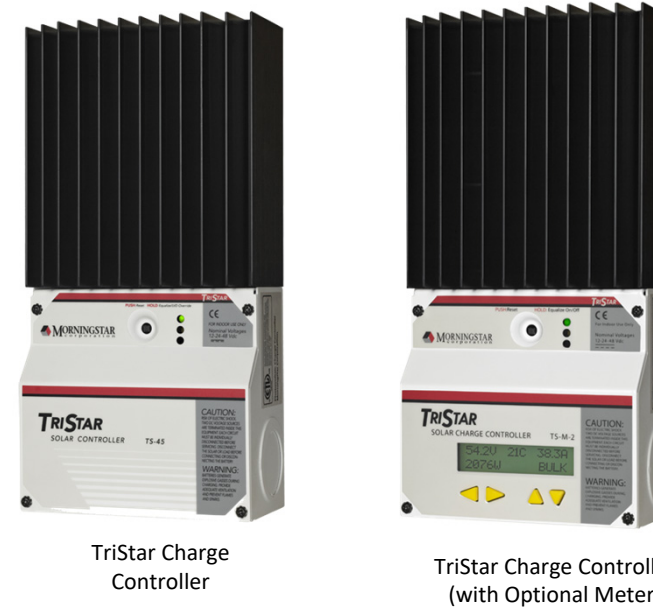
SOLAR CHARGING SYSTEM CONTROLLER

Quick Start Guide

TriStar PWM Models:

TS-45	TS-60	TS-60M
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For use with 12 Vdc, 24 Vdc, or 48 Vdc Systems



TriStar Charge Controller

TriStar Charge Controller (with Optional Meter)

Scan QR Code to go directly to the TriStar PWM Installation Manual and warranty information online.



CAUTION: This guide must be used with the full product manual that includes important information. Carefully read the TriStar-PWM product manual for all specifications, safety, regulatory and warranty information, and for all required instructions on installation procedures, configuration, and operation.

Warranty Registration: <https://www.morningstarcorp.com/product-registration/>

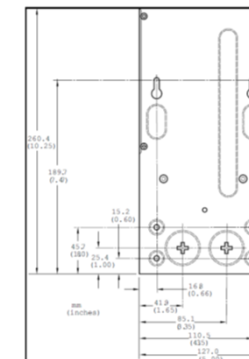
In the Box:



TriStar Solar Charge Controller



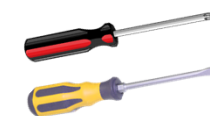
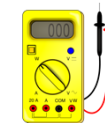
#10 Mounting Screws (x4)



Mounting Template

Tools Required:

- #2 Philips Screwdriver
- 3/16 (5 mm) & 1/8" (3.8 mm) Flathead Screwdriver
- Drill with a 1/8" (3.8 mm) bit
- Multimeter



Optional Accessories



TS-M-2



TS-RM-2



Remote Temperature Sensor (RTS)



MeterHub MeterBus Communication Hub (HUB-1)

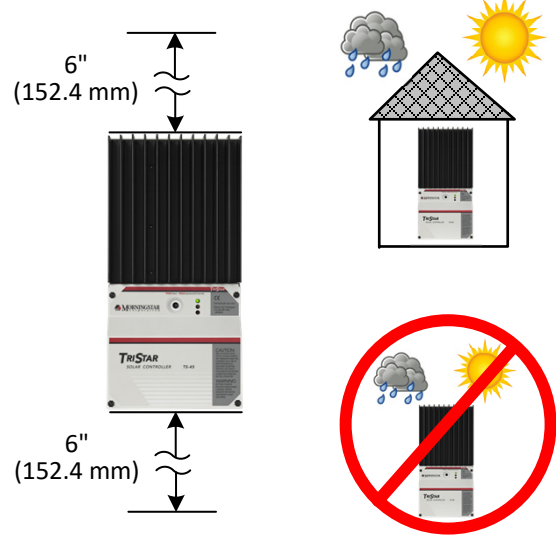


Relay Driver (RD-1)



Ethernet MeterBus Converter (EMC-1)

Minimum Clearance Requirements:



WARNING: Explosion Hazard

Never install the TriStar in an enclosure with vented/flooded batteries. Battery fumes are flammable and will corrode and destroy the TriStar circuits. Ensure sufficient ventilation.

