



MORNINGSTAR
World's Leading Solar **Controllers** & **Inverters**

Product Catalog

Version 14



Others survive harsh conditions. We THRIVE in them

With over 25 years of experience and well over four million products in over 100 countries—most of them still in operation—Morningstar has truly earned its reputation for building the “world’s leading solar controllers.” At Morningstar, the word “reliability” means a lot more than a marketing adjective. It means a hardware failure rate of less than 0.4%—which is why we’re the one manufacturer who even dares share this kind of specification.

That’s why system designers of the most mission-critical solar energy installations around the world insist on Morningstar components, and why you should too on your next project. From mineral mines in South America to telecom repeater stations in Canada, from gas wells in the Middle East to mountain peaks in Nepal, Morningstar technology and legendary quality make the difference between success and failure—and make renewable energy a practical, cost-effective, and long-term solution.

Morningstar achieved its reputation by starting with faster, “smarter” signal processing optimized through superior engineering. Next, because heat reduces efficiency and product life, we add state-of-the-art thermal design to ensure that there are no fans to fail—unlike other higher-powered solar controller and inverter brands.

To raise the bar further, we use oversized, higher-spec components to achieve unprecedented performance levels. The result: products that literally stand by themselves and set new standards for the rest of the industry.

The reason Morningstar has such dedication to excellence is that we’re an employee-owned company. We not only can afford to be perfectionists, we have to be, since our brand’s reputation is synonymous with our own. Our determination and spirit of innovation is what gave Morningstar charge controllers their legendary staying power. Now with inverter-chargers to match the excellence of our controllers, we’re proud to offer a Morningstar solution perfect for your application.



Morningstar Professional Series

For decades, Morningstar’s Professional Series™ has been the first choice of leading system designers and installers. Legendary reliability and performance make Professional Series components the first choice for mission-critical remote solar power projects ranging from off-grid telecommunications, oil & gas operations, and traffic control systems to lighting, surveillance monitoring, and agricultural installations.

With over four million Professional Series products in the field and a 25-year track record of unparalleled dependability, the industry’s leading solar installers know they can bet their reputations on Morningstar.



A series proven by the professionals who depend on it to power their projects

“Having distributed solar products in Africa for more than 15 years, I know which manufacturers tend to last and which ones fail. **Morningstar being very much in the lasting category.**”

Lincoln Dahl, African Energy

“My SunSaver-10 has been running my 90 watt solar panel **non-stop since September 1, 1998. It still works perfectly.** That is now more than 17 years! Well past the listed 15 year expected life span noted in the Operator’s Manual.”

Peter Caffall-Davis



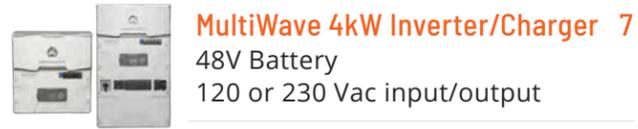
Advanced infra-red security monitoring network protecting wildlife from poachers in Kafue National Park, Zambia, Africa.

“Morningstar components were an obvious choice being readily available and dependable in remote bush applications at reasonable cost”

Operations Manager

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INVERTERS



Morningstar inverters are based on the same acclaimed technology that's behind our charge controllers, applying our superior thermal engineering and advanced software design expertise to the challenging field of power conversion. The result: inverters that are capable of stable, dependable operation over the long term, with no cooling fans necessary. There are no moving parts to fail or pull dust and debris into the system. The proven SureSine inverter will soon be joined by the revolutionary new high-frequency MultiWave inverter/charge-- which will provide Morningstar-quality solution for renewable and other energy systems at both ends of the spectrum.

MultiWave™ 4kW Inverter/Charger 48V Battery • 120 or 230 Vac input/output



Ambient Operating Temperature	-40 °C To +60 °C
Battery Terminals:	1/0 AWG - 4/0AWG
AC Terminals	6 AWG - 10 AWG
Weight	
MW-4048-120	20 kg / 45 lbs
MW-4048-230	20 kg / 45 lbs
MW-4048-SP	22 kg / 48 lbs
MW-4048-120-B	26 kg / 58 lbs
MW-4048-SP-B	28 kg / 62 lbs
Dimensions	
Standard Version	46.8 x 47.9 x 23.8 cm 18.43 x 18.86 x 9.37 in
BOS 'B' Version	46.8 x 78.7 x 23.8 cm 18.43 x 31 x 9.37 in
Warranty	5 years

Certifications

- UL1741 CSA 22.2 #107.1-01
- CE, IEC 62109-2, FCC Class B

Inverters

MultiWave 4kW Continuous Inverter/Charger

The MultiWave™ inverter/charger establishes a new benchmark for battery-based inverters. Combining the surge and power capabilities of a low-frequency inverter with the agility and compactness of a high-frequency design, MultiWave is a radical all-new inverter/charger built with advanced energy storage technologies in mind—one leapfrogging decades of incremental progress in power conversion. MultiWave's innovative, software-driven digital architecture can deliver more power with less weight, achieve peak efficiency of 95% across a wide load range, and is fast enough for use in uninterrupted power supply (UPS) applications.

Flexible and easy to install, MultiWave features a high-resolution display for programming and data access. A built-in DIN ReadyRail expansion system accommodates snap-in ReadyBlocks for adding generator control, system monitoring alert capability, battery management systems (BMS) and other future-proofing features as they become available.

MultiWave	MW-4048-120	MW-4048-230	MW-4048-SP	MW-4048-120-B	MW-4048-SP-B
Nominal DC Input Battery Voltage			48VDC		
Peak Efficiency			95%		
Maximum Output Charge Current			90A		
AC Input Frequency Range			42-68 Hz		
AC Output Frequency (selectable)			50/60 Hz		
AC Transfer Time			<10 ms		

KEY FEATURES AND BENEFITS

Quality:

- Passively-cooled with no fans required; full power to +40°C
- 200% surge capacity: 8kW/5 seconds, for starting large inductive loads
- Sine-wave smoothing and power factor correction help clean up dirty AC power

Modes:

- Off-Grid, UPS, Solar Priority

Ease of Installation

- Easy commissioning with built-in meter, SD card or web-based MS Live View config
- Pre-wired BOS options for NEC-compliant installation
- Reduced weight through advanced electronic design allows easy mounting by a single person

Generator Features

- Advanced bi-directional charger rated at full inverter power
- Two AC inputs allow separate configuration for grid and generator charging, transfer and voltage/frequency window of operation

Expandability

- Ethernet-enabled for future communications with Morningstar inverters and charge controllers
- DIN ReadyRail expansion system accommodates snap-in ReadyBlocks for adding future functionality and capabilities, including relay control, communications, battery management systems (BMS)

Data

- Full-featured standard meter
- Web interface provides real-time data, logging, advanced control, and configuration
- Open MODBUS communications protocol to communicate with third party devices
- SD Card allows installer/user to boot load new firmware and upload custom settings

*Charging: 4000W / 80A at 50VDC / 100A max output

SureSine™ Inverter

300 W; 12 Vdc input, 115 or 220 Vac output



Inverters

SureSine is a pure sine wave inverter delivering AC power in off-grid solar applications, including rural electrification, telecom, remote homes, RVs, caravans and boats. A cast, anodized aluminum enclosure with no internal cooling fan needed ensures long-term reliability in the harshest conditions.

