

Charge Controllers – PWM and MPPT

A charge controller is an electronic voltage regulator, used in off-grid systems and grid-tie systems with battery backup, that controls the flow of power from the charging source to the battery. The charge controller automatically tapers, stops, or diverts the charge when batteries become fully charged. Some charge controllers have metering and datalogging capability to show system operation parameters and battery charge status. Some have low battery load disconnect to prevent over-discharge and some have built-in light controls to turn on lights at night.

Charge controller capacities ranges from 4 amps to 80 amps and multiple charge controllers can be used in parallel for larger systems. The simplest charge controllers turn off the charge when the battery reaches a voltage near full charge, and turn it on when the voltage drops about one volt. Pulse width modulated (PWM) charge controllers turn on an off very rapidly, holding the batteries at full charge, making better use of available power.

Maximum power point tracking (MPPT) charge controllers take power from the charging source at a voltage where it can put out the most power (its maximum power point) and convert that to the correct voltage to charge the battery. This technique significantly increases the power from a solar array, especially when batteries are discharged, battery voltage is low, and the temperature is low causing the maximum power point voltage of the solar modules to be high. Most MPPT charge controllers can take an array voltage much higher than what is required by the batteries, allowing the use of modules with higher peak power voltage, designed for grid-tie use. A higher voltage solar array also allows smaller wire to be used between the array and the charge controller, which can save wire and installation cost in large systems. Maximum power point tracking allows a PV array to deliver up to 30% more power to a battery than it would if it were connected directly to the battery.

Apollo Solar

NEW! T100 and T80 PV MPPT Battery Charge Management Systems

The T80 and T100 Charge Controllers integrate maximum power point tracking, battery charge management, state-of-charge information and communications into a single device. The T80 can deliver 80 amps continuous output to 12-, 24- or 48-volt battery systems from PV arrays with open circuit voltage up to 140 VDC (150 volts absolute maximum voltage).

The new The T100 provides 100 amps continuous output and allows you to wire modules in series up to 200 Voc max/160 volts nominal.

Wire modules in series to use smaller wire between the array and charge controller. These MPPT charge controllers capture up to 35% more power from the PV array. Their MPPT algorithm starts early and locks onto the peak power during rapidly changing insolation and temperature. Four-stage charging with adjustable set points for all parameters.

The T80 and T100 produce full-rated power without de-rating up to 40 degrees C ambient temperature. Above that, the output current is reduced gradually to protect the life of the T80, and then automatically ramped up as the temperature decreases. High efficiency power circuits and robust thermal design minimize heat generation. The internal temperature-controlled variable speed fan runs just fast enough to maintain optimum reliability. UL Listed. Dimensions are 15.2" x 8.5" x 4.4" and weight is 22 lbs.

Both controllers include a built-in energy monitor using TriMetric technology from Bogart Engineering. The monitor tracks energy production and consumption to calculate the energy remaining in the battery. State of charge (SOC) is displayed in percent full, amp-hours, watt-hours, and bar-graph format. They store 90 days of energy-harvest history and feature a slot for add-in cards providing system performance, data communication, and firmware updates via the Apollo Solar Wireless Remote Monitoring Display, PCs, and the Internet. Controllers do not include shunt. Order a 50mV/500A shunt on page 119 if your system doesn't have one. Both the T80 and T100 support flooded lead acid (FLA), GEL and absorbed glass mat (AGM) batteries.

Two independently programmable SPST relays can be used to control external devices based on battery voltage, charge or discharge current or battery state of charge. Contact rating is ½ amp at up to 50 VDC.

Optional wired and wireless displays are available. The RD wired display can be up to 100 feet from the controller using 4-conductor telephone cable. The RD100 wireless display can be 100 feet away from controller in buildings and 300 feet line-of-sight. Its built-in rechargeable batteries last up to 3 months and can be recharged from 12 or 24 VDC or 115 VAC.

Optional network card allows you to stack up to 16 controllers on one battery bank. Add a network card to each controller and connect with Cat 5 cables. One controller acts as a master and the others as slaves.



Model	Description	Item code	Price
T100	Apollo T100 charge controller	020-07076	\$995
T80	Apollo T80 charge controller	020-07080	\$849
RD-WIRED	Wired remote display	020-07085	\$199
RD100	Wireless remote display	020-07087	\$399
ASNET	Network option card	020-07091	\$99

Xantrex

XW-MPPT60-150 Charge Controller

The XW-MPPT60-150 can be used with PV arrays with a voltage equal to anything from battery voltage to 150 VDC and can support an output of up to 60 amps into the battery for battery voltage of 12 to 60 VDC. The PV open circuit voltage must not exceed 150 VDC.

Maximum power point tracking allows the charge controller to harvest the maximum energy available from the PV array and deliver it to the batteries. The MPPT algorithm continuously adjusts the operating points in an attempt to find the maximum power point of the array. The algorithm can then determine if it is harvesting more or less power than the previous operating points.

The charge controller has a configurable auxiliary output (producing 5 to 13 volts at 200 mA) to drive a relay for load control or to turn on devices such as vent fans or indicator alarms. The auxiliary output can be configured to perform only one function at a time.

Its large aluminum heatsink allows it to operate at full power with only convection cooling, without the need for a fan. Built-in PV ground fault protection allows code-compliant installation without the need for additional ground fault protection. The XW-MPPT60-150 can be mounted on the side or top of the XW power distribution panel, or used by itself in other PV systems. The front panel features a 2-line 16-character display and four buttons for configuration and system monitoring. A battery temperature sensor is included with the controller.

The XW-MPPT60-150 is able to communicate its settings and activity to other Xanbus-enabled devices, such as the XW Series inverter/charger, the system control panel II (SCP), XW automatic generator start (XW-AGS), and other Xantrex XW-MPPT-60-150 solar charge controllers through the Xanbus network.

