

# **SUNKEEPER™**

## **Solar Charge Controller**

### ***Installation and Operation Manual***



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### ***Junction Box ( J-Box) Mounted Solar Controller***

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#### **Models**

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<b>SunKeeper-6</b>	<b>6A / 12V</b>
<b>SunKeeper-12</b>	<b>12A / 12V</b>



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# 1.0 Safety Instructions

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**SAVE THESE INSTRUCTIONS** – This manual contains important instructions that should be followed for proper installation and maintenance.

Read all of the instructions and cautions in the manual before starting the installation.

**WARNING** – Be very careful when working with batteries. Lead-acid batteries can generate explosive gases, and short circuits can potentially draw hundreds or thousands of amps from the battery.

Do not exceed the voltage or current ratings of the controller. Use only with a 12V battery.

There are no user serviceable parts in the SunKeeper. Do not disassemble or attempt to repair.

The negative system conductor should be properly grounded per U.S. National Electric Code (NEC) guidelines for most effective lightning protection.

# 2.0 Installation

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## 2.1 Installation Notes

**Hazardous Locations:** The SunKeeper family of charge controllers has been listed to UL1604 and CSA 22.2 No.213-M1987 for use in Class 1, Division 2, Groups A, B, C and D hazardous locations. In order to comply with the UL and CSA standards, the installation should follow the requirements of the National Electrical Code Article 501-4(b) and/or Canadian Electrical Code Article 18-156 when installing a SunKeeper in a Hazardous (Classified) Location.

**System Wiring:** Use copper wire only. Power conductors should be joined or spliced using insulated butt splice solderless crimp connectors or by brazing, welding, or soldering wire ends. If soldered, the spliced joint should be mechanically and electrically secure before soldering. All splices and joints should be covered with insulation equivalent to that of the conductors.

**System Fusing:** The battery positive lead should be fused no further than 12 inches (305 mm) from the battery.

SK-6	8A fuse
SK-12	16A fuse

**Temperature Compensation Select:** The SunKeeper has three temperature compensation options. The blue Temperature Compensation Loop can be configured for the following temperature compensation options:

- ◆ *Loop not cut:* Internal temperature sensor used for temperature compensation (factory default).
- ◆ *Loop cut, left open:* No temperature compensation. Insulate/cap loose ends.
- ◆ *Loop cut, connected to RTS:* Remote Temperature Sensor (RTS)\* used for temperature compensation.

\* The RTS is an optional Morningstar accessory purchased separately. Only use a Morningstar RTS with the SunKeeper.

**Cover the Solar Module(s):** Keep the solar module out of sunlight or covered with an opaque sheet until installation is complete.

