# INSTRUCTIONS

GEK-41995

OVERCURRENT RELAY

TYPE SLC51B

POWER SYSTEMS MANAGEMENT DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

CONTENTS

# TYPE SLC51B OVERCURRENT RELAY

## DESCRIPTION

The SLC51B is a static, three phase, overcurrent relay which provides direct trip functions and supervision of associated phase and ground distance relays in a permissive overreaching transferred tripping pilot relaying scheme. The relay is packaged in a single two rack unit case as shown in Figure 1. Internal component locations are shown in Figure 2, and the relay internal connections are shown in Figure 3.

The SLC51B relay is not intended for use by itself but rather as part of a complement of equipment that forms a complete protective relaying scheme. A typical scheme, in addition to this relay, would include an SLY phase tripping relay, an SLYG ground tripping relay, an SLA logic relay, an SLAT output relay, and an SSA power supply. The SLC51B relay outputs are d-c logic signals that are fed into the SLA logic relay, the circuitry of which depends upon the overall protection scheme. These static circuits require $\pm$ 15 volts d-c which is obtained from the SSA power supply. For a complete description of the overall scheme in which this relay is employed, refer to the overall logic diagram and its associated logic description which are supplied with each terminal of equipment.

The functions which are included in the SLC51B relay are as follows:

I3Ø - Three-phase overcurrent trip supervision.

G2 - Ground overcurrent trip supervision.

PH4 - Three-phase direct trip instantaneous overcurrent (if used).

G4 - Ground direct trip instantaneous overcurrent.

IW - Three-phase overcurrent for weak source terminal (if used).

IOW - Ground overcurrent for weak source terminal (if used).

## APPLICATION

The SLC51B static overcurrent relay is designed to provide the overcurrent functions required in a permissive overreaching transferred tripping pilot relaying scheme. This relay is not intended for use by itself but rather as part of an equipment that forms a complete protective relaying scheme. The additional relays and other equipment required for a complete relaying scheme are shown on the specific overall logic diagram and accompanying logic description for that scheme. Figure 4 shows the a-c current connections to the relay.

The measuring functions included in this relay are intended for use as indicated below:

### I3Ø

I3Ø is a three-phase, non-directional overcurrent function that serves two purposes:

(a) Supervision of MT to prevent a false trip on loss of AC potential.

(b) Seal-in of the trip circuit in the event of a zero voltage fault.

The I function must be set to operate at 65 percent or less of the minimum three phase fault current for any internal fault. If this pickup setting is greater than the maximum full load current then the functions for (a) and (b) above are fully effective. If the maximum full load current exceeds the I pickup setting, the protection for (a) above is only partly effective. In any event MT could still trip

falsely on loss of AC potential during the occurrence of an external fault. If the I function is to be used for only (b) above, it must be sensitive enough to operate for the minimum close in three phase fault. A link is provided to remove the I supervision of MT trip, (a) above. The seal-in of (b) above, however, cannot be removed. It is also desirable to coorinate I3Ø with IW as discussed later.

The I functions are operated by delta current ($I_1 - I_2$) and they therefore have the same ohmic reach on three phase as on phase-to-phase faults.

G2

G2 is a non-directional zero sequence overcurrent fault detector used to supervise the tripping level of the ground MTG functions. The setting must not exceed 75 percent of the minimum single-phase-to-ground fault current in the relay (3Io) for a fault at the remote bus with the remote breaker closed. It is also desirable to coordinate G2 with $I_{OW}$, as discussed later.

PH4

PH4 is a three phase, non-directional, direct trip instantaneous overcurrent function that is intended to provide direct tripping for heavy multi-phase faults. The PH4 function must be set to operate at 125 percent or more of the maximum external three phase fault current. Because PH4 is non-directional, faults at the bus directly behind the relay as well as faults at the remote terminal must be considered. PH4, like I3Ø, responds to the delta currents; therefore, it too will have the same response for all multi-phase faults at the same location.