- **Improved load operation** – Pure sine wave provides quality AC equivalent to grid power. Toroidal transformer design generates good wave form throughout the range of input voltages. Handles 200% surge up to 600W.
- **High reliability** – No internal cooling fan or other moving parts. Uses epoxy encapsulation, conformal coating, stainless steel hardware and an anodized aluminum enclosure to protect against harsh tropical and marine environments.
- **More power available** – High efficiency and low self consumption maximizes power to the loads. Automatic stand-by reduces consumption during no load conditions.

“...how all inverters should be made. Thank you, Morningstar”

Ambient Operating Temperature	-40 °C TO +45 °C -40 °F TO +113 °F
Terminal	35 mm ² / 2 AWG
Product Weight	4.5 kg / 10 lbs
Unit Shipping Weight	5.2 kg / 11.5 lbs
Dimensions	21.3 x 15.2 x 10.5 cm 8.4 x 6.0 x 4.1 in
Warranty	2 years

Certifications

- CE, RoHS and REACH Compliant
- ETL Listed (UL 458) - 115V version ONLY
- FCC Title 47 (CFR), Part 15 Subpart B for Class B Device
- EN 60950-1+A11:2001, rev. 4/4/04
- Manufactured in a Certified ISO 9001 Facility



SureSine	SI-300-115V-UL	SI-300-220V
Continuous Power Rating	300W @ 25 °C	300W @ 25 °C
Peak Power Rating (10 minutes)	600W @ 25 °C	600W @ 25 °C
DC Input System Voltage	10.0 - 15.5V	10.0 - 15.5V
Waveform	Pure Sine Wave	Pure Sine Wave
AC Output Voltage (RMS)	115 Vac +/- 10%	220 Vac +/- 10%
AC Output Frequency	60 Hz +/- 0.1%	50 Hz +/- 0.1%

Options	All Versions	
Remote Meter (RM-1)	Yes	Yes
PC MeterBus Adapter (MSC)	Yes	Yes
Relay Driver (RD-1)	Yes	Yes
EIA-485 Adapter (RSC-1)*	Yes	Yes
Ethernet Meterbus Converter (EMC-1)	Yes	Yes

* The EIA-485/RS-232 Adapter can be used in conjunction with the PC Meter-Bus Adapter to enable the SureSine to communicate over a 485 network.



MPPT Controllers



Maximum Power Point Tracking (MPPT) optimally matches the solar array to the battery—no wasted solar electricity. Morningstar MPPT Controllers feature Trakstar™ technology, an advanced control algorithmic function which harvests the maximum power possible from a solar array. Trakstar better maintains battery health by optimizing state of charge and protecting against overcharging and undercharging. All models incorporate advanced thermal design requiring no cooling fans, which ensures long-term reliability with no moving parts to fail. This is a unique feature among higher-powered controllers.

TriStar MPPT™ 600V Controller

60A at up to 600Voc

MPPT Controllers



Standard, DB, TR, and TR with GFPD versions shown with optional display meters

The TriStar MPPT 600V (TS-MPPT-600V) is a breakthrough in charge controller design. By accepting PV array input up to 600 Voc, it enables installers to design systems with longer, fewer strings, reducing cabling and hardware which make installation and wiring easier and faster. Morningstar's advanced digital engineering combined with superior thermal management make the TS-MPPT-600V with TrakStar technology the only charge controller in its class that doesn't require a cooling fan or fans, making it both extremely reliable and efficient (with 97.9% peak efficiency). Ideal for DC-coupled energy storage applications. Available in four versions:

- TS-MPPT-60-600V-48: Standard
- TS-MPPT-60-600V-48-DB: with Disconnect Box
- TS-MPPT-60-600V-48-DB-TR: with DC Transfer Switch
- TS-MPPT-60-600V-48-DB-TR-GFPD: Pre-wired with Ground Fault Protection Device

Noteworthy features

- Accommodates PV systems > 150 Voc with long wire runs from the array to the controller.
- Uses Morningstar's patented 4-stage charging algorithm to optimize battery health.
- Features extensive system networking, monitoring and communications.
- Optimized for harsh environments and equipped with electronic protections.
- Enables battery back-up for grid-tied systems using more efficient DC-coupling system topology (as opposed to AC-coupling).

Ambient Operating Temperature	40 °C to +45 °C -40 °F to +113 °F
Power terminals	2.5 mm ² -35 mm ² 14 AWG-2 AWG
Product Weight	TS-MPPT-60-600V-48 8.98 kg / 19.8 lbs TS-MPPT-60-600V-48-DB 12.3 kg / 27.1 lbs TS-MPPT-60-600V-48-DB-TR 12.75 kg / 28 lbs TS-MPPT-60-600V-48-DB-TR-GFPD 16.79 kg / 37 lbs
Unit Shipping Weight	TS-MPPT-60-600V-48 9.9 kg / 21.7 lbs TS-MPPT-60-600V-48-DB 12.3 kg / 27.1 lbs TS-MPPT-60-600V-48-DB-TR 13.0 kg / 28.7 lbs TS-MPPT-60-600V-48-DB-TR-GFPD 18.0 kg / 39.7 lbs
Dimensions	Standard Box 39.2 x 22.1 x 14.9 cm 15.4 x 8.7 x 5.9 in DC Disconnect Box 54.2 x 22.1 x 14.9 cm 21.4 x 8.7 x 5.9 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- IEC 62109
- ETL Listed [UL-1741 and Canadian CSA C22.2 No. 107.1.01]
- EMC Compliance
- FCC Class B Part 15 Compliant
- U.S. National Electrical Code (NEC) Compliant
- Manufactured in a Certified ISO 9001 Facility

TriStar MPPT 600V All Versions

Maximum Battery Current	60A
Nominal Solar Input	3200Wp
Maximum Open Circuit Voltage	600V
Battery Operating Voltage Range	16 - 72 Vdc
Nominal System Voltage	24, 48, 60 Vdc
Input Operating Voltage Range	Battery Voltage to 525V

Options All Versions

Ground Fault Protection Device (GFPD-150V and GFPD-600V)	Yes
MeterHub (HUB-1)	Yes
Relay Driver (RD-1)	Yes
TriStar Meter-2-600V (TS-M-2-600V)	Yes
TriStar Remote Meter-2 (TS-RM-2)	Yes
Ethernet MeterBus Converter (EMC-1)	Yes
Remote Temperature Sensor (RTS)	Included

TriStar MPPT™ Controller

30A, 45A or 60A at up to 150 Voc

MPPT Controllers



"one of the best charge controllers out there... these things are tanks"

The industry-leading TriStar MPPT with TrakStar Technology is an advanced maximum power point tracking controller for larger off-grid photovoltaic (PV) energy systems up to 3kWp. An iconic design, TriStars have been proven in solar installations around the globe and remain the first choice for designers of mission-critical systems where failure is not an option.

