

# **115VAC SOURCE SWITCH**

## **DESCRIPTION**

The 115vac Source Switch determines which 115vac source (commercial or Inverter generated) is connected to the load. When commercial 115vac is present, the 115 Source Switch will select commercial 115vac to be supplied to the load. When commercial 115vac is absent, the 115 Source Switch will select Inverter generated 115vac to be supplied to the load.

When commercial 115vac is present (normal mode of operation) the Source Select Relay 1A3RY1 is energized and commercial 115vac is connected to the load. The Source Select Relay is held energized by rectifying, filtering, and regulating a +15 volts from commercial 115vac line.

When commercial 115vac is lost, the regulated +15 volts is lost and the Source Select Relay de-energizes. This connects the Inverter generated 115vac output to the load.

While the Source Select Relay immediately switches over to Inverter 115vac with the loss of commercial 115vac, the Inverter will not be powered up for 2 minutes (see Timing Control). If commercial power is restored before this 2 minute timeout, commercial 115vac will be immediately reconnected to the load. If the 2 minute timeout does occur, the Timing Control circuits will energize Main Relay 1RY1, battery power will be applied to the Inverter, and the Inverter will begin generating 115vac to the load.

When commercial 115vac is restored, the Timing Control circuits will hold the Inverter powered up for another 5 minutes. This means the load will remain connected to the Inverter for 5 minutes after commercial 115vac is restored. This is accomplished through the NC secondary contacts of Main Relay 1RY1. When the Main Relay is energized, these contacts open and prevent the Source Select Relay from energizing immediately after commercial 115vac is restored. These contacts will remain open until 5 minutes has timed and the Main Relay de-energizes. Once the Main relay has de-energized, the

Source Select Relay is allowed to energize and connect commercial 115vac to the load.

The circuit is built on two PCB's. The 1A2 Source Sw Control board contains the +15 supply and relay controlling circuitry. The 1A3 Source Sw Relay PCB contains the Source Select Relay.

## **DETAILED THEORY OF OPERATION**

### **Circuit Description**

#### **1A2 115 Source Sw Control PCB:**

F1 fuses commercial 115vac to the PCB. 1T1 is a step down transformer with a secondary voltage of 16vac. D1 is a full wave bridge rectifier, C1 is a rectification filter capacitor, C3 is a noise bypass capacitor for IC1 input. IC1 is an LM340 3 terminal +15 volt IC regulator. C4 is an IC output noise filter. D3 and D4 protect IC1 from filter capacitor discharges through the IC in the event of a short at the input or output of the IC. C2 is an after regulation filter capacitor. R1 is a base current limiter for Q1. R2 is a base current limiter of Q2, R3 is a collector load resistor for Q2. Q1 is the Relay drive transistor. Q2 is an SCR control transistor. Q3 is an SCR.

#### **1A3 115 Source Sw Relay PCB:**

RY1 is a triple DPDT 12 volt relay. Only two sets of the DPDT contacts are used. The contacts are rated at 120vac, 10amps. D1 dampens inductive kickback when RY1 de-energizes.

### **Circuit Operation**

There are three basic modes of operation for the 115 Source Switch.

- 1). Commercial 115vac Present, Normal Mode
- 2). Commercial 115vac Absent, Inverter Mode
- 3). Commercial 115vac Restored, Restoration Mode

**Commercial 115vac Present, Normal Mode**

For Normal Mode operation it is assumed commercial 115vac is present and has been present for a long period of time.

**Quick Summary of Circuit Condition:**

IC1 input 20v/output 15v, Q1 on, Q2 off, Q3 on, and RY1 energized.

**Detailed Normal Mode Operation:**

Commercial 115vac enters the 1A2 Source Sw Control PCB via TB1 pins 1 & 2. The hot side of the line is fused via F1 and then exits the PCB on TB1 pins 3 & 4 for application to chassis mounted step down transformer 1T1. 1T1 generates a 16vac output which re-enters the PCB on TB1 pins 6 & 7. The 16vac is applied to diode bridge rectifier D1. Pulsating DC on the bridge output is filtered/smoothed by C1 and then input to regulator IC1. IC1 regulates it's output at +15v, C2 provides after regulation filtering/smoothing. C3 and C4 filter off high frequency noise and improve regulation. D3 and D4 are IC protection diodes which shunt capacitor discharge currents away from the IC regulator if a short occurs either on the input or output of the IC. Base current limiter R1 applies a positive voltage to Q1 base turning Q1 on. Whenever commercial 115vac is present, Q1 is turned on.