Array size can be up to 750 watts when charging a 12-volt battery, 1,500 watts when charging at 24 volts and 3,000 watts when charging at 48 volts. See the Xantrex array sizing tool at www.xantrex.com/support. Dimensions are 14 ½"H x 5 ¾"W x 5 ½"D and weight is 12 lbs. 5-year warranty.

Xantrex model	Description	Item code	Price
XW-MPPT60-150	60-amp MPPT charge controller	020-08040	\$650



OutBack

MX60 and FLEXmax80 MPPT Charge Controllers

Rated for up to 60 amps of DC output current, the OutBack MX60 can be used with battery systems from 12 to 60 VDC with PV open-circuit voltage as high as 140 VDC. The MX60 setpoints are fully adjustable to allow use with virtually any battery type, chemistry and charging profile. The OutBack MX60 allows you to use a higher output voltage PV array with a lower voltage battery – such as charging a 12- or 24-VDC battery with a 48-VDC PV array. This reduces wire size and power loss from the PV array to the battery/inverter location and can maximize the performance of your PV system. Array size can be up to 750 watts when charging a 12-volt battery, 1,500 watts when charging at 24 volts and 3,000 watts when charging at 48 volts.

The FLEXmax80 (FM80) is the latest innovation in Maximum Power Point Tracking (MPPT) charge controllers from OutBack Power Systems. Its innovative MPPT algorithm is both continuous and active, increasing your renewable energy yield up to 30%. Thanks to enhanced cooling, the FM80 can operate at its full 80-amp maximum current rating in ambient temperatures as high as 104°F (40°C). Array size can be up to 1,000 watts when charging a 12-volt battery; 2,000 watts when charging at 24 volts; and 4,000 watts when charging at 48 volts.

Both controllers come standard with an easy-to-use-and-understand display of PV system performance. The 4-line, 80-character backlit LCD display is also used for programming and monitoring of the system's operation. They can be connected to the OutBack MATE system controller and display to allow monitoring of



OutBack model	Description	Item code	Price
FX80	OutBack 80 A MPPT charge controller	020-02020	\$749
MX60	OutBack 60A MPPT charge controller	020-02015	\$649
RTS	Remote temperature sensor with 20' cable	030-04190	\$29
MATE	System controller – shipped with a 50' cable	030-04180	\$295
MATE-B	Black version of the MATE above	030-04180-B	\$295
MATE-2	Flush mount version of the MATE	030-04181	\$295

up to eight MX60 controllers from a distant location – up to 300 feet away. The MATE also includes an optoisolated RS232 port for connection to a PC computer for data logging and system monitoring. ETL Listed. Dimensions 14.5"H x 5.75"W x 5.75"D for the MX 60. The FM80 is 16.25"H. All other dimensions are the same. Weight: 12 lbs. 2-year warranty.

Blue Sky Energy

Solar Boost MPPT Charge Controllers

The Blue Sky Solar Boost features reverse-polarity protection, MPP tracking and selectable-charge voltage for flooded and gel lead-acid batteries. An equalize function periodically conditions liquid electrolyte lead-acid batteries. An optional user-friendly digital display is available to monitor PV charge performance. The display shows battery voltage, solar current, charge current and charge mode, either in the controller, as a remote panel installed up to 300 feet away, or both. Optional temperature compensation of charge voltage is also available to further improve charge controller and battery performance. Solar Boost controllers available with or without digital display and optional remote display. 3-year limited warranty.



Solar Boost 50L

This charge controller can be used on 12- and 24-volt systems. It can also be used to charge a 12-volt battery from a 24 volt array. Maximum open-circuit PV array voltage is 57 VDC.

Solar Boost 6024H

The 6024H is designed for charging 12- or 24-volt batteries from 36-, 48- or 60-volt PV arrays (maximum open circuit voltage is 140). This allows for a much smaller wire size between the array and battery in large systems. Maximum charge current is 60 amps at 12 or 24 volts.

Solar Boost 3048

SB3048 is designed to charge 24- and 48-volt battery systems from a 48- to 60-volt array (maximum open-circuit voltage is 140). Maximum charge current is 30 amps output at 24 or 48 VDC.

Model	Description	System voltage	Charge amps	Item code	Price
SB50L	Charge controller	12 or 24	50	020-03140	\$479
SB50DL	Controller w/ digital display	12 or 24	50	020-03137	\$569
SB50PDL	Front cover w/ digital display for SB50L			020-03134	\$125
SB6024HL	Charge controller	12 or 24	60	020-03143	\$549
SB6024HDL	Controller w/ digital display	12 or 24	60	020-03146	\$599
SB6024HPDL	Front cover w/ digital display for SB6024HL			020-03131	\$125
SB3048L	Charge controller	24 or 48	30	020-03128	\$539
SB3048DL	Controller w/ digital display	24 or 48	30	020-03125	\$629
SB3048PDL	Front cover w/ digital display for SB3038L			020-03131	\$125
Model	Description of optional accessories			Item code	Price
SB50RD25	Remote digital display w/ 25' cable			020-03152	\$125
930-0022-20	Battery temperature sensor			020-03149	\$32

Solar Boost 2000E

This 25-amp solar charge controller is for 12-volt systems. It mounts in a 5-11/16" x 3-15/16" cut-out and is wired from the rear. This controls very popular in RV installations. Optional box allows surface mounting.

Model	Description	System voltage	Charge amps	Item code	Price
SB2000E	Charge controller	12	25	020-03122	\$259
	Wall mount box for SB2000			020-03119	\$32



Blue Sky IPN Controllers

Solar Boost 3024i and 2512iX charge controllers include load control outputs. These controllers can also serve as lighting controllers with complete flexibility over post-dusk and pre-dawn ON time settings. An IPN-ProRemote is required to enable and configure dusk-to-dawn lighting control. The IPN-ProRemote does not need to remain with the system and can be used as a setup tool only.

