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Light System – Solar Powered

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Section 1

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Section 2

General Information

This manual consists of information, which will be useful in the operation and maintenance of the Miner Light System. It includes operating, maintenance and troubleshooting procedures along with illustrations to assist in identifying various components.

Carefully read and understand the SAFETY PRECAUTIONS SECTION of this manual; in addition to safety, precautions prescribed by the AAR, FRA, and individual handling railroads.

It is expressly understood that issuance of these Miner instructions which were prepared in good faith and are believed to be complete and accurate, shall not be construed to mean that Miner Enterprises, Inc. assumes any liability on account of accidents to persons or property involving the Miner Light System.

Miner Enterprises is not responsible for car construction or design, including modifications for the application.

The solar electric system is designed to provide operating power to a specified load. Using loads other than those for which the system was designed for will result in poor system performance and possible damage to the batteries.

System components have been carefully selected and configured for the intended application. Solar module, support structure, and battery components maybe provided separately.

To answer questions about the system, contact Miner Customer Service at (630) 232-3000



Section 3

Safety Precautions

In addition to safety precautions prescribed by the car owner, loading site, unloading site, repair shop and handling railroad, the following safety precautions must be observed whenever a Miner Light System is operated and whenever any maintenance is performed on it.

1. All maintenance, repair, or adjustment must be made on a shop or repair track where the car will not be moved.
2. Read and follow Caution Notes posted on the side of the car.
3. Always report an inoperable or damaged system component to a supervisor so that it may be properly repaired or replaced.
4. Always turn the main power supply switch to the off position before servicing components.
5. **WARNING: Electrical Shocks and Burns Hazard-** Photovoltaic (PV) modules generate electricity when exposed to light, even when they are not connected in a circuit. Shocks and burns can result from contact with module output wiring. These hazards are increased when multiple modules are interconnected to increase array output current or voltage. Cover module front surfaces completely with an opaque cloth or other opaque material before performing any operation involving module or system electrical connections. Use appropriate safety equipment (insulated tools, insulating gloves, etc.) and procedures.
6. **CAUTION: Module Breakage -** The module glass is tempered and will shatter if exposed to impact. Avoid rough handling and lay the modules on a flat, protected surface during assembly. This will also prevent power output at the electrical terminals. Avoid shorting the terminals whenever sunlight is present on the module front surface.



7. **WARNING: Chemical Hazard-** Batteries contain sulfuric acid which can cause burns and other serious injury. In the event of contact with sulfuric acid, flush immediately and thoroughly with water. The use of safety goggles, rubber apron, and rubber gloves is recommended.

8. **WARNING: Explosive Hazard-** Batteries can generate explosive gases, which when released, can explode and cause blindness and other serious injury. Keep sparks, flames, and smoking materials away from the battery area.

9. **WARNING: Electrical Hazard-** Photovoltaic modules generate high voltage whenever exposed to sunlight. Voltages can be as high as 22 VDC.

10. Batteries contain high discharge currents, use insulated tools on and around batteries.

11. **CAUTION: Electrical Hazard-** Ensure all fuses are removed and all circuit breakers or switches are in the OFF position before beginning any wiring.

12. Connect the battery output cables to the battery. Connect the red wire to the battery positive (+) terminal and the black wire to the battery negative (-) terminal. Refer to the System Wiring Diagram.

Section 4 Component Identification

General Description

The Light System was designed and built for rail cars. There are three major components in the photovoltaic system: solar modules, batteries, and the system charge controller. The power to the load is provided by the solar array. Four lights have been provided as the designed load for this system. Two switch boxes have been provided to turn the lights on/off, two lights per switch.

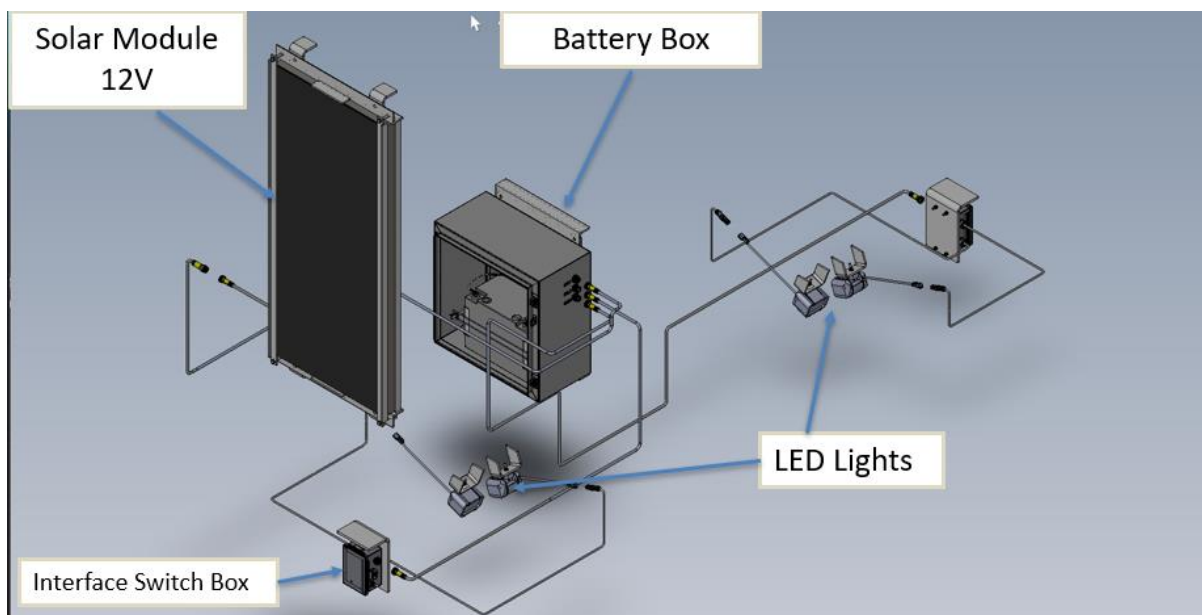
Component Identification

For a complete list of components and descriptions and part numbers, refer to latest revision of the following:

- General Arrangement drawing
- Electrical Schematic drawing
- Customer Schedule

For a complete list of Miner part numbers and descriptions refer to the latest revision of the Customer Schedule. Any of these documents can be obtained by contacting Miner Customer Service at (630) 232-3000.

Part Identification





Section 5

Principle of Operation

General Description

The Light System was designed and built to illuminate the work area for operations on rail cars. The solar module will supply current to charge the battery bank. The controller regulates the battery charging by monitoring the battery terminal voltage and limits the charging current to the battery bank as required. The controller will charge the battery until the voltage reaches 14.1 VDC, then taper the current to maintain a float voltage of 13.7 VDC. The controller also contains a temperature probe and adjusts the charge voltage at a rate of $-0.030 \text{ VDC}/^{\circ}\text{C}$ from 25°C . This temperature compensation feature ensures the battery is properly charged in cold temperatures and not overcharged in warm temperatures.

Carefully read and understand the SAFETY PRECAUTIONS SECTION of this manual.

Section 6

Operating Instructions

The Light System was designed and built to illuminate the bottom of the rail cars. Two switch boxes have been provided to turn the lights on/off, two lights per switch.

To operate the light system, switch to the on position.

Note: the lights should be turned off when not in use to maximize system availability, failure to turn off the lights can result in poor system performance.



The switch box is shown. There is one switch box per side operating two lights each.



Section 7

Installation Instructions

General Description

The Miner Light System comes pre-assembled and tested. All that is required is to mount the module and enclosure, install the battery, and make the final cable connections. Special care must be taken when selecting the solar module mounting location to maximize exposure to solar rays. Connecting loads with power requirements greater than those for which the system was designed for will result in poor system performance and possible damage to the batteries.

Carefully read and understand the SAFETY PRECAUTIONS SECTION of this manual.

Installation Instructions

The Miner Enterprises General Arrangement Drawing and all drawings referenced by said drawings will be necessary to perform system installation.

Switch Box wiring involves routing a cable from the system enclosure to each switch box. At the switch box, connect to the connector on the side of the box, at the system enclosure, connect to the LOAD1 or LOAD2 connector on the side of the enclosure. Refer to wiring as shown in the System Wiring Diagram. The lights come with integrated two conductor male cables. Route the cables to the appropriate switch box. At the switch box, connect to the connectors on the side of the box. Refer to the System Wiring Diagram

Electrical Installation Instructions

The Miner Enterprises General Arrangement Drawing and Electric Schematic Drawing will be necessary to perform electrical installation.

SYSTEM INSTALLATION CHECKLIST:

Make sure cable connections and mechanical fasteners are secured.

Record the initial battery voltage at the controller is (12-14) VDC.

Make sure charging LED is illuminated.

Lights should operate on toggle switch activation.



Section 8

Troubleshooting

Carefully read and understand the SAFETY PRECAUTIONS SECTION of this manual.

If the system is not functioning correctly, there are a few simple steps to isolate the problem. The solar module and shield must be inspected regularly for damage due to vandalism, wildlife, and clouding. Loose or damaged wiring can cause voltage drop (power loss) or an open circuit of the array, battery or load. In general, basic maintenance should be performed.

Following are some of the typical factors that contribute to the failure of the system to operate within design parameters:

- 1 Shading During Operation – Shading of the solar module can result in diminished output and could result in reduced system performance. The solar array must be inspected and cleaned at regular intervals; obstructions should be removed as necessary. Inspect the module shield for damage or clouding. Replace if necessary.
- 2 Shading During Extended Storage – Occasionally unusual weather patterns may occur for an extended period (exceeding the sunless days of battery reserve designed into the system) which could result in reduced system performance. When storing the rail cars for extended periods, particularly during the winter, consider orienting the cars to allow for maximum exposure of the solar rays on the module. Inspect the module shield for damage or clouding. Replace if necessary.
- 3 System component damage or malfunction – If none of the above has corrected the problem; then a failed component is most likely the cause and should be isolated and replaced.
 - a. A damaged solar module will produce less or no power at all (depending on the severity of the damage). Examine the solar module for visible damage.
 - b. The charge controller may experience malfunction due to excessive currents or a lightning strike.



- c. Battery failure may be caused by several factors: age, controller failure, or excessive load operation. If the battery is more than 5 years old, it may need to be replaced.
 - d. Excessive load operation may result in permanent battery damage. The load should be monitored to confirm it is operation within the design parameters of the system.
2. If any of the above fails to correct the problem or if new components are required contact Miner Enterprises Customer Service at (630) 232-3000 for additional assistance, please have available the system model number and a brief description of the problem.