CAUTION: Equipment Damage

Do not expose the TriStar CC to weather. Locate in a dry, protected area to prevent equipment damage. Ensure the minimum clearance requirements are followed to provide adequate ventilation and prevent the unit from overheating.

Mounting:

Step 1: Choose mounting location

- Locate the TriStar on a vertical surface that is protected from direct sun, high temperatures, and water.

Step 2: Wiring accessibility and air flow clearance

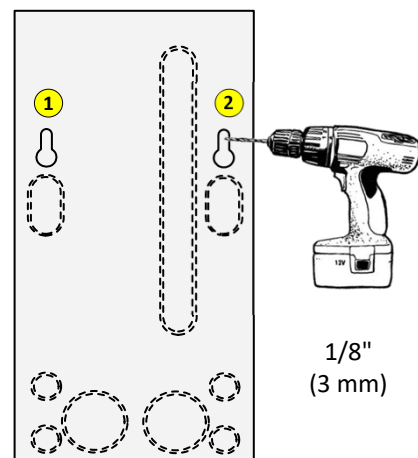
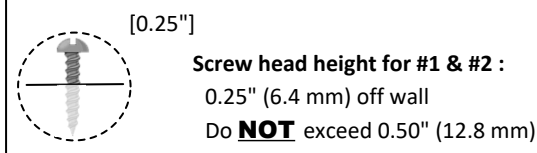
- Plan and confirm wire routing-access.
- Verify that there is at least 6" of space above and below the unit, and at least 3" (75 mm) around the heatsink.

Step 3: Drill holes

- Place the TriStar template on the wall where the unit will be mounted.
- Mark and drill two (2) 1/8" (3.175 mm) holes in the top end (slot) of each template keyhole.
- Drive a #10 screw into each drill hole to 0.25" (or 6.4 mm) from flush with the wall.

Step 4: Secure the controller

- Place the controller circular keyhole areas over the wall screws, and pull the unit down to lock the screws into the slots.
- Use the two remaining screws to fasten the lower part of the unit to the wall.



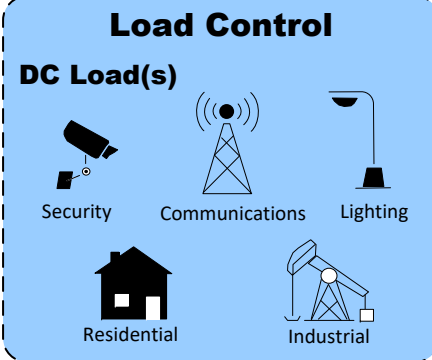
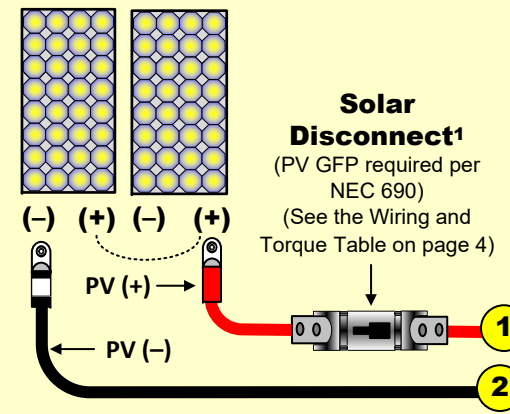
IMPORTANT: Array Voltage should NEVER exceed the maximum input voltage.

WARNING: Hazardous Voltage
The solar PV array can produce open-circuit voltages in excess of 125 Vdc when in sunlight. Verify that the solar input breaker or disconnect has been opened (disconnected) before installing the system wires.