- **Maximizes energy harvest** - superior peak power tracking over conventional MPPT controllers.
- **Highest peak efficiency** for off-grid controllers in the industry: 99% (TS-150).
- **Built for reliability and performance**, with an oversized heatsink and over-spec'd components. Fully-rated for operation at temperatures up to 45C.
- **Extensive networking and communications** features enable system monitoring, data logging, and adjustability.
- **On-board RS-232 port included on all models**; Ethernet included on all 60A models.
- **Extensive electronic protections** include short-circuit, over-current and reverse polarity to ensure the controller will not be damaged by wiring mistakes or overloads.
- **Fanless design** for long-term reliability.

Ambient Operating Temperature	-40 °C to +45 °C -40 °F to +113 °F
Terminals	35 mm ² / 2 AWG
Product Weight	TS-MPPT-30 3.6 kg / 8 lbs TS-MPPT-45 3.6 kg / 8 lbs TS-MPPT-60 4.1 kg / 9 lbs TS-MPPT-60M 4.3 kg / 9.4 lbs
Unit Shipping Weight	TS-MPPT-30 4.5 kg / 9.9 lbs TS-MPPT-45 4.5 kg / 9.9 lbs TS-MPPT-60 5.0 kg / 11 lbs TS-MPPT-60M 5.2 kg / 11.4 lbs
Dimensions	29.1 x 13.0 x 14.2 cm 11.4 x 5.1 x 5.6 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- IEC 62109
- ETL Listed [UL-1741 and Canadian CSA C22.2 No. 107.1.01]
- EMC Compliance
- FCC Class B Part 15 Compliant
- U.S. National Electrical Code (NEC) Compliant
- Manufactured in a Certified ISO 9001 Facility

TriStar MPPT TS MPPT-30 TS MPPT-45 TS MPPT-60 TS MPPT-60M

Maximum Battery Current	30A	45A	60A	60A
Nominal Solar Input				
12V Battery Bank	400Wp	600Wp	800Wp	800Wp
24V Battery Bank	800Wp	1200Wp	1600Wp	1600Wp
48V Battery Bank	1600Wp	2400Wp	3200Wp	3200Wp
Maximum Open Circuit Voltage	150V			
Nominal System Voltage	12, 24 or 48Vdc			

Options TS MPPT-30 TS MPPT-45 TS MPPT-60 TS MPPT-60M

TriStar Meter-2 (TS-M-2)	Yes	Yes	Yes	Pre-installed
TriStar Remote Meter 2 (TS-RM-2)	Yes	Yes	Yes	Yes
MeterHub (HUB-1)	Yes	Yes	Yes	Yes
Ethernet Port	No	No	Included	Included
EIA-485 Adapter (RSC-1)	Yes	Yes	Included	Included
Remote Temperature Sensor (RTS)	Included	Included	Included	Included
Ground Fault Protection Device (GFPD-150V and GFPD-600V)	Yes	Yes	Yes	Yes
Ethernet MeterBus Converter (EMC-1)	Yes	Yes	Yes	Yes

ProStar™ MPPT Controller

25A or 40A at up to 120 Voc

MPPT Controllers



with Wirebox

Prostar MPPT solar charge controller is an advanced maximum power point tracking (MPPT) battery charger for off-grid photovoltaic (PV) systems up to 1100 watts. All versions have TrakStar Technology and include load control.

The ProStar design has been proven in over two decades of use in the world's most demanding installations—and ProStar today reflects Morningstar's policy of continuous improvement through regular upgrades and enhancements. Because Morningstar's employee-owned culture never "rests on success," ProStar customers can own both a legend and the latest in a single product.

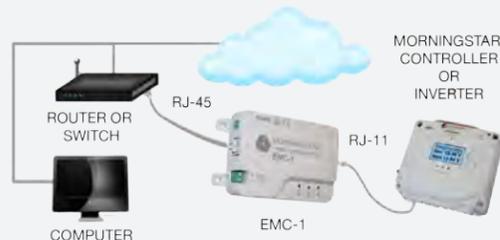
- **Maximizes energy harvest** - superior peak power tracking over conventional MPPT controllers.
- **Custom programmable** - with or without a computer.
- **Advanced self-diagnostics** - warns against installation errors.
- **Data logging** - up to 256 days of detailed power & load data.
- **Automatic Lighting Control** - multi-event load control provides powerful options for PV lighting systems.
- **Extensive electronic protections** include short-circuit, over-current and reverse polarity to ensure the controller will not be damaged by wiring mistakes or overloads.
- **Fanless design** for long-term reliability.

"Best of the best. Have used and seen many others. This is the most durable..."

Ambient Operating Temperature	-40 °C to +60 °C -40 °F to +140 °F
Terminal	16 mm ² / 2 AWG
Product Weight	1.4 kg / 3.1 lbs
Unit Shipping Weight	1.9 kg / 4.2 lbs
Dimensions	20 x 19.3 x 7 cm 7.9 x 7.6 x 2.8 in
Warranty	5 years

Certifications

- CE and RoHS Compliant
- IEC 62109
- ETL Listed [UL-1741 and Canadian CSA C22.2 No. 107.1.01]
- FCC Class B Part 15 Compliant
- Manufactured in a Certified ISO 9001 Facility



SunSaver MPPT™ Controller

15A at up to 60Voc

MPPT Controllers



"...an amazing product...well built, and well designed"

SunSaver MPPT with TrakStar technology is the perfect charging solution for smaller off-grid solar systems up to 400Wp. An industrial-grade design proven in challenging applications and environments, SunSaver has been called the "single most successful charge controller in the solar industry."

- **Maximum power point tracking (MPPT)** optimally matches the solar array to the battery—no wasted PV electricity.
- **Use of high voltage modules** - In addition to 12V crystalline modules, enables use of high voltage modules for off-grid battery charging.
- **Converts 36V or 24V arrays** for use with either a 24V or 12V battery.
- **Automatic Lighting Control** - four programmable timer sequences for PV lighting applications using MSView.
- **Extensive electronic protections** include short-circuit, over-current and reverse polarity to ensure the controller will not be damaged by wiring mistakes or overloads.

