# SOLAR BOOST™ 2000E

25AMP 12VDC MAXIMUM POWER POINT TRACKING
PHOTOVOLTAIC CHARGE CONTROLLER

*INSTALLATION AND OPERATION MANUAL*


THIS MANUAL INCLUDES IMPORTANT SAFETY INSTRUCTIONS FOR MODEL SB2000E
SAVE THESE INSTRUCTIONS.

COVERED UNDER ONE OR MORE OF THE FOLLOWING US PATENTS
6,111,391

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## IMPORTANT SAFETY INSTRUCTIONS

This manual contains important instructions for Model SB2000E
SAVE THESE INSTRUCTIONS

1. Refer installation and servicing to qualified service personnel. High voltage is present inside unit. Incorrect installation or use may result in risk of electric shock or fire. No user serviceable parts in this unit.
2. To reduce the risk of electric shock, fire or personal injury, the following symbols are placed throughout this manual to indicate dangerous conditions, or important safety or operational instructions.

| WARNING | CAUTION | IMPORTANT |
|---|---|---|
|  |  |  |
| Indicates dangerous conditions or electric shock potential. Use extreme caution. | Indicates items critical to safe installation or operation of the unit. | Follow these instructions closely for proper operation of the unit |

3. PERSONAL PRECAUTIONS
   a) Working in the vicinity of lead-acid batteries is dangerous. Batteries produce explosive gasses during normal operation.
   b) To reduce risk of battery explosion, follow these instructions and those published by battery manufacturer and manufacturer of any equipment you intend to use in vicinity of battery.
   c) Someone should be within range of your voice or close enough to come to your aid when you work near a lead-acid battery.
   d) Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing or eyes.
   e) Wear complete eye protection and clothing protection. Avoid touching eyes while working near battery.
   f) If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 15 minutes and get medical attention immediately.
   g) NEVER SMOKE or allow a spark or flame in vicinity of battery.
   h) Be extra cautious to reduce risk of dropping metal tool onto battery. It might spark or short circuit battery or other electrical part that may cause explosion.
   i) Remove personal metal items such as rings, bracelets and watches when working with a lead-acid battery. A lead-acid battery can produce a short circuit current high enough to weld a ring or the like to metal, causing a severe burn.
   j) Remove all sources of power, photovoltaic and battery before servicing or installing.
4. CHARGER LOCATION & INSTALLATION
   a) This unit is designed to charge 12V (6 cell) flooded or sealed type lead-acid chemistry batteries within the range of 10 to 10,000 amp-hours. Follow battery manufacturers charging recommendations when considering this unit for use with other battery chemistry.
   b) This unit employs components that tend to produce arcs or sparks. NEVER install in battery compartment or in the presence of explosive gases.
   c) This unit must be installed and wired in accordance with National Electrical Code, ANSI/NFPA 70.
   d) Over current protection for the battery must be provided externally. To reduce the risk of fire, connect to a circuit provided with 30 amperes maximum branch-circuit over current protection in accordance with National Electrical Code, ANSI/NFPA 70.
   e) Insure that unit is properly configured for the battery being charged.
   f) This unit is not water tight. Do not expose to rain, snow or excessive moisture.
   g) Insure all terminating connections are clean and tight. Battery, PV and battery temperature sensor terminals are to be tightened to 9 in-lb (1 nm).
   h) Do not connect to a PV array capable of producing greater than 20 amperes of short circuit current @ STC.
   i) This unit is not provided with a GFDI (ground-fault detector/interrupter) device and must be used with an external GFDI device as required by Article 690 of National Electrical Code for the installation location.
5. PREPARING TO CHARGE
   a) Never charge a frozen battery.
   b) Be sure battery is mounted in a well ventilated compartment.
   c) Add distilled water in each cell of a lead-acid battery until battery acid reaches level specified by battery manufacturer.

## PRODUCT DESCRIPTION

Solar Boost™ 2000E is a 25 amp 12 volt *Maximum Power Point Tracking* (MPPT) photovoltaic (PV) battery charge controller with built in digital display. Through the use of patented MPPT technology the 2000E can increase charge current up to 30% or more compared to conventional controllers. The 2000E's sophisticated charge control system improves battery performance and life while minimizing battery maintenance. The unit is fully protected against voltage transients, over temperature, over current, reverse battery and reverse PV connections. An automatic current limit feature allows use of the full 25 amp capability without worrying about overload or nuisance fuse blow from excessive current. An environmentally sealed high current high reliability relay is used to disconnect the PV array at night to prevent unwanted current drain.

### PART NUMBERS AND OPTIONS

- SB2000E .....Solar Boost 2000E charge controller
- 930-0022-20 .....Optional battery temperature sensor
- 720-0011-01 .....Optional wall mount box, black powder coated steel

## OPERATION

Charge control and MPPT current boost operations are fully automatic. Charge turns on whenever the PV array is capable of producing approximately 0.15 amps at @ 14 volts. Note that there must be a battery in the system with a minimum voltage of 9 volts or greater for the 2000E to operate. Electronic current limit prevents the possibility of overload by limiting output current to 25 amps regardless of available PV input current or input power.

