



GEK-86040C

INSTRUCTIONS

**STATIC, THREE-PHASE OFFSET
PHASE DISTANCE RELAY
TYPE SLY92A**

GENERAL ELECTRIC

TABLE OF CONTENTS

DESCRIPTION	PAGE
APPLICATION	3
RATINGS	3
GENERAL	4
SURGE WITHSTAND CAPABILITY	4
POWER SUPPLY	5
CONTACTS	5
TARGET AND SEAL-IN UNIT	6
CHARACTERISTICS	6
OPERATING PRINCIPLES	7
RELAY REACH	7
SENSITIVITY	7
BURDENS	8
CIRCUIT DESCRIPTION	9
CALCULATION OF SETTINGS	9
CONSTRUCTION	13
RECEIVING, HANDLING AND STORAGE	15
ACCEPTANCE TESTS	16
GENERAL	16
VISUAL INSPECTION	16
MECHANICAL INSPECTION	17
Cradle and Case Blocks	17
Target Unit	17
Telephone Relay	17
ELECTRICAL TESTS, GENERAL	17
DIELECTRIC TESTS	18
Introduction	18
Hipot Tests	18
Restoring Relay to Service	18
DETAILED ELECTRICAL TESTING INSTRUCTIONS	19
Required Settings	19
Relay Base Reach Angle and Reach Check	19
Testing Mho Characteristics	19
Offset Tests (R setting)	21
Integrating Timer Tests	21
INSTALLATION PROCEDURE	21
INTRODUCTION	22
SURGE GROUND AND RELAY CASE GROUND CONNECTIONS	22
TEST PLUGS	22
INSTALLATION TESTS	23
Visual Inspection	23
Mechanical Inspection and Adjustments	23
Target Unit	23
Reach Tests	23
PERIODIC CHECKS AND ROUTINE MAINTENANCE	23
CONTACT CLEANING	24
ELECTRICAL TESTS	24
SERVICING	24
RENEWAL PARTS	24
APPENDIX I - DEFINITION OF SYMBOLS	26
LIST OF TABLES	28
LIST OF ILLUSTRATIONS	29
	30

STATIC, THREE-PHASE OFFSET

PHASE DISTANCE RELAY

TYPE SLY92A

DESCRIPTION

The Type SLY92A relay is a three-phase, single-zone static phase distance relay with provisions for offsetting its circular mho characteristic. It is a special-purpose relay, designed for use in applications where a delta-wye or wye-delta transformer bank exists between the relay location and the protected line. One Type SLY92A, plus a suitable Type SAM timing relay, provides one zone of time-delay phase distance fault protection. The relay is not intended for use as a first-zone relay.

The SLY92A includes two normally-open contacts, one equipped with a target seal-in unit, and one normally-closed contact. The relay is mounted in the deep, large-size, double-ended (L2D) drawout case. Outline and panel drilling dimensions are shown in Figure 23 and relay internal connections are shown in Figure 2. A functional block diagram is provided in Figure 1.

APPLICATION

The SLY92A relay finds application where a delta-wye or wye-delta transformer bank is located between the relay and the circuits to be protected. Because of this, it is well suited for application in unit generator protection schemes to provide back-up protection against faults on the adjacent system that are not cleared by the first line relays. Figure 3 illustrates the external AC and DC connections to the SLY92A relay for this type of protection.

Since the relay is intended to detect faults on lines off the bus on the remote side of a delta-wye step-up transformer (see Figure 5), the actual line impedance must be corrected to account for infeed from other lines connected to the bus, for the impedance of the transformer bank, and for the effect of the low-side to high-side bank ratio. Thus, for the AC connections shown in Figure 3, the SLY92A relay will see the following impedance:

$$Z = 0.866 (Z_T + KZ_L) \left(\frac{V_L}{V_H} \right)^2 \left(\frac{CT \text{ Ratio}}{PT \text{ Ratio}} \right) \quad (\text{Eq. 1})$$

where:

- Z = Impedance seen by the relay in ohms.
- Z_T = Power transformer impedance in ohms referred to the high side
- Z_L = Line impedance in primary ohms

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

K = Ratio of current in the line (I_L) to current in the line side of the power transformer (I_{PT}), as shown in Figure 5. This constant corrects for infeed.

