RV POWER PRODUCTS

# SOLAR BOOST™ 2000E

25A 12V MAXIMUM POWER POINT TRACKING
PHOTOVOLTAIC CHARGE CONTROLLER

## *INSTALLATION AND OPERATION*

## *MANUAL*

| THIS MANUAL INCLUDES IMPORTANT SAFETY INSTRUCTIONS<br>*SAVE THESE INSTRUCTIONS* |
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COVERED UNDER US PATENT 6,111,391



430-0012 C

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**RV Power Products, Inc.**
**1058 Monterey Vista Way**
**Encinitas CA, 92024, USA**

**800-493-RVPP • 760-944-8882**
**www.rvpowerproducts.com**

# IMPORTANT SAFETY INSTRUCTIONS

1. Refer servicing to qualified service personnel. Incorrect installation may result in risk of electric shock or fire. No user serviceable parts in this unit.

2. Remove all sources of power, photovoltaic and battery before servicing or installing.

3. WARNING - RISK OF EXPLOSIVE GASES
   a) Working in the vicinity of lead-acid batteries is dangerous. Batteries produce explosive gasses during normal battery 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.

4. PERSONAL PRECAUTIONS
   a) Someone should be within range of your voice or close enough to come to your aid when you work near a lead-acid battery.
   b) Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing or eyes.
   c) Wear complete eye protection and clothing protection. Avoid touching eyes while working near battery.
   d) 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 10 minutes and get medical attention immediately.
   e) NEVER smoke or allow a spark or flame in vicinity of battery.
   f) 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.
   g) Remove personal metal items such as rings, bracelets, necklaces, 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.
   h) Use charger for charging 12 volt lead-acid batteries only. Charging other battery types may cause these batteries to burst and cause injury to persons and damage to property.

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 until battery acid reaches level specified by battery manufacturer. This helps purge excessive gas from the cells. Do not overfill. For a battery without cell caps, carefully follow manufacturers charging instructions.

6. CHARGER LOCATION & INSTALLATION
   a) Controller employs components that tend to produce arcs or sparks. NEVER install in battery compartment or in the presence of explosive gases.
   b) Protect all wiring from physical damage, vibration and excessive heat.
   c) Insure that the controller is properly setup for the battery being charged. Do not exceed maximum safe charging current as specified by battery manufacturer.
   d) Do not expose controller to rain or snow.
   e) Insure all terminating connections are clean and tight to prevent arcing and overheating.
   f) Charging system must be properly installed as described in these instructions prior to operation.

# <u>SAVE THESE INSTRUCTIONS</u>

# PRODUCT DESCRIPTION

Solar Boost™ 2000E is a 12 volt 25 amp fully automatic, very high performance Maximum Power Point Tracking (MPPT) photovoltaic (PV) charge controller. Through the use of patented MPPT technology, Solar Boost 2000E can increase charge current up to 30% or more. A high accuracy digital display is also provided to monitor PV charge performance. The controller is fully protected against voltage transients, reverse polarity, and overload conditions.

Solar Boost 2000E employs series pass Pulse Width Modulation (PWM) charge voltage control. Precise PWM voltage control leads to a more fully charged battery, with longer life and less maintenance. Solar Boost 2000E also includes automatic electronic current limit which allows you to use the full 25 amp capability without worrying about overload or nuisance fuse blow from excessive current. A manual equalize function is also included to periodically condition liquid electrolyte lead-acid batteries. The PWM control system uses highly efficient and reliable power MOSFET transistors. The MOSFET's are turned on and off at high frequency to precisely control charge voltage and MPPT. An environmentally sealed high current high reliability relay is used to disconnect the PV array at night to prevent unwanted current drain. A relay is used rather than blocking diodes for improved power conversion efficiency and MPPT current boost performance. The relay is not stressed by functioning as part of the voltage control system and continually turning on and off as with other PV controllers. It simply turns on in the morning and off in the evening, and in this application has a life expectancy in excess of $10^5$ operations.

Fully automatic temperature compensation of charge voltage is available as an option to further improve charge control, battery performance and battery life. The available SensorLug™ battery temperature sensor is built for long term reliability. The sensor element is environmentally sealed and encapsulated into a copper lug which mounts directly to the battery terminal. Order the SensorLug with 20ft/6.1m of cable as RVPP part number 930-0022-20.

## PART NUMBERS AND OPTIONS

- SB2000E ........................ Solar Boost 2000E with digital display
- 930-0022-20 ................... SensorLug™ battery temperature sensor with 20' cable
- 720-0011-01 ................... Wall mount box for SB2000E

# 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 10 volts or greater for the Solar Boost 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 solar array to Solar Boost 2000E, whereas Output Charge Current displays current in amps flowing from Solar Boost 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 that PV output power is insufficient for MPPT current boost to function, Output Charge Current may show 0.1 amps less than Solar Panel Current. This is normal as Solar Boost 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 Solar Boost 2000E battery terminals. Although the measurement system is highly accurate, displayed voltage will 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 Solar Boost 2000E and battery. Error during charge can be minimized by using large low resistance wiring.

