

# **POWER BACKUP SYSTEM**

## **DESCRIPTION**

The Power Backup System is designed to supply backup 115vac in the event commercial 115vac is lost. Backup 115vac is generated by an Inverter running from a 12 volt lead-acid battery. The system is designed to supply a 382 watt load consisting of the basement Video Distribution Board, the front room TV, a front room lamp, a front room fan, and a basement lamp.

The Inverter is a 500 Watt TrippLite design modified to provide a frequency stable symmetrical output waveform and additional power output capability in excess of 500 Watts.

The batteries are Sears 96524 (Stock # 22896524) 12 volt Marine Deep Cycle lead-acid batteries. The batteries will provide approximately 4 to 5 hours backup 115vac with a full 382 Watt load. The batteries will automatically be disconnected from the Inverter should battery voltage drop to 11.5 volts thus preventing damage to the battery due to excessive discharge.

Battery charging is automatic and consists of a power supply and a charger. The power supply is an old Micor battery backup power supply capable of providing up to 30 amps of current. The power supply has been modified to provide 19 volts to the charger. The charger limits charge current to a maximum of 8 amps and will charge the battery to 13.7 volts then automatically turn off. After a loss of commercial 115vac, charging will automatically begin when commercial 115vac is restored. Charging will also automatically start when battery voltage drops to 12.5 volts during normal operation. Battery charging can also be initiated manually via a front panel push button switch.

The front panel provides metering for AC Output Voltage (both Commercial and Inverter), Charging Voltage, Battery Voltage, Charging Current, and Inverter Current Draw. Front panel status indicators show AC Input – red indicator (commercial 115vac present) Charging On - amber indicator, Inverter On

– green indicator, and AC Output – red indicator (both commercial and Inverter generated). Front panel controls are System Shut-off (Inverter Shutdown) and Manual Charger Start.

## **OPERATION**

The operation of the Power Backup System is designed to be fully automatic and does not require any user interface to function.

The Power Backup System is designed to provide backup power to a front room lamp, the front room TV, a front room fan, the Video Distribution System in the basement, and a 40 watt lamp in the basement. Power is provided to these items via their respective outlets which have been rewired to provide either commercial 115vac or Inverter generated 115vac.

When commercial 115vac is available a 115vac Source Switch has commercial 115vac selected as the source of power to the load. When commercial 115vac is lost, there is a two minute delay before Inverter operation is initiated and Inverter generated 115vac is selected as the source of power to the load. When commercial 115vac is restored there is a five minute delay in which the load continues to operate on Inverter generated 115vac. If commercial 115vac has been restored for a five minute period the 115vac Source Select Switch will switch back to commercial 115vac and the Inverter will be shutdown. Upon Inverter shutdown and switch over to commercial 115vac battery charging will begin to restore the batteries. The batteries will provide approximately 4 to 5 hours backup 115vac with a full 382 Watt load.

Some of the system circuitry is designed to run from battery power continuously as they are required to be powered up even with a loss of commercial 115vac. Therefore there will always be a small discharge current from the battery. The Charging System is designed to monitor battery voltage level and automatically start charging the battery when it drops to 12.5 volts. This is to ensure there is always sufficient charge to provide backup power when commercial 115vac is lost.

System design prevents excessive deep discharge of the battery that may occur due to prolonged periods of commercial 115vac loss. Battery voltage is monitored during Inverter operation and if it drops to 11.5 volts the Power Backup System will be shutdown preventing further deep discharge of the battery. In this shutdown condition, the only circuits powered up are the Low Battery Disconnect circuit and part of the charger circuitry which together only draw a few milliamperes of current. These circuits must remain powered up so the system can be restored and charging of the battery begun when commercial 115vac returns. When the system is in this shutdown condition, there is no five minute delay when commercial 115vac is restored. Battery charging will be started immediately and commercial 115vac will be selected and supplied to the load immediately.

### **FUNCTIONAL DESCRIPTION**

#### **Commercial 115vac Present Normal Operation**

Commercial 115vac enters the Power Backup System through 15 amp circuit breaker 1CB1 and passes through Surge Suppressor 1SP1. Commercial 115vac is applied to the 1A8 Power Supply, the 1A2/1A3 115vac Source Switch, the 1A6 Timer-Line Sense Module, the AC In indicator 1NE1, and the Charger Blowers 1BL1/1BL2 via 1RY2 Charge Relay Normally Open (NO) secondary contacts.

The 1A2/1A3 115 Source Switch senses commercial 115vac is present and energizes the Source Switch relay which selects commercial 115vac as the source to the load. With commercial 115vac both AC Out indicator 1NE3 and AC Voltmeter 1M1 will indicate the availability of power to the load.

The 1A6 Timer-Line Sense Module will sense commercial 115vac is available and disable the 1A1 Timing Control circuits. With the Timing Control circuits disabled Main Relay 1RY1 is de-energized preventing the battery from powering up the Inverter.

#### **Commercial 115vac Present Charger Operation**

With commercial 115vac applied to the 1A8 Power Supply, the power supply will produce a +19 volt output for application to the Charger circuitry.