V_L/V_H = low-side to high-side voltage ratio of the power bank on the taps used.

$\frac{CT \text{ Ratio}}{PT \text{ Ratio}}$ - converts to secondary impedance

Note that the AC voltage is shifted 30° leading by internal circuitry so that it is equivalent to the high-side voltage.

The worked example in the section on **CALCULATIONS OF SETTINGS** illustrates how this equation is used to calculate the desired reach setting when the relay is used to provide back-up protection at a generator for faults on the system side of the step-up transformer.

The Type SLY92A relay may also be applied as the carrier-start relay on installations where there is a wye-delta or delta-wye transformer bank between the relay location and the line protected by the directional comparison carrier blocking scheme. The objective in using the SLY92A relay in this situation is to realize the same relay response during external faults in the blocking direction as would be the case if the relay were connected to CTs and PTs on the line side of the bank. This simplifies coordination with the carrier trip relays at the remote end of the protected line.

The external connections in Figure 4A or 4B are recommended for this application as a carrier-start relay. The relay connections will differ depending on whether the voltage on the relay side of the bank leads or lags the voltage on the other side by 30° . Use the connections in Figure 4A when the relay-side voltage lags by 30° ; use those in Figure 4B when the relay-side voltage leads by 30° . Also note in these external connection diagrams that if the transformer bank is connected wye-grounded on the relay side, it is necessary to provide a zero-sequence current shunt, by means of the 5/5 amp auxiliary CTs, to prevent zero-sequence current from flowing in the relay operating coils.

RATINGS

GENERAL

The Type SLY92A relay is designed for continuous operation in ambient temperatures between -20°C and $+55^\circ\text{C}$ per ANSI Standard C37.90-1978. In addition, these relays will not malfunction nor be damaged if operated at an ambient temperature up to 65°C .

The current circuits of the relays, which are rated 5 amperes RMS, will carry 10 amperes continuously, and will carry 250 amperes for 1 second. The potential circuits are rated 120 volts RMS, line-to-line, and will continuously withstand 110% of this value.

The Type SLY92A relay is available with an impedance range as shown in Table I.

TABLE I
AVAILABLE REACHES

Relay Current Circuit Rating Amperes	Base Reach Tap in Positive-Sequence Ohms Z_{R1}	Impedance Range in Positive-Sequence Ohms Z_R	Offset Range in % of Z_R
5	0.75	0.75 to 7.5	0/10/20/30
5	1.5	1.5 to 15.0	0/10/20/30
5	3.0	3.0 to 30.0	0/10/20/30
			*

* 0% Offset is achieved by removing all three offset jumper plugs on CP card.

Selection of the desired base reach tap (Z_{R1}) is made by means of the three tap screws at the lower rear of the relay (see Figure 6). All three tap screws ($\emptyset A$, $\emptyset B$, $\emptyset C$) must be in equal ohmic tap positions.

The reach (Z_R) of the relay is continuously adjustable within the range shown in Table I for a particular tap, by means of a three-gang precision potentiometer at the lower front of the relay (see Figure 7). The ten-turn dial of this potentiometer is calibrated in percent restraint setting (T), and is adjustable from 10% (fully counterclockwise) to 110% (fully clockwise). The maximum recommended setting is 100%. An enlarged picture of the dial is shown in Figure 9.

The relay reach is given by equation 2:

$$\text{Relay Reach} = Z_R = \frac{100 \times Z_{R1}}{T} \quad (\text{Eq. 2})$$

where:

- T = Restraint setting in percent
- Z_R = Relay reach in ohms
- Z_{R1} = Base reach tap in positive-sequence ohms

The relay reach should be within 5% of the value given by equation 2 if the ambient temperature is within the rated range of -20°C to +55°C.