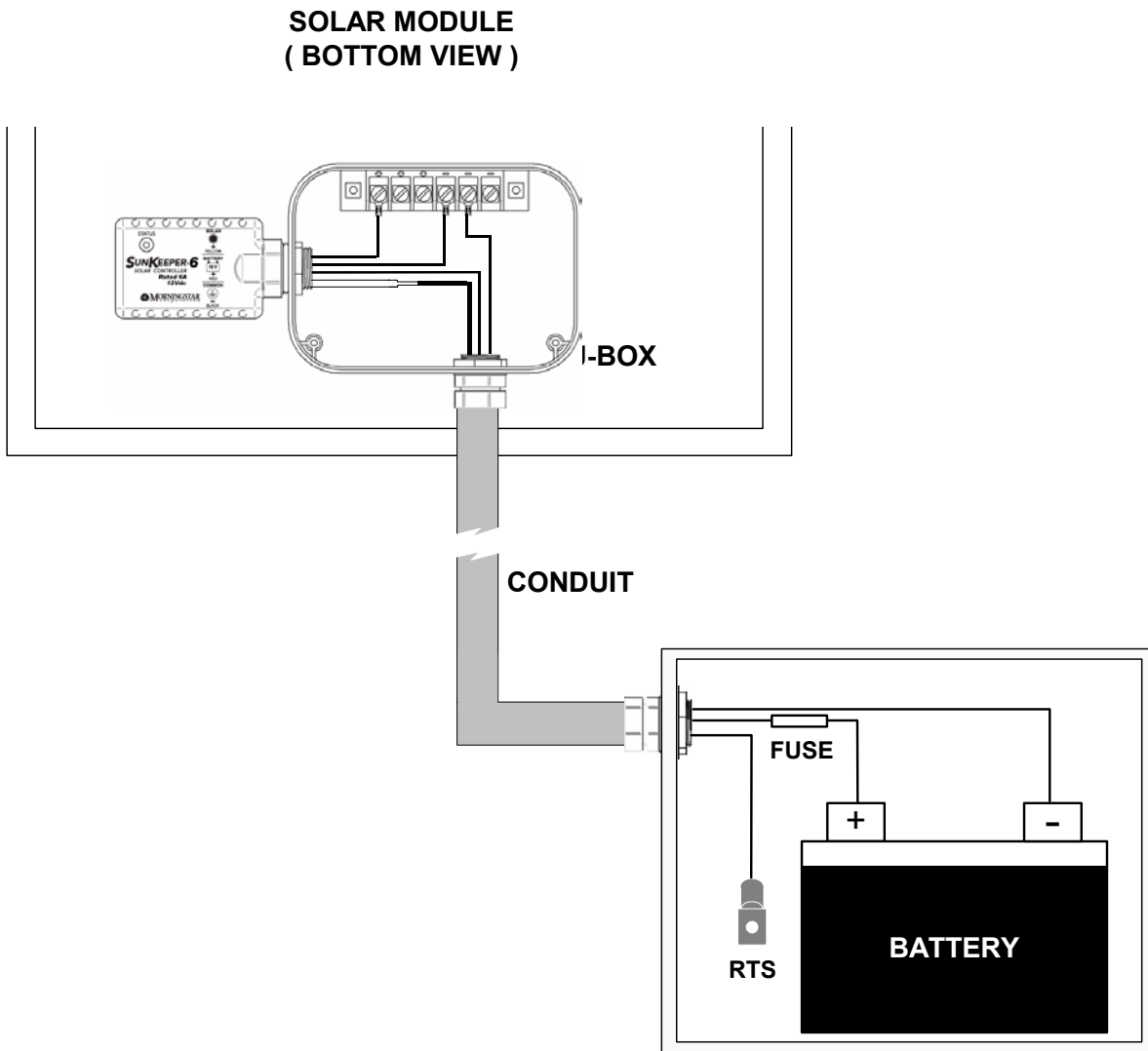
### **SunKeeper Wire Lead Definitions:**

Solar +	Yellow
Battery +	Red
Common Negative	Black
RTS Option	Blue Loop

NOTE: The RTS connection has no polarity. The red and black RTS wires may be wired to either of the blue Temperature Compensation Loop leads.

## 2.2 Mounting to a J-box

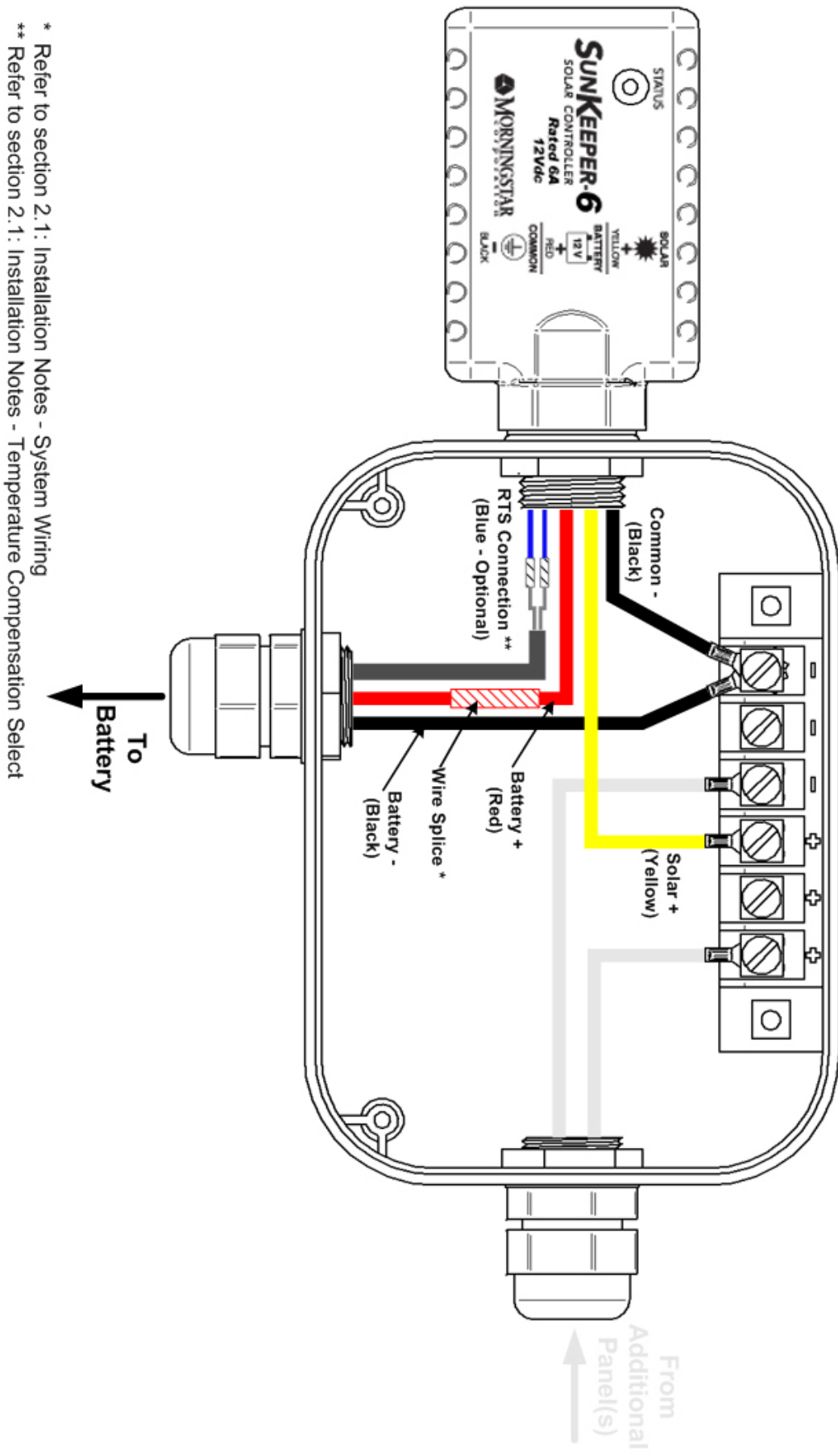
**NOTE:** Complete steps 1 through 7 before mounting the solar module.



**Figure 1. Typical System**

1. Remove the solar module j-box cover (refer to solar module documentation if necessary).
2. Unscrew the SunKeeper locknut and remove the plastic mounting feet. Store the mounting feet in a safe place. They are not needed when mounting to a j-box.

3. On the solar module j-box: choose knockouts or drill 7/8 inches (22.2 mm) holes for the SunKeeper and 1/2" conduit entry into the j-box. If drilling holes, choose locations that will allow easy wiring access to the solar module power terminals and easy exit into the 1/2" conduit.
4. Insert the SunKeeper leads into the chosen knockout or drilled hole.
5. Thread the SunKeeper leads through the locknut and slide the locknut down to meet the threaded neck of the SunKeeper.
6. Screw the locknut hand-tight onto the threaded neck of the SunKeeper. The rubber o-ring should seat firmly against the j-box outside wall around the perimeter of the hole forming a watertight seal. When satisfied that a good seal is made, fully tighten the locknut.
7. Pull 2 cables for battery positive and battery negative as well as the RTS sensor lead (if using an RTS) through the conduit.
8. On the SunKeeper: select the temperature compensation configuration required (Refer to section 2.1: *Installation Notes -Temperature Compensation Select*) .  
If using an RTS:
  - a. Cut the blue Temperature Compensation Loop on the SunKeeper in the middle of the loop creating two (2) equal length wire leads.



\* Refer to section 2.1: Installation Notes - System Wiring

\*\* Refer to section 2.1: Installation Notes - Temperature Compensation Select

Figure 2. J-Box Wiring

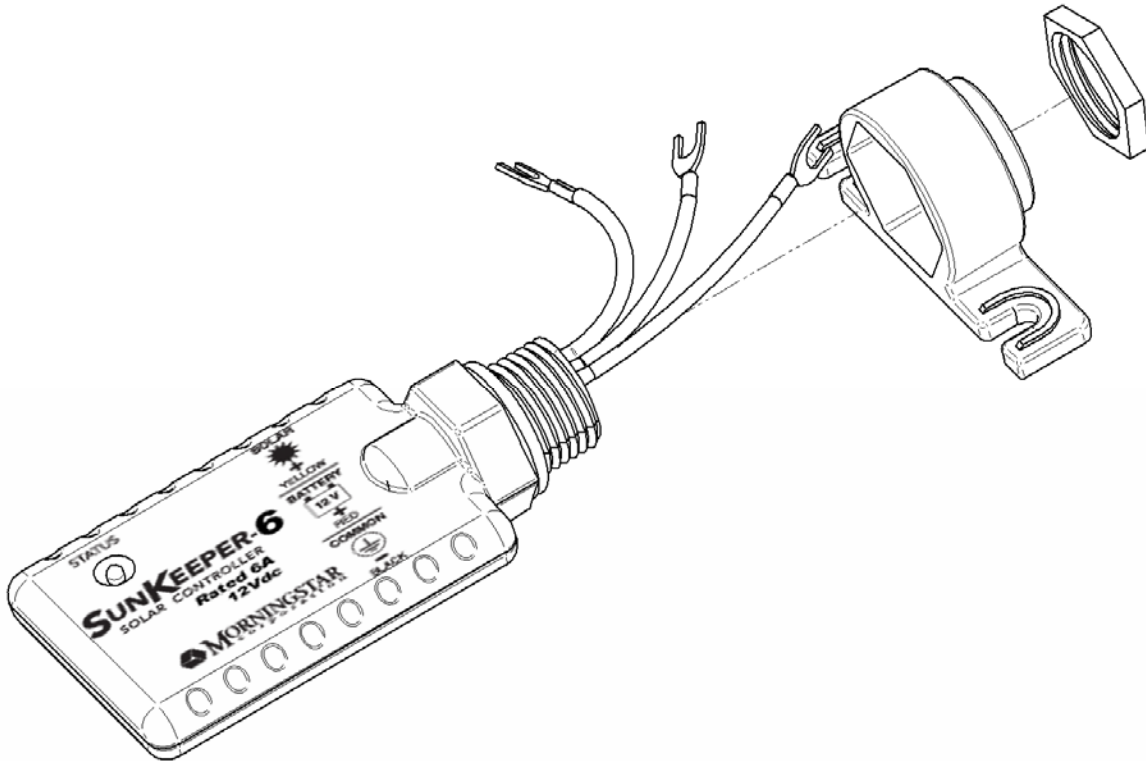


- b. Strip ½” (13 mm) of insulation off each of the leads.
  - c. Crimp or splice the two (2) blue wire leads to the two RTS wires (red & black). Polarity is not important. Refer to section 2.1: *Installation Notes - System Wiring*.
9. Wire the SunKeeper as shown in Figure 2. Wiring may differ slightly depending on the solar module manufacturer. Terminal locations and the number of terminals may also differ. Splices may not be necessary if extra junction terminals are provided. Refer to the documentation supplied with the solar module.
  10. In the battery box, wire an in-line fuse holder and fuse to the Battery + cable. Connect the battery cables to the battery lugs. Refer to section 2.1: *Installation Notes - System Fusing*.
  11. If a Morningstar RTS is used, secure the RTS terminal lug to a battery lug.
  12. Uncover the solar module and replace the j-box cover.

## **2.3 Surface Mounting**

**CAUTION:** To conform to Class 1, Division 2 Group A,B,C,D hazardous location requirements, the SunKeeper and wiring must be contained inside an approved enclosure.