Solar Boost 2512i and 2512iX

The low-cost Solar Boost 2512i provides a fully automatic 3-stage charge controller system. A partial IPN network interface is also included to allow use of the IPN-Remote or IPN-ProRemote displays.

Additional features provided in the Solar Boost 2512iX include automatic or manual equalization, battery temperature sensor input, full IPN network compatibility, and an auxiliary output. The user-configurable auxiliary output can serve as either a 25-amp load controller or a 2-amp auxiliary battery charger. The auxiliary battery charge feature is ideal for charging a separate battery such as the engine battery in an RV.

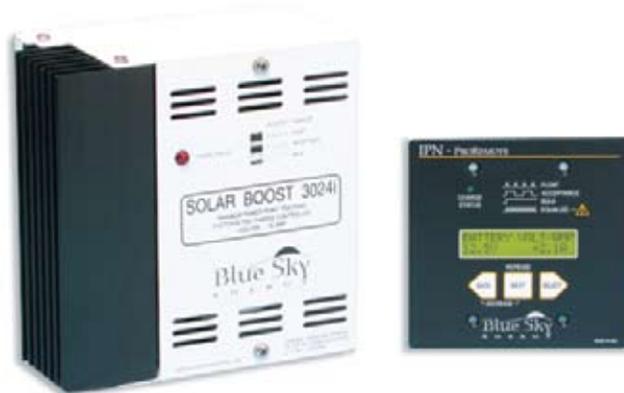


Solar Boost 3024iL

SB3024iL is designed to charge 12- and 24-volt battery systems from a 24-volt array (maximum open circuit voltage is 57). Maximum charge current is 40 amps output at 12 and 30 amps at 24 VDC. The new IPN network interface coordinates multiple controllers and shares temperature sensors and display.

Optional Equipment

A remote temp probe and a remote digital display can be mounted up to 300 feet away and used with all of the Solar Boost controllers. Optional shunts allow it to monitor other charging sources and loads.



IPN Remote

The IPN Remote display provides basic monitoring for IPN compatible charge controllers. The unit displays battery voltage, output current and charge controller system status for up to 8 charge controllers on a single IPN network.

An LED display is used to provide readability in any lighting. The charge status indicator displays present charge controller system status and shows relative battery state-of-charge. When the battery is being charged the display toggles between battery voltage and charge controller output current. The current display can be configured to show the total output current from all controllers on the IPN network, or the output current from a particular controller. Multiple IPN-Remote displays can be placed on a single IPN network even if an IPN-ProRemote is already present.



IPN Pro-Remote

The Pro-Remote combines charge controller monitoring and battery system monitoring into a single user-friendly remote display. With the IPN-ProRemote you no longer have to guess how much battery capacity remains. A high-accuracy calculation of remaining battery capacity compensates for a variety of factors including charge/discharge current, battery size, type, temperature and how the battery was brought back to full charge. Information learned from past battery behavior is used to continuously improve metering accuracy. The IPN-ProRemote also monitors and controls BlueSky's IPN-based charge controllers. It can monitor both the combined total and individual status of up to eight IPN charge controllers on a single IPN network.

Model	Description	System voltage	Charge amps	Item code	Price
SB2512i	Charge controller	12	25	020-03123	\$199
SB2512iX	Charge controller	12	25	020-03124	\$239
SB3024iL	Charge controller	12 or 24	40/30	020-03158	\$359
SB3024DiL	Controller w/ digital display	12 or 24	40/30	020-03159	\$419
SB3024PDi	Front cover w/ digital display for SB3024i			020-03157	\$99
IPNPRO-S	IPN Pro-Remote display w/ 500 amp shunt			020-03161	\$229
IPNPRO	IPN Pro-Remote display			020-03162	\$189
IPNREM	IPN Remote			020-03163	\$89
Model	Description of optional accessories			Item code	Price
930-0022-20	Battery temperature sensor			020-03149	\$30
CS-100	Remote shunt 100A/100mV			028-09245	\$35
CS-500	Remote shunt 500A/50mV			028-09253	\$35

Morningstar SunSaver MPPT Charge Controller

The SunSaver MPPT charge controller is designed for 12V and 24V battery charging from PV modules with a maximum open circuit voltage of 75V. Use up to three 36-cell modules in series. It can be used with 200 watts of PV when charging a 12-volt battery and up to 400 watts when charging a 24-volt battery.



Provides an estimated 5-25% boost of amps from the PV array into the battery. Actual boost depends on PV cell temperature and battery state of charge. Enables the use of high voltage PV modules (designed for on-grid applications) for off-grid 12V or 24V battery charging. Provides a means to use a 24V PV array to charge a 12V battery, reducing power losses in systems with a long cable run between the PV array and the battery. The controller has electronic protection from short circuit, overcurrent, reverse polarity, high temp, high voltage, lightning and transient surges. An adjustable low battery voltage load disconnect protects the battery from over-discharge. LED indicators indicate charging, low battery and faults. Dimensions are 6.6" x 2.75" x 2.2". Weight is 1.65 lbs. 5-year warranty.

Model	Description	System voltage	Charge amps	Item code	Price
SS-15MPPT	SunSaver MPPT charge controller	12 or 24	15	020-01261	\$ 292

SunSaver Duo RV Charge Controller

The SunSaver Duo two battery controller for RVs, caravans, boats and cottages is rated for 25 amps at 12 volts DC. This product will charge two separate and isolated batteries at the same time, such as a house and an engine battery, based on user selectable priorities. The SunSaver Duo employs Morningstar's legendary SunSaver controller technology, whose long-term track record for high reliability and improved battery charging is well-recognized in the solar industry.