SURGE WITHSTAND CAPABILITY

These relays will withstand the surge test specified by ANSI C37.90-1978 without incorrect operation or damage to any component.

POWER SUPPLY

Models are available with ratings of 48 volts DC (38 to 56 volts), 110 volts DC (88 to 120 volts), or 125 volts DC (100 to 140 volts). The power supply includes a DC-to-DC converter to provide isolation between the DC input control power and the solid state circuitry of the relay.

CONTACTS

The trip contacts will make and carry 30 amperes for tripping duty. The interrupting ratings of the contacts are listed in Table II. Their continuous current ratings are limited by the target ratings as listed in Table III.

TABLE II
INTERRUPTING RATINGS IN AMPERES OF OUTPUT CONTACTS

VOLTAGE	TRIP OUTPUT CONTACTS	
	INDUCTIVE**	NON-INDUCTIVE
115 volts AC	0.75	2.0
230 volts AC	0.5	1.0
48 volts DC	1.0	3.0
125 volts DC	0.5	1.5
250 volts DC	0.25	0.75

**The inductive ratings are based on an L/R ratio of 0.04

TARGET AND SEAL-IN UNIT

A target and seal-in unit is provided for the output contact between terminals 11 and 12. The ratings of this target unit are given in Table III.

TABLE III
CHARACTERISTICS OF TARGET SEAL-IN UNITS

		Dual Rated			
		0.2/2.0 Amp		0.6/2.0 Amp	
		0.2	2.0	0.6	2.0
Carry 30 amps for	(seconds)	0.05	2.2	0.5	3.5
Carry 10 amps for	(seconds)	0.45	2.0	5.0	30.0
Carry continuously	(amperes)	0.37	2.3	1.2	2.6
Minimum operating	(amperes)	0.2	2.0	0.6	2.0
Minimum dropout	(amperes)	0.05	0.5	0.15	0.5
DC resistance	(ohms)	8.3	0.24	0.78	0.18
60 hertz impedance	(ohms)	50.0	0.65	6.2	0.64
50 hertz impedance	(ohms)	42.0	0.54	5.1	0.54
DC Resistive Interrupting rating (amperes)		2.5 Amperes @ 125 VDC			

CHARACTERISTICS

OPERATING PRINCIPLES

The SLY92 relay utilizes a three-input phase angle comparator for the phase distance measurement. The three inputs for the phase A-B measurements are:

$$(I_A) Z_{R1} - \frac{T}{100}(V_{AB}) \quad \text{Operating Quantity} \quad (\text{Eq. 3})$$

$$\frac{T}{100}(V_{AB} + DV_{AB1}) + R(I_A)Z_{R1} \quad \text{Polarizing Quantity} \quad (\text{Eq. 4})$$

$$(I_A) Z_{R1} \quad \text{Overcurrent Supervision} \quad (\text{Eq. 5})$$

where:

- I_A is the current in the faulted phase
- D is a design constant, equal to 0.3 per unit.
- R is a ratio tap to provide an "offset" equivalent to 0.1, 0.2 or 0.3 of the relay reach.
- T is the restraint setting in percent.
- V_{AB} is the faulted phase-to-phase voltage
- V_{AB1} is the positive-sequence component of the faulted phase-to-phase voltage.
- Z_{R1} is the base reach impedance with an impedance angle of 75°

The use of the positive-sequence component of voltage in the polarizing signal results in a relay characteristic of the "variable mho" type; that is, the characteristic expands as the source impedance behind the relay increases, providing an automatic accommodation of increasing arc impedance. The positive-sequence component of voltage in the polarizing signal also improves the directional integrity of the distance measurement.

The third input to the comparator provides an overcurrent supervision function.