**The front panel serves as a heat sink for power control devices. It is normal for the front panel to be warm during operation.**

**PANEL LAYOUT**

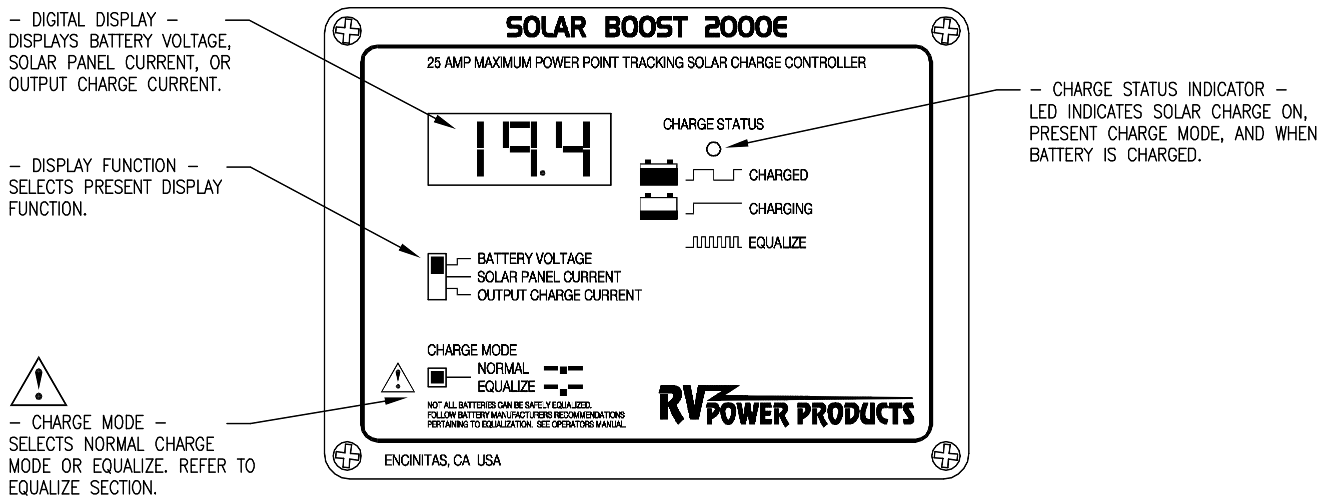



**Figure 1**

# TWO STAGE CHARGE CONTROL

Solar Boost 2000E charges the battery in a two stage charge process, *bulk* and *constant voltage*. A third manually initiated *equalization* mode is also available to periodically condition liquid electrolyte lead-acid batteries.

### *Bulk Charge*

Solar Boost 2000E will be in the bulk charge stage when the battery is at a low state of charge, typically less than 90% full. Solar Boost 2000E delivers as much charge current as possible during bulk to recharge the battery as rapidly as possible. Maximum charge current varies with the number and size of solar panels installed, available solar energy, and operation of the proprietary MPPT current boosting system. Battery voltage increases as the battery recovers charge in the bulk stage. When the battery recovers sufficient charge for battery voltage to reach the charge voltage setpoint, the system switches to the constant voltage stage. During the bulk charge stage, the Charge Status LED will be on continuously.

### *Constant Voltage Charge*

Once the battery becomes more than approximately 90% charged, the system changes to a constant voltage mode and the Charge Status LED blinks. The charge voltage setpoint is factory calibrated to approximately 14.0 volts. While charge voltage is held constant, charge current slowly decreases as the last 10% or so of battery capacity is restored. If there was no DC load on the system, output current from Solar Boost 2000E would eventually drop to approximately the battery amp-hour rating divided by 500, or approximately 0.5 amps for a 230 amp-hour battery. The precision PWM voltage control method provided by Solar Boost 2000E prevents over charge while maintaining a more fully charged battery.

# CHARGE STATUS INDICATOR

A Charge Status indicator LED is provided on the Solar Boost 2000E panel. For small scale solar electric systems where the Solar Boost 2000E is typically used, an excellent indication of a highly charged battery is when the Solar Boost 2000E is able to hold the battery at the desired charge voltage. These systems usually consist of 75 – 400 watts of solar power, and charge a battery bank in the range of 200 – 800 amp-hours. With sufficient sun and the battery under light load so that there is at least 1 amp 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 Solar Boost 2000E to be in the constant voltage mode, the battery is considered charged.

If solar power generation is too low and/or load current is too high for there to be at least 1 amp 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 solar array will tend to show a charged condition sooner.

**CHARGE STATUS INDICATOR**

| INDICATOR ACTION | CHARGE MODE | TYPICAL BATTERY STATE OF CHARGE |
|---|---|---|
| OFF | CHARGE OFF<br>NO SOLAR INPUT | NOT DISPLAYED |
| CONTINUOUSLY ON | BULK | LESS THAN 90% FULL |
| BLINKING<br>2 SEC ON / 2 SEC OFF | CONSTANT VOLTAGE | GREATER THAN 90% FULL |
| BLINKING RAPIDLY<br>0.2 SEC ON / 0.2 SEC OFF | EQUALIZE | N/A |

**Table 1**

## OPTIONAL TEMPERATURE COMPENSATION

The charge voltage required by lead-acid batteries changes with battery temperature. Temperature compensation of charge voltage leads to increased battery life and decreased battery maintenance. If your system includes the optional battery temperature sensor (p/n 930-0022-20), charge voltage will continuously adjust to the proper value based on measured battery temperature. Both liquid and gel electrolyte 12 volt lead-acid batteries require the same compensation characteristic of –30.0 millivolts/°C. The graph of Figure 2 shows charge voltage setpoint vs. battery temperature for the factory setting of 14.0 volts @ 80°F. The slope of curve remains constant for different 80°F voltage settings. As described in the installation section, Solar Boost 2000E can also provide the necessary –20.0 millivolts/°C compensation curve for NiCd (10 cell) batteries.