Charge Control

See the Morningstar PV String Calculator at: <https://www.morningstarcorp.com/support/>

Photovoltaic (PV) Array



DC Load Disconnect¹
(See the Wiring and Torque Table on page 4)

Battery Disconnect¹
(See the Wiring and Torque Table on page 4)

¹Fuse or breaker sizing must be based on required wire ampacity.

IF USING A FUSE, DO NOT INSERT THE FUSE IN THE FUSE-HOLDER UNTIL AFTER ALL THE OTHER CONNECTIONS HAVE BEEN COMPLETED.

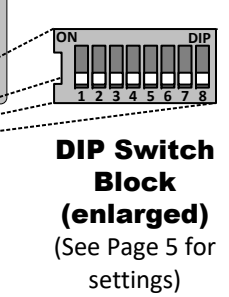
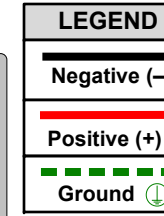
Battery / Battery Bank
(12-volt, 24-volt, or 48-volt)

WARNING: Risk of Fire
If no Remote Temperature Sensor (RTS) is connected, use the TriStar-PWM within 10 feet (3 m) of the batteries. Use of the RTS is strongly recommended.

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

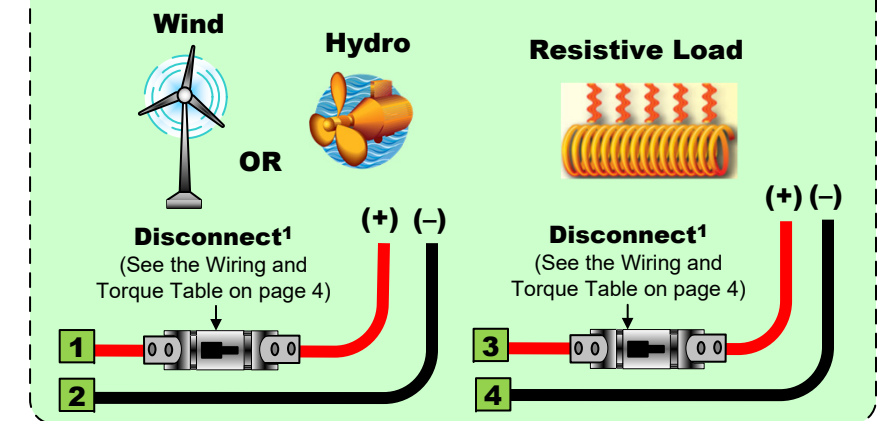
IMPORTANT: Ensure there is only 1 DC Negative-to-Ground Bond in the entire system.

WARNING: Hazardous Voltage
Test between all terminals and ground before touching. Power or accessory terminals are NOT electrically isolated from DC input and may be energized with hazardous voltage.