1. Plastic mounting feet are included with the SunKeeper to allow for surface mounting.



**Figure 3. Mounting Feet Assembly**

2. Assemble the SunKeeper, mounting feet, and locknut as shown in Figure 3.
3. Place the SunKeeper on the surface where it will be mounted and determine where the wires will be routed. Be sure there is sufficient bending room for the wires. With a pen or pencil, mark the location of the screws.
4. With a drill and 1/8" (3 mm) bit, drill pilot holes for both mounting screws where marked in step three (3).

5. Place the SunKeeper onto the surface and align the two (2) mounting feet slots with the pilot holes. Use #10 (M5) pan-head screws (not supplied) to secure the SunKeeper to the surface.
6. On the SunKeeper: select the temperature compensation configuration required (Refer to section 2.1: *Installation Notes - Temperature Compensation Select*) .  
If using an RTS:
  - a. Cut the blue Temperature Compensation Loop on the SunKeeper in the middle of the loop creating two (2) equal length wire leads.
  - b. Strip ½” (13 mm) of insulation off each of the leads.
7. Wire the SunKeeper to the RTS (if used) and the solar module. Refer to section 2.1: *Installation Notes – SunKeeper Wire Definitions*.
8. In the battery box, wire an in-line fuse holder and fuse to the Battery + cable. Connect the battery cables to the battery lugs. Refer to section 2.1: *Installation Notes - System Fusing*.
9. If a Morningstar RTS is used, secure the RTS terminal lug to a battery lug.
10. Uncover the solar module.

## 3.0 LED Indications

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**Green LED (blinks 3 times):** Indicates correct installation. Displayed at installation start up (when solar or battery power is first applied).

**Green LED (ON):** Bulk charging stage. Solar power is available and the battery is being charged. A single blink of the green LED every 5 seconds indicates that the SunKeeper is still operational.

**Green LED (fast blinking):** Regulation / Float stage. The battery has charged to Regulation voltage, solar power is being limited to prevent over-charge. When the battery is fully charged at Regulation voltage, the SunKeeper will transition to Float stage and the green LED will continue blinking.

**No LED (OFF):** Night condition. No solar power is available for charging. The SunKeeper is in sleep mode until solar power becomes available. A single blink of the green LED every 5 seconds indicates that the SunKeeper is still powered and operational.

**Red (blinking) LED:** System installation error and/or operation fault. See Section 6.2 in *Troubleshooting*.

**Red (ON) LED:** Critical fault. See Section 6.3 in *Troubleshooting*.

# 4.0 Operation

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## 4.1 Operator's Tasks

The SunKeeper is a fully automatic solar charge controller that includes many electronic functions to protect both the controller and the system.

**The only manual tasks performed by the operator are:**

- a. Installation (see section 2.0)
- b. Temperature Compensation selection (see section 2.1 – *Temperature Compensation Select*)
- c. Routine Maintenance (see section 5.0)

## 4.2 Charging Algorithm

The SunKeeper battery charging algorithm is optimized for sealed lead-acid batteries. There are four main stages to the charging algorithm:

**Night** – There is no solar power available, the solar module is disconnected from the battery to prevent nighttime reverse current leakage.

**Bulk Charge** – Solar power is available, the battery is recharging and has not yet reached full state-of-charge.

**Regulation** – The battery has charged to the Regulation setpoint, the SunKeeper is limiting

solar charging current to prevent battery over-charge while bringing the battery to full state-of-charge.

**Float** – The battery has reached full state-of-charge and the SunKeeper has reduced battery voltage to the lower Float setpoint.

## 4.3 Charging Features

**Temperature Compensation** - Lead-acid battery chemistry changes with temperature. The SunKeeper adjusts the Regulation and Float voltage setpoints as temperature changes so that the battery is correctly charged. The user may choose to add an RTS (purchased separately), or use the internal temperature sensor. Temperature compensation can also be disabled. See section 2.1 for more information.

**Maximum Charge Voltage** – The SunKeeper limits the charge voltage to 15V, regardless of ambient temperature, so that voltage-sensitive DC loads are not damaged.

**Night Disconnect** – The SunKeeper periodically checks for nighttime condition. When night is detected, the SunKeeper disconnects the solar module to prevent reverse current leakage. An external blocking diode is not required.