G4

G4 is a zero sequence, non-directional, direct trip instantaneous overcurrent function that is intended to provide direct tripping for heavy ground faults. The G4 function must be set to operate at 125 percent or more of the maximum external ground fault current ($3I_0$). Because G4 is non-directional, it is necessary to consider faults at the bus directly behind the relay as well as at the remote terminal.

IW-IOW

These are non-directional overcurrent fault detectors intended for use at a weak source terminal. These units must be set so that they operate for external faults behind the weak source terminal but do not operate for internal line faults. The phase IW units must have a pickup setting that is greater than the maximum load that is expected through the weak source terminal. This will avoid the possibility of the IW function remaining operated on through load current in the unfaulted phases for an internal single-phase-to-ground fault. It is preferable that the IW function setting at the weak source terminal be coordinated with the I3Ø overcurrent fault detector at the remote line terminal. Similarly, the IOW function setting at the weak source terminal should be coordinated with the G2 function at the remote line terminal. This coordination may be achieved by setting these pickups so that I3Ø $\geq$ 1.33 IW or G2 $\geq$ 1.33 IOW. In this way, coordination will be maintained for all external faults.

## RATINGS

The Type SLC51B relays are designed for use in an environment where the air temperature outside the relay case does not exceed -20°C or +65°C.

The current circuits of the Type SLC51B relay are rated at 5 amperes, 60 cycles, for continuous duty and have a one second rating of 300 amperes.

The range of adjustment of the functions in the Type SLC51B relay are listed below:

$I_{3Ø}$ - 1.0 to 15 amperes
$I_W$ - 1.0 to 10.0 amperes
PH4 - 5.0 to 80.0 amperes
G2 - 0.5 to 8.0 amperes
$I_{OW}$ - 0.5 to 6.0 amperes
G4 - 2.5 to 40 amperes

## BURDENS

The current burden measured at 5 amps line current is as follows:

Phase Current Burden - R = 0.020, X = 0.013, Z = 0.024 $\angle$ 33°

Neutral Burden - R = 0.028, X = 0.018, Z = 0.033 $\angle$ 33°

## OPERATING PRINCIPLES AND CHARACTERISTICS

The functions in the SLC51B are adjustable non-directional overcurrent functions of which G2, $I_{0W}$, and G4 operate on residual (3Io) current while $I_{3\emptyset}$, IW, and PH4 operate on the highest delta ($I_1$-$I_2$, etc.) current.

## CIRCUIT DESCRIPTION

The internal connection diagram of the SLC51B relay (Figure 3) shows the current inputs on the left side, the small squares denote the specific points on the "RA" terminal board at the rear of the unit. The double arrow points on right side represent the plug connections between relay units.

The input currents are routed through transactors of which the output voltages are controlled by secondary loading set at the factory. These voltages are filtered, full wave rectified and fed to the customer adjustable level detector. The detector output pulses are stretched to provide continuous output logic signals routed to the SLA logic unit via cable C071.

## CONSTRUCTION

The Type SLC51B relay is packaged in a metal enclosure designed for mounting on a 19 inch rack. The relay is 2 rack units high (one rack unit is 1 3/4 inches) and has a 90° hinged front cover and removable top cover. It contains the magnetics, filtering and printed circuit cards required to provide the phase and ground overcurrent functions previously listed.

The operating level of each overcurrent function is adjustable via a potentiometer mounted on the printed circuit card associated with the function. The card identification, such as D101, and its position denoted by the letter in the small square in the lower right corner is shown on the unit internal Figure 3. One test card is included at the extreme right position "T". Test point #1 at the top of the card is connected to relay reference; TP10 at the bottom of the card is connected to the +15 VDC bus. Other test points are located at select points within the logic circuitry to permit test measurement of the various functions and facilitate trouble shooting.

The potentiometers, P1 to P6, located to the left of the printed circuit cards are factory set to provide the range of operation of the associated overcurrent function.