The highly accurate digital display consumes very little power and is always on and available for use. As shown in Figure 1, the display can be selected to show Solar Panel Current, Output Charge Current or Battery Voltage. Solar Panel Current displays current in amps flowing from the PV array to the 2000E, whereas Output Charge Current displays current in amps flowing from the 2000E to the battery. When MPPT current boost is functioning, Output Charge Current will be greater than Solar Panel Current. If operating conditions are such extra power is not available from the PV array and MPPT current boost is unable to operate, Output Charge Current may show 0.1 amps less than Solar Panel Current. This is normal as the 2000E consumes approximately 0.090 amps to operate when PV charge is on. When PV charge is off, standby current consumption is quite low at approximately 0.017 amps.

Battery Voltage is measured at the 2000E's battery terminals. Although the measurement system is highly accurate, displayed voltage may be somewhat higher than actual battery terminal voltage when high charge current is being delivered to the battery. This is due to voltage drop in the wires between the 2000E and battery. Error during charge can be minimized by using large low resistance wiring.

➢ The 2000E operates on battery power, not PV power. A battery must be connected with a minimum voltage of 9 volts for the unit to operate.

### CHARGE CONTROL

The 2000E provides a two stage charging process, Bulk and Constant Voltage. A third manually actuated Equalize mode is also available. The 2000E will be in Bulk charge when battery voltage is below the charge voltage setpoint (factory set to 14.0 volts). During Bulk the 2000E delivers as much charge current as possible to rapidly recharge the battery and drive battery voltage up to the charge voltage setpoint. Once the battery recovers sufficient charge for battery voltage to rise to the charge voltage setpoint, both PV current and output charge current are reduced as necessary to control battery voltage at the charge voltage setpoint.

### CHARGE STATUS INDICATOR

A Charge Status indicator LED is provided on the 2000E panel. For small scale solar electric systems an excellent indication of a highly charged battery is when the 2000E is able to hold the battery at the desired charge voltage setpoint. These systems usually consist of 75 – 400 watts of PV power, and charge a battery bank in the range of perhaps 100 – 600 amp-hours. With sufficient PV power and the battery under light load so that there is at least 2 amps of net charge current per 100 amp-hours of battery capacity, the system will show the battery to be charged when the battery is greater than approximately 90 – 95% full. When the Charge Status LED blinks showing the 2000E to be in the constant voltage mode, the battery is considered charged.

If PV power generation is too low and/or load current is too high for there to be at least 2 amps of net charge current available per 100 amp-hours of battery capacity the Solar Boost 2000E may be unable to hold battery voltage at the desired charge voltage setpoint. This will cause a discharged condition to be displayed even though the battery may be highly charged. A charged condition will again be displayed if sufficient net charge current becomes available and the battery is indeed charged. A smaller battery and/or larger PV array will tend to show a charged condition sooner.

CHARGE STATUS INDICATOR

| CHARGE STATUS INDICATOR | CHARGE MODE | APPROXIMATE CHARGE LEVEL |
|---|---|---|
| OFF | CHARGE OFF | ——— |
| CONTINUOUSLY ON | BULK | LESS THAN 90% FULL |
| BLINKING • 2 SEC ON / 2 SEC OFF | CONSTANT VOLTAGE | GREATER THAN 90% FULL |
| RAPID BLINKING • 0.2 SEC ON / 0.2 SEC OFF | EQUALIZE | ——— |

TABLE 1

➢ The 2000E front panel serves as a heat sink for power control devices. It is normal for the front panel to be quite warm to the touch during operation while delivering high charge current.