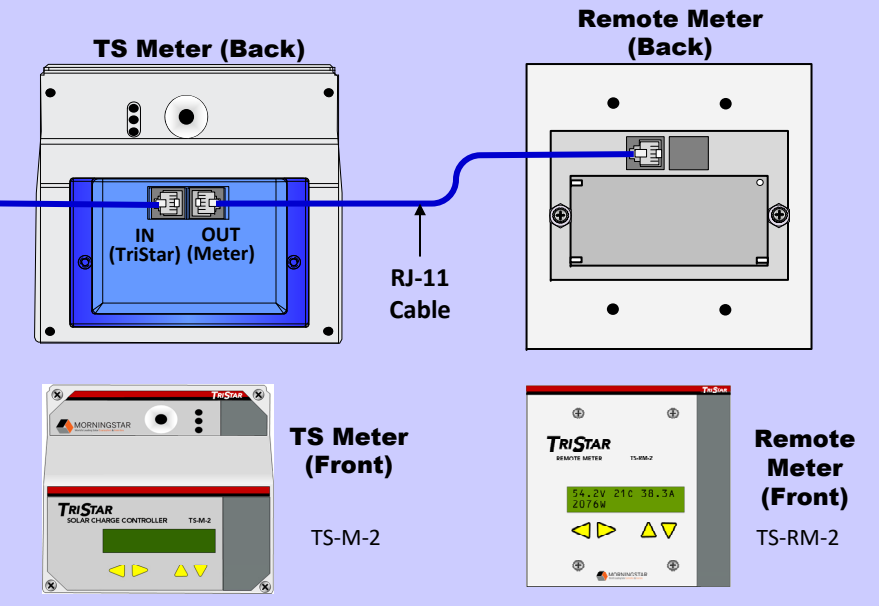


IMPORTANT: Example only. Actual wiring may vary. READ the TriStar PWM Installation, Operations, and Maintenance Manual for mandatory safety requirements. All configuration must comply with local and national electric codes. Consult your local electric authority to ensure compliance.

Diversion Control



Optional Accessories



Power UP Sequence:

1. Connect Battery/Battery Bank.
2. Connect Solar or loads.

Power DOWN Sequence:

1. Disconnect Solar or loads.
2. Disconnect Battery/Battery Bank.

Operational Settings:

DIP Switch #1: Battery Charging/Load Control Mode

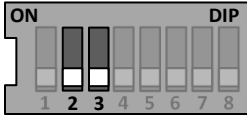


Battery Charging

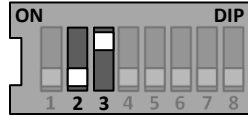


Load Control Mode

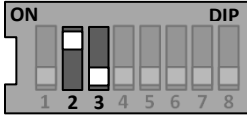
DIP Switch #2 & 3: Battery Voltage



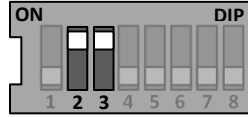
Auto Select



12 Volts



24 Volts



48 Volts

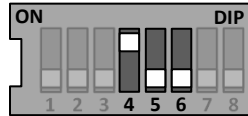
DIP Switch #4, 5, & 6: Mode Settings

Mode: A = Battery Charging
B = Load Control
C = Lighting Control
D = Diversion Control

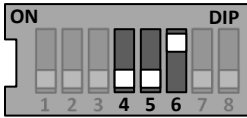
Definitions:
PWM = Pulse Width Modulation
LVD = Low Voltage Disconnect



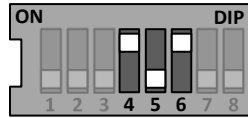
A = PWM 14.0 V
B = LVD 11.1 V
C = 6 hours after sunset
D = 13.8 V



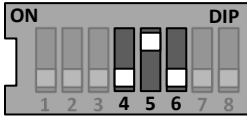
A = PWM 14.6 V
B = LVD 11.9 V
C = 4 hours after sunset,
2 hours before sunrise
D = 14.6 V



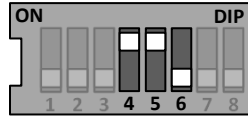
A = PWM 14.15 V
B = LVD 11.3 V
C = 8 hours after sunset
D = 14.0 V



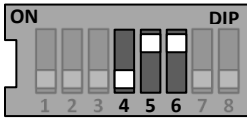
A = PWM 14.8 V
B = LVD 12.1 V
C = 6 hours after sunset,
2 hours before sunrise
D = 14.8 V



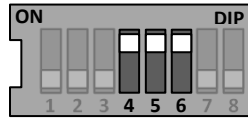
A = PWM 14.35 V
B = LVD 11.5 V
C = 10 hours after sunset
D = 14.2 V



A = PWM 15.0 V
B = LVD 12.3 V
C = Dusk to Dawn
D = 15.0 V



A = PWM 14.4 V
B = LVD 11.7 V
C = 3 hours after sunset,
1 hour before sunrise
D = 14.4 V



A = PWM Custom*
B = LVD Custom*
C = Custom*
D = Custom*
(*Requires Computer Connection. See TriStar PWM Installation Manual for details.)