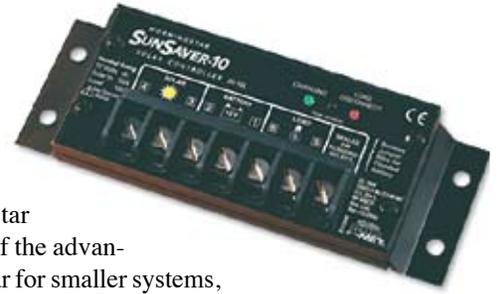


This controller includes a backlit remote meter which may be mounted in or on a wall, and displays digital and pictorial status information about the solar power system. The SunSaver Duo is epoxy encapsulated for environmental protection, is user adjustable via DIP switch or connection to a personal computer and has an optional remote temperature sensor. 5-year warranty.

Model	Description	System voltage	Charge amps	Item code	Price
SK-6	SunSaver Duo	12	25	020-01250	\$188

SunSaver Charge Controllers

The SunSaver is a very reliable charge controller and uses the same battery charging algorithm as the ProStar and offers many of the advantages of the ProStar for smaller systems, at a reduced cost. Constant voltage pulse width modulation (PWM) charging is a proven advance compared to the common on/off PV regulators. SunSavers are field-selectable for sealed or flooded batteries. A rugged anodized aluminum case and epoxy encapsulated electronics ensure durability and longevity. A temperature compensation sensor in the charge controller varies full charge voltage with temperature. They have LED charging and load control indicators in LVD models. 5-year warranty. Dimensions: 6" x 2.2" x 1.3".



Model	Description	System voltage	Charge amps	LVD amps	Item code	Price
SS-6-12V	SunSaver	12	6	No	020-01245	\$50
SS-6L-12V	SunSaver w/ LVD	12	6	6	020-01248	\$61
SS-10-12V	SunSaver	12	10	No	020-01230	\$57
SS-10L-12V	SunSaver w/ LVD	12	10	10	020-01233	\$73
SS-10L-24V	SunSaver w/ LVD	24	10	10	020-01236	\$79
SS-20L-12V	SunSaver w/ LVD	12	20	20	020-01239	\$95
SS-20L-24V	SunSaver w/ LVD	24	20	20	020-01242	\$105

SunLight Charge Controller with Lighting Control

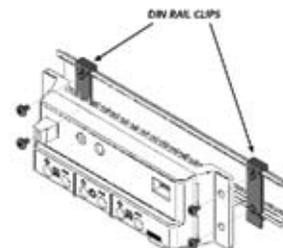
The SunLight has all of the features of the SunSaver controller. It also has a rotary switch that allows it to turn on the loads after dusk for 2, 4, 5, 8, or 10 hours. It also has the option to turn loads on at dusk, off and on again before dawn. In this configuration, you can choose the following settings (in hours): 3/off/1, 4/off/2, or 6/off/2. "On" from dusk to dawn is also possible. A test button turns light on for five minutes. 5-year warranty. Dimensions: 6.6" x 2.2" x 1.3".



Model	Description	System voltage	Charge amps	LVD amps	Item code	Price
SL-10L-12V	SunLight w/ LVD	12	10	10	020-01218	\$108
SL-10L-24V	SunLight w/ LVD	24	10	10	020-01221	\$116
SL-20L-12V	SunLight w/ LVD	12	20	20	020-01224	\$141

SunSaver DIN Rail Clips

Morningstar's Polypropylene 35mm DIN rail clips provide a simple way to install the SunSaver family of charge controllers to DIN rails in industrial enclosures. These rugged plastic clips have been custom made to match the mounting holes on the SunSaver controllers and to either snap on to the middle of the rail or to slide on from the end of the rail. The DIN rail clips are compatible with the SunSaver, SunLight, SunSaver Duo, SunSaver MPPT, and SunLight MPPT.



Model	Description	Item code	Price
DIN 1	DIN rail clip - each	020-01259	\$1

TriStar Charge Controllers



The TriStar pulse width modulated (PWM) controller can operate as a solar charge controller, a load controller, or a diversion regulator in 12-, 24- or 48-volt systems. It can operate in only one of these modes at a time, but two or more controllers can be used to provide multiple functions. PWM operation may be changed to on/off operation to prevent telecom noise. Two models are available with UL current ratings of 45 and 60 amps. A choice of 7 different setpoints are easily selectable with DIP switches. An RS-232 communications enables PC connection to adjust control setpoints and data logging. An optional digital display may be mounted on the front of the controller or up to 100 feet away using 4-conductor phone cable with RJ-11 jacks. Battery temperature compensation may be added with the optional temperature sensor. Knock-outs on the bottom of the charge controller match knock-out spacing on the Xantrex DC-175/250 disconnect and the OutBack FLEXware power system components, allowing easy mounting on either. Dimensions: 10.25" H x 5" W x 2.8" D; weight is 3.5 lbs. 5-year warranty. UL Listed.

Model	Description	System voltage	Charge amps	Item code	Price
TS-45	TriStar 45 charge controller	12, 24 or 48	45	020-01105	\$175
TS-60	TriStar 60 charge controller	12, 24 or 48	60	020-01108	\$226
RTS	Battery temperature sensor			020-01141	\$32
TS-M	Digital display mounts on front of charge controller			020-01113	\$99
RM	Remote display with 100 ft. cable			020-01115	\$136

ProStar Charge Controllers



Recently revised, this sophisticated line of PV charge controllers incorporates constant voltage PWM to make maximum use of valuable PV power. They have automatic equalization, temperature compensation and very high efficiency. They can be used on 12-, 24- and 48-volt systems with sealed, gel and wet-cell lead-acid batteries. Front panel LEDs indicate when the batteries are being charged and relative battery state of charge. Reverse polarity protection on input and output. In the event of a load short circuit, the load is automatically disconnected. "M" models include LCD meter of battery voltage, PV charging current, and load current. Low voltage LVD is current-compensated to prevent false disconnect when the battery is heavily loaded. Units are conformal coated to guard against corrosion.