PANEL LAYOUT

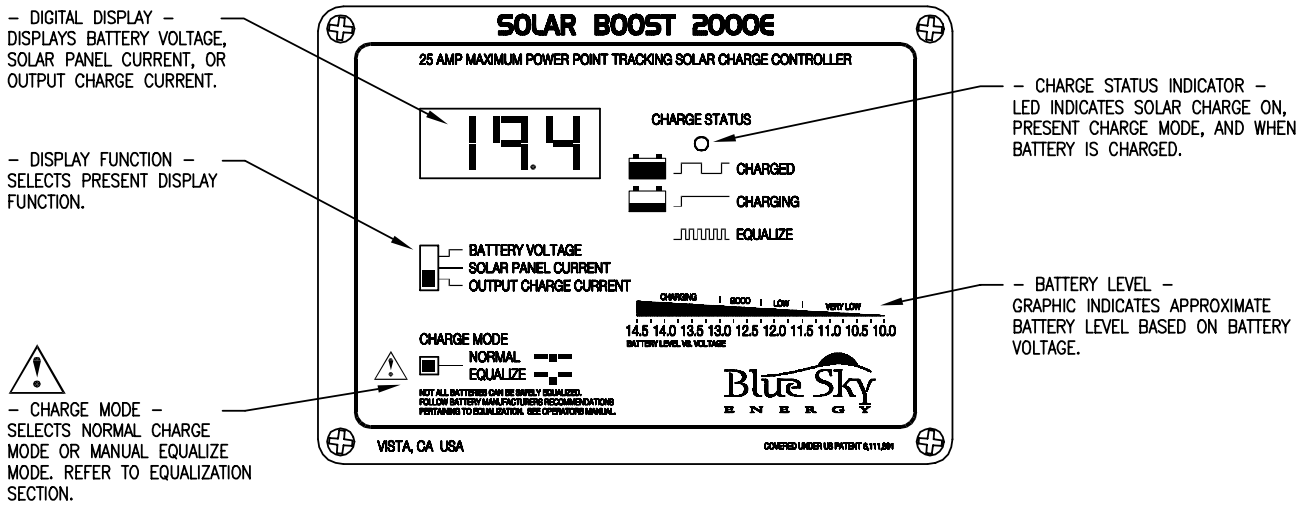



Figure 1

BATTERY LEVEL GRAPHIC

The 2000E also provides a battery level graphic on the front panel which indicates approximate battery level versus battery voltage. The indication covers a fairly wide range of voltage because at a given state of charge battery voltage can vary significantly depending on whether the battery is being charged, is at rest, or is being discharged under load. A higher voltage is generally better than a lower voltage.

A battery being charged will typically range in voltage from about 12.5 volts after charge begins to perhaps 14.0 volts or greater when the battery is highly charged. Once charge stops and the battery is delivering power to a load voltage will drop which is normal and typically ranges between about 12.6 volts when the battery is full down to about 12.2 volts when the battery is about 50% discharged. Most battery manufacturers recommend not discharging below 50% DOD (depth of discharge) to promote improved battery performance and life. Battery voltage will continue to fall as the battery is further discharged. Note that the voltage during discharge will tend to be higher under light load and lower under heavy load. NEVER allow battery voltage to drop below 10.0 volts.

EQUALIZATION

➢ WARNING: Not all batteries can be safely equalized. Equalization should be performed only on vented liquid electrolyte lead-acid batteries. Always follow battery manufacturers recommendations pertaining to equalization. Equalization applies a relatively high voltage producing significant battery gassing. Disconnect equipment that cannot tolerate the high equalization voltage which is temperature compensated. The 2000E equalization function is fully manual and an operator should always plan and monitor the process.

Equalization is essentially a controlled over charge and should only be performed on vented liquid electrolyte lead-acid batteries. Repeated charge/discharge cycles can lead to an imbalance in the specific gravity and state of charge of individual battery cells. Equalization brings all battery cells up to the same specific gravity, and eliminates electrolyte stratification by heavily gassing the battery. Periodic equalization per the battery manufacturers recommendations will improve battery performance and life.

A minimum net charge current of approximately 3.5 amps per 100 amp-hours of battery capacity is required for the battery reach the equalization voltage. Battery voltage setpoint during equalization will be the present charge voltage setpoint plus 1.2 volts or 15.2 volts for the factory calibrated charge voltage setpoint of 14.0 volts. Note that with temperature compensation, the equalization voltage can be quite high at cool temperatures. The operator should disconnect equipment that may not tolerate the high equalization voltage applied to the battery.

As shown in Figure 1, the blue equalization push-button is located on the 2000E panel. Equalization is enabled when the push-button is in, and the Charge Status LED blinks rapidly. Always follow the battery manufacturers recommendations pertaining to equalization. Equalization is normally conducted approximately once per month, with the battery held at the equalization voltage for a period of approximately two hours. It is best to equalize a battery that is already fully charged so that the desired equalization voltage is reached quickly. Following the desired equalization period, the equalization cycle is terminated and normal charge operation is resumed by again pressing the equalization push-button. The battery should then be topped off with distilled water per the battery manufacturers recommendations.

CURRENT LIMIT

If PV input power is high enough to produce more than 25 amps of output current, the 2000E will automatically prevent output current from exceeding 25 amps to prevent overload or nuisance fuse blow.

OPTIONAL TEMPERATURE COMPENSATION

The charge voltage required by flooded or sealed (AGM or GEL) lead-acid chemistry batteries changes with battery temperature. Temperature compensation of charge voltage leads to improved battery performance and life, and decreased battery maintenance. Automatic temperature compensation can be provided using the optional battery temperature sensor p/n 930-0022-20. Most 12 volt lead-acid chemistry batteries require a compensation characteristic of –30.0 millivolts/°C (–5.00mV/°C/cell). The graph of Figure 2 shows charge voltage setpoint vs. battery temperature for the factory setting of 14.0 volts @ 80°F and the compensation characteristic of –30.0 millivolts/°C. As described in the installation section the 2000E can also provide a –20.0 millivolts/°C compensation characteristic required for 10 cell NiCd batteries and some GEL or AGM lead-acid chemistry batteries.

FACTORY DEFAULT CHARGE VOLTAGE SETPOINT -VS.- BATTERY TEMPERATURE

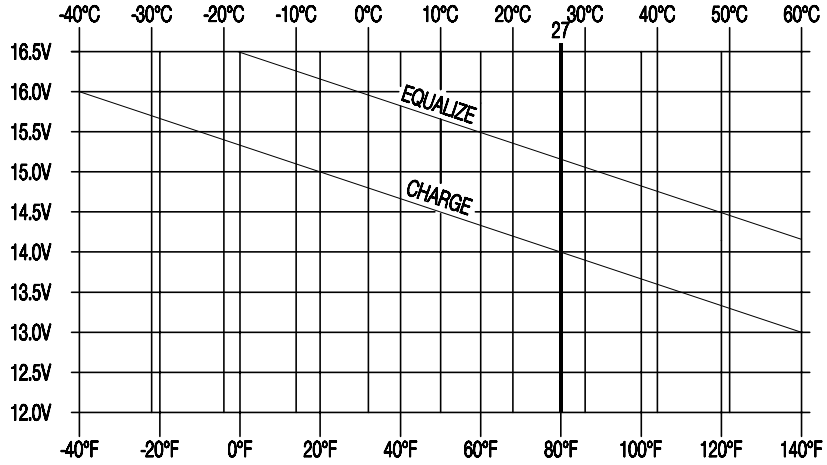



FIGURE 2

MAXIMUM POWER POINT TRACKING (MPPT)