Ambient Operating Temperature	-40 °C to +60 °C -40 °F to +140 °F
Terminal	16 mm ² / 6 AWG
Product Weight	0.60 kg / 1.3 lbs
Unit Shipping Weight	0.7 kg / 1.6 lbs
Dimensions	16.9 x 6.4 x 7.3 cm 6.6 x 2.5 x 2.9 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- IEC 62109
- ETL Listed [UL-1741 and Canadian CSA C22.2 No. 107.1.01]
- EMC Compliance
- FCC Title 47 (CFR), Part 15 Subpart B for Class B Device
- Manufactured in a Certified ISO 9001 Facility

SunSaver MPPT

SS-MPPT-15L

Maximum Battery Current	15A
Nominal Solar Input	
12V Battery Bank	200Wp
24V Battery Bank	400Wp
Maximum Open Circuit Voltage	75V
Nominal System Voltage	12/24 Vdc

Options

SS-MPPT-15L

Remote Meter (RM-1)	Yes
Remote Temperature Sensor (RTS)	Yes
MeterHub (HUB-1)	Yes
PC MeterBus Adapter (MSC)	Yes
DIN Rail Clips (DIN-1)	Yes
Ground Fault Protection Device (GFPD-150V and GFPD-600V)	Yes
Ethernet MeterBus Converter (EMC-1)	Yes



ProStar MPPT

PS-MPPT-25 PS-MPPT-25M PS-MPPT-40 PS-MPPT-40M

Maximum Battery Current	25A	25A	40A	40A
Nominal Maximum Operating Power				
12 volt battery	350W @45C	350W @45C	550W @45C	550W @45C
24 volt battery	700W @60C	700W @60C	1100W @60C	1100W @60C
Maximum PV Open Circuit Voltage (Voc)	120 Volts (without damage to unit)			
Nominal Battery Voltage	12V or 24V			

Options

PS-MPPT-25 PS-MPPT-25M PS-MPPT-40 PS-MPPT-40M

Digital Meter	No	Included	No	Included
Remote Meter (RM-1)	Yes	Yes	Yes	Yes
Remote Temperature Sensor (RTS)	Yes	Yes	Yes	Yes
MeterHub (HUB-1)	Yes	Yes	Yes	Yes
Wire Box (PS-MPPT-WB)	Yes	Yes	Yes	Yes
PC Meterbus Adapter (MSC)	Yes	Yes	Yes	Yes
USB MeterBus Adapter (UMC-1)	Yes	Yes	Yes	Yes
Relay Driver (RD-1)	Yes	Yes	Yes	Yes
Ethernet MeterBus Converter (EMC-1)	Yes	Yes	Yes	Yes

PWM Controllers



Pulse-Width Modulation (PWM) technology controllers are ideal for use in solar energy situations where 36 or 72 cell PV modules are available and the site is unshaded with no physical space limitations. All models incorporate advanced thermal design requiring no cooling fans, which ensures long-term reliability with no moving parts to fail-- a unique feature among higher- powered controllers.

TriStar™ Controller

45A or 60A at 12-48V



"It is a Morningstar, what do you expect! It is great"

Ambient Operating Temperature	-40 °C to +45 °C -40 °F to +113 °F
Terminal	35 mm ² / 2 AWG
Product Weight	TS-45 1.6 kg / 3.5 lbs TS-60 1.6 kg / 3.5 lbs TS-60M 1.8 kg / 4 lbs
Unit Shipping Weight	TS-45 2.0 kg / 4.4 lbs TS-60 2.0 kg / 4.4 lbs TS-60M 2.2 kg / 4.8 lbs
Dimensions	26.0 x 12.7 x 7.1 cm 10.3 x 5.0 x 2.8 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- IEC 62109
- ETL Listed [UL-1741 and Canadian CSA C22.2 No. 107.1.01]
- EMC Compliance
- FCC Title 47 (CFR), Part 15 Subpart B for Class B Device
- Manufactured in a Certified ISO 9001 Facility

PWM Controllers

Three-function PWM controller for larger systems, providing reliable PWM solar battery charging or load control or diversion regulation.

- **Built for reliability and performance**, with an oversized heatsink and over-spec'd components. Fully-rated for operation at temperatures up to 45C.
- **More information with LED indicators.** Optional meter displays extensive system and controller information in five languages; automatic self-test and reset.
- **Communications capability** with RS-232 port, connects to a PC for custom settings, data logging, remote monitoring and control.
- **Fully adjustable** with DIP switches for seven digital presets. Additional custom setting via RS-232.
- **Extensive electronic protection** against reverse polarity, short circuits, overcurrent and excessive temperature.
- **Fanless design** for long-term reliability.



TriStar	TS-45	TS-60	TS-60M
Rated Solar, Load or Diversion Current	45A	60A	60A
Nominal System Voltage	12, 24 or 48 Vdc		

Options	TS-45	TS-60	TS-60M
TriStar Meter-2 (TS-M-2)	Yes	Yes	Pre-installed
TriStar Remote Meter-2 (TS-RM-2)	Yes	Yes	Yes
MeterHub (HUB-1)	Yes	Yes	Yes
EIA-485 Adapter (RSC-1)	Yes	Yes	Yes
Remote Temperature Sensor (RTS)*	Yes	Yes	Yes
Ground Fault Protection Device (GF-PD-150V and GFPD-600V)	Yes	Yes	Yes

* Required for temperature compensated charging. Not included.



Portable LED lighting towers providing 24/7 illumination for safer, more efficient mining operations throughout Brazil and Latin America.

"I like to use Morningstar because it's really robust and reliable"

Ricardo Righi Reis

ProStar™ Controller

15A or 30A at 12/24V

PWM Controllers



"...you get what you pay for, and this one is worth every penny...count on Morningstar"

Mid-range PWM solar charge controller for both professional and consumer applications, incorporating legendary ProStar design and performance.

- **Longer battery life** through 4-stage charging and temperature compensation. Constant voltage PWM series regulation. Choice of three battery types. Voltage-sense terminals for more accurate battery monitoring.
- **More information** with three battery-level LED indicators. Optional meter includes safety disconnect and displays amps, volts, temperature and self-test.
- **Extensive electronic protection** against reverse polarity, reverse current at night, short circuits, overcurrent and excessive temperature. No mechanical fuses.
- **Fanless design** for long-term reliability.