## RECEIVING, HANDLING AND STORAGE

This relay will normally be supplied as a part of a static relay equipment, mounted in a rack or cabinet with other static relays and test equipment. Immediately upon receipt of a static relay equipment, it should be unpacked and examined for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Sales Office.

Reasonable care should be exercised in unpacking the equipment. If the equipment is not to be installed immediately, it should be stored indoors in a location that is free from moisture, dust, metallic chips, and severe atmospheric contaminants.

Just prior to final installation the shipping support bolt should be removed from each side of all relay units, to facilitate possible future unit removal for maintenance. These shipping support bolts are approximately 8 inches back from the relay unit front panel. Static relay equipment, when supplied in swing rack cabinets, should be securely anchored to the floor or to the shipping pallet to prevent the equipment from tipping over when the swing rack is opened.

## INSTALLATION TESTS

The Type SLC51 relay is usually supplied from the factory mounted and wired in a static relay equipment.

All units of a given terminal have been calibrated together at the factory and will have the same summary number on the unit nameplates.

These units must be tested and used together.

## NECESSARY ADJUSTMENTS

The following checks and adjustments should be made by the user in accordance with the procedures given below under DETAILED TESTING INSTRUCTIONS, before the relays are put in service. Some of the following items are checks of factory calibrations and settings, or installation connections and hence do not normally require readjustment in the field. Other items cover settings or adjustments which depend on installation conditions and hence must be made on the installed equipment.

1. G2, $I_{0W}$, and G4 overcurrent operating levels.

2. $I_{3\emptyset}$, $I_W$, and PH4 overcurrent operating levels.

# GENERAL TESTING INSTRUCTIONS

## INPUT CIRCUITS

The Type SLC51B relay has a terminal block on the rear of the unit identified as "RA". In a static relay equipment the terminal block is usually wired to the test panel where input currents can be supplied through the standard Type XLA test plug. Where other test facilitites are used, input currents should be applied to test points which connect to the same RA terminal points as those shown on the job elementary.

## OUTPUT SIGNALS

Output signals are measured with respect to the reference bus or TP1. Outputs are continuous signals of approximately +12 to +15 volts for the "ON" condition and 0 volts for the "OFF" condition. This output can be monitored with an oscilloscope, a portable high impedance d-c voltmeter, or with the test panel voltmeter if available. To connect the test panel voltmeter, place the test lead in the proper test point pin jack and the other end in the pin jack on the test panel.

# DETAILED TESTING INSTRUCTIONS

## REQUIRED ADJUSTMENTS

The overcurrent function settings may be made and tested using a single phase test source. A possible test circuit is shown in Figure 5 with the input connections for the SLC51B given below in Table I.

CAUTION: THIS RELAY IS RATED AT 5 AMPERES CONTINUOUS DUTY. TO SET FOR HIGHER CURRENT LEVELS, APPLY TEST CURRENT TO THE RELAY ON MOMENTARY BASIS (APPROXIMATELY ONE SECOND).

To set the test circuit for higher current levels it is recommended that a resistance be connected between points "A" and "B" of Figure 5. The value of the resistance should be equal to the impedance of the AC circuit to be tested (see above). When the desired current level is established, remove the resistor and connect the relay per Table I. Momentarily apply test current and monitor the output. Adjust the proper potentiometer for the desired operating point (clockwise pot rotation raises the operating point).