Patented MPPT technology can extract more power and increase charge current up to 30% or more compared to conventional charge controllers. The principal operating conditions which affect current boost performance are PV array temperature and battery voltage. At constant solar intensity, available PV voltage and power *increase* as PV temperature *decreases* but it takes an MPPT controller to access this extra power. When PV voltage is sufficiently high in Bulk for MPPT to operate, a *constant power* output is delivered to the battery. Since output power is constant a *decrease* in battery voltage produces a further *increase* in charge current. This means that the 2000E provides the greatest charge current increase when you need it most, in cold weather with a discharged battery. In cool comfortable temperatures most systems see about 10 – 20% increase. Charge current increase can go to zero in hot temperatures, whereas charge current increase can easily exceed 30% with a discharged battery in near freezing temperatures. For a more complete MPPT description see www.blueskyenergyinc.com.

## INSTALLATION

➢ WARNING: Read, understand and follow the Important Safety Instructions in the beginning of this manual before proceeding. This unit must be installed and wired in accordance with National Electrical Code, ANSI/NFPA 70. Over current protection must be provided externally. To reduce the risk of fire, connect to a circuit provided with 30 amp maximum branch-circuit over current protection in accordance with National Electrical Code, ANSI/NFPA 70. Do not connect a PV array capable of delivering greater than 20 amps of short circuit current $I_{SC}$ at STC. Do not connect BAT– and PV– together external to the unit or improper operation or damage will result. Terminal block connections accept #20–10 AWG wire and are to be tightened to 9 in-lb (1 nm). The front panel serves as a heat sink for power control devices and requires free air circulation for cooling. Do not enclose the front panel behind a tight fitting door or otherwise substantially restrict air flow. Figure 3 shows generalized connections only and is not intended to show all wiring, circuit protection and safety requirements for a photovoltaic or DC battery electrical system.

➢ CAUTION: The unit is protected against reverse battery and PV polarity, and swapped PV and battery connections, but will be damaged by reverse battery to the PV terminals. Transient voltage protection is provided, but steady state voltage in excess of 30VDC on the battery or PV terminals will damage the unit. The unit is not water tight and must be installed in an area free from rain, snow or excessive moisture. Damage due to improper installation, corrosion, or adjustments or connections other than those shown in Figure 3 void the limited warranty.

ELECTROSTATIC HANDLING PRECAUTIONS

All electronic circuits may be damaged by static electricity. To minimize the likelihood of electrostatic damage, discharge yourself by touching a water faucet or other electrical ground prior to handling the 2000E and avoid touching components on the circuit board. The risk of electrostatic damage is highest when relative humidity is below 40%.

SELECTING PV MODULES

Voltage, current and power produced by Photovoltaic (PV) modules fluctuate widely with operating conditions. As a result a set of test conditions referred to as ***Standard Test Conditions*** (***STC***) are used to rate modules in a meaningful manner and accurately predict real world performance. STC ratings are not maximum or optimal ratings. Conditions can be present where $V_{OC}$ and $I_{SC}$ approach 1.25 times STC ratings which is why National Electrical Code and our recommendations call for 1.25 derating of both $V_{OC}$ and $I_{SC}$. Yet in real world conditions $I_{MP}$ is commonly only about 75 – 80% of $I_{MP}$ at STC.

Key PV module specifications;

$P_{MAX}$ Maximum power in watts ($P_{MAX} = V_{MP} \times I_{MP}$)
$V_{OC}$ Voltage with module open circuit (typically ≈20 – 22V for 12V nominal modules)
$V_{MP}$ Voltage where module produces Maximum Power (typically ≈17 – 18V for 12V nominal modules)
$I_{MP}$ Current where module produces Maximum Power
$I_{SC}$ Current with module Short Circuit

The 2000E will provide the best MPPT current boost performance if all PV modules are identical. Dissimilar modules should have $V_{MP}$ values within ≈0.5V or better and be of the same basic cell technology so their $V_{MP}$ will tend to track as operating conditions change. If module types are very different consider using a separate charge controller for each module type to obtain the best MPPT current boost performance. Select PV modules that do not exceed the maximum ratings shown below, and preferably produce at least 3.5 amps of $I_{MP}$ per 100 amp-hours of battery capacity. For more detail on PV module sizing see technical bulletin #100214 at www.blueskyenergyinc.com.

| Maximum PV Power @ STC | Maximum PV Isc @ STC | Maximum PV $V_{OC}$ @ STC | Recommended range of $V_{MP}$ at STC |
|---|---|---|---|
| | | | Nominal 12V PV |
| 340W | 20A | 28.0V | 16.5 – 18.5V |

TEMPERATURE COMPENSATION

For temperature compensation to operate, battery temperature sensor p/n 930-0022-20 must be installed and temperature compensation enabled via dip switches 3 & 4. The sensor is electrically isolated and may mount to any battery terminal, but battery negative is preferred. Select a temperature compensation characteristic that most closely matches the battery manufacturers recommendation. Most 12 volt flooded or GEL lead-acid chemistry batteries require the –30.0 millivolts/°C (–5.00mV/°C/cell) setting. NiCd and many lead-acid chemistry AGM type batteries require the –20.0 millivolts/°C (–3.33mV/°C/cell) setting.