Dimensions: 6.01" x 4.14" x 2.2". 5-year warranty.

Model	Description	System voltage	Charge amps	Item code	Price
PS-15	ProStar 15	12 or 24	15	020-01120	\$112
PS-15M	ProStar 15 w/ digital display	12 or 24	15	020-01123	\$179
PS-15M-48V	ProStar 15 48V w/ display	48	15	020-01126	\$222
PS-15M-48-PG	48V w/ display & positive ground	48	15	020-01129	\$239
PS-30	ProStar 30	12 or 24	30	020-01132	\$152
PS-30M	ProStar 30 w/ digital display	12 or 24	30	020-01135	\$219
PS-30M-PG	30 w/ digital display & positive ground	12 or 24	30	020-01138	\$236
RTS	Battery temperature sensor			020-01141	\$32

SunGuard Charge Controller



The SunGuard uses the same charging circuit as the SunSaver. It is ideal where a 12-volt low-power controller is needed. It can control up to 75 watts of PV module(s). Since it is epoxy encapsulated, it can be used outdoors in a harsh environment. Dimensions are 2.5" x 2" x 1.6" with wire leads for connecting module and battery. 5-year warranty.

Model	Description	System voltage	Charge amps	LVD amps	Item code	Price
SG-4	SunGuard	12	4.5	No	020-01215	\$30

SunKeeper Charge Controller



The SunKeeper is available in 6-amp or 12-amp versions at 12 volts DC. To withstand the high temperatures at the solar module, the controller has been designed using extremely efficient power electronics and is rated to 70C. The SunKeeper is also certified for use in Class 1, Division 2 hazardous locations, making it an ideal controller for solar powered oil/gas applications. Mounts in 1/2" knockout. 5-year warranty.

Model	Description	System voltage	Charge amps	Item code	Price
SK-6	SunKeeper6	12	6	020-01252	\$63
SK-12	SunKeeper12	12	12	020-01253	\$89

NEW from MORNINGSTAR...



15 Amps at
12/24 Volts DC

- Maximum PV input of 400W
- Enables use of high voltage modules up to 75Voc
- Converts up to 36 volt PV to 24V or 12V battery
- Provides power boost and maximizes PV output
- Smaller and less expensive than other MPPT controllers

SUNSAVER MPPT™

Solar Controller with Maximum Power Point Tracking



- Ideal for RVs, boats and cottages
- Independently charges both the "house" and engine battery
- Charging priority is user selectable
- Remote meter displays digital and pictorial system information

SUNSAVER DUO™

Two Battery Solar Controller with Remote Meter

Our 15th Anniversary

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Phone: +1-215-321-4457 Fax: +1-215-321-4458
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Specialty Concepts Inc.

ASC Charge Controllers



The ASC is a compact, encapsulated, battery charge regulator for use in small photovoltaic systems. It is available in 12-volt and 24-volt units up to 16 amps. The ASC is a switching shunt regulator, housed in an anodized aluminum chassis and encapsulated in a hard epoxy resin. The terminal block accepts up to 12-gauge wire or a spade connector, providing simple installation.

We stock a variety of 12- and 24-volt controllers. See the table below. Some have temperature compensation, low-battery voltage disconnect and adjustable set points or a combination of some of these. All ASC controllers are FM approved, Class 1, Division 2 explosion-proof devices so they are an excellent choice for oil, gas and industrial installations.

Shipping weight 1 pound. Five-year warranty.

SCI RV Charge Controllers



These charge controllers are designed by Specialty Concepts Inc. for the RV market. They are designed to flush-mount in a rectangular cut-out. They have a digital amp- and volt-meter for accurate information and an LED bar graph display for at-a-glance battery status. Charging is set to stop at 14.4 volts and resume at 13.0, but the full charge level can be adjusted by turning a small screw on the back of the circuit board. Terminal strip on back of unit accepts up to 10 AWG stranded wire. The Mark 15 and 22 controllers have array and battery fuses on the back of the panel and a switch to set the display to volts, amps, or off. The optional black anodized aluminum box can be used to surface-mount this controller on a wall. Knock-outs are provided for wiring. Dimensions: 7.5" W x 4.25" H x 1.5" D. 5-year warranty.

Model	System voltage	Charge amps	Item code	Price
Mark 15/12	12	15	020-04215	\$119
Mark 22/12	12	22	020-04217	\$129
Surface mount box			020-04211	\$25

Model	Optional features	Battery voltage	PV amps	Load amps	Dimensions L x W x D	Weight (lbs)	Item code	Price
ASC-12/4	Charge controller only	12	4		6" x 3.5" x 3"	1	020-04327	\$47
ASC-12/8	Charge controller only	12	8		6" x 3.5" x 3"	1	020-04331	\$54
ASC-12/8 A	Temp compensation	12	8		6" x 3.5" x 3"	1	020-04332	\$64
ASC-12/8 AF	Temp compensation, adjustable set point	12	8		6" x 3.5" x 3"	1	020-04355	\$59
ASC-12/12	Charge controller only	12	12		6" x 3.5" x 3"	1	020-04341	\$62
ASC-12/12 A	Temp compensation	12	12		6" x 3.5" x 3"	1	020-04343	\$64
ASC-12/12 AF	Temp compensation, adjustable set point	12	12		6" x 3.5" x 3"	1	020-04346	\$67
ASC-12/16	Charge controller only	12	16		6" x 3.5" x 3"	1	020-04352	\$66
ASC-12/16 AF	Temp compensation, adjustable set point	12	16		6" x 3.5" x 3"	1	020-04356	\$78
ASC-12/16 AEF	Temp compensation, low-bat disc, adjustable	12	16	10	6" x 3.5" x 3"	1	020-04357	\$94
ASC-24/8 AF	Temp compensation, adjustable set point	24	8		6" x 3.5" x 3"	1	020-04437	\$61
ASC-24/16 AF	Temp compensation, adjustable set point	24	16		6" x 5" x 3"	1	020-04457	\$78
ASC-24/16 AEF	Temp compensation, low-bat disc, adjustable	24	16	10	6" x 5" x 3"	1	020-04458	\$94