**CHARGE VOLTAGE SETPOINT -VS.- BATTERY TEMPERATURE**

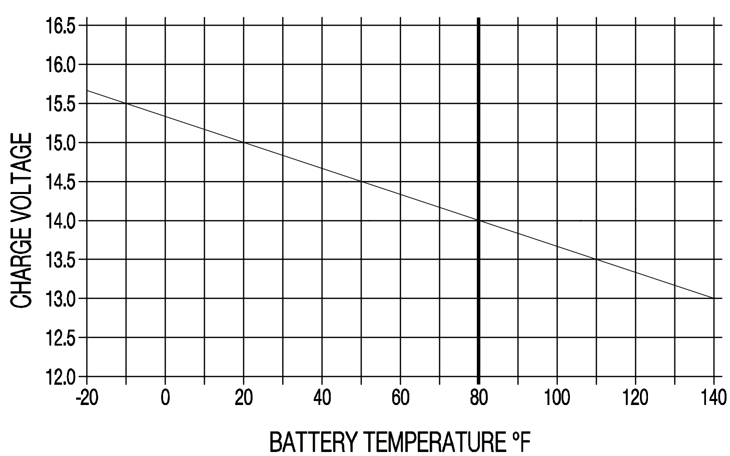



**Figure 2**

# EQUALIZATION

**WARNING: Not all batteries can be safely equalized. Equalization should only performed on vented liquid electrolyte lead-acid batteries. Follow battery manufacturers recommendations pertaining to equalization.**

Equalization is essentially a controlled over charge and should only be performed on vented liquid electrolyte lead-acid batteries. Since each cell of a battery is not identical, repeated charge/discharge cycles can lead to an imbalance in the specific gravity of individual battery cells. Stratification of the electrolyte can also occur. Equalization brings all battery cells up to the same specific gravity, and eliminates stratification by heavily gassing the battery. Periodic equalization per the battery manufacturers recommendations will greatly improve battery performance and life. Most batteries fail due to sulfation, which periodic equalization helps to prevent.

A proper equalization cycle is a substantial over charging of the battery at relatively high voltages with significant battery gassing. Solar Boost 2000E features a manually operated equalization function since an operator should always plan and monitor the process. The operator should ensure that equipment connected to the battery can tolerate the high equalization voltage which will be applied to the battery, and that the battery attains the proper voltage for the desired time period. 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.

As shown in Figure 1, the blue equalization push-button is located on the front of the Solar Boost 2000E panel. Equalization is enabled when the push-button is in, and the Charge Status LED blinks rapidly. 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.

Equalization works best with a relatively large PV array. This is because approximately 2.8 amps of charge current per 100 amp-hours of battery capacity is required to actually drive battery voltage up to the desired 15.2 volts @ 80°F. This means at least 12 amps of charge current is needed to properly equalize a 440 amp-hour battery. Even if your solar array is too small to drive battery voltage up to the desired 15.2 volts, substantial benefit will be realized by periodically applying an increased charge voltage for several hours once a month.

# MAXIMUM POWER POINT TRACKING (MPPT)

MPPT and associated current boost operation is fully automatic and will function whenever sufficient PV voltage and current are available. The percent increase you will receive in Output Charge Current relative to Solar Panel Current is variable, and will change with operating conditions. When conditions are such that sufficient PV voltage and current are not available to produce an increase in output current, Solar Boost 2000E will operate as a high performance series pass PWM controller. Boost performance can be easily monitored using the digital display. Whenever Output Charge Current is greater than Solar Panel Current, MPPT current boost is functioning. A minimum PV current of just under one amp is required before MPPT can begin to operate.

The principal operating conditions which affect current boost performance are battery voltage and PV array temperature. At constant solar intensity the power available from a PV array changes with PV array temperature. A PV array's power vs. temperature characteristic is such that a cool PV array can produce a higher voltage, and therefore more power, than a hot PV array. When PV voltage is sufficiently high for MPPT to operate, Solar Boost 2000E delivers a constant power output to the battery. Since output power is essentially constant while MPPT is operating, a *decrease* in battery voltage produces a corresponding *increase* in charge current. This means that the greatest current increase occurs with a combination of cool ambient temperature and low battery voltage. Solar Boost 2000E delivers the highest charge current increase when you need it most, in cold weather with a discharged battery.