DIP Switch #7: Battery Equalization or Diversion Control Mode



A = Battery Equalization = Manual
B & C = NOT USED - MUST BE OFF
D = Diversion Control = OFF



A = Battery Equalization = Auto
B & C = NOT USED - MUST BE OFF
D = Diversion Control = ON

DIP Switch #8: Noise Reduction, Lighting/Load Control, or Battery Equalization

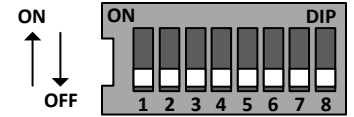


A = Normal PWM Charging
B = Load Control
C = Load Control
D = Battery Equalization = Manual



A = Noise Reduction Mode
B = NOT USED - MUST BE OFF
C = Lighting Control
D = Battery Equalization = Auto

Default Settings



Battery Charging/Load Control Mode (1)
Battery Voltage (2,3)
Mode Settings (4, 5, 6)
Battery Equalization/Diversion Mode (7)
Noise Reduction/Load or Lighting Control/
Battery Equalization (8)

DIP	Function
(1)	Battery Charging Mode
(2,3)	Auto Voltage Select
(4, 5, 6)	Lowest Battery Charging Voltage (14.0 V)
(7)	Manual Equalization
(8)	Normal PWM Charging Mode



CAUTION: EQUIPMENT DAMAGE

The default position for the DIP switches is **OFF**. Each switch position must be confirmed during installation. **Incorrect settings could cause damage to the battery or other system components.**



IMPORTANT:

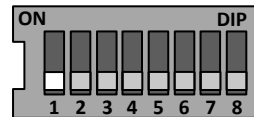
The DIP switches should be changed only when there is no power to the controller. Turn off disconnect switches and remove all power to the controller before changing a DIP switch. A fault will be indicated if a switch is changed while the controller is powered.

Settings by Mode:

Mode A = Battery Charging

DIP	Function
(1)	Battery Charging Mode
(2,3)	Select Battery Voltage ³
(4, 5, 6)	Standard Battery Charging Programs ³
(7)	Manual or Automatic Equalization ³
(8)	PWM Charging or Noise Reduction ³

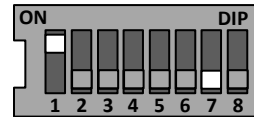
³Select settings for DIP 2-8 that are specific to the installation. DIP 1 must be OFF.



Mode B = Load Control or Mode C = Lighting Control

DIP	Function
(1)	Load Control Mode
(2,3)	Select Battery Voltage ⁴
(4, 5, 6)	Low Voltage Disconnect ⁴
(7)	Not Used - MUST BE OFF
(8)	Load Control or Lighting Control ⁴

⁴Select settings for DIP 2-6 & 8 that are specific to the installation. DIP 1 must be ON. DIP 7 MUST be OFF.



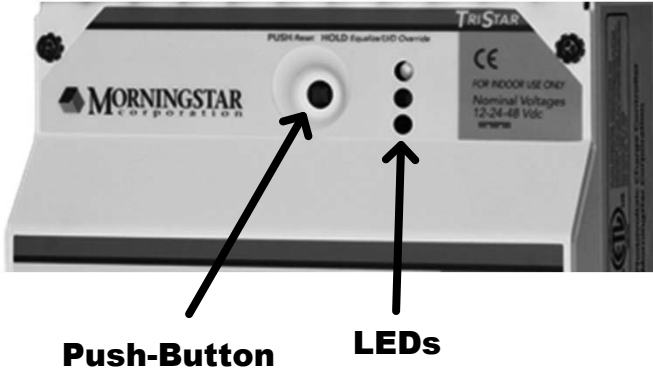
Mode D = Diversion Control

DIP	Function
(1)	Load Control Mode
(2,3)	Select Battery Voltage ⁵
(4, 5, 6)	Select Diversion Control Limits ⁵
(7)	Diversion Control Mode ON ⁵
(8)	Battery Equalization (Manual or Auto) ⁵

⁵Select settings for DIP 2-6 & 8 that are specific to the installation. DIP 1 must be ON. DIP 7 MUST be ON.