Xantrex

C-35, C-40 and C-60 PWM Controllers



The Xantrex C-35, C-40, and C-60 PWM (pulse width modulator) controllers can be used as PV charge controllers, DC load controllers or DC diversion regulators in 12-, 24- and 48-volt systems (except only the C40 can be used in 48-volt systems). They operate in only one mode at a time, so to provide both PV charge controller and low battery load disconnect, two controllers must be used. As DC load controllers they disconnect the load at a user-settable low voltage and reconnect at a higher voltage reconnect point. As diversion controllers they send excess power to a “dummy load”

(such as a water or space heater) to regulate hydroelectric or wind generators. When used in diversion mode, derate the amperage by 25%. All Xantrex controllers, when used as a charge controller, have field-adjustable bulk and float setpoints and perform automatic equalization every 30 days or whenever LVD is reached. Equalization can be manually initiated with automatic shut-off. Order the optional temperature sensor for a more accurate battery charge controller. The optional LCD digital display shows battery voltage, array amps and watts, cumulative amp-hours and a separately resettable “trip” amp-hour measurement. The digital display is available for mounting on the front of the charge controller, or with a 50- or 100-foot cable for remote mounting in a double-gang electrical box. UL Listed. 2-year warranty.

Model	Description	System voltage	Max PV amps	Item code	Price
C-35	Charge controller	12 or 24	35	020-08004	\$119
C-40	Charge controller	12, 24 or 48	40	020-08005	\$159
C-60	Charge controller	12 or 24	60	020-08009	\$199
BTS/15	Battery temperature sensor with 15 foot cable			020-08025	\$29
BTS/35	Battery temperature sensor with 35 foot cable			020-08029	\$32
CM	Digital display mounts on front of charge controller			020-08016	\$99
CM/R50	Remote display with 50 foot cable			020-08019	\$126
CM/R100	Remote display with 100 foot cable			020-08017	\$146

Xantrex C-12 Charge & Lighting Controller

The Trace C-12 controller is PWM microprocessor-based and ideal for small village power systems, vacation homes, outdoor area lighting, sign lighting, and bus shelters. It has a 12-amp low-voltage disconnect and an automatic lighting control. The lighting control turns the light on at dusk, then has an adjustable duration timer for 2 to 8 hours of run time, or can be set to run all night. If the battery gets low, lights are turned off. User-adjustable LVD set points. For use in 12-volt systems only. Can be mounted outdoors. Dimensions: 6.5" x 4.3" x 1.5". UL Listed. 2-year warranty.

Model	Description	System voltage	Max PV load amps	Item code	Price
C-12	Charge controller / lighting controller	12	12 / 12	020-08002	\$110



Phocos

NEW! CXN Charge Controllers

Phocos CXN 12/24V solar charge controllers have exceptional features at a very good price. They feature pulse width modulator (PWM) regulation with integrated temperature compensation, low-battery load disconnect and a comprehensive display. Battery state of charge, charge and discharge current, and faults are clearly displayed on an LCD in a bar graph.



These only consume 4 mA at night. The deep discharge protection function can be set up to three different modes: voltage controlled, SOC controlled or adaptive (fuzzy logic).

CXN controllers have a built-in data logger. Data can be accessed by a PC by using the CXN-USB interface converter. Data includes maximum and minimum battery voltage, state of charge at beginning and end of day, amp-hours produced by PV array and more. Daily data is available for the past 7 days.

Other features include audible warnings and a programmable nightlight function.

Phocos new CXN charge controllers can be used in systems where the array, battery and load negatives are grounded. Dimensions are 3.5" x 3.5" x 1.5". Not UL Listed. 3-year warranty.

Model	System voltage	Max PV amps	Max load amps	Item code	Price
CXN10	12 or 24	10	10	020-05016	\$66
CXN20	12 or 24	20	20	020-05017	\$86
CXN40	12 or 24	40	40	020-05018	\$125
CX - USB interface for data logger				020-05011	\$58

NEW! PL60 Charge Controllers

This PWM charge controller works well as a diversion controller for wind and hydroelectric systems and a solar charge controller at the same time. It can be used on 12, 24, 32, 36 and 48 volt systems. Maximum diversion load is 30 amps.

It can be programmed with the button on the front panel and the LCD display and it has built-in data monitoring.



Model	System voltage	Max PV amps	Max load amps	Item code	Price
PL60	12, 24, 32, 36, 48	60	30	020-05007	\$650

NEW! CML Charge Controllers

These low-cost Phocos charge controllers can be used for 12- or 24-volt systems with sealed or flooded batteries. They offer low-voltage load disconnect and have 5 LEDs to display battery and load status.



Model	System voltage	Max PV amps	Max load amps	Item code	Price
CML15	12 or 24	15	15	020-05135	\$55
CML20	12 or 24	20	20	020-05137	\$63

Atkinson Lighting Controllers

This fully waterproof PV charge and lighting controller for area lighting, roadside signs, and warning signs can be used with 12- or



24-volt systems. 15-amp and 40-amp versions are available. Controllers have low-voltage load disconnect and temperature compensation and can be used with sealed or flooded batteries. Pulse action reduces sulfation.

Model	System voltage	PV amps	Load amps	Dimensions L" x W" x D"	Item code	Price
PVLC-15	12 or 24	10	10	2 X 3 X 1.25	020-05425	\$95
PVLC-40	12 or 24	20	20	3.3 X 5.5 X 1.7	020-05427	\$140

Lighting Controllers with Motion Sensor

This fully waterproof PV charge and lighting controller for area lighting, roadside signs, and warning signs can be used with 12- or 24-volt systems. 15-amp and 40-amp versions are available. Controllers have a motion sensor to activate the light or load when motion is sensed. They have temperature compensation and can be used with sealed or flooded batteries. Pulse action reduces sulfation.