TABLE I

| FUNCTION | CONNECT "RA" TERMINALS TO TEST CIRCUIT POINTS A | B | JUMPER | MONITOR OUTPUT AT | ADJUST POT. ON CARD |
|---|---|---|---|---|---|
| G2 | 5 | 6 | --- | TP4 | N |
| $I_{0W}$ | 5 | 6 | --- | TP3 | M |
| G4 | 5 | 6 | --- | TP5 | P |
| $I_{3\Phi}$, Ø1-2 | 7 | 9 | 8 to 10 | TP6 | * |
| $I_W$, Ø1-2 | 7 | 9 | 8 to 10 | TP7 | * |
| PH4, Ø1-2 | 7 | 9 | 8 to 10 | TP8 | * |
| $I_{3\Phi}$, Ø2-3 | 9 | 11 | 10 to 12 | TP6 | * |
| $I_W$, Ø2-3 | 9 | 11 | 10 to 12 | TP7 | * |
| PH4, Ø2-3 | 9 | 11 | 10 to 12 | TP8 | * |
| $I_{3\Phi}$, Ø3-1 | 11 | 7 | 12 to 8 | TP6 | * |
| $I_W$, Ø3-1 | 11 | 7 | 12 to 8 | TP7 | * |
| PH4, Ø3-1 | 11 | 7 | 12 to 8 | TP8 | * |

* PH4, $I_3$ , and $I_W$ level detectors operate on the highest phase to phase current input; if operating point differences are observed, calibration procedure is described below.

## CALIBRATION

The SLC51B relay calibration may be checked by applying a reactance limited single phase current per Figure 5 and Table II. Use of the card adapter will provide access to the required measurement points.

TABLE II

| FUNCTION | CONNECT "RA" TERMINALS TO TEST CIRCUIT POINTS A | B | JUMPER | AMPS | ADJ. POT. | MEASURE PIN 3 TO PIN 1 CARD | VOLTAGE |
|---|---|---|---|---|---|---|---|
| G2 | 5 | 6 | --- | 4.0 | P2 | N | $4.1V_{0-PK}$ |
| $I_{0W}$ | 5 | 6 | --- | 3.2 | P1 | M | $8.3V_{0-PK}$ |
| G4 | 5 | 6 | --- | 1.0 | P3 | P | $2.0V_{0-PK}$ |
| $I_{3\Phi}$, Ø1-2 | 7 | 9 | 8 to 10 | 1.0 | P4 | R | $0.58V_{0-PK}$ |
| $I_{3\Phi}$, Ø2-3 | 9 | 11 | 10 to 12 | 1.0 | P5 | R | $0.58V_{0-PK}$ |
| $I_{3\Phi}$, Ø3-1 | 11 | 7 | 12 to 8 | 1.0 | P6 | R | $0.58V_{0-PK}$ |

NOTE - The residual current (In 5 out 6) will be a sinusoidal wave while the phase currents will be a fully rectified wave.

The PH4 card input voltage (pin 3 to pin 1 of "S" card) with 5.0 amps applied at any one of the three phase to phase connections should be 0.45 to 0.55 volts zero to peak.

# MAINTENANCE

## PERIODIC CHECKS

For any periodic testing of the Type SLC51 relay the trip coil circuit of the circuit breaker should be opened by opening the disconnect switches or other test switches provided for this purpose.

## TROUBLE-SHOOTING

Test points are provided at selected points in the Type SLC51B relay to observe outputs if trouble-shooting is necessary. The use of a card adapter will make the pins on any one card available for testing.

For the physical location of components and cards refer to Figure 2, the component location diagram.

SPARE CARDS

The number of spare cards to carry in stock would depend on the total number of static relays, using similar cards, at the same location or serviced by the same test group. For each type of card (different code designation) a suggested minimum number of spare cards would be:

1 spare for 1 to 25 cards
2 spares for 26 to 75 cards
3 spares for 76 to 125 cards

CARD DRAWINGS

Details of the circuits of the printed circuit cards can be obtained in the printed circuit card book GEK-34148.