## 4.4 Protections

The SunKeeper is fully protected against system faults listed below. Recovery is automatic except where noted below. Refer to section 3.0 for fault LED indications.

**Reverse Polarity Solar (LED OFF)** – no charging, disconnects solar module *until wired with correct polarity*.

**Reverse Polarity Battery (red blinking LED)** – no charging, displays fault *until battery wired with correct polarity*.

**Short Circuit Solar (LED OFF)** – stops charging until short clears or will enter Night stage (LED OFF) if fault persists.

**Charging Over-current (red blinking LED)** – charging current has exceeded SunKeeper current rating; fully automatic recovery; retry every 10 seconds.

**High Temperature Condition (red blinking LED)** – ambient temperature is too high; charging automatically resumes when SunKeeper has cooled to a safe temperature.

**Temperature Sensor Failure (red blinking LED)** – detects a failure in the SunKeeper's internal temperature sensor or a disconnect of the Remote Temperature Sensor (if used). *Fault persists until the problem is corrected.*

## 5.0 Inspection and Maintenance

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The following inspections and maintenance tasks are recommended at least once per year for best controller performance.

- ✓ Inspect for loose or broken connections at the battery. If an RTS is installed, be sure the RTS terminal lug is secured to a battery terminal.
- ✓ Check the wires and cables for frays, pinches, or other insulation damage.
- ✓ Inspect the SunKeeper plastic case for damage.
- ✓ Verify that the o-ring still maintains a seal against the j-box outside wall.
- ✓ Open the solar module j-box and inspect for water ingress. Also inspect the j-box wiring for corrosion and loose connections.
- ✓ Check that the SunKeeper functions and the LED indicator are correct for the system conditions at that time.



# 6.0 Troubleshooting

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The SunKeeper continuously monitors for system faults (blinking red LED) and critical SunKeeper internal circuit faults (solid red LED). This section explains how to test a SunKeeper for correct operation and provides troubleshooting checklists for both types of faults.

## 6.1 Testing for Correct Operation

The SunKeeper operation can be verified by simply measuring a few voltages. You will need a volt or multi-meter to take voltage measurements. If testing the SunKeeper on a bench, a power supply which is current limited to 2A and 15V can be used instead of a solar module.

1. Disconnect the battery and solar module from the SunKeeper.
2. Connect a battery (11V or more) to the SunKeeper battery leads. Verify that the LED blinks green 3 times on power-up. The LED should remain off after start-up (Night condition).
3. Measure the voltage on the SunKeeper Solar input leads (Solar + to Common -). The voltage on the Solar input leads should be approximately half of the measured battery voltage. If the voltage is zero volts or about the same as

battery voltage, there is a problem with the SunKeeper.

4. Disconnect the battery.
5. Connect the solar module (in full sun) to the SunKeeper Solar input leads. The LED should blink 3 times. After a few seconds the LED should begin blinking green (Regulation).
6. Measure the output voltage on the open Battery leads (Battery + to Common -). Voltage should exist on the Battery leads, however **the output voltage will NOT be 14.1V**. The output voltage is a pulsed waveform. The multimeter will display the average or RMS of the waveform. If there is no voltage output, the SunKeeper may be damaged.
7. Keep the solar module connected and connect the battery to the Battery output leads. If the SunKeeper is in Bulk charge (solid green LED), the voltage on the Solar Input terminals should be the same as the voltage on the Battery output leads. If the SunKeeper is in Regulation (blinking green LED), the battery voltage should be maintained at full charge voltage.

## 6.2 Flashing Red LED

Installation Error or Operation Fault  
(SunKeeper is not damaged)

A red flashing LED indicates that a fault exists in the system or the SunKeeper faulted during operation. Corrective action is needed. Check the system for the following conditions:

**Reverse Battery** – The battery connection is reversed at the SunKeeper or at the battery terminals. Disconnect the battery connection at the SunKeeper and measure the voltage with a voltmeter. Verify correct polarity. Connecting the battery with correct polarity will clear the fault condition.

**RTS Disconnected** – If a Remote Temperature Sensor is wired to the SunKeeper, the cable may be pinched or broken. Inspect the RTS cable and connections for frays or breaks. Properly reconnecting the RTS will clear the fault condition.

**Over-current Condition** – The charging current exceeds the current rating of the SunKeeper. Be sure that the solar output from the solar module(s) does not exceed the 6A (SK-6) or 12A (SK-12) maximum charge current rating.

**High Temperature Disconnect** – The SunKeeper internal temperature has exceeded safe limits. This fault condition will automatically clear when

the SunKeeper internal temperature has cooled to a safe operating temperature.

## **6.3 Solid Red LED**

Critical Faults  
(SunKeeper may be damaged)

If the SunKeeper Status LED indicates a Solid Red critical fault, the SunKeeper should be removed from service immediately.

**Internal Temperature Sensor Failure** – The internal temperature sensor has failed. The SunKeeper can no longer monitor internal temperature, which is critical for proper battery charging.

**Damaged Power Transistors** – Power transistors switch the charging current in the SunKeeper. If the power transistors or the circuitry that control them is damaged, the SunKeeper can no longer control current. The SunKeeper may over-charge the battery or not allow any charging current.

# 7.0 Warranty

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The SunKeeper is warranted to be free from defects in material and workmanship for a period of FIVE (5) years from the date of shipment to the original end user. Morningstar will, at its option, repair or replace any such defective products.

## **CLAIM PROCEDURE**

Before requesting warranty service, check the Operator's Manual to be certain that there is a fault with the SunKeeper. Return the defective product to your authorized Morningstar distributor with shipping charges prepaid. Provide proof of date and place of purchase. To obtain service under this warranty, the returned products must include the model, serial number and detailed reason for the failure. This information is critical to a rapid disposition of your warranty claim. Morningstar will pay the return shipping charges if the repairs or replacement are covered by the warranty.

## **WARRANTY EXCLUSIONS AND LIMITATIONS**

This warranty does not apply under the following conditions:

- Damage by accident, negligence, abuse or improper use.
- Unauthorized product modification or attempted repair
- Damage occurring during shipment

THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHERS, EXPRESS OR IMPLIED. MORNINGSTAR SPECIFICALLY DISCLAIMS ANY AND ALL IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. No Morningstar distributor, agent or employee is authorized to make any modification or extension to this warranty.

MORNINGSTAR IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DOWNTIME, GOODWILL OR DAMAGE TO EQUIPMENT OR PROPERTY.

# 8.0 Technical Specifications

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## Electrical

Nominal System Voltage	12 V
Maximum Solar Input Voltage	30 V
Rated Solar Input:	
SK-6	6 A
SK-12	12 A
Self-consumption Current	< 7.0 mA (charging) ~2.0 mA (night)
Battery Operating Range	0 – 15 V
Battery Charging Setpoints:	
Regulation Voltage	14.10 V (@ 25C)
Float Voltage	13.70 V (@ 25C)
Temperature Compensation	-30 mV / C
Maximum Charge Voltage Limit	15V

## Mechanical

Power Wires (red-yellow-black)	2.0 mm <sup>2</sup> / 14 AWG
RTS Wire Loop (blue)	0.13 mm <sup>2</sup> / 22 AWG
Leads Conductor Material	Copper
Weight	0.11 kg / 0.25 lbs
Dimensions	99x51x13 mm / 3.9x2.0x0.5 in
Knockout Size	M20 / PG 13.5 / ½ ”

## Environmental

Ambient Temperature Range	-40 C / -40 F to 70C / 158 F
Storage Temperature Range	-55C / -67 F to 85C / 185 F
Humidity	100 %
Oxygen Concentration	< 21 % by vol.
Atmospheric Pressure	1 atm

## **Protections**

Reverse Polarity – Solar and Battery

Short Circuit Solar

Charging Over-current

High Temperature shut-down

Temperature Sensor Failure

Nighttime Reverse Current Leakage (no blocking diode needed)

## **Certifications**

CE

UL 1604 and CSA 22.2 No. 213-M1987 for use in Class 1, Division 2, Groups A,B,C,D hazardous locations

*Specifications subject to change without notice.*

For product and purchase inquiries contact:

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