➢ WARNING: Do not attach a sensor or any connections other than Blue Sky Energy battery temperature sensor p/n 930-0022-20 to the temperature sensor terminals. Be certain to observe proper RED/BLK polarity as shown in Figure 3. The 2000E cannot properly limit and control battery voltage if temperature compensation is enabled with the sensor installed reverse polarity. Additionally, output current will be disabled if temperature compensation is enabled without the sensor installed.

| SWITCH 3 | SWITCH 4 | TEMPERATURE COMPENSATION |
|---|---|---|
| OFF | OFF | DISABLED |
| ON | ON | –30.0 millivolts/°C<br>Flooded Lead-Acid (–5.00mV/°C/cell • 6 cells) |
| ON | OFF | –20.0 millivolts/°C<br>NiCd (–2.00mV/°C/cell • 10 cells) ♦ AGM Lead-Acid (–3.33mV/°C/cell • 6 cells) |

BATTERY AND PV WIRING

The 2000E panel should be mounted in a dry location that provides easy routing of large size wires to the PV array and battery, and keeps PV/battery wire length as short as practical. The location should also provide free air circulation around the front of the panel, and if possible, around the rear. Take great care not to touch or damage circuit board components as this damage is not covered under the limited warranty. Figure 4 provides a 1:1 template for the panel cut-out.

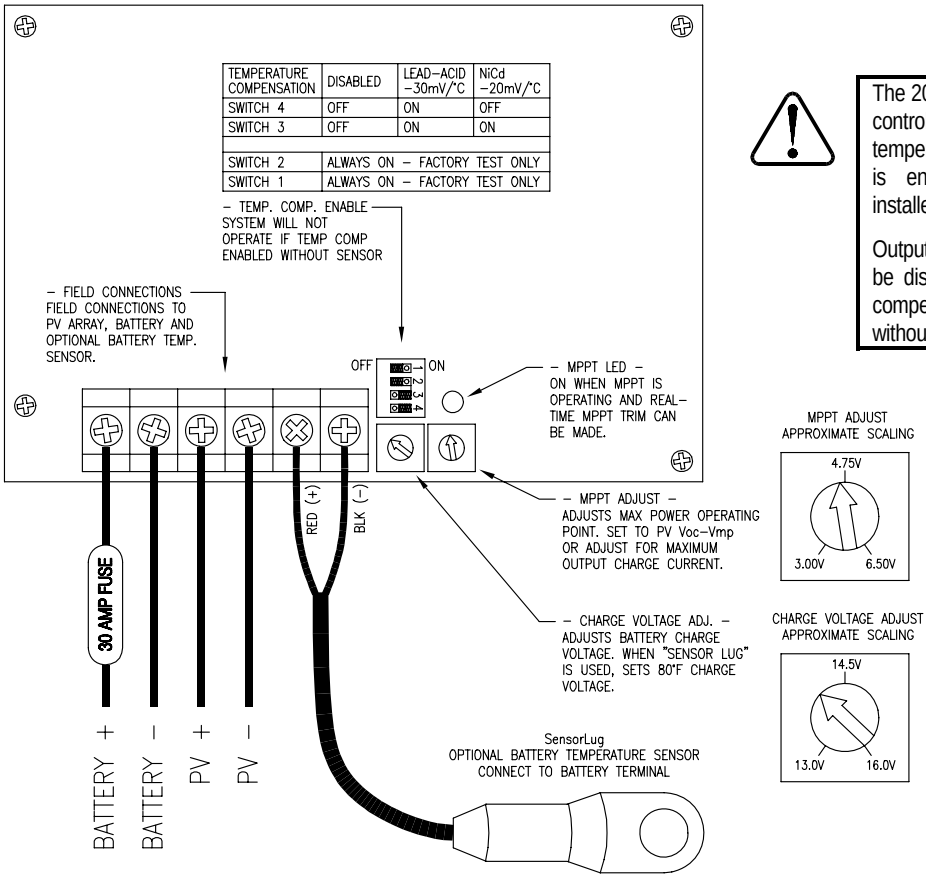
Wiring and connections used with the 2000E can have a significant effect on current boost performance. The 2000E increases charge current by transforming previously wasted or unharvested power into useable charge current. The effect wiring has on current boost performance is that power wasted heating wires or connections is power that becomes unavailable to charge the battery. A desirable installation will produce a total system wiring voltage drop of 3% or less. The lengths shown in Table 2 are one way from the PV modules to the battery with the 2000E located along the path. Wire length can be increased inversely proportional to actual current. If current was reduced by ½ (to 10 amps), wire lengths could be doubled and still provide the same 3% voltage drop.