RELAY REACH

The balance point of the relay is defined as the point at which the operating quantity goes to a null, which for phase A-B is:

$$(I_A) Z_{R1} = \frac{TV_{AB}}{100} \quad (\text{Eq. 6})$$

or

$$V_{AB} = \frac{100 (I_A) Z_{R1}}{T} \quad (\text{Eq. 7})$$

For a phase A to phase B fault where $I_A = -I_B$

$$V_{AB} = \frac{100 (I_A) Z_{R1}}{T} \quad (\text{Eq.8})$$

The reach of the relay is defined as:

$$Z_R = \frac{V_{AB}}{I_A} = \frac{100 Z_{R1}}{T} \quad (\text{Eq.9})$$

where: Z_R is the relay reach in ohms

To set the relay for the desired reach, it is necessary first to select the proper base reach tap. This tap should be the highest base reach tap that is smaller than the desired ohmic reach. The setting of this tap is explained in the **CONSTRUCTION** section in this book. After the base reach tap is selected, the percent restraint may now be chosen to produce the required relay reach.

SENSITIVITY

Sensitivity is defined as the steady state RMS voltage or current (at the relay terminals) required for a particular quantity to pick up the relay if all quantities are in the optimum phase relationship. The nominal sensitivities for the signal quantities in the SLY92 relay are as follows:

Polarizing Sensitivity:

0.2 volts

Overcurrent Supervision Sensitivity:

Sensitivity is shown in Table IV.

TABLE IV

<u>OVERCURRENT ADJUSTMENT RANGE</u>			
<u>BASE REACH TAP</u> <u>IN OHMS</u>	<u>ADJUSTMENT RANGE IN</u> <u>Ø-Ø AMPERES RMS</u>	<u>V_{IN}</u>	<u>ANGLE</u>
0.75	0.52 - 10	0.39 - 7.5	75°
1.5	0.26 - 10	0.39 - 15	75°
3.0	0.13 - 10	0.39 - 30	75°

Operate Circuit Sensitivity:

See Figure 10 for sensitivity in terms of $V_{LL} \times \frac{T}{100}$

where: V_{LL} is faulted phase voltage.

The current sensitivity for phase pair A-B is given by the relationship:

$$(I_A) Z_{R1} = \frac{0.032 (I_{rated})}{1 - X} \quad (\text{Eq.10})$$

where: I_{rated} = Relay current circuit rating amperes

$$X = \frac{\text{Actual Relay Reach}}{\text{Nominal Relay Reach}} \quad (\text{Eq.11})$$

For example, if $X = 0.8$, and $Z_{R1} = 3$ ohms, then:

$$I_A = \frac{0.032(5)}{3(1-0.8)} = 0.27 \text{ amperes}$$

BURDENS

The potential circuit burden per phase at 120 volts rms is 0.4 volt-amperes, 0.2 watts, 0.35 vars. The current circuit impedance per circuit, measured at rated current, is given in Table V below. The relay current rating is 5 amperes.

TABLE V

CURRENT CIRCUIT BURDENS

CURRENT CIRCUIT	PER PHASE
Impedance, Z, in ohms	0.027
Resistance, R, in ohms	0.027
Reactance, X, in ohms	0.002

The current requirements at the DC control power input (studs 19 and 20) are given in Table VI below:

TABLE VI

DC CONTROL CIRCUIT BURDENS

RELAY RATED DC VOLTAGE	CONDITION OF OUTPUT RELAY K2	CONTROL CIRCUIT BURDEN IN MILLIAMPERES
48	Dropped out	200
48	Picked up	315
125	Dropped out	80
125	Picked up	155

CIRCUIT DESCRIPTION

The internal connections for the Type SLY92 are shown in Figure 2. The terminal numbers at the tops and bottoms of these diagrams represent the external connections to the relays. The external connections can be grouped as shown in Table VII.