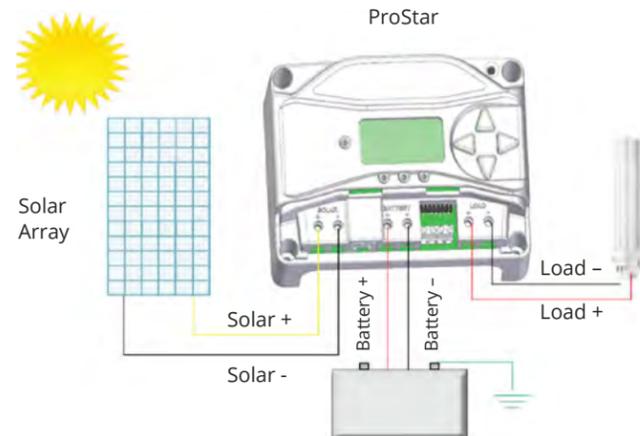
ProStar PS-15 PS-15M PS-30 PS-30M

Rated Solar Current	15A	15A	30A	30A
Rated Load Current *	15A	15A	30A	30A
Nominal System Voltage	12/24 Vdc			

Options PS-15 PS-15M PS-30 PS-30M

Digital Meter	No	Included	No	Included
Remote Meter (RM-1)	Yes	Yes	Yes	Yes
Ethernet MeterBus Converter (EMC-1)	Yes	Yes	Yes	Yes
Remote Temperature Sensor (RTS)	Yes	Yes	Yes	Yes
Ground Fault Protection Device (GF-PD-150V and GF-PD-600V)	Yes	Yes	Yes	Yes

* Low voltage disconnect included on all ProStar controllers.



Certifications

- CE, RoHS and REACH Compliant
- IEC 62109
- Manufactured in a Certified ISO 9001 Facility
- FCC Part-15 Class B Compliant

SunSaver™ Controller

6A, 10A or 20A at 12V or 24V

PWM Controllers



"This is the only one I'd use...it's the one I wish I bought first"

The world's leading small solar controller for industrial and consumer markets. Proven in demanding locations, including mines and oilfields.

- **Ideal for oil/gas applications.** Approved for use in hazardous locations: Class 1, Division 2, Groups A-D.
- **Longer battery life** through PWM 4-stage charging and temperature compensation. Sealed or flooded battery select.
- **Tropicalization** - hardened for field use with anodized aluminum enclosure, epoxy encapsulation, marine-rated terminals.
- **Additional features** include full electronic protections, 3-state battery LED indicators, terminal cover, dead battery recovery, high voltage load protection for sensitive loads.
- **L-versions** include low-voltage load disconnect.

SunSaver SS-6-12V SS-6L-12V SS-10-12V

Rated Solar Current	6A	6A	10A
Rated Load Current	6A	6A	10A
Nominal System Voltage	12 Vdc		
Low Voltage Disconnect	No	Yes	No

SunSaver SS-10L-12V SS-10L-24V SS-20L-12V SS-20L-24V

Rated Solar Current	10A	10A	20A	20A
Rated Load Current	10A	10A	20A	20A
Nominal System Voltage	12Vdc	24Vdc	12Vdc	24Vdc
Low Voltage Disconnect	Yes	Yes	Yes	Yes

Options All Versions

DIN Rail Clips (DIN-1)	Yes
Ground Fault Protection Device (GF-PD-150V and GF-PD-600V)	Yes

Ambient Operating Temperature	-40 °C to +60 °C -40 °F to +140 °F
Terminal	5 mm ² / 10 AWG
Product Weight Unit Shipping Weight	0.23 kg / 0.5 lbs 0.4 kg / 0.9 lbs
Dimensions	15.2 x 5.5 x 3.4 cm 6.0 x 2.2 x 1.3 in
Warranty	5 years

Certifications

- Hazardous Locations - Class 1, Div. 2 Groups A-D
- CE, RoHS and REACH Compliant
- UL 1604/ANSI/ISA 12.12.01-2000 (USA) and CSA C22.2 No. 213-M1987 (Reaffirmed 2004) (CANADA) Listed
- ETL Listed: UL 1741 (with terminal cover)*
- FCC Title 47 (CFR), Part 15 Subpart B for Class B Device
- Manufactured in a Certified ISO 9001 Facility

* Wire terminal cover included with every SunSaver



SunSaver Duo™ Controller

25A at 12V

PWM Controllers



"Love it...it was worth the extra money over other brands that seemed to be of lesser quality"

A two-battery solar charge controller with optional remote meter, designed for RV/caravan and marine use.

- **Rugged design** - epoxy encapsulation protects against dust and high humidity. Extensive electronic protections include short-circuit, over-current and reverse polarity to ensure the controller will not be damaged by wiring mistakes or overloads.
- **User adjustable** - set parameters with on-board DIP switches or further customize with a PC using Morningstar MSView software.
- **Dual battery charging capability;** house and vehicle for example.



Ambient Operating Temperature	-40 °C to +45 °C -40 °F to +113 °F
Terminal	16 mm ² / 6 AWG
Product Weight	SSD-25 0.26 kg / 0.57 lbs SSD-25RM 0.27 kg / 0.59 lbs
Unit Shipping Weight	SSD-25 0.6 kg / 1.3 lbs SSD-25RM 1.0 kg / 2.2 lbs
Dimensions:	17.0 x 5.6 x 4.1 cm without meter 6.7 x 2.2 x 1.6 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- Manufactured in a Certified ISO 9001 Facility



SunKeeper™ Controller

6A or 12A at 12V

PWM Controllers



"This is a great little unit...an outstanding charge controller"

Compact "point of use" design mounts directly to the solar module junction box or module frame and eliminates the need for an additional controller housing.

- **High temperature rated** - to 70° for operation in high temperatures at the solar module; no need to de-rate.
- **Rugged design** - approved for outdoor use without an additional enclosure. IP65 rated with UV-resistant case; epoxy encapsulated electronics and watertight connection to junction box.
- **Ideal for oil/gas applications.** Approved for use in hazardous locations: Class 1, Division 2, Groups A-D.

Ambient Operating Temperature	-40 °C to +70 °C -40 °F to +158 °F
Terminal	2.0mm ² / 14 AWG
Product Weight	0.11 kg / 0.25 lbs
Unit Shipping Weight	0.2 kg / 0.4 lbs
Dimensions	9.9 x 5.1 x 1.3 cm 3.9 x 2.0 x 0.5 in
Warranty	5 years

Certifications

- Hazardous Locations - Class 1, Div. 2 Groups A-D
- CE, RoHS and REACH Compliant
- UL 1604/ANSI/ISA 12.12.01-2000 and CSA C22.2 No. 213-M1987 Listed
- Manufactured in a Certified ISO 9001 Facility

SunSaver Duo	SSD-25	SSD-25RM
Rated Solar Current	25A	25A
Rated Load Current*	None	None
Nominal System Voltage	12Vdc	12Vdc

Options	SSD-25	SSD-25RM
Remote Meter (RM-1)	Yes	Included
Remote Temperature Sensor (RTS)	Yes	Yes
PC MeterBus Adapter (MSC)	Yes	Yes
DIN Rail Clips (DIN-1)	Yes	Yes
EIA-485 Adapter (RSC-1)**	Yes	Yes
Ground Fault Protection Device (GFPD-150V and GFPD-600V)	Yes	Yes
Ethernet MeterBus Converter (EMC-1)	Yes	Yes

* There is no load connection on the SunSaver Duo.

** The EIA-485 / RS-232 Adapter can be used in conjunction with the PC MeterBus Adapter to enable these devices to communicate over a 485 network.

SunKeeper	SK-6	SK-12
Rated Solar Current	6A	12A
Rated Load Current*	None	None
Nominal System Voltage	12Vdc	12Vdc

Options	All Versions
Remote Temperature Sensor (RTS)**	Yes

* There is no load connection on the SunKeeper.

** Installation of the RTS to the SunKeeper requires some soldering



SunLight™ Controller

10A or 20A at 12V or 24V

PWM Controllers

World's leading solar lighting controller for street and pathway lighting, parking areas, bus stations, signage, and much more.

- **Provides 10 lighting options** with accurate on-board timer. User adjustable for 2 to 10 hours ON or for ON all night. Unique ON/OFF/ON settings conserve energy and turn lights on again for 1 or 2 hours before sunrise. Timer accuracy is within 2 seconds.
- **Easy to set-up**, with test-button feature and LED indicator. To confirm correct installation, test button turns light on during the day and LED indicates selected lighting option.
- **Rugged design** with anodized aluminum enclosure, epoxy encapsulation, corrosion-resistant terminals.



"Bulletproof and dependable...I will use them again and again"

Ambient Operating Temperature	-40 °C to +60 °C -40 °F to +140 °F
Terminal	5.2mm ² / 10 AWG
Product Weight	0.27 kg / 0.6 lbs
Unit Shipping Weight	0.3 kg / 0.7 lbs
Dimensions	16.8 x 5.5 x 3.4 cm 6.6 x 2.2 x 1.3 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- Manufactured in a Certified ISO 9001 Facility

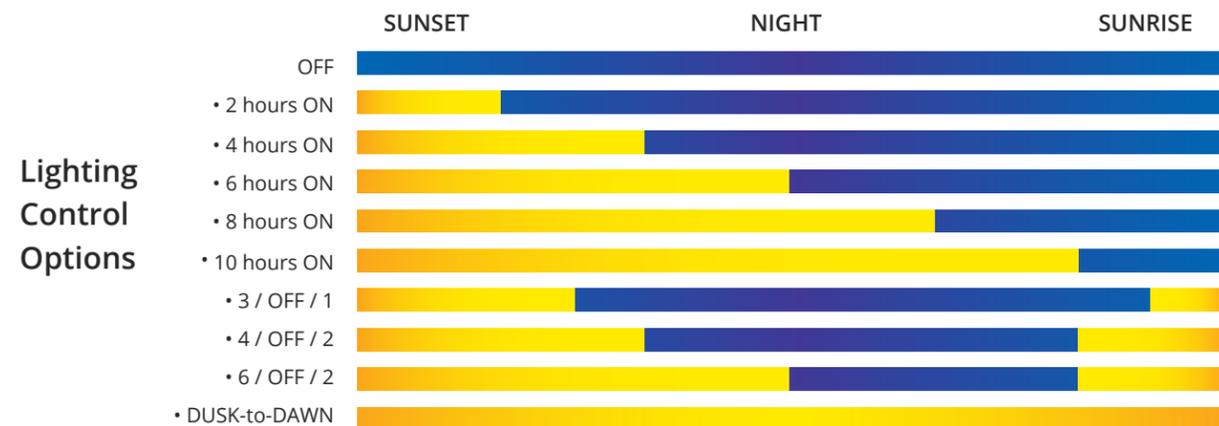
SunLight SL-10L-12 SL-10L-24 SL-20L-12 SL-20L-24

Rated Solar Current	10A	10A	20A	20A
Rated Load Current*	10A	10A	20A	20A
Nominal System Voltage	12Vdc	24Vdc	12Vdc	24Vdc

Options All Versions

DIN Rail Clips (DIN-1)	Yes	Yes	Yes	Yes
Ground Fault Protection Device (GFPD-150V and GFPD-600V)	Yes	Yes	Yes	Yes

* Low Voltage Disconnect is included in all SunLight Controllers.



SunGuard™ Controller

4.5A at 12V

PWM Controllers

Single module, compact solar charge controller for small systems, ideal for both professional and consumer use.

- **Rugged design** - 100% solid state, epoxy encapsulated; rated for 25% overloads (no need to de-rate)
- **Longer battery life** - series design PWM charging (instead of shunt) with temperature compensation, low self-consumption.
- **Easy to install** - outdoor rated connecting wires make a waterproof connection to the solar module and battery.



"Rock solid, potted so waterproof, long track-record...great charge controller for a small system"

Ambient Operating Temperature	-40 °C to +60 °C -40 °F to +140 °F
Product Weight	0.1 kg / 0.2 lbs
Unit Shipping Weight	0.1 kg / 0.3 lbs
Dimensions	6.4 x 5.1 x 3.8 cm 2.5 x 2.0 x 1.5 in
Warranty	5 years

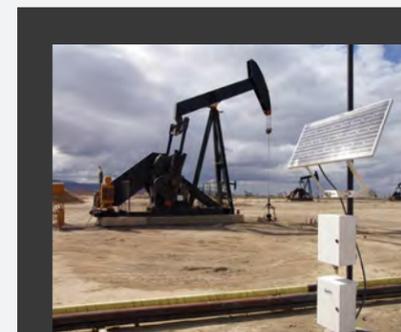
Certifications

- CE, RoHS and REACH Compliant
- Manufactured in a Certified ISO 9001 Facility

SunGuard SG-4

Rated Solar Current	4.5A
Rated Load Current*	None
Nominal System Voltage	12Vdc

* There is no load connection on the SunGuard.



Morningstar SunKeeper and SunSaver controllers are standard operating equipment for solar-powered applications on remote oil and gas extraction sites.



THE ONLY SOLAR
CONTROLLER THAT
DARES
TURN ITS BACK ON YOU

At Morningstar, this is our best side.

Because we're the only complete line of full-powered solar controllers that don't need cooling fans. All of our controllers, including the legendary ProStar MPPT, get rid of excess heat more intelligently, through advanced passive cooling.

From the single-module SunGuard to the breakthrough TriStar 600V, Morningstar controllers—unlike our competition—have no moving parts to fail, no fans to suck in dirt and debris, no fan motor loads to affect solar harvest. It's one reason why leading solar professionals in the oil & gas, telecommunications, security, transportation and other industries have put over four million Morningstars into service since 1993. Learn how we can help your next project at www.morningstarcorp.com



TriStar Meter-2-600V (TS-M-2-600V)



Accessories

On-Board Advanced Digital Display for the TriStar MPPT 600V Controller. Displays extensive system and controller information, logged data, bar graph metering, as well as alarms and faults for easy troubleshooting.

Compatible with:

TriStar MPPT 600V Controller
MeterHub

- 2 x 16 character LCD display
- Mounts to the controller*
- Displays extensive system and controller information, logged data, bar graph metering as well as alarms and faults for easy troubleshooting
- Choice of 5 languages (English, French, German, Portuguese or Spanish)

* Replaces stock front faceplate

TriStar Meter-2 (TS-M-2)



On-Board Advanced Digital Display for the TriStar and TriStar MPPT Controllers. The meter will display a great deal of information about your TriStar controller and the operation of your system. In addition, the meter enables manual functions and controller diagnostics. These capabilities will increase your confidence that the system is working properly and will help you to improve reliability, battery life and system performance.

Compatible with:

TriStar MPPT Controller
TriStar Controller
MeterHub

- 2 x 16 character LCD display
- Mounts to the controller*
- Displays extensive system and controller information, logged data, bar graph metering as well as alarms and faults for easy troubleshooting
- Choice of 5 languages (English, French, German, Portuguese or Spanish)

* Replaces stock front faceplate on TriStar and TriStar MPPT controllers.

Accessories

TriStar Remote Meter-2 (TS-RM-2)

Remote Digital Display for the TriStar Family Controllers. The TS-RM-2 provides the same data display as the TS-M-2, except that it ships with 30 meters of cable and a flat faceplate. These features enable convenient mounting away from the controller.



Compatible with:

TriStar MPPT 600V Controller
 TriStar MPPT Controller
 TriStar Controller
 MeterHub

- 2 x 16 character LCD display
- Displays extensive system and controller information, logged data, bar graph metering, as well as alarms and faults for easy troubleshooting
- Choice of 5 languages (English, French, German, Portuguese or Spanish)

Accessories

MeterHub (HUB -1)

This product electrically isolates devices that supply power to the network, preventing damage to the network in the event of grounding problems.



Compatible with:

TriStar MPPT 600V Controller
 TriStar MPPT Controller
 ProStar MPPT Controller
 SunSaver MPPT Controller
 TriStar Controller
 TriStar Meter 2
 TriStar Remote Meter 2
 Relay Driver

- Allows several Morningstar products to communicate over a MeterBus network (maximum 15 devices)
- In multi-controller systems the TS-M-2, TS-M-2-600V and TS-RM-2 are networkable using Morningstar's MeterHub to allow individual controller data and aggregate system data to be displayed together on a single meter.
- Enables multiple controllers to share a TriStar Meter or Relay Driver
- Provides electrical isolation

Remote Meter (RM-1)

Remote Digital Display for viewing a controller or inverter in a separate location. This meter provides comprehensive system information for easy monitoring including voltage, current and temperature.



Compatible with:

ProStar MPPT Controller
 SunSaver MPPT Controller
 SunSaver Duo Controller
 SureSine Inverter
 ProStar Controller

- Easy to install and use
- Low self-consumption
- 4 digit display with custom icons
- Displays systems information, logged data*, alarms and errors
- May be mounted in the wall or on the wall with included frame
- Includes 10 meters of cable

*Logged data only available for the SunSaver MPPT, ProStar MPPT and ProStar controllers

PC MeterBus Adapter (MSC)

Converts RJ-11 MeterBus to RS-232 Connector



Compatible with:

ProStar MPPT Controller
 SunSaver MPPT Controller
 SunSaver Duo Controller
 SureSine Inverter

- Used to connect a Morningstar controller or inverter to a PC or other third party serial enabled device
- Communications link enables monitoring and logging of data as well as customizing of set points

Accessories

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

Converts RS-232 to EIA-485 Connector

Compatible with:

TriStar MPPT Controller SunSaver Duo Controller
 SunSaver MPPT Controller SureSine Inverter
 TriStar Controller Relay Driver

- Allows up to 128 Morningstar products to communicate on the same communications bus and over much greater distances than with RS-232
- All data is transmitted via MODBUS™ protocol
- Removable four (4) position EIA-485 terminal
- 9-pin RS-232 connector (male)
- Status LED for monitoring and diagnostics
- Molded tabs for attachment to 35mm standard DIN rail
- RS-232 ribbon cable (not shown) with low-profile connectors

Typical configurations include:

- Networking several TriStar and/or TriStar MPPT controllers
- Adding Morningstar PC Meterbus Adapters (MSC) for use with an RJ-11 port in multi-device networks
- Adding Morningstar's Relay Driver (RD-1) to a network
- Integrating any compatible Morningstar product into an existing EIA-485 network, such as those used by industrial control or SCADA systems



Accessories

Ethernet MeterBus Converter (EMC-1)

Allows data transfer to the internet

Compatible with:

TriStar MPPT Controller
 ProStar MPPT Controller
 SunSaver MPPT Controller
 TriStar Controller
 ProStar Controller
 SunSaver Duo Controller
 SureSine Inverter

- Connects to any meterbus enabled controller to provide enhanced data and network features
- Adds IP based MODBUS connectivity for remote communication and control
- Live View displays system status and log data directly from the EMC in an easy to view webpage
- Powered via meterbus port on controller, PoE or DC Input for 12,24 or 48V systems



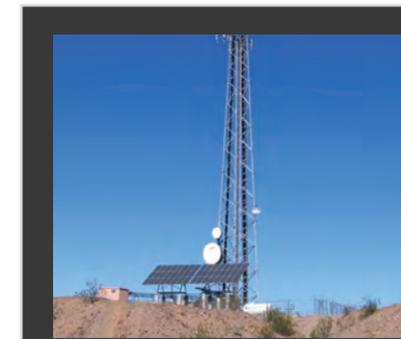
USB MeterBus Adapter (UMC-1)

Converts the MeterBus RJ-11 to a standard USB 2.0 interface

Compatible with:

ProStar MPPT Controller
 SunSaver MPPT Controller
 SunSaver Duo Controller
 SureSine Inverter
 ProStar Controller

- Allows communication between a computer and compatible Morningstar products
- Can be used for:
 - Programming custom charging set-points
 - Logging live data
- Communication with third party hardware that supports MODBUS™ communication



Remote telecommunications repeater installations in the Canadian Arctic using TriStar high-voltage controllers.

Ground Fault Protection Device

Off-grid and on-grid PV safety device



Morningstar's Ground Fault Protection Device (GFPD) prevents current from following any unintended paths during a ground fault.