MAXIMUM CONDUCTOR PAIR LENGTH – 3% VOLTAGE DROP

| WIRE GAUGE AWG | 12 VOLT SYSTEM @20AMPS FEET / METERS |
|---|---|
| 12 AWG | 6.4 / 1.9 |
| 10 AWG | 10.2 / 3.1 |
| 8 AWG | 16.2 / 4.9 |
| 6 AWG | 25.7 / 7.8 |
| 4 AWG | 40.8 / 12.5 |

TABLE 2

SETUP AND WIRING DIAGRAM




The 2000E cannot limit and control battery voltage if temperature compensation is enabled with sensor installed reverse polarity.

Output charge current will be disabled if temperature compensation is enabled without sensor installed.

FIGURE 3

SETTING CHARGE VOLTAGE

Charge voltage should be set to the battery manufacturers recommendations. The factory setting of 14.0 volts is suitable for most lead-acid chemistry batteries and does not typically require adjustment. For a predominately float application a somewhat lower voltage of 13.8 volts may be beneficial in decreasing water loss. For a heavily cycling application, a somewhat higher voltage of 14.5V may be beneficial in decreasing charge time and increasing amp-hours delivered. The adjustment potentiometer location is shown in Figure 3. With the Charge Status LED blinking indicating that the battery at or near full charge, adjust the charge voltage potentiometer to the desired battery charge voltage as displayed on the 2000E digital display. If optional temperature compensation option is installed, disable temperature compensation, adjust the charge voltage to the desired 80°F value, and then turn temperature compensation back on.

Since charge voltage is calibrated by adjusting actual battery charge voltage as displayed on the 2000E, setting charge voltage therefore requires that the battery be at or near full charge so that the unit is actually controlling battery voltage at the charge voltage setpoint. This can sometimes be hard to achieve when battery capacity is large compared to available PV charge current. Charge Voltage Calibration Tool P/N 930-0031-01 as described in technical bulletin #100209 simplifies charge voltage calibration be eliminating the need to have the battery be highly charged. To access this and other technical bulletins, see www.blueskyenergyinc.com.

MAXIMUM POWER VOLTAGE

The nominal setting for this adjustment is the difference between the PV panel's *open circuit voltage* ($V_{OC}$) and *maximum power voltage* ($V_{MP}$). These voltage values are typically listed on both the PV panel datasheet and on the rating label affixed to each PV panel. This value needs to be set correctly for the MPPT system to deliver maximum current boost. The factory setting is 4.4 volts which is the appropriate value for many popular 36 cell PV modules. These modules typically list $V_{OC}$ at ≈21.4 volts and $V_{MP}$ at ≈17.0 volts, which yields; 21.4 volts - 17.0 volts = 4.4 volts.

*OPTIMIZING MPPT*

The combined effects of manufacturing tolerances in the PV panel and wiring resistance in a particular installation can sometimes shift the optimum setting. While not required, it is recommended that for maximum MPPT current boost performance this adjustment be fine-tuned following installation. This is a one-time setup and does not require seasonal adjustment. Fine tuning is also desirable following installation of additional PV panels or other substantial system change.

Fine tuning is easily accomplished by slowly adjusting the MPPT adjust potentiometer to obtain maximum Output Charge Current. Adjustment is best done in near full sun with a discharged battery and cool ambient temperatures. The red MPPT Active LED above the potentiometer turns on when MPPT is

functioning and adjustment can be made. Verify that the LED remains on at the maximum current adjustment point, and as you check for a slight drop in current on either side of the maximum point. If LED does not remain on, MPPT is not operating due to a combination of high PV temperature and/or high battery voltage. MPPT can usually be made to operate by lowering battery voltage through application of a heavy DC load. If in doubt, leave the adjustment at the factory default position of midway between 11:00 and 12:00 o'clock as shown in Figure 3. Note that the LED briefly turns off every 10 seconds while the system recalculates the MPPT operating point.