TABLE VII
EXTERNAL CONNECTIONS

TERMINAL NUMBERS	DESCRIPTION
1 thru 6	AC current inputs
9	Contact (other end connected to #19)
10	Surge ground
11 thru 13	Normally-open contact with target seal-in
14 and 18	Normally-closed contact without target
15 thru 17	AC potential inputs
19 and 20	DC control power input

The line-to-line input voltages are connected to the primaries of step-down potential transformers (T_A , T_B and T_C). The secondaries of these potential transformers are connected to the signal processing (SP) card, as well as to a three-gang potentiometer. The voltages on the sliders of the potentiometers are also connected as inputs to the SP card.

The input phase currents pass through the primaries of transactors (X_A , X_B and X_C). The transactors produce secondary voltages proportional to their primary currents in magnitude; however, the secondary voltages lead their respective primary currents by a phase angle of 75° . Taps are provided on the primaries of these transactors and the secondary voltages are connected as inputs to the SP card.

The SP card combines the above-mentioned quantities to produce various output signals, which are then fed as inputs to other cards. Table VIII indicates the types of output signals produced by the SP card, and the cards which use these signals as an input.

TABLE VIII
OUTPUTS FROM SP CARD

OUTPUT SIGNAL FROM SP CARD	INPUT TO CARD
V_{AB} , V_{BC} , V_{CA}	Combined Polarizing (CP)
$(I_A)Z_{R1}$ $(I_B)Z_{R1}$ $(I_C)Z_{R1}$	Coincidence Logic (CL) and Combined Polarizing (CP)
$(I_A)Z_{R1} - TV_{AB}$ $(I_B)Z_{R1} - TV_{BC}$ $(I_C)Z_{R1} - TV_{CA}$	Operate Signal (OS)

The combined polarizing (CP) card produces the following voltages by algebraic summations of V_{AB} , V_{BC} and V_{CA} :

$$V_{AB} + 0.3 V_{AB1} \quad \text{and} \quad V_{BC} + 0.3 V_{BC1} \quad \text{and} \quad V_{CA} + 0.3 V_{CA1}$$

where:

V_{AB} = phase A to phase B voltage in volts RMS
 V_{BC} = phase B to phase C voltage in volts RMS
 V_{CA} = phase C to phase A voltage in volts RMS
 V_{AB1} = positive sequence of V_{AB} voltage in volts RMS
 V_{BC1} = positive sequence of V_{BC} voltage in volts RMS
 V_{CA1} = positive sequence of V_{CA} voltage in volts RMS

A current compensating component equal to $R(I_A)Z_{R1}$ is added to the $V_{AB} + 0.3 V_{AB1}$ voltage. The other two voltages are similarly compensated. These voltages are then filtered in active bandpass filters with natural frequencies (f_0) equal to the system frequency. These three filtered voltages are fed to the coincidence logic (CL) card as polarizing quantities.

The operate signal (OS) card filters its input signals from the SP card in active bandpass filters with natural frequencies equal to system frequency. Circuitry is also provided to bypass this filtering for (IZ-TV) (see functional block diagram, Figure 1) signals of large magnitudes. The outputs of the OS card are fed to the CL card as operating signals.

Each phase of the CL card has three input signals and produces a HIGH logic (+15 volts DC) output signal whenever these signals have the proper instantaneous phase relationship. Table IX shows the various input signals for phase AB, and where the signals are obtained. In order for the output of CL to be high, inputs 1 and 3 must have the same polarity, and input 2 must have an opposite polarity.

TABLE IX
INPUTS TO CL CARD

INPUT NO.	INPUT SIGNAL	DERIVED FROM
1	Combined polarizing	CP card
2	Operate signal	OS card
3	$(I_A)Z_{R1}$	SP card

The CL card outputs are fed to the integrating timer (IT) card, which measures the time that each CL output signal is HIGH. If the input signal to the IT card is HIGH for 4.16 milliseconds on a repetitive basis or 5.5 milliseconds on a single-shot basis, the output of the IT card will go to a HIGH logic value, which picks up a reed relay (K1) mounted on the power supply (PS) card. A normally-open contact on K1 energizes a telephone relay (K2) mounted on the front panel. One normally-open

contact of K2 is connected in series with the coil of a target to provide the main tripping contact (terminals 11 and 12). In addition, a second normally-open contact of K2 is connected between terminals 19 and 9, without a target, for auxiliary functions. A normally-closed contact is connected between terminals 13 and 14 for blocking duty.