Battery voltage is monitored by the 1A5 Charger circuit via the Battery 13.4V line from the 1A7 Battery Fuse/Filter Assembly. When battery voltage drops to 12.5 volts 1A5 Charger will energize the Charge Relay 1RY2. With the Charge Relay energized the Charge Regulator Assembly is connected to the battery and charge current begins to flow. Charge current and charge voltage can be monitored via front panel meters 1M5 and 1M6 respectively. The 1A5 Charger monitors charging progress via the voltage drop across parallel resistor network 1R6,7,11,12.

With the Charge Relay energized, it's normally open secondary contacts close applying 115vac to the Charger On indicator 1NE2 and the Charge Blowers 1BL1 and 1BL2. 1BL1 cools the Charge Regulator Assembly during the charging operation and 1BL2 vents the battery compartment.. Also, when the Charge Relay energizes, it's Normally Closed secondary contacts open removing 9.6 volts from the 1A5 Charger start circuit. This inhibits the charger turn on circuitry after the charger has already turned on. If for some reason the Charge Relay did not energize, this 9.6 volts via the normally closed contacts will continue to try and turn on the charger.

Once the battery reaches full charge (13.7 volts), charge current will be minimal. This minimal current is sensed by the voltage drop across resistor network 1R6,7,11,12 and will cause the Charge Relay to de-energize, removing the charger from the batteries and preventing over charging of the batteries. When charging is complete Charge Relay 1RY2 de-energizes, Blowers 1BL1 and 1BL2 turn off, Charger On indicator 1NE2 goes off, the battery is disconnected from the Charger, and 9.6 volts is re-applied to the 1A5 Charger to enable the Charge start circuit when battery voltage drops to 12.5 volts again.

Battery charging can be started manually via front panel push button switch 1S1 or board mounted pushbutton switch 1A5S1. Once the charger has started, operation is the same as explained above. The 12.5 volt charger on level is set via 1R4.

#### **Loss of Commercial 115vac Inverter Operation**

A loss of commercial 115vac is sensed by the 1A2/1A3 115 source Switch and the 1A6 Timer-Line Sense Module. Charging circuits are disabled with the loss of commercial 115vac due to the loss of the 19 volt power supply 1A8.

The sensed loss of commercial 115vac in the 1A2/1A3 115 Source Switch causes the Source Switch relay to de-energize immediately selecting Inverter generated 115vac for the load. The loss of commercial 115vac is also sensed by the 1A6 Timer-Line Sense Module and initiates a 2 minute time out in the 1A1 Timer circuits. If commercial 115vac is restored prior to this 2 minute time out, the 115 source Switch will immediately reconnect commercial 115vac to the load and the sensed restoration of commercial 115vac in the 1A6 Timer Line Sense Module resets the 2 minute timer. If commercial 115vac is out for the full 2 minute time out, Main Relay 1RY1 will energize connecting the battery to the Inverter and the Inverter will begin generating 115vac to the load.

The 2 minute time out prevents Inverter turn on if power outage is only momentary. It also prevents Inverter turn on and off due to brown outs, line dips, and line sags.

When Main Relay 1RY1 energizes, 30-40 amps of current will begin flowing in the Inverter and can be monitored via front panel meter 1M3. Inverter operation will be indicated by Front Panel green indicator 1DS1. With the Main Relay energized it's normally open secondary contacts will close applying a ground to the 1A1 Timer, disabling the 2 minute timer. This prevents possible falsing of the timing circuits. Also, the Main Relay normally closed secondary contacts open, removing a ground from the 115 Source Switch circuits. This has no effect at this time, the removal of this ground is used when commercial 115vac is restored.

Inverter operation can be shutdown via front panel center off switch 1S2.

### **Loss of Commercial 115vac Low Battery Shutdown Operation**

With the Inverter operating, battery voltage level is monitored by the 1A1 Low Battery Disconnect circuits via the Battery 13.4V line from the 1A7 Battery Fuse/Filter Assembly. If battery voltage drops to 11.5 volts the Low Batt Disconnect circuitry will de-energize Disconnect Relay 1A7RY1 and remove Sw. 9.6V from the 1A1 Timer circuits. With a loss of Sw. 9.6 volts in the Timer circuits, Main Relay 1RY1 de-energizes removing battery power from the Inverter thus preventing damage to the battery due to excessive deep discharge.

### **Restoration of Commercial 115vac Transition to Normal Operation**

Restoration of commercial 115vac is sensed by the 1A6 Timer-Line Sense Module which triggers a 5 minute time delay in the timer circuits. During this 5 minute time out, Main Relay 1RY1 remains energized and the Inverter continues to generate 115vac to the load even though commercial 115vac is again available. Restoration of commercial 115vac is also sensed by the 115 Source Switch but the switch is prevented from selecting commercial 115vac due to the now open, normally closed secondary contacts of Main Relay 1RY1. The removal of this ground from the 115 Source Switch inhibits the Source Relay from energizing and selecting commercial 115vac. Once the 5 minute time out delay ends, Main Relay 1RY1 de-energizes, battery power is removed from the Inverter, the normally closed secondary contacts reapply a ground to the 115 Source Switch enabling the Source Relay to energize selecting commercial 115vac for the load.

The 5 minute delay is to ensure commercial 115vac has been restored and not a temporary restoral.