## TROUBLESHOOTING GUIDE

| SYMPTOM | PROBABLE CAUSE | ITEMS TO EXAMINE OR CORRECT |
|---|---|---|
| Completely dead, no display | No battery power | Battery disconnected, overly discharged, or connected reverse polarity. Battery powers the system, not PV. Battery voltage must be present for unit to operate. |
| Display OK, but system will not turn on (charge status LED off) | PV disconnected | Verify PV connection. Requires PV to supply at least 0.15A at ≈14V to begin charge. |
| | PV reverse polarity | Reverse polarity PV will cause front panel to heat, and display to show "negative" PV current if battery is connected. |
| | PV- connected to BAT- | PV- & BAT- must be separate for proper operation. PV- must receive earth ground via shunts in the 2000E which internally connect PV- to BAT-. External connection prevents proper operation of the internal current measurement system. |
| Charge status LED on in Bulk, but no output charge current | Dip switches set incorrectly | Double check dip switches #1-4. |
| | Low PV power | Correct PV's. |
| Charge status LED on & blinking in Constant Voltage mode but no output charge current | Battery voltage greater than charge voltage setpoint | This is normal operation. Output is off due to high battery voltage which may be caused by other charging systems. |
| | Temp comp. enabled without sensor, or sensor failed open | Disable temp compensation, or replace sensor. Proper temp sensor terminal voltage when connected is 2.98V at 25°C, changing at +10mV/°C. |
| | Battery voltage too low | A minimum battery voltage of ≈9.0V is required for the unit to operate. |
| Charge status LED on in Constant Voltage, relays click on/off | Charge current is very low and the system is on the edge of being able to stay on | If charge current is very low (≈0.1 – 0.2A) because battery voltage is at setpoint, relays may switch on/off. This normal and will cause no harm. The on/off symptom will go away with a slight increase or decrease in battery voltage, or load current. |
| | PV- connected to BAT- | PV- & BAT- must not connect together external to controller for proper operation. |
| Relays click on/off rapidly | Dip switch #2 off | Double check dip switch #2, must always be on. Used for factory test only. |
| Charge status LED blinking, charge voltage high | System in equalize mode | Disable equalize by pressing the equalize pushbutton. |
| | Temp sensor failed short, or installed reverse polarity | Replace sensor, or remove sensor and disable temp compensation. Proper temp sensor terminal voltage when connected is 2.98V at 25°C, changing at +10mV/°C. |
| Charge current is lower than expected, PV current may be low as well | Battery is highly charged | Normal operation, system will be in Constant Voltage mode and current is reduced to control battery voltage. |
| | Worn out PV modules | Replace, or use as is. |
| | Low insolation | Atmospheric haze, PV's dirty, sun low on horizon, etc. |
| | PV- connected to BAT- | PV- & BAT- must be separate for proper operation. PV- must receive earth ground via shunts inside the 2000E which internally connect PV- to BAT-. External connection prevents proper operation of the internal current measurement system. |
| | MPPT improperly setup | See Maximum Power Voltage and Optimizing MPPT sections. |
| MPPT Current boost is less than expected | PV maximum power voltage ($V_{MP}$) is not much higher than battery voltage, leaving little extra power to be extracted | May result from PV's with low $V_{MP}$. PV's with higher $V_{MP}$ produce greater power and current boost potential. PV's with $V_{MP} \geq 17V$ work best, PV's with <36 cells tend to work poorly. |
| | | Excessive PV wiring voltage drop due to undersize wiring, poor connections, etc., consumes and wastes available power. This simulates having PV's with low $V_{MP}$. |
| | | Battery is nearly charged and battery voltage is near setpoint. Output during MPPT operation is "constant power" so higher battery voltage produces less charge current. |
| | PV's hot | $V_{MP}$ and available power decrease with increasing PV cell temperature. Cooler PV's will produce greater boost. MPPT LED off indicates that extra power is not available from PV array. It is normal for boost to decrease as temperature rises. |
| | MPPT improperly setup | See Maximum Power Voltage and Optimizing MPPT sections. |
| At high temperature, unit shuts down | System temporarily shuts down due to high temperature | Improve ventilation or reduce PV power. Providing sufficient ventilation or operating conditions which do not cause over temperature shut down will improve reliability. |

## SPECIFICATIONS

Output current rating .....25A
System voltage.....12V nominal
Max. PV Open circuit voltage.....30V
Max. battery voltage .....30V
Output current limit .....25±1A
Volt meter full scale range.....19.99V
Volt meter accuracy.....±0.1% full-scale
Current meter full scale range.....±26A
Current meter accuracy.....±0.75% full-scale
Charge voltage adjustment .....13 - 16V typical
Equalization voltage .....charge set +1.2V
Power conversion efficiency .....95% typical @ 15A

Temperature compensation coefficient
Lead-acid..... -30.0mV/°C
NiCd..... -20.0mV/°C
Current consumption
Standby ..... 17mA typical
Charge on..... 90mA typical
Panel dimensions..... 4.6"Hx6.4"Wx1.8"D
Storage temperature range ..... -40 to +85°C
Specified temperature range ..... 0 to +40°C
Extended range..... -40 to +50°C
(will operate but may not meet specifications,
see Technical Bulletin #100206)

As a part of our continuous improvement process
specifications are subject to change without prior notice.

## FIVE YEAR LIMITED WARRANTY

Blue Sky Energy, Inc. (hereinafter BSE), hereby warrants to the original consumer purchaser, that the product or any part thereof shall be free from defects due to defective workmanship or materials for a period of five (5) years subject to the conditions set forth below.