The input DC control power (48 or 125 volts) is connected to the PS card, which contains a DC-to-DC converter. The outputs of the DC-to-DC converter are regulated at +15 and -15 volts DC and supply the necessary control power to the other cards. The transformer in the DC-to-DC converter provides isolation between the solid state circuitry of the relay and input DC control power (i.e., station battery). A yellow LED monitors the output voltage from this internal power supply.

The internal connections and card layouts for each printed circuit card are listed in Table X. The printed circuit cards have test points accessible from the front of the cards. Each test point, except the reference connection, "0V," on the PS card, is buffered by a resistor to prevent a disturbance to the circuitry if a test point is accidentally short-circuited. The test points are labeled functionally, that is, the AB phase input to the integrating timer is labeled "AIN." The internal connection drawings show the test points with the same label.

TABLE X
INTERNAL CONNECTIONS FOR CARDS

CARD DESIGNATION	CARD FUNCTION	FIGURE NUMBER OF INTERNAL CONNS.	FIGURE NUMBER OF CARD LAYOUT
SP	Signal processing	11A	11B
CP	Combined polarizing	12A	12B
OS	Operate signal	13A	13B
CL	Coincidence logic	14A	14B
IT	Integrating timer	15A	15B
PS	Power supply (125 VDC)	16A	16B
PS	Power supply (48 VDC)	17A	17B

CALCULATION OF SETTINGS

Assume a system as shown in Figure 5 with the relay supplied from current and potential transformers on the generator side of the step-up transformer. Further assume that the following parameters describe the system:

$$V_L/V_H = 13.8/132 \quad (\text{Eq.12})$$

$$Z_L = \text{Miles} \times 0.81 \angle 80^\circ / \text{ohms per mile} \quad (\text{Eq.13})$$

$$Z_T = 10\% \text{ on } 100,000 \text{ KVA base at } 86^\circ, \text{ lagging}$$

where:

V_L is transformer phase-to-phase voltage, low side
 V_H is transformer phase-to-phase voltage, high side
 Z_L is line impedance
 Z_T is transformer impedance
 Miles is length of transmission line in miles

From the **APPLICATION** section, the impedance seen by the relay for a fault on the high voltage system is:

$$Z = 0.866 (Z_T + KZ_L) \left(\frac{V_L}{V_H} \right)^2 \left(\frac{CT \text{ Ratio}}{PT \text{ Ratio}} \right) \quad (\text{Eq. 1})$$

where:

Z is the impedance seen by the relay

On the system described above the ratio of the main potential transformers would be:

$$PT \text{ Ratio} = 14,400/120 = 120/1 \quad (\text{Eq.14})$$

Assume that the generator CT ratio is 5000/5, which is a reasonable rating for CTs used on a 100,00 KVA, 13.8 KV unit.

$$CT \text{ Ratio} = 5000/5 = 1,000 \quad (\text{Eq.15})$$

The primary ohms of the transformer (Z_T) referred to the 132 KV side, may be obtained from the following equation:

$$Z_T = \text{per unit impedance} \frac{(\text{KV})^2}{\text{MVA Base}} \quad (\text{Eq.16})$$

$$Z_T = 0.10 \frac{(132)^2}{100} = 17.4 \text{ ohms } \angle 86^\circ$$

Now assume that the SLY92A relay needs to reach no further than 30 miles out from the high voltage bus on any of the three circuits under any condition of infeed from the other two. Thus:

$$Z_L = 30 \times 0.81 \angle 80^\circ = 24.3 \text{ primary ohms (from Eq.13)}$$