Other ground fault detection/interruption products break the bond to the grounded conductor. When this occurs, not only is the earth bond compromised, but the battery and DC loads can also be left ungrounded and floating. For a negatively grounded system this means that the negative side of the battery and loads can float to negative Voc in relation to ground and the positive side can float to (negative Voc + Vbat). **Morningstar's GFPD better isolates the array from the battery and loads, while maintaining the bond to ground.**

Compatible with:

TriStar MPPT-600V Controller TriStar MPPT Controller

- Disconnects both the positive and negative conductor and completely isolates PV source circuits
- Trips at 300mA compared to 1A for alternative solutions
- Provides design flexibility to accommodate large and small array configurations
- Uses high quality breaker solutions rather than fuses which are problematic to replace at remote sites
- Works like a traditional AC GFI
- Maintains the integrity of earth bond for battery and loads
- Does not require an extra warning label at the battery per U.S. National Electric Code requirements
- Makes it easier to locate and troubleshoot ground faults
- Powered via the pv system's battery
- Equipped with both visual and audible alarms
- Built to support both single controller and multiple controller systems
- When the earth bond is not broken, Morningstar's GFPD will only shut off affected controllers
- All loads will continue to operate safely with the battery remaining bonded to ground
- Multiple controllers and GFPDs can be added on an as-needed basis

Ground Fault Protection Device	GFPD-150V	GFPD-600V
Number of Poles	2	2
Maximum Solar Voltage	150V	600V
Maximum Solar Current	60A	50A
Trip Method	Relay	
Mounting	DIN-rail or Panel-Mount	
Input Voltage	8-72 Vdc	
Self-Consumption	<0.5W	
Ground Fault Threshold Current	300 mA +/- 10%	
Output Trip Signal	12V	
Nominal System Voltage	12, 24, 36 or 48 Vdc	

Ambient Operating Temperature	-40 °C to +60 °C -40 °F to +140 °F
Terminal	25 mm ² / 4 AWG and 35 mm ² / 2 AWG
Weight	GFPD-150V 2.0 kg / 4.4 lbs GFPD-600V 4.4 kg / 8.9 lbs
Dimensions	GFPD-150V 26.9 x 12.8 x 11.2 cm 10.6 x 5.1 x 4.4 in GFPD-600V 35.7 x 22.1 x 10.6 cm 14.1 x 8.7 x 4.2 in
Warranty	5 years

Certifications

- CE, RoHS and REACH Compliant
- ETL Listed: UL 1741
- CSA C22.2 No. 107.1-01 Listed
- GFPD-150V is UL-489 Compliant
- GFPD-600V is UL-1077 Compliant
- FCC Class B Part 15 Compliant
- U.S. National Electrical Code (NEC) 690.5 Compliant for use as a GFPD device
- Meets EMC Directives (Immunity, Emissions and Safety)
- Manufactured in a Certified ISO 9001 Facility

Relay Driver (RD -1)



Logic Module for system control functions. The Relay Driver provides high level system control functions such as high/low voltage alarms, load control and generator start.

Compatible with:

TriStar MPPT 600V Controller ProStar Controller
TriStar MPPT Controller SunSaver Duo Controller
ProStar MPPT Controller SureSine Inverter
SunSaver MPPT Controller MeterHub
TriStar Controller

- Cost-effective and Highly reliable
- Fully Programmable
- Advanced Generator Control
- Industrial Design
- LED Indicators
- 4 independent relay driver outputs (relays not included)
- Used for high/low voltage alarms, load control, and generator start
- Reads digital data inputs from 'compatible' controllers and inverters
- Reads battery voltage in systems with other controllers

Wire Box (PS-MPPT-WB)



An optional two-piece enclosure accessory for ProStar MPPT. Provides effective cover for wires and conduit leading to and from the ProStar MPPT controller. This Wire Box may be required or recommended by authorities having jurisdiction to reduce hazards associated with exposed wires, conduits and connections.

Compatible with:

ProStar MPPT Controller

- Material: High strength polycarbonate Lexan
- Enclosure space: accommodates 35mm² wire
- Meets NEC standards for conduits and wire bending



Accessories

Remote Temperature Sensor (RTS)

Sends battery temperature data to controllers



Compatible with:

TriStar MPPT 600V Controller*	TriStar Controller
TriStar MPPT Controller*	ProStar Controller
ProStar MPPT Controller	SunSaver Duo Controller
SunSaver MPPT Controller	SunKeeper Controller

- Improves battery charging by using temperature at the battery for very accurate temperature compensation
- Recommended for solar systems that experience temperature variations during the year or whenever the temperature at the battery will be more than 5 °C (9 °F) different than the temperature at the controller

*Remote Temperature Sensors included with all TriStar MPPT units.

DIN Rail Clips (DIN-1)

For installing controllers and accessories to DIN Rails

Compatible with:

SunSaver MPPT Controller
SunSaver Controller
SunSaver Duo Controller
SunLight Controller

- Rugged plastic clips match SunSaver and SunLight mounting holes
- Provides a simple way to install controllers to DIN rails
- Enables removal of controllers from DIN rails without removing the clips
- Polypropylene clips
- Fits all 35mm standard DIN rails
- Includes mounting screws



How Mission-Critical Solar Becomes

Mission ACCOMPLISHED

With a track record that goes back further than most solar brands, Morningstar's ProStar and TriStar charge controllers are more than industry standards. They're icons, recognized by designers the world over as the first choice for systems where failure isn't an option.

TriStar & ProStar Controllers

In fact, Morningstar is a choice that's been made by professionals well over three million times during the past several decades. In installations spanning from middle-east oil fields to Antarctic research stations. Morningstar products earned their place not just by surviving harsh conditions but by thriving in them, through best-in-class engineering, advanced thermal design for fanless operation, and using components rated well above industry-standard specs.

We design our products as over-achievers because, as an employee-owned company, our own reputations go out on the line along with every Morningstar product shipped. That's why the industry's leading installers keep betting their reputations on Morningstar. You can, too, with our comprehensive line ranging from the new game-changing 600V TriStar controller to the single-module SunGuard. Whatever your need, there's a Morningstar powering solution perfect for your next project.



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Greenland

"I chose **Morningstar** because of its datalogging and communication capabilities"

Alaska

"My sunsaver has been **working perfectly** since 1998"

United Kingdom

"My customers **swear by Morningstar**"

Canada

"Morningstar's technical service is the **best in the industry**"

Romania

"Morningstar **allows me to remotely monitor** my house"

Nepal

"SunSaver controllers **were very reliable** at our camp during our record breaking climb to Mt. Annapurna"

New Mexico

"Thanks for a **great product**. Morningstar is **the best**"

Costa Rica

"Morningstar's performance and support **has always been excellent**"

Colombia

"I selected Morningstar controllers because they don't need cooling fans and the MPPT algorithm is **superior to others**"

Australia

"Morningstar's TRAKSTAR technology provides **more power** to batteries than other brands"

Chile

"The SunSaver I installed for an R.E. project **still works well after 20 years**"

Africa

"I know which manufacturers' products tend to last and which ones fail. **Morningstar lasts**"

Saudi Arabia

"Morningstar provides **reliable power** in the harshest conditions"

Taiwan

"Morningstar provides **quality products** that we need in remote places"

Antarctica

"The TriStar MPPT is **the best** battery charger for our applications"



MORNINGSTAR

World's Leading Solar **Controllers & Inverters**

Due to Morningstar's policy of continuous improvement, product availability, features and specifications are subject to change without notice. Information in this publication has been checked for accuracy; however, no responsibility is assumed for typos or errors.