1. This limited warranty is extended to the original consumer purchaser of the product, and is not extended to any other party.
2. The limited warranty period commences on the date the product is sold to the original consumer purchaser. A copy of the original purchase receipt identifying purchaser and date of purchase, must accompany the product to obtain warranty repairs.
3. This limited warranty does not apply to, and future warranty shall become void, for any product or part thereof damaged by; a) alteration, disassembly or application of a foreign substance, b) repair or service not rendered by a BSE authorized repair facility, c) accident or abuse, d) corrosion, e) lightning or other act of God, f) operation or installation contrary to instructions pertaining to the product, or g) cosmetic aging.
4. If BSE's examination of the product determines that the product is not defective the consumer shall be charged a test and evaluation fee of $20 and be responsible for all transportation costs and insurance related to returning the product to the consumer. The consumer is ultimately responsible for proper installation and operation of the product and BSE's prior troubleshooting assistance shall not serve as a waiver of the test and evaluation fee. The test and evaluation fee is subject to change without prior notice.
5. If within the coverage of this limited warranty, BSE shall repair or replace the product at BSE's sole discretion and return the product via standard ground transportation of BSE's choosing within the continental US. The consumer shall be responsible for all transportation costs and insurance to return the product outside the continental US, and for all transportation costs and insurance related to expedited return of the product. BSE's liability for any defective product or any part thereof shall be limited to the repair or replacement of the product. BSE shall not be liable for any loss or damage to person or property, or any other damages, whether incidental, consequential or otherwise, caused by any defect in the product or any part thereof.
6. Any implied warranty for merchantability or fitness for a particular purpose is limited in duration to the length of this warranty.
7. To obtain warranty repairs, contact BSE at 760-597-1642 to obtain a Returned Goods Authorization (RGA) number. Mark the outside of the package with the RGA number and return the product, postage prepaid and insured to the address below. The consumer is responsible for all transportation costs and insurance related to returning the product to BSE, and for any shipping damage which may void the warranty or increase the cost of repairs.

Blue Sky Energy, Inc.
2598 Fortune Way, Suite K
Vista, CA 92081 USA

800-493-7877 ● 760-597-1642 ● Fax 760-597-1731 ● www.blueskyenergyinc.com

MOUNTING TEMPLATE

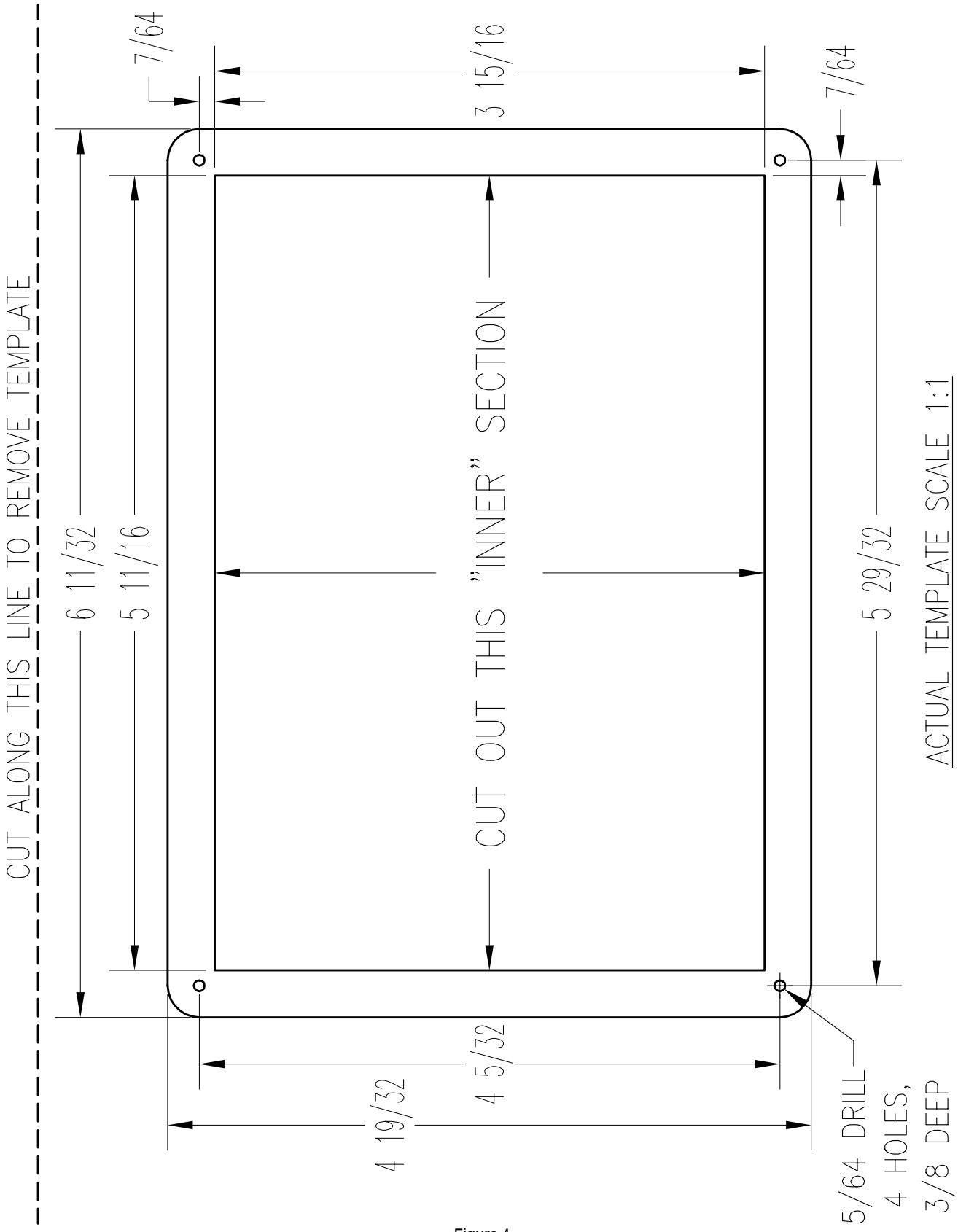



Figure 4