Morningstar Corporation

Columbia, Maryland USA

Bench Testing Morningstar SunSaver Controllers

Important Information:

- The bench testing procedure pertains to individuals with access to external power sources, a battery, and the various tools and materials outlined below. For on-site testing or troubleshooting of the SunSaver controller where a power supply is not available, refer to the SunSaver Field Testing document.

- Due to the fabrication process of the SunSaver controller, it may only be possible to determine if the unit is functioning properly. The exact damaged component or part may not be evident. Other factors however, may be apparent that will enable the technician to determine the cause for failure. These factors include, but are not limited to:
  burned leads
  excessive loads
  evidence of short circuits on load leads
  over-rated current input

Recommended Tools:

- Digital Multi-meter with fine tip probes (frequency and duty cycle measurements helpful)
- Phillips Screwdriver
- Flat Bladed Screwdriver

Materials and Equipment:

- Small motorcycle type battery (12V)
- Variable power supply capable of supplying 2A @ 15-20Vdc
- 12V/2A load (e.g. type 1156 automotive lamp with socket)
- Short length (8-12cm) of 12AWG($3.23mm^2$) solid wire

Caution:

The procedures outlined below assume a basic knowledge of electric circuits. Exercise the necessary precautions when dealing with the live circuits present in solar energy systems.

Testing Procedure:

Step 1: *No Power* Applied to the SunSaver

A) With no power applied to the SunSaver, check for short circuits to ground between the following terminals:

i)PV (+) and PV (-) terminals
ii)Battery (+) and Battery (-) terminals
iii)Load (+) and Load (-) terminals

B)If the controller has LVD, check the LVD FET by measuring a diode drop between the Battery (+) and Load (+) terminals. If no diode drop is present or if an open circuit is measured, the LVD FET is damaged. If there is a short circuit between the terminals, the unit will still (most likely) regulate the battery voltage properly, however the controller will no longer have LVD capability.

C)Check for continuity between the ground connections on the terminal strip (PV(-), Battery (-) and Load (-)). If an open circuit exists between any of the ground terminals, the controller has a damaged ground trace. The unit is not operational.

D)Remove the 4 screws from the face plate. Bend a small hook in the end of the 12AWG(3.23 mm^2) wire. Insert the hook into one of the open screw holes and pull of the face plate. The face may be stuck to the internal potting and may make a cracking sound when removed. This is normal and will not damage the internal circuitry. Inspect for burns, damaged traces etc.

Step 2: Power Supply connected to battery terminals of the SunSaver

A) Adjust the Power supply output voltage to about 13.5Vdc. Check the voltage at the battery terminals with a multi-meter.
B) Attach the 2A load to the Load terminals of the SunSaver. The load should operate correctly (assuming the power supply is capable of driving the load).
C) If the SunSaver is equipped with the LVD option, adjust the voltage down to about 11.0Vdc. The Red LVD LED should light and the load should turn off when the voltage drops below 11.4Vdc. Adjust the power supply voltage to 14Vdc, the red LED should go out and the load should turn on.

Step 3: Only Battery Connected to the Battery Terminals

Note: The green “Charging” LED should be off.

A) Using a multi-meter, measure the voltage at the battery terminals.

B) Using a multi-meter, measure the voltage at the load terminals. The voltage should be the same as the battery voltage. If it is significantly lower, the LVD FET's or the power traces inside the SunSaver are damaged.
C) Using a multi-meter, measure the voltage at the array terminals. The voltage should be less than 2.5Vdc. If the Green LED is on and/or if battery voltage is measured, the input FET's are damaged and the unit will not regulate the Battery voltage properly.

Step 4: Power Supply connected to PV Terminals and Battery connected to the controller.

A) Adjust the Power supply voltage to 14.0Vdc and limit the power supply current to about 2 Amps. The green "Charging" LED should be lit.
B) The voltage across the PV terminals should be the same as the voltage across the Battery terminals if the batteries are not fully charged.
C) Disconnect the power supply.
D) Adjust the output voltage of the power supply to 15Vdc and reconnect the power supply to the PV terminals. If the batteries are charged, there will be a voltage difference between the Battery (+) terminal and the PV (+) terminal. If the multi-meter has a frequency measuring option, a 300Hz AC signal should be measured between Battery (+) and PV (+). The duty cycle of this signal can also be measured to give a rough indication of the battery state of charge. The lower the duty cycle, the more fully charged the battery.

Step 5: Power Supply Connected to PV, Connected Battery and a Small (2A) Load Connected to the Controller

Note: This test will provide a simple system to verify the correct operation of the controller.

A) Adjust power supply voltage to approximately 15Vdc.
B) With the lamp turned on, measure the load voltage, it should be within 20-30 mV of the battery voltage. If it is more than 0.25V lower than the battery voltage, the LVD FET's are damaged.

Step 6: SunSaver Installed in the Power System.

A) Check the correct operation of the SunSaver based on the above tests.
B) Check the condition of any fuses that might be in the power path.
C) Verify the system wiring is correct and intact.
D) Check all connections and terminals for good electrical contact.