Because output power is constant while MPPT is operating, anything that leads to lower battery voltage will produce an increase in Output Charge Current. While a discharged battery is one way to produce lower output voltage, and therefore higher output current, other normal conditions may produce lower voltage as well. Any 12 volt power consumption during the day will decrease net battery charge current, which decreases battery voltage.

### *TYPICAL CURRENT BOOST PERFORMANCE*

As described above current boost performance for a particular installation varies with PV array temperature and battery voltage. Two of the other primary factors which affect boost performance include system wiring and PV panel design. The effect wiring has on performance is that power wasted heating undersized wiring becomes unavailable for charging. The effect PV panel design has on performance is that panels with a maximum power voltage ($V_{MP}$) of 17 volts or greater will tend to produce more boost, whereas PV panels with $V_{MP}$ less than 17 volts will tend to produce less boost. Additionally, more PV panels will tend to produce more boost, whereas fewer PV panels will tend to produce less boost.

For a system using four 75 watt PV panels with peak power specifications of 4.45 amps @ 17 volts @ 25°C, representative boost performance under a variety of operating conditions is shown in Table 2. Your current boost performance will vary due to a variety of factors. What you can be sure of is that Solar Boost 2000E will automatically deliver the highest charge current possible for a given installation and set of operating conditions.

**TYPICAL CURRENT BOOST PERFORMANCE**
**FOUR 75 WATT PV PANELS**

| BATTERY CONDITION AND VOLTAGE | AMBIENT CONDITIONS | PV INPUT CURRENT | OUTPUT CHARGE CURRENT | PERCENT INCREASE |
|---|---|---|---|---|
| FULLY DISCHARGED 10.9V | 35°F EARLY MORNING | 8.8 AMPS | 12.1 AMPS | 38% |
| HIGHLY CHARGED 13.8V | 45°F CLOUDY, BREEZY | 7.9 AMPS | 9.3 AMPS | 18% |
| HIGHLY DISCHARGED 11.8V | 65°F CLEAR, STILL AIR | 16.7 AMPS | 18.4 AMPS | 10% |
| HIGHLY CHARGED 13.8V | 75°F CLEAR, STILL AIR | 18.5 AMPS | 18.5 AMPS | 0% |

**TABLE 2**

### *HOW MPPT AND CURRENT BOOST WORKS*

A PV panel is a *constant current* type device. As shown on a typical PV panel voltage vs. current curve, current remains relatively constant over a wide range of voltage. A typical 75 watt panel is specified to deliver 4.45 amps @ 17 volts @ 25°C. Traditional PV controllers essentially connect the PV array directly to the battery when battery voltage is low. When this 75 watt panel is connected directly to a battery charging at 12 volts, the PV panel still provides approximately the same current. But, because PV output voltage is now held at 12 volts by the battery rather than 17 volts, it only delivers 53 watts to the battery. This wastes 22 watts of available power.

Solar Boost 2000E's patented MPPT technology operates in a very different fashion. Under these conditions Solar Boost 2000E calculates the maximum power voltage ($V_{MP}$) at which the PV panel delivers its maximum available power, in this case 17 volts. It then operates the PV panel at 17 volts which extracts maximum power from the PV panel. Solar Boost 2000E continually recalculates the maximum power voltage as operating conditions change. This is referred to as Maximum Power Point Tracking (MPPT).

Input power from the MPPT controller, in this case 75 watts, feeds a switching type power converter which reduces the 17 volt input to battery voltage at the output. The full 75 watts which is now being delivered at 12 volts would produce a charge current of 6.25 amps. A charge current increase of 1.8 amps or 40% is achieved by converting the 22 watts that would have been wasted into useable charge current. Note that this example assumes 100%

efficiency to illustrate the principal of operation. In actual operation, boost will be somewhat less as some available power is lost in wiring, connections, fuse and in Solar Boost 2000E.

# INSTALLATION

**WARNING: Read, understand and follow the Important Safety Instructions in the beginning of this manual before proceeding.**

**IMPORTANT: Solar Boost 2000E is not protected against and will be damaged by reverse battery connection to the PV terminals. Install in a dry non-corrosive environment. Damage due to reverse battery connection to the PV terminals, corrosion, or adjustments or connections other than those shown in Figure 3 void the limited warranty.**

## OVER VOLTAGE / REVERSE POLARITY PROTECTION

Solar Boost 2000E is protected against reverse polarity and high voltage transients for both the PV array and the battery. If the battery is connected reverse polarity, Solar Boost 2000E will not operate and there will be nothing shown on the display. If the PV array is connected reverse polarity, Solar Boost 2000E will not provide output current and the PV input current display will show *negative* current. Should high PV current be available during reverse PV connection, the front panel will become quite warm. High reverse PV current applied for an extended period may damage the Solar Boost 2000E and is not covered by the limited warranty.

## ELECTROSTATIC HANDLING PRECAUTIONS

While transient voltage protection is provided for terminal block connections, exposed circuits may be damaged by electrostatic discharge during installation and handling. Discharge yourself by touching a water faucet or other electrical ground prior to handling the unit and avoid touching components on the circuit board. Keep Solar Boost 2000E in it's electrostatic protective bag until the unit is installed. All electronic circuits may be damaged by static electricity and these instructions combined with special packaging are provided to minimize the possibility of damage. The risk of electrostatic damage is highest when relative humidity drops below 40%.

## ENABLING TEMPERATURE COMPENSATION

For temperature compensation to operate, the SensorLug battery temperature sensor must be installed and temperature compensation must be enabled. The sensor is electrically isolated and mounts directly to any battery terminal. Note that connections are polarized (red/black), and must be connected as shown in Figure 3**.**

| SWITCH 3 | SWITCH 4 | TEMPERATURE COMPENSATION |
|---|---|---|
| OFF | OFF | DISABLED |
| **ON** | **ON** | LEAD-ACID BATTERY –30.0 millivolts/°C |
| **ON** | OFF | NiCd (10cell) –20.0 millivolts/°C |

WARNING: Solar Boost 2000E cannot control battery voltage if temperature compensation is enabled with the sensor installed reverse polarity, and will not provide output current if temperature compensation is enabled with the sensor not installed.

## CHARGE VOLTAGE

The factory setting of approximately 14.0 volts is suitable for most liquid electrolyte batteries in a predominately cycling application and does not require adjustment. For a predominately float application, a somewhat lower voltage of perhaps 13.8 volts may be beneficial in decreasing water loss. For a heavily cycling application, a somewhat higher voltage of perhaps 14.3 volts may be beneficial in decreasing charge time and increasing amp-hours delivered. If you need to change the setting, 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 as desired. If the SensorLug temperature compensation option is installed, first turn switches #3 & 4 off to disable temperature compensation. The SensorLug does not need to be disconnected. Adjust the charge voltage to the desired 80°F value, and then turn temperature compensation back on.

## 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 panels. These panels typically list $V_{OC}$ at ≈21.4 volts and $V_{MP}$ at ≈17.0 volts, which yields; 21.4V - 17.0V = 4.4V.

### *OPTIMIZING MPPT*

As indicated above, the peak power voltage setting ($V_{OC} – V_{MP}$) is a nominal value. 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 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.

## SOLAR BOOST 2000E INSTALLATION

The Solar Boost 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 damage circuit board components as this damage is not covered under the limited warranty. Figure 5 provides a 1:1 template for the panel cut-out. A surface mounting box is also available as RVPP part number 720-0011-01.

**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.**

## SYSTEM WIRING

Wiring requirements for Solar Boost 2000E are somewhat different than traditional PV controllers. While the performance of other controllers may be affected by wiring, wiring and connections used with Solar Boost 2000E can have a significant effect on current boost performance. Solar Boost 2000E increases charge current by transforming previously wasted 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. RV Power Products offers a variety of low resistance installation and wiring kits to make installation easy and get the most out of your new Solar Boost 2000E.

## SOLAR BOOST 2000E SETUP ADJUSTMENTS AND FIELD CONNECTIONS

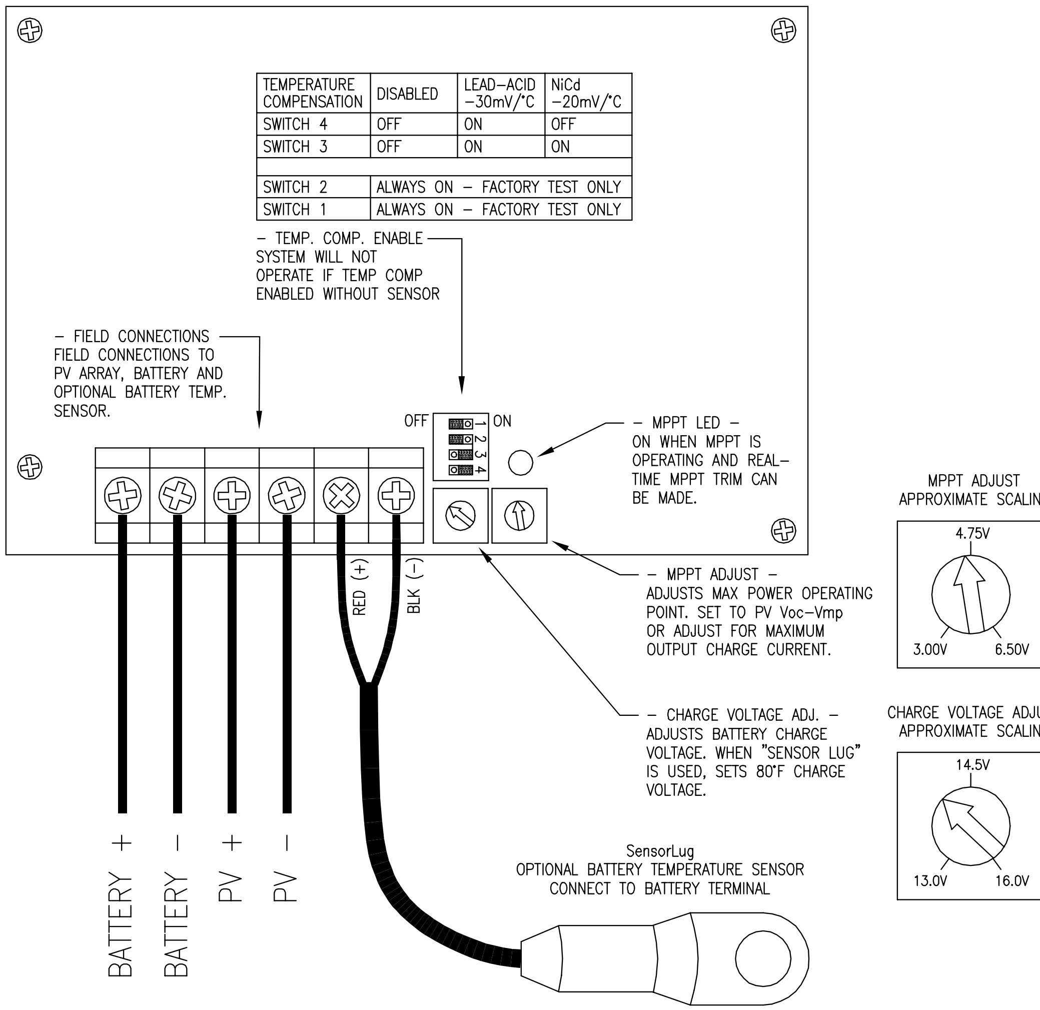
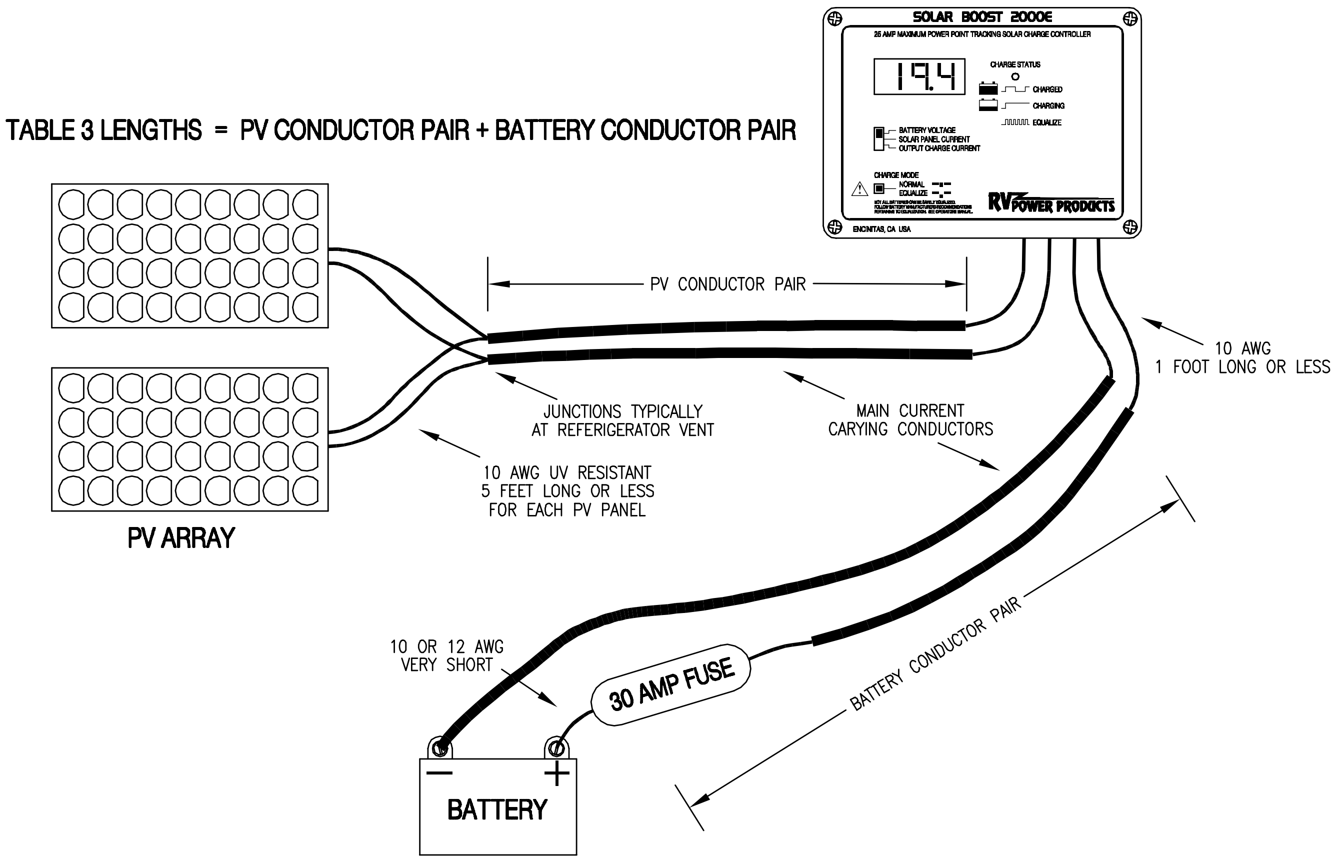



**FIGURE 3**

A desirable installation would produce a total system wiring voltage drop of 0.6 volts or less, which can be achieved using the wiring method shown in Figure 4 and wire sizes shown in Table 3. The wire lengths shown in Table 3 will provide a maximum voltage drop of 0.42 volts (4% of 14 volts), with the remainder of the 0.6 volts consumed by connections, fuse and so on. Note that lengths in Table 3 are shown for PV short circuit current values of 10 amps and 20 amps. For other values of PV short circuit current, maximum wire lengths scale inversely proportional to current, such that half the current doubles the maximum wire length. For example, two 75W panels with $I_{SC}$ = 4.45 amps could be wired with up to 22.8 feet of 10AWG wire ((10 ÷ (4.45 x 2) x 20.3ft).

Table 3 is meant to serve as a wire size guide which will lead to good boost performance with reasonable wire sizes. The lengths shown in Table 3 are one way from the PV array to the battery, with the Solar Boost 2000E placed somewhere along the path. Larger wire sizes will improve boost performance whereas smaller wire sizes will reduce boost performance. If the preferred wiring described here is not practical or possible, Solar Boost 2000E will still properly charge the battery but current boost performance may be diminished.

# PREFERRED WIRING METHOD




## Figure 4

The preferred wiring method shown in Figure 4 employs smaller wire sizes where necessary (roof wiring, panel connections and fuse), and larger wire sizes where possible (long wire runs between PV array, panel and battery). Use 10AWG UV resistant cable to connect from the PV Panel(s) to the vicinity of the refrigerator vent or other connection area, where the UV resistant 10AWG cable(s) connect to the PV conductor pair. As shown in Figure 4, short lengths of 10AWG wire should be used to connect this conductor pair to the Solar Boost 2000E terminal block. Figure 3 shows the terminal block connections which will directly accept wire up to 10AWG. Connection to the battery is made in a manner similar to PV wiring, except that a 30 amp fuse or circuit breaker must be installed in the positive wire near the battery. Select a fuse holder with physically large internal components and a wire size of at least 12AWG.

## MAXIMUM ONE WAY WIRE LENGTH FOR LESS THAN 0.42 VOLT DROP

| WIRE GAUGE AWG | MAX LENGTH @ 20 AMPS FEET / METERS | MAX LENGTH @ 10 AMPS FEET / METERS |
|---|---|---|
| 12 AWG | 6.4 / 2.0 | 12.8 / 3.9 |
| 10 AWG | 10.2 / 3.1 | 20.3 / 6.2 |
| 8 AWG | 16.2 / 4.9 | 32.3 / 9.0 |
| 6 AWG | 25.7 / 7.8 | 51.4 / 15.7 |
| 4 AWG | 40.8 / 12.4 | 81.7 / 24.9 |
| 2 AWG | 64.9 / 19.8 | 129.9 / 39.6 |
| 1/0 AWG | 103.3 / 31.5 | 206.7 / 63.0 |

## TABLE 3

# 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 | ±25A |
| 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 |
| Charge temp. coefficient. | -30.0mV/°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) |

# THREE YEAR LIMITED WARRANTY

RV Power Products, Inc. (hereinafter RVPP), hereby warrants to the original consumer purchaser, that the product or any part thereof will be free from defects due to defective workmanship or materials for a period of three (3) years subject to the conditions set fourth below. If within the coverage of this limited warranty, RVPP will repair or replace the product at RVPP's discretion. During year one (1), parts and labor are provided at no cost. During years two (2) and three (3), parts are provided at no cost and labor is charged at RVPP's prevailing labor rate. The original consumer purchaser is responsible for all transportation costs and insurance.

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 original consumer purchaser.

3. This limited warranty does not apply to any product or part thereof damaged by; a) alteration or disassembly, b) repair or service not rendered by an RVPP authorized repair facility, c) accident or abuse, d) corrosion, or e) operation or installation contrary to instructions pertaining to the product.

4. RVPP's liability for any defective product or any part thereof shall be limited to the repair or replacement of the product, at RVPP's discretion. RVPP will 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. Some states do not allow exclusions or limitations of incidental or consequential damages, so the above limitation may not apply to you.

5. Any implied warranty for merchantability or fitness for a particular purpose is limited in duration to the length of this warranty. Some states do not allow exclusions or limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

6. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

7. To obtain warranty repairs, contact RVPP at 800-493-7877 or 760-944-8882 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. A copy of the purchase receipt identifying original consumer purchaser must accompany the product to obtain warranty repairs.

**RV Power Products, Inc.**
**1058 Monterey Vista Way**
**Encinitas CA, 92024, USA**

# 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. |
| Display OK, but system will not turn on (charge status LED off) | PV disconnected<br><br>PV reverse polarity<br><br>PV- connected to BAT- | Verify PV connection. Requires PV to supply at least 0.15A at ≈14V to begin charge.<br><br>Reverse polarity PV will cause front panel to heat, and display to show "negative" PV current if battery is connected.<br><br>PV- & BAT- must be separate for proper operation. PV- must receive earth ground via shunts in the SB2000E 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. |
| Charge status LED on in Constant Voltage mode but no output charge current | Battery voltage greater than charge voltage setpoint<br><br>Temp comp. enabled without sensor, or sensor failed open | This is normal operation. Output is off due to high battery voltage which may be caused by other charging systems.<br><br>Disable temp compensation, or replace sensor. Proper temp sensor terminal voltage when connected is 2.98V at 25°C, changing at +10mV/°C. |
| 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. |
| 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<br><br>Temp sensor failed short, or installed reverse polarity | Disable equalize by pressing the equalize pushbutton.<br><br>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<br><br>Worn out PV modules<br><br>Low insolation<br><br>PV- connected to BAT-<br><br>MPPT improperly setup | Normal operation, system will be in Constant Voltage mode and current is reduced to control battery voltage.<br><br>Replace, or use as is.<br><br>Atmospheric haze, PV's dirty, sun low on horizon, etc.<br><br>PV- & BAT- must be separate for proper operation. PV- must receive earth ground via shunts inside the SB50 which internally connect PV- to BAT-. External connection prevents proper operation of the internal current measurement system.<br><br>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<br><br>PV's hot<br><br>MPPT improperly setup | 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.<br><br>Excessive PV wiring voltage drop due to undersize wiring, poor connections, etc., consumes and wastes available power. This simulates having PV's with low $V_{MP}$.<br><br>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.<br><br>$V_{MP}$ 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.<br><br>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. |

**MOUNTING TEMPLATE** (may not print 1:1 in printed .pdf file)

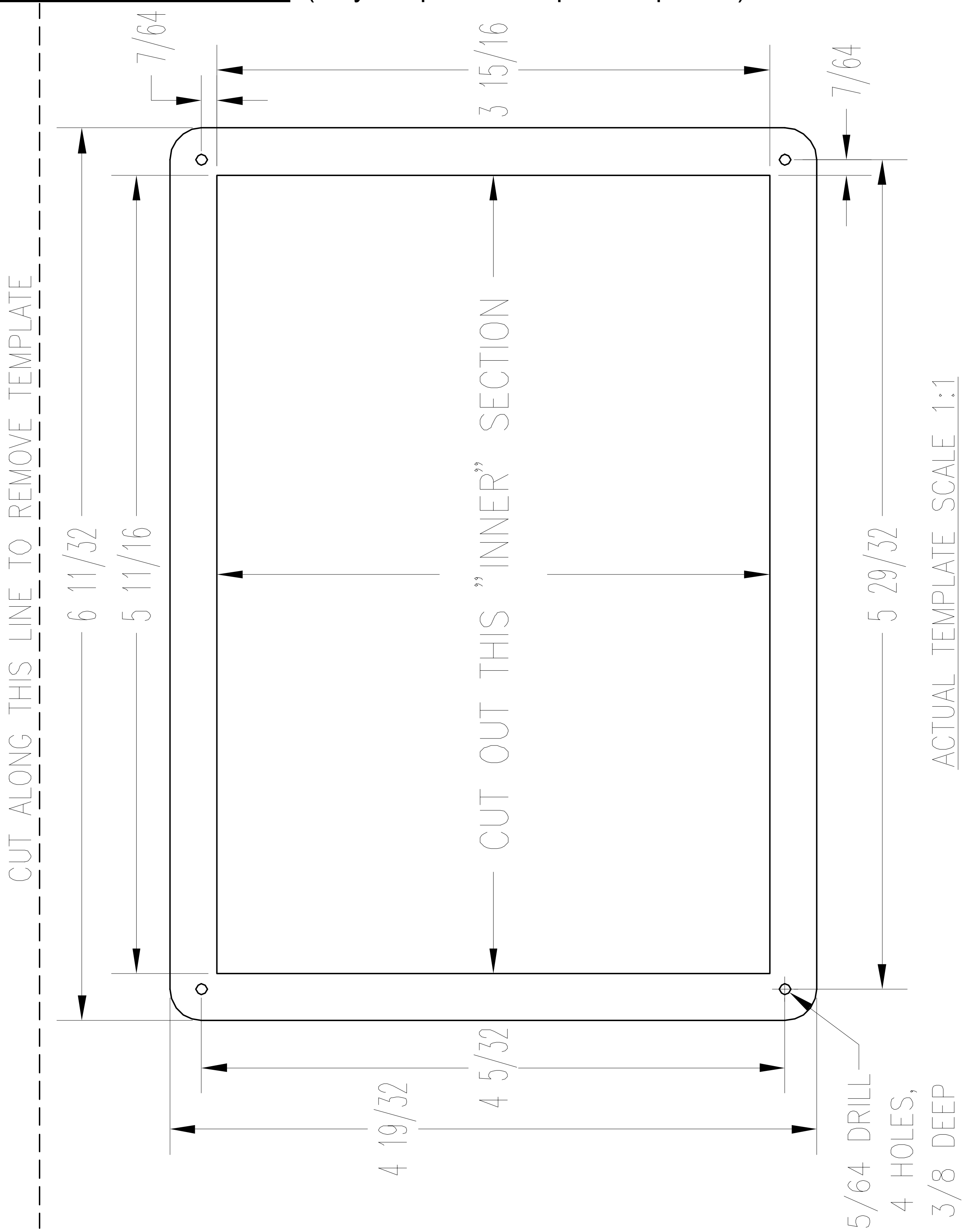



**Figure 5**