Assume that a fault study indicates that the minimum value of infeed under any reasonable system conditions will result in K being no less than 1.2. Thus:

$$K = 1.2$$

From equation 1, the relay should be set with a forward reach of:

$$Z = 0.866 (17.4 \angle 86^\circ + 1.2(24.3 \angle 80^\circ)) \left(\frac{13.8}{132} \right)^2 \left(\frac{1000}{120} \right) \quad (\text{from Eq.1})$$

$$Z = (40.3 \angle 82.2^\circ) (0.01093) (8.33)$$

$$Z = (3.67 \angle 82.2^\circ) \text{ secondary ohms}$$

It should be noted that on a radial system, K will be equal to 1.0. In order to be absolutely certain that the relay does not reach beyond the desired distance under any conditions on any system, some users may prefer to assume $K = 1.0$.

Thus, if a K factor of 1.2 were used, the relays should be set with a forward reach of about 3.7 ohms at 82° . However, in applications of this kind, some users prefer to set the relay with offset in order to obtain some additional backup protection for faults in the leads between the generator and the transformer. If this is the case, select an offset tap that gives the required coverage.

When the Type SLY92A relays are applied as carrier-start relays, as shown in Figure 4A or 4B, they are looking away from the transformer bank and protected line and must coordinate with the carrier stop and trip relays at the remote end of the line. Since the relay responds as through the CTs and PTs were on the line side of the bank, the blocking relay will see the same impedance on the relay side of the bank (i.e., blocking direction in Figures 4A and 4B) as the tripping relays at the remote end of the line will see. This simplifies the blocking versus tripping coordination, since it is only necessary to set the blocking relay reach for a reasonable multiple, say 1.5, of the amount that the remote tripping relay reaches beyond the transformer bank.

For this application, the SLY92A relay should be set for its minimum offset of 10% of its reach in the blocking direction to ensure that the relay remains "operated" during a zero-voltage fault in the blocking direction. If the relay is being used in conjunction with a static mho tripping relay, such as the SLY81, at the remote end, it is recommended that a 5 milliseconds delay be introduced into the tripping circuit at the remote end to ensure that the blocking and tripping schemes coordinate on a time basis.

CONSTRUCTION

The Type SLY92A relay is assembled in a deep, large size, double-end (L2D) drawout case, having studs at both ends in the rear for external connections. The electrical connections between the relay unit and the case studs are made through stationary molded inner and outer blocks, between which nests a removable connecting plug, which completes the circuits. The outer blocks attached to the case have the studs for the external connections, and the inner blocks have terminals for the internal connections.

Every circuit in the drawout case has an auxiliary brush, as shown in Figure 18, to provide adequate overlap when the connecting plug is withdrawn or inserted. Some circuits are equipped with shorting bars (see internal connections in Figure 2), and it is especially important that the auxiliary brush make contact on these circuits with adequate pressure to prevent the opening of important interlocking circuits.

The relay is mounted in a steel framework called a cradle, and is a complete unit with all leads terminated at the inner block. The cradle is held firmly in the case with a latch at both the top and the bottom, and by a guide pin at the back of the case. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also locks the latch in place. The cover, which is drawn to the case by thumbscrew, holds the connecting plug in place. The target reset mechanism is part of the cover assembly.

The relay case is suitable for either semi-flush or surface mounting on all panels up to 2 inches thick. Appropriate hardware is available; however, panel thickness must be indicated when ordering the relay to ensure that proper hardware is inclined with the relay.

The outline and panel drilling for the SLY92A is shown in Figure 23.

A separate test plug can be inserted in place of the connection plug to test the relay in place on the panel, either from its own source of current and voltage, or from other sources. The relay can also be drawn out and replaced by another relay that has been tested in the laboratory.

The potential transformers (TA, TB and TC), and the transactors (XA, XB and SC), are mounted at the rