LOW BATTERY DISCONNECT

DESCRIPTION

The purpose of the Low Battery Disconnect circuit is to prevent permanent damage to the lead acid battery due to excessive deep discharge.

Battery disconnect is set to occur when battery voltage drops to 11.5 volts. When low voltage disconnect occurs the backup system will be in a Low Battery Disconnect Mode, and the Inverter will be shutdown via the de-energization of Main Relay 1RY1 and thus the removal of the battery from the Inverter.

The Low Battery Disconnect circuit is part of the 1A1 Timer-Low Battery Disconnect PCB. Battery voltage level is sensed via a resistive voltage divider. One half of the voltage divider is a chassis mounted potentiometer used to precisely set the 11.5 volt disconnect point. When a low battery voltage condition is sensed, the Low Battery Disconnect circuit de-energizes Disconnect Relay 1A7RY1. De-energizing 1A7RY1 removes switched 9.6 volts from the Timer Control circuits de-energizing Main Relay 1RY1. With the Main Relay de-energized, battery power is removed from the Inverter preventing further heavy discharge of the battery. The Power Backup System will now be in a Low Battery Shutdown condition and will remain in this condition until commercial 115vac is restored.

The Low Battery Disconnect circuit remains energized when the system is in shutdown. This is necessary to allow the Low Battery Disconnect circuit to detect battery voltage is above 11.5 volts when commercial 115vac is restored and battery charging begins. Once battery charging has begun and battery voltage is above 11.5 volts, the Power Backup System is back in Normal Mode Operation.

DETAILED THEORY OF OPERATION

Circuit Description

R15 and 1R3 form the voltage divider which senses battery voltage level. 1R3 is adjusted to trigger a battery disconnect at 11.5 volts. Q8 is a comparator. It compares a zener referenced voltage on it's emitter with the battery sensed voltage from the battery voltage sense divider on its base. R17 sets D2 zener static conduction level. R16 is a Q8 collector load resistor. D3 is a coupling zener. Q9 provides isolation and prevents loading of the Q8 comparator circuit. R18 is an emitter load resistor. R19 is a base current limiter for Q10. Q10 is a voltage gain and inversion stage, R20 is a Q10 collector load resistor. R20 also serves as a base current limiter for Q11 when Q10 is cutoff. R21 has been jumpered out of the circuit. This modification provided better relay response. Q11 is a relay drive transistor. 1A7RY1 is a 10v relay with 2 DPDT sets of contacts. 1A7D1 is used to dampen inductive kick from 1A7RY1 when it de-energizes.

Circuit Operation

There are 2 modes of Low Battery Disconnect circuit operation.

1). Battery Voltage Normal, Normal Mode
2). Battery Voltage Low, Disconnect Mode

Battery Voltage Normal, Normal Mode

For normal mode operation, it is assumed battery voltage is above 11.5 volts. Backup system may be in either normal condition (commercial 115vac present) or in Inverter condition (commercial 115vac absent).

Quick Summary of Circuit Condition:

Q8 on, Q9 off, Q10 off, Q11 on, 1A7RY1 energized.

Detailed Normal Mode Operation:
Battery voltage is sensed by voltage divider R15 and 1R3. R15 is connected directly to the battery through fuse F1. With battery voltage above 11.5 volts, the

base of Q8 is more positive than the reference on it's emitter. This has Q8 conducting and it's collector is low (approximately equal to the emitter reference voltage of 4.7 volts). With Q8 collector low (at 4.7 volts), zener D3 is well below it's zener knee (6.2v) and not enough current will be allowed to flow in Q9 base-emitter junction to turn it on. Therefore Q9 is off, it's emitter is at 0 volts, Q10 base is at 0 volts, and Q10 is cuttoff. With Q10 cuttoff, it's collector is high thus turning Q11 on, and energizing 1A7RY1. With 1A7RY1 energized, regulated 9.6 volts is passed onto the Timing control circuits.

Battery Voltage Low, Disconnect Mode

For Disconnect Mode operation, it is assumed that the backup system is in Inverter operation, commercial 115vac is not present, the battery is connected to the Inverter through energized Main Relay 1RY1, and heavy current has been drawn from the battery for some period of time. It is also assumed that battery voltage has dropped to 11.5 volts.

Quick Summary of Circuit Condition:

Q8 off, Q9 on, Q10 on, Q11 off, 1A7RY1 de-energized.

Detailed Disconnect Mode Operation:
Q8 compares a reference voltage on its emitter with battery terminal voltage on its base. With battery voltage above 11.5 volts, Q8 base is positive enough to maintain conduction of Q8.

With prolonged discharge of the battery, battery terminal voltage begins to drop. Battery terminal voltage is sensed by resistive voltage divider R15 and 1R3. Therefore, as battery terminal voltage drops, Q8 base voltage also drops. Disconnect level set pot 1R3 is adjusted to cause Q8 to cuttoff when battery terminal voltage drops to 11.5 volts.

When Q8 cuts off, its collector voltage goes high. The high on Q8 collector is sufficient to drive zener D3 past its zener knee and D3 begins to conduct current through Q9 base-emitter junction. Q9 turns on and its emitter rises high. This high, through R19 base current limiter, turns Q10 on causing its collector to pull low. The low on Q10 collector is felt on Q11 base and Q11 turns off thus de-energizing Disconnect Relay 1A7RY1.

With 1A7RY1 de-energized, 9.6 volts is removed from the Timing Control circuits. With the Timing Control circuits de-energized, Main Relay 1RY1 de-energizes and battery power is removed from the Inverter preventing further deep discharge of the battery.

The Low Battery disconnect circuit remains energized when the Power Backup System is in a Disconnect mode. When commercial 115vac is restored, the battery will begin charging and battery terminal voltage should rise due to the charger applied voltage. The Low Battery Disconnect will sense this and revert back to Normal Mode operation. 1A7RY1 will energize and 9.6 volts will be reapplied to the Timing Control circuits.

LOW BATTERY DISCONNECT LEVEL SET

Method 1

1). On the 1A1 Timer-Low Batt Disconnect PCB disconnect the Battery 13.4V from TB1-4.
2). Substitute an 11.5 volt power supply at TB1-4.
3). Adjust the Disconnect Level pot 1R3 until Disconnect Relay 1A7RY1 de-energizes (if desired Sw. 9.6v can monitored at 1A1TB1-2).
4). Rock pot 1R3 back and forth until precise disconnect level is 11.5 volts.
5). Test the circuit reaction several times by raising, then dropping power supply voltage to 11.5v. Readjust 1R3 as necessary.
6). Remove the substituted power supply from TB1 pin 4.
7). Reconnect the Battery 13.4V to TB1-4.

Method 2

1). With the system operating in Inverter Mode, monitor the voltage at TB1 pin 4 of the 1A1 Timer-Low Battery Disconnect PCB. This is Battery 13.4v from 1A7TB2-4.
2). When battery voltage drops to 11.5 volts, adjust Disconnect Level pot 1R3 until Main Relay 1RY1 drops out and the system shuts down.