LED DISPLAY AND PUSH-BUTTON FUNCTION:



Push-Button

LEDs

PUSH-BUTTON FUNCTION:

Battery Charging Mode (both solar and diversion):

- **PUSH and RELEASE:** Reset from an error or fault.
- **PUSH and RELEASE:** Reset the battery service indication if this has been activated with the PC software. A new service period will be started, and the flashing LEDs will stop blinking. If the battery service is performed before the LEDs begin blinking, the push-button must be pushed at the time when the LEDs are blinking to reset the service interval and stop the blinking.
- **PUSH AND HOLD 5 SECONDS:** Begin battery equalization manually. This will begin equalization in either the manual or automatic equalization mode. The equalization will automatically stop per the battery type selected.
- **PUSH AND HOLD 5 SECONDS:** Stop an equalization that is in progress. This will be effective in either the manual or automatic mode. The equalization will be terminated.

Load and Lighting Control:

- **PUSH and RELEASE:** Reset from an error or fault.
- **PUSH and HOLD 5 SECONDS:** After a low voltage disconnect (LVD) of the load, the push-button can be used to reconnect the loads again. The loads will remain on for 10 minutes, and will then disconnect again. The push-button can be used to override the LVD without limit.



NOTE: The purpose of the LVD is to protect the battery. Repeated overrides of an LVD can deeply discharge the battery and may damage the battery.

LED Legend

- **G** = Green LED is illuminated
- **Y** = Yellow LED is illuminated
- **R** = Red LED is illuminated
- **G/Y** = Green and Yellow are both illuminated at the same time
- **G/Y - R** = Green & Yellow are both illuminated, then Red is illuminated alone
- **Sequencing** (faults) has the LED pattern repeating until the fault is cleared

General Transitions:

- Controller start-up **G - Y - R** (one cycle)
- Push-button transitions blink all 3 LEDs 2 times
- Battery service is required all 3 LEDs blinking until service is reset

Battery Status:

Condition	Indication
Absorption	G flash – every second
Float	G flash – every 2 seconds
Start Equalization	[G / Y / R] x2 – G - G
Stop Equalization	[G / Y / R] x2 – R - R
Equalize	G flash – 2 per second

Battery State-of-Charge (SOC) when battery is charging):

- **G** = 80% to 95% SOC
- **G/Y** = 60% to 80% SOC
- **Y** = 35% to 60% SOC
- **Y/R** = 0% to 35% SOC
- **R** = battery is discharging

Battery Charging Status:

	12 V	24 V	48 V
G	13.3 V - PWM	26.6 V - PWM	53.2 V - PWM
G/Y	13.0 to 13.3 V	26.0 to 26.6 V	52.0 to 53.2 V
Y	12.65 to 13.0 V	25.3 to 26.0 V	50.56 to 52.0 V
Y/R	12.0 to 12.65 V	24.0 to 25.3 V	48.0 to 50.56
R	0 to 12.0 V	0 to 24.0 V	0 to 48.0 V

Load Control:

		12 V	24 V	48 V
G	LVD +	0.60 V	1.20 V	2.40 V
G/Y	LVD +	0.45 V	0.90 V	1.80 V
Y	LVD +	0.30 V	0.60 V	1.80 V
Y/R	LVD +	0.15 V	0.30 V	0.60 V
R Blinking		At LVD Threshold		
R		Below LVD		

Faults & Alarms:

- Short circuit - solar/load
 - Overload - solar/load
 - Over-temperature
 - High voltage disconnect
 - Reverse polarity - battery
 - Reverse polarity – solar
 - DIP switch fault
 - Self-test faults
 - Temperature probe (RTS)
 - Battery voltage sense
- R/G - Y sequencing**
R/Y - G sequencing
R - Y sequencing
R - G sequencing
 No LEDs are illuminated
 No fault indication
R - Y - G sequencing
R - Y - G sequencing
R/Y - G/Y sequencing
R/Y - G/Y sequencing



For Fault Recovery Instructions, see the TriStar PWM Installation, Operation and Maintenance Manual.