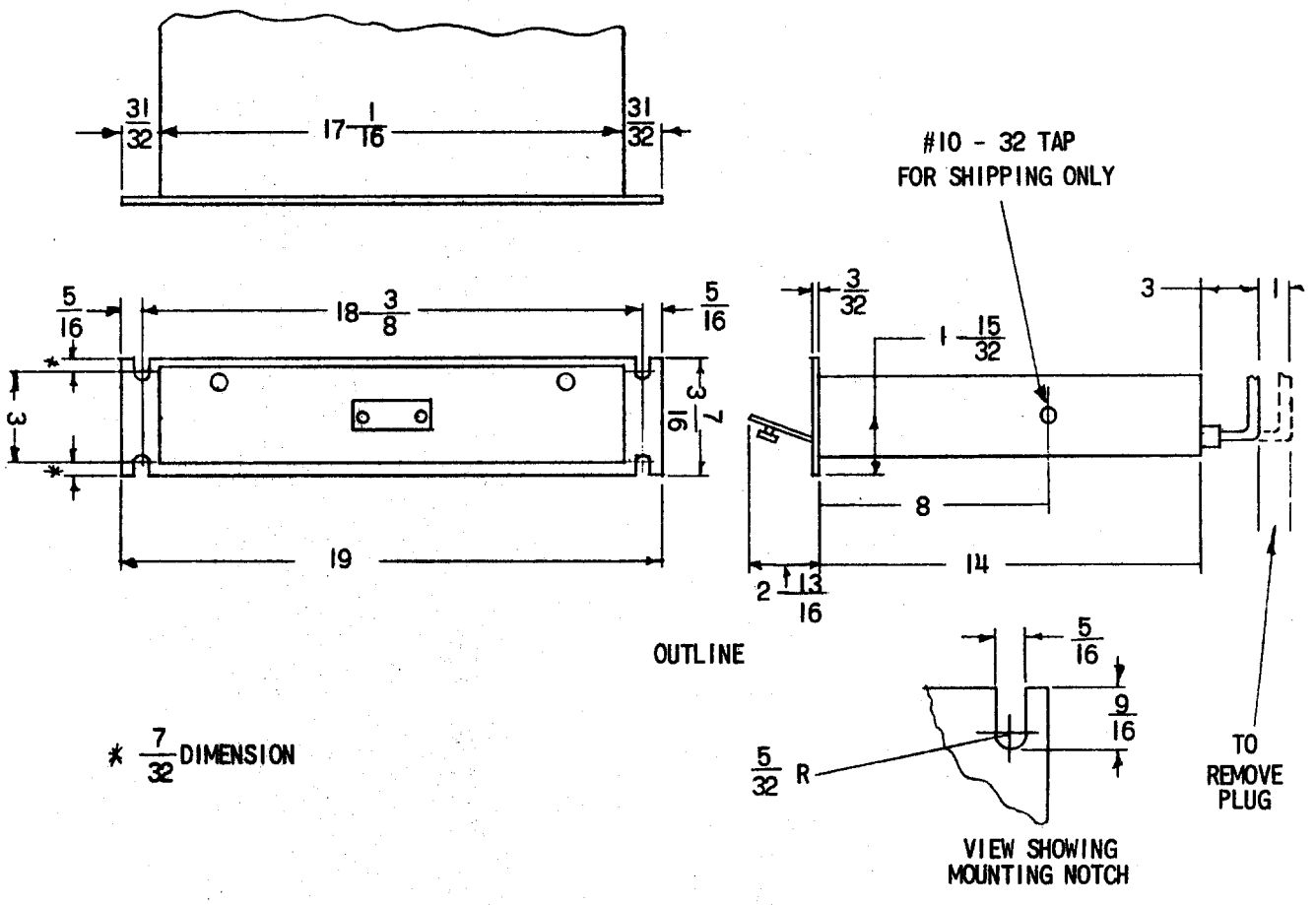


FIG. 1 (0227A2036-0) Outline And Mounting Dimensions For The SLC51B Relay

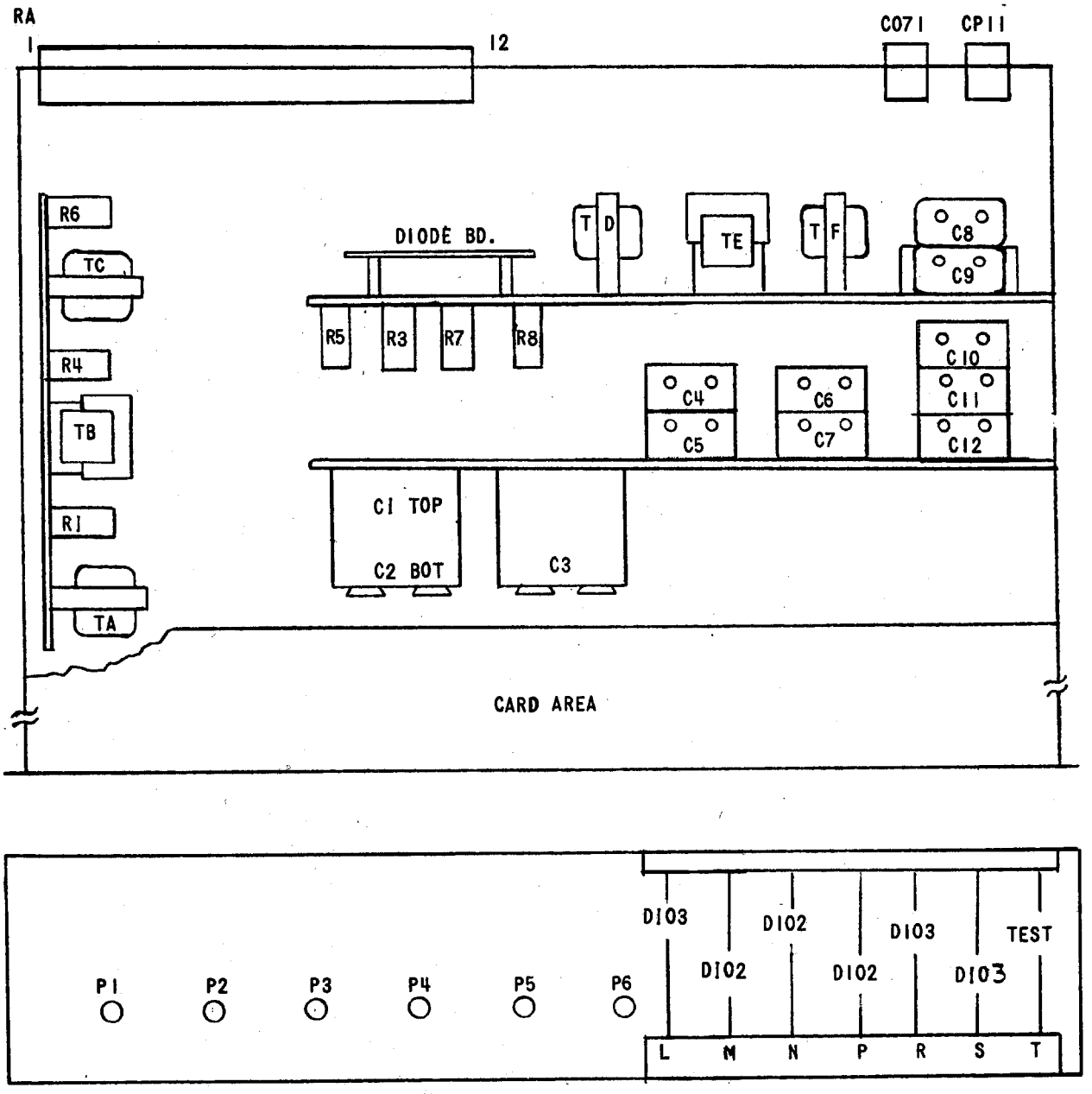