Model	System voltage	PV amps	Load amps	Dimensions L" x W" x D"	Item code	Price
PVLC-15MD	12 or 24	10	10	2 X 3 X 1.25	020-05432	\$130
PVLC 40MD	12 or 24	20	20	3.3 X 5.5 X 1.7	020-05435	\$160

Atkinson GSCM



The GSCM (Generator Start Controller Module) is a micro-processor-based generator-starting controller that receives start commands from the 12-volt output from an OutBack FX inverter auxiliary relay, a user-supplied switch, an auxiliary relay in an inverter, a voltage controlled relay, a timer or any user-supplied contact closure. It automatically controls a gas/propane or diesel powered generator or pump, and is totally sealed for harsh environment operation.

The GSCM provides contact signal relays to start the engine and disconnect the starter when a minimum generator frequency output is measured. It monitors the generator operation, shutting it down if one of several fault conditions is detected. LEDs are flashed to indicate the cause of the shutdown. Manually resetting the GSCM removes the lockout and allows the generator to restart if called. The GSCM is powered by 12 to 24VDC from a battery bank and will start generators for 12 to 48V systems. For 48V systems the GSCM must be powered by a 24V-or-less tap on the 48V battery bank. The GSCM provides a 30-day exercise function which can be synchronized with a photovoltaic input to only start each 30-day period at the beginning of the solar charge day. 2-year limited warranty. Dimensions are 5.5" x 3.3" x 1.5".

Model	Description	Item code	Price
GSCM	Generator start controller module	020-06341	\$322

GSCM-mini



This generator start controller is optimized for use with OutBack inverters. It supports three types of 3-wire gas-generator control: momentary, maintained or ignition. It has a fixed crank time and over and under frequency shutdown.

Model	Description	Item code	Price
GSCM-mini	Generator start controller module	020-06343	\$165

Magnum AGS - RV Auto Generator Start



The Magnum AGS is compatible with most major generators, including Onan, Powertech, Generac, and Weterbeke. Please check with us for specific model compatibility. The Magnum Auto Generator Start (AGS) is designed to automatically start your coach generator based on low battery condition or the inside temperature of the coach.

You can set the battery start voltage from 10-12 VDC or 20-22 VDC, the start temperature from 65°-85°F, the run time from one to five hours, and the quiet time with an easy-to-set clock. Auto Gen Start settings do not interfere with the manual start / stop operation of the generator. Just use any existing start / stop switch in your coach.

Two models are available. The standalone version of the AGS works well for installation and operation without an inverter. The network version of the AGS allows operation of the AGS via the ME Series remote panel.

Model	Description	Item code	Price
AGS-S	Automatic generator start standalone	020-06375	\$299
AGS	Automatic generator start – Magnum network version – use with Magnum inverters only	020-06377	\$299

Morningstar

Relay Driver

The Relay Driver is a logic module which provides control functions such as high/low voltage alarms, load control and generator start for 12-, 24- or 48-volt battery systems. It controls four independent relay driver outputs by reading digital data inputs from Morningstar's TriStar controller or by reading battery voltage. Outputs can be used to operate any of the relays in the next column or any other mechanical or solid state relay with a coil voltage that is the same as the battery voltage used to power the relay driver. Maximum current for each output channel is 750 mA.

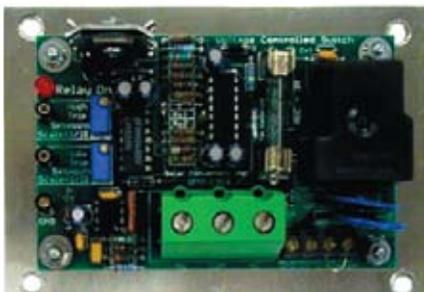


The Relay Driver may be mounted to a DIN rail and is fully programmable with the included PC software via serial RS-232 port connection. Dimensions are 6.4" x 3.2" x 1.3" and weight is 0.4 lb. Terminals can accept 16- to 24-AWG wire. Self consumption is less than 20 mA and the unit will operate from 8 to 68 volts DC. 3-year warranty

Description	Item code	Price
Morningstar Relay Driver RD-1	020-01255	\$169

Voltage-Controlled Switches

These are user-adjustable voltage-activated relays with SPDT (single pole, double throw) contacts rated for 30 amps. The relay coil in the "Active-High" version is powered when the voltage rises to the high setpoint. The relay in the "Active-Low" is powered when voltage drops to the low setpoint. The SPDT relay allows the voltage controlled switch to either connect or disconnect a circuit when it operates or to turn one thing on while turning another thing off.



Voltage settings are user-adjustable and can be read with a voltmeter. An active high relay can be used as a DC pump controller, a diversion load controller, or to operate a large relay for a high-powered charge controller. An active low can be used as a 2-wire generator start controller or as a low battery voltage load disconnect. These devices consume 17mA when off. Maximum switched current is 30A at 12/24 VDC, 3A at 48 VDC. VCS-1 measures approx. 3" x 5.3" x 1.75".

VCS-2 comes in a 5" x 7" x 2" enclosure. 1-year warranty.

Model	Mode of operation	Enclosure	Item code	Price
VCS-1AH	Active High	No	020-06218	\$112
VCS-2AH	Active High	Yes	020-06215	\$180
VCS-1AL	Active Low	No	020-06221	\$112
VCS-2AL	Active Low	Yes	020-06224	\$180

SPDT 12V 40A Relay

These single pole, double throw 40-amp enclosed relays are widely used in the automotive industry. Wires may be attached with 1/4" quick-connect terminals or the relay socket below may be used. Nominal operating current is 140mA. Relay socket has 2 feet of wire.



SPST N.O. 12V 75A Relay

This enclosed single-pole, single-throw relay has one set of contacts that close when power is applied to the coil terminals. It can be used to turn on 12-volt loads of up to 75 amps. Power terminals are 10-32 screws and coil terminals are 1/4" quick disconnects. 300mA is nominal operating current.



DPDT 30A Relays

These double-pole, double-throw relays can be used for up to 30 amps at 12 or 24 volts DC or 120/240 volts AC. All contact surfaces are silver alloy with gold flashing. Contact terminals are #8-32 screws and coil terminals are #6-32 screws. Relays with 120 VAC or 240 VAC coils can be used to build simple transfer switches. Relays with DC coils can be used for remote operation of pumps and fans. By connecting a relay with a DC coil to a voltage controlled switch, AC or DC loads may be turned on or off based on battery voltage levels.



Battery Isolator Relay

This relay is designed to isolate a second battery in a vehicle. The contact terminals are connected between the positive terminal of the starting battery and the positive terminal of the second battery. The negative terminals of both batteries are connected to the vehicle chassis. One of the coil terminals is connected to chassis ground and the other coil terminal is connected to the ignition switch or fuse box. When the vehicle is running, both batteries are connected together in parallel and being charged by the alternator. When the ignition switch is off, the contacts are open, disconnecting the second battery from the vehicle electrical system. 80-amp maximum continuous current. 12-volt coil.



Description	Coil current	Item code	Price
40 A SPDT 12V relay	140 mA	053-08290	\$8
Relay socket for 40 A relay		053-08291	\$4
75 A SPST relay	300 mA	053-08293	\$30
DPDT 30A relay – 12VDC coil	170 mA	053-08281	\$48
DPDT 30A relay – 24VDC coil	53 mA	053-08287	\$48
DPDT 30A relay – 120VAC coil	83 mA	053-08278	\$48
DPDT 30A relay – 240VAC coil	42 mA	053-08284	\$4
Dual battery isolator relay		053-08272	\$28

Diversion Load Information

In most hydroelectric and wind-powered battery charging systems, the charging source cannot be disconnected from the batteries while running without the possibility of damaging them from over-voltage.

The typical way to regulate battery charging voltage with this type of generating system is to use a "load diversion" type charge controller. The Morningstar TS45 and TS60 and the Xantrex C-35, C-40 and C-60 can be configured for this mode of charge controller. A diversion-type charge controller also may be used in a PV system. If the array is much larger than necessary to charge the battery, excess power can be used to heat water by using a water heating diversion load.

In operation, when battery voltage reaches the full charge setting in the charge controller, it begins to divert power to the diversion load. The controller uses pulse width modulation to turn

the load on just enough to keep the battery voltage from rising further. To determine wattage of these diversion loads at other voltages, use Ohm's Law: voltage = amps x ohms.

The critical requirements are that the diversion load can dissipate more watts than the charging source can deliver, and that the maximum amperage that the load can draw is smaller than the maximum diversion rating of the charge controller. Order one or more loads with a total current (amps) draw greater than your charging system's maximum output, but no more than the maximum power rating of the charge controller in the diversion mode. We recommend that you do not use a load that draws more than 75 percent of the maximum rating of the charge controller. For example, if the charging source can deliver 20 amps at 24 volts, use a 30-amp diversion load with a 40-amp or larger charge controller.

Low-Voltage Water Heating Element

These low-voltage water-heating elements are for use as diversion loads for wind or hydroelectric systems. Use one or more of these heating elements with a charge controller designed for load diversion, such as the Xantrex C40 or C60, Morningstar TS-45 or TS-60 or the OutBack MX-60 to turn your excess power into hot water. They fit most standard electric water heaters with screw-in elements.

We have one model for 12-volt and 24-volt systems and another for higher power 24-volt systems and 48-volt systems. Each unit has two elements that can be wired in series or parallel or used individually, depending on voltage and desired amp draw. See the table to determine what each element will draw at various charging voltages.

If your water heater tank is designed for square flange elements, use one square flange adapter for each element. 1" male pipe threads. 2-year warranty.



Regulation voltage:		14.00			28.00		56.00		Item code	Price
Model	Wiring	ohms	amps	watts	amps	watts	amps	watts		
12v / 24v	Series	0.96	14.6	204	29.2	817			021-09275	\$120
	Single	0.48	29.2	408						
	Parallel	0.24	58.3	817						
24v / 48v (12v also)	Series	2.48	5.6	79	11.3	316	22.6	1265	021-09279	\$120
	Single	1.24	11.3	158	22.6	632				
	Parallel	0.62	22.6	316	45.2	1265				
Square flange element adapter									021-09285	\$25

Air Heating Diversion Loads



These resistive loads enclosed in vented aluminum boxes can be used in 12-, 24 and 48-volt diversion regulation systems. The aluminum box may get very hot in operation. It should be mounted on a nonflammable surface and should be at least 12" from any flammable material.

HL-100 is shipped as a 4-ohm resistor and can be reconfigured as a 1-, 0.5- or 0.25-ohm resistor by easily changing connections in the terminal block.

HL-75 is shipped as a 3-ohm resistor and can be reconfigured as a 0.75-ohm resistor by changing connections in the terminal block. See table below for diverted amps at various voltages. 2-year warranty.

Model	Resistance setting	Diversion load amps at voltage below						Item code	Price
		14V	15V	28V	30V	56V	60V		
HL-100	0.25	56	60					021-09330	\$235
	0.50	28	30						
	1 ohm	14	15	28	30				
	4 ohms	3.5	3.8	7	7.5	14	15		
HL-75	0.75 ohms	19	20	38	40			021-09335	\$235
	3 ohms	4.7	5	9.3	10	19	20		