Main Relay 1RY1 is de-energized therefore it's NC secondary contacts are closed applying a ground to Q2 base. Q2 is turned off and it's collector is high. This high gates SCR Q3 on with R3 serving as the gate current limiter resistor. With Q1 and Q3 on, Disconnect Relay RY1 is energized connecting commercial 115vac to the load.

**Commercial 115vac Absent, Inverter Mode**

For Inverter Mode it is assumed that commercial 115vac is lost.

**Quick Summary of Circuit Condition**

IC1 input 0v/Output 0v, Q1 off, Q2 off, Q3 off, and Disconnect Relay RY1 de-energized.

**Detailed Inverter Mode Operation:**

With no commercial 115vac present, no operating voltages are developed for the circuitry. Therefore the whole circuit is powered down and Disconnect Relay RY1 is de-energized. With RY1 de-energized Inverter generated 115vac is connected to the load.

This Inverter generated 115vac will not be immediately present when commercial 115vac is lost. The Timing Control circuits will delay the application of battery power to the inverter for 2 minutes.

**Commercial 115vac Restored, Restoration Mode**

For Restoration Mode it is assumed commercial 115vac has just been restored. There are two possible scenarios in Restoration Mode. 1) Commercial 115vac is restored less than 2 minutes after it was lost and 2) Commercial 115vac is restored longer than 2 minutes after it was lost. Restoration Mode immediately reverts to Normal Mode if commercial 115vac was out less than 2 minutes. If commercial 115vac was out longer than 2 minutes, Restoration Mode will last 5 minutes before reverting to Normal Mode.

**Quick Summary of Circuit Condition:**

IC1 input 20v/output 15v, Q1 on, Q2 (if commercial 115vac was out less than 2 minutes Q2 off, if commercial 115vac was out for greater than 2 minutes Q2 is on for 5 minutes after commercial 115vac is restored, then off), Q3 (if commercial 115vac was out less than 2 minutes Q3 on, if commercial 115vac was out for greater than 2 minutes Q3 is off for 5 minutes after commercial 115vac is restored, then on), and RY1 (if commercial 115vac was out less than 2 minutes RY1 is energized, if commercial 115vac was out for greater than 2 minutes RY1 is de-energized for 5 minutes after commercial 115vac is restored, then energized).

**Detailed Restoration Mode Operation:**

Immediately after commercial 115vac is restored, IC1 produces 15 volts operating voltages for the circuit and Q1 is biased on. However, depending on how long commercial 115vac was absent, SCR Q3 may or may not be on.

If commercial 115vac was absent for less than 2 minutes, Main Relay 1RY1 would not have energized. 1RY1 NC contacts will have remained closed holding a ground on Q2 base, thus Q2 will remain off when circuit operating voltage was restored with the return of commercial 115vac. Q2 collector will be high, and SCR Q3 will turn on immediately with the restoration of commercial 115vac. Therefore, Disconnect Relay RY1 will energize immediately with the return of commercial 115vac and reconnect commercial 115vac to the load.

The Inverter would never have started operation and Inverter 115vac would never have been produced.

If commercial 115vac was absent for greater than 2 minutes, Main Relay 1RY1 would have energized opening it's NC secondary contacts. This removes the ground from Q2 base. When commercial 115vac is restored, the Timing Control circuits will hold Main Relay 1RY1 energized for 5 minutes and the Inverter will continue to generate 115vac to the load. With commercial 115vac restored, but the Main Relay still energized, a positive voltage is felt on Q2 base through base current limiter R2. This turns Q2 on and it's collector goes low. The low on Q2 collector prevents SCR Q3 from gating on and Disconnect Relay RY1 remains de-energized. When 5 minutes times out, the Main Relay de-energizes applying a ground to Q2 base, Q2 cuts off, Q2 collector goes high triggering SCR Q3 on, the Disconnect Relay energizes through already turned on Q1, and commercial 115vac is reconnected to the load.