FIG. 2 (0227A2194-1) Component Location Diagram For The SLC51B Relay

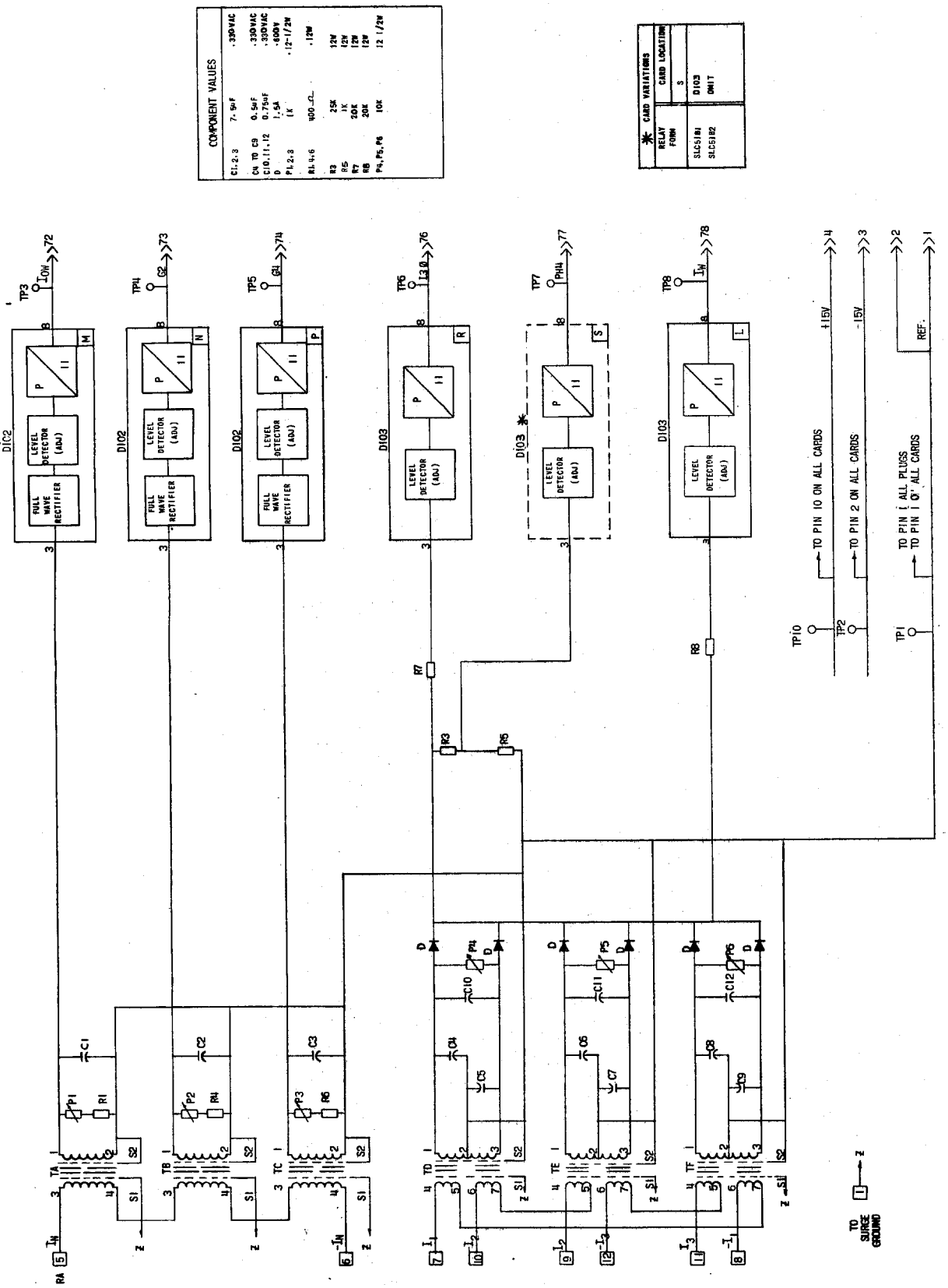


FIG. 3 (0149C7373-0) Internal Connections Diagram For The SLC51B Relay

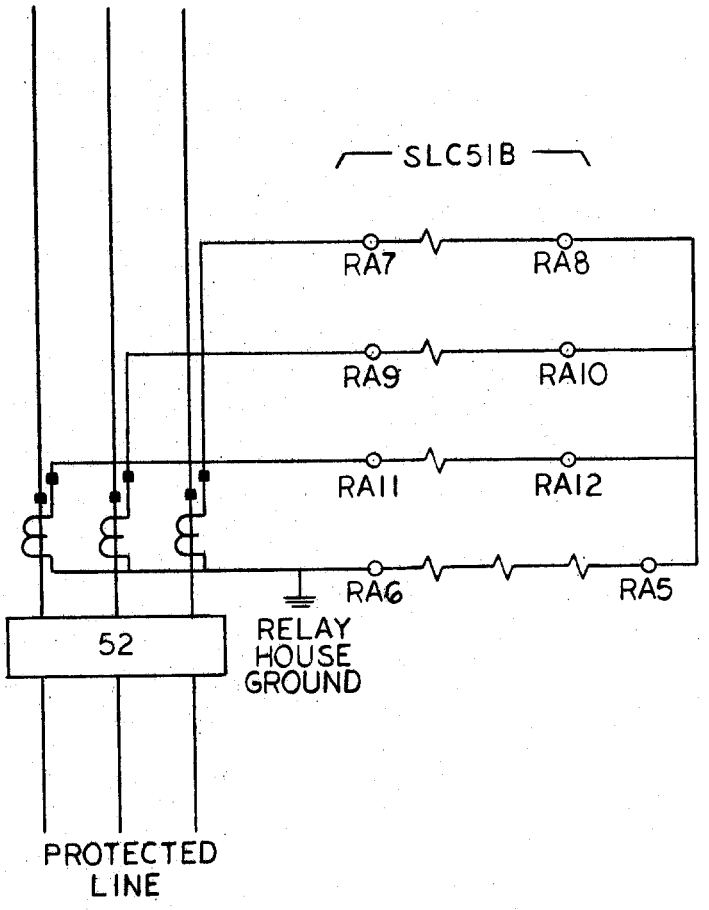


FIG. 4 (257A5792-0) ) AC Current Connections To SLC51B Relay

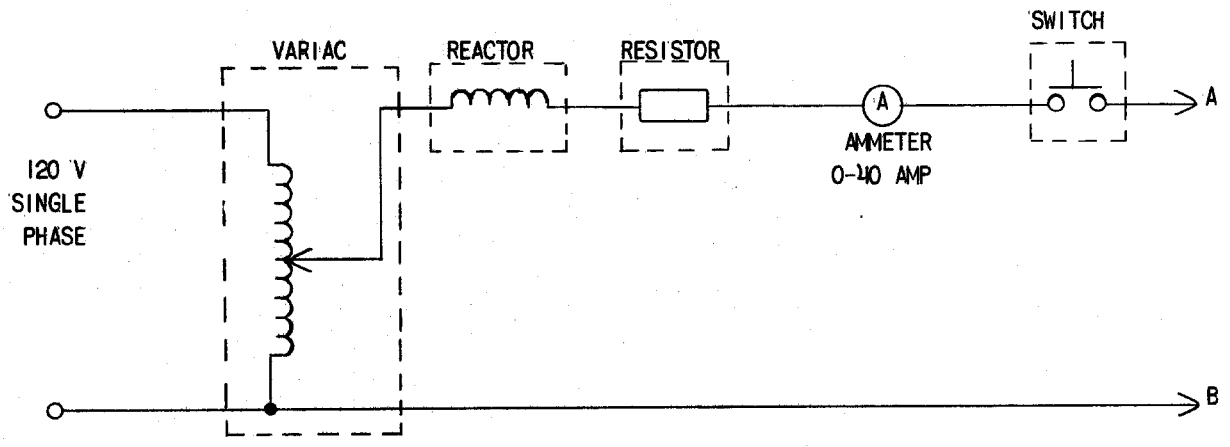


FIG. 5 (0246A3681-0 ) Overcurrent Function Test Current

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