

Things *That* Work

Tested by Home Power



RV Power Products' Solar Boost™ 50 MPPT PV Charge Controller

Tested by Richard Perez & Joe Schwartz

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How would you like to get 10 to 30 percent more energy out of your PV modules? This maximum power point tracking (MPPT) charge controller will do just that!

What Is Maximum Power Point Tracking?

A maximum power point tracker is similar to the transmission in an automobile. They both couple a power source to a load more effectively and efficiently. What a car's transmission does mechanically, MPPT does electrically.

All PV modules have what is known as a maximum power point. The maximum power point is where module voltage times output current equals maximum power. A PV's maximum power point is constantly changing with module temperature and solar insolation. The MPPT controller tracks that power point as it changes.

In most PVs, the maximum power point at 25°C (77°F) is at 16.5 VDC or higher, while a typical battery bank is in the 12 to 15 V range. This overhead voltage or "voltage overkill" is built into PV modules by their manufacturers to compensate for voltage loss when the modules are hot. Heating a module can cause voltage depression of over 2.5 VDC just from a 25 to 50°C (77–122°F) temperature change. Batteries also change in voltage. A fully depleted 12 volt battery will have a voltage of about 12.5 VDC while under charge. A fully recharged battery will be about 15 VDC while under charge. (These figures assume a C/20 to C/10 rate of charge. Battery temperature and age are also factors).

Both voltages are well below a PV's maximum power point.

The net effect is that PV modules spend most of their lifetime not operating at their maximum power point. There is more power to be had from the module, but we can't get at it because battery voltage, and thereby system voltage, is different from the voltage at which the PV module gives its maximum power.

The MPPT solves this problem by allowing the PV module, or PV array, to operate at its maximum power point regardless of battery voltage or module temperature. This little bit of electronic wizardry can enable a PV array to produce between 10 and 30 percent more power than it does without the MPPT. Day after day, this adds up to more energy for the system.

Documentation & Shipping

Lately we've received a heap of poorly packaged products damaged in shipping. We're happy to report that the Solar Boost 50 (SB50) was well packaged and arrived in fine shape. The manual is detailed, complete, and relatively easy to follow. It is eighteen pages long and contains wiring diagrams, tables, and more than enough illustrations.

Solar Boost 50 Features & Programming

The Solar Boost 50 model we tested, which includes a digital display, retails at US\$469 and has a 36 month warranty. A model without a digital display is also available, and retails at US\$389. The controller is field selectable for either 12 or 24 VDC operation. A 48 VDC model is in the works, but not yet available. The SB50 has a rated output of 50 amps at either 12 or 24 VDC.



An optional remote LCD display is available for US\$109. This display is the SB50's best advertisement. It shows battery voltage, PV current into the controller, and current out of the controller. We often switch between the two current settings and walk away thinking, "man, it's like having another two modules!" Battery temperature sensors are also available for US\$28.

While the Solar Boost 50's maximum power point tracking capabilities are awesome, it's also a well designed three-stage, pulse width modulated (PWM) charge controller. The Solar Boost 50 uses MOSFET transistors for efficient PWM regulation. Bulk, acceptance, and float mode set points are potentiometer based, and are fully adjustable for regulation up to 32 VDC.

For systems that are cycled on a daily basis, the float mode can be disabled, making overcharge amp-hours available to the battery. A manually initiated equalization mode is also provided. The controller is reverse-polarity

protected and features an automatic current limit of 50 amps. This eliminates the nuisance tripping of breakers due to current spikes caused by edge-of-cloud effect on PV arrays.

The overall dimensions of the Solar Boost 50 are 10 by 9 by 3.5 inches (25 x 23 x 9 cm). A heat sink runs the entire height of the controller. Even at maximum output, you can comfortably keep your hand on the controller's heat sink. This is a simple indicator that the controller is running efficiently and is well designed thermally.

Installing the Solar Boost 50

Home Power's Solar Boost 50 regulates the output of sixteen BP-590 PV modules mounted on a Wattsun dual-axis tracker. BP-590s have a high peak voltage of 18.5 VDC, and are an excellent module for power point tracking. The array's 40 amp output consistently pushed the SB50's output up to its rated 50 amps.

Transmission line loss should be kept to a minimum because the SB50 uses overhead voltage to increase power into the batteries. The output of our BP array is

Solar Boost 50 Data Sheet

| Outside Temp | Solar Insolation | PV Voltage | Battery Voltage | Input Current | Output Current | Amps Boost | Watts Boost | % Amps Boost | Watts In | Watts Out | Eff % |
|--------------|------------------|------------|-----------------|---------------|----------------|------------|-------------|--------------|----------|-----------|-------|
| 46.8 | 0.27 | 34.40 | 25.65 | 12.2 | 15.8 | 3.6 | 92.3 | 29.5% | 419.7 | 405.3 | 96.6% |
| 55.7 | 0.24 | 33.25 | 25.30 | 8.4 | 10.8 | 2.4 | 60.7 | 28.6% | 279.3 | 273.2 | 97.8% |
| 52.6 | 0.22 | 34.10 | 25.75 | 8.0 | 9.9 | 1.9 | 48.9 | 23.8% | 272.8 | 254.9 | 93.4% |
| 61.3 | 1.05 | 32.60 | 25.45 | 39.6 | 49.0 | 9.4 | 239.2 | 23.7% | 1291.0 | 1247.1 | 96.6% |
| 52.8 | 0.48 | 34.10 | 26.95 | 17.9 | 21.9 | 4.0 | 107.8 | 22.3% | 610.4 | 590.2 | 96.7% |
| 61.7 | 1.01 | 32.55 | 25.40 | 40.0 | 48.0 | 8.0 | 203.2 | 20.0% | 1302.0 | 1219.2 | 93.6% |
| 42.5 | 0.75 | 33.35 | 27.65 | 28.4 | 33.6 | 5.2 | 143.8 | 18.3% | 947.1 | 929.0 | 98.1% |
| 54.6 | 0.96 | 31.10 | 25.60 | 36.2 | 42.7 | 6.5 | 166.4 | 18.0% | 1125.8 | 1093.1 | 97.1% |
| 47.3 | 1.17 | 35.95 | 29.60 | 31.0 | 36.2 | 5.2 | 153.9 | 16.8% | 1114.5 | 1071.5 | 96.1% |
| 52.3 | 0.80 | 32.45 | 27.75 | 13.6 | 15.8 | 2.2 | 61.1 | 16.2% | 441.3 | 438.5 | 99.3% |
| 46.3 | 0.03 | 32.95 | 28.15 | 23.1 | 26.8 | 3.7 | 104.2 | 16.0% | 761.1 | 754.4 | 99.1% |
| 42.7 | 0.82 | 32.10 | 27.05 | 29.7 | 34.3 | 4.6 | 124.4 | 15.5% | 953.4 | 927.8 | 97.3% |
| 43.2 | 0.88 | 32.05 | 27.50 | 33.7 | 38.2 | 4.5 | 123.8 | 13.4% | 1080.1 | 1050.5 | 97.3% |
| 46.9 | 1.08 | 32.15 | 27.70 | 40.4 | 45.6 | 5.2 | 144.0 | 12.9% | 1298.9 | 1263.1 | 97.2% |
| 39.9 | 0.89 | 31.95 | 27.60 | 33.5 | 37.8 | 4.3 | 118.7 | 12.8% | 1070.3 | 1043.3 | 97.5% |
| 48.7 | 0.86 | 32.05 | 29.00 | 31.4 | 34.2 | 2.8 | 81.2 | 8.9% | 1006.4 | 991.8 | 98.6% |
| 47.2 | 1.10 | 30.75 | 27.40 | 41.7 | 45.4 | 3.7 | 101.4 | 8.9% | 1282.3 | 1244.0 | 97.0% |
| 55.0 | 1.11 | 30.80 | 27.90 | 42.3 | 45.8 | 3.5 | 97.7 | 8.3% | 1302.8 | 1277.8 | 98.1% |
| 51.9 | 0.97 | 30.95 | 28.15 | 36.8 | 39.8 | 3.0 | 84.5 | 8.2% | 1139.0 | 1120.4 | 98.4% |
| 58.9 | 1.04 | 30.10 | 27.15 | 39.5 | 42.7 | 3.2 | 86.9 | 8.1% | 1189.0 | 1159.3 | 97.5% |
| 54.0 | 1.02 | 30.20 | 27.60 | 38.5 | 41.2 | 2.7 | 74.5 | 7.0% | 1162.7 | 1137.1 | 97.8% |
| 50.7 | 0.71 | 32.55 | 29.55 | 26.2 | 28.0 | 1.8 | 53.2 | 6.9% | 852.8 | 827.4 | 97.0% |
| Average | | | | | | 4.2 | 112.3 | 15.6% | 950.1 | 923.6 | 97.2% |
| Minimum | | | | | | 1.8 | 48.9 | 6.9% | 272.8 | 254.9 | 93.4% |
| Maximum | | | | | | 9.4 | 239.2 | 29.5% | 1302.8 | 1277.8 | 99.3% |

run through 90 feet (27 m) of #4/0 (107 mm²) aluminum URD cable to the power room. The negative leg is routed through a 100 mV/100 A shunt for metering, and then to the Solar Boost 50. The positive input leg runs through a 60 amp Square D breaker and is terminated at the SB50. Output from the controller goes to the positive and negative buses in the Ananda power center.

The SB50 uses an internal shunt to measure the rate of controller output charge current. When regulated current falls below approximately 1.0 amps per 100 amp-hours of battery capacity, the controller goes into float mode. Most residential battery banks experience highly variable loads during charging, depending on what appliances are being operated. The SB50 is equipped with external battery shunt sense terminals. These terminals can be wired directly to the main battery shunt. In this configuration the controller “sees” the loads and uses net battery current, rather than controller output current, as a reference point for more precise regulation.

The Solar Boost 50 is well built and a pleasure to work with. It has a full enclosure that is conduit ready, with 1/2 inch and 1 inch knockouts. The input and output terminals and circuit board are solidly mounted. And the enclosure leaves plenty of room for wire wrestling during installation.

Solar Boost 50 Performance

We have been testing the Solar Boost 50 since September of 1999. During this time, we've seen current and power boosts in the range of 5 to 29.5 percent. We measured outside ambient temperature, solar insolation (with a Li-Cor SB200 pyranometer), PV array voltage, battery voltage, input current to the Solar Boost 50, and output current from the Solar Boost 50. The high operating voltage of the BP-590 modules provide optimal conditions for the SB50 MPPT. Typical boost may be slightly lower. The table shows the measured and derived data.

The Solar Boost 50 works best when the battery voltage is low and/or the PV modules are cold. Both of these conditions are more prevalent during the winter, when we need the solar energy the most. At high battery voltage, 29.60 VDC, we measured 16.8 percent current boost. At low battery voltage, 25.45 VDC, we measured 23.7 percent boost. Power boost during the entire test varied from a low of 48.9 watts to a high of 239.2 watts. Average power boost was 112.3 watts during the entire test.

Solar insolation is the instantaneous amount of solar power striking a surface. The reference standard is 1 KW/m², which is also called 1 sun. We took data on the

Solar Boost in a variety of sunlight conditions, including times with much less than full sun (1 KW/m²). At 0.22 KW/m², the Solar Boost increased array current by 23.8 percent, from 8.0 amperes to 9.9 amperes. Similar boosts of 22 to 29.5 percent were seen during solar isolations of 0.24 KW/m² to 0.48 KW/m².

The Solar Boost 50 is a very efficient charge controller. A clue to this is that it contains no cooling fan and barely gets warm when processing well over 1 kilowatt of power. We measured a high efficiency of 99.3 percent and a low efficiency of 93.4 percent, with an average efficiency of 97.2 percent during our test. Efficiency in percent is watts out divided by watts in times 100.

If you have an array with four or more modules, you will save money by using an MPPT controller. The Solar Boost 50 is the right choice if your array output is 20 amps or more. The smaller Solar Boost 2000 (*Things that Work! HP73*, page 70) is appropriate for smaller arrays. When doing cost comparisons, bear in mind that you are buying a quality PWM controller in addition to the MPPT capability. Direct comparison is not always easy, since the Solar Boost 50 is cheaper than some non-MPPT 50–60 amp controllers, and more expensive than others.

Revolutionary

Every so often a product comes along that significantly changes the RE industry. The Solar Boost 50 is one of those products, and RV Power products is in the process of obtaining a patent on their MPPT technology. The real world performance of the Solar Boost 50 is roughly equivalent to having two extra PV modules on our tracked array. Considering that the cost of the Solar Boost is less than the cost of a single module, this controller is not only energy effective, but also cost effective. If you are not using a Solar Boost 50 MPPT charge controller in your system, you're wasting some of your expensive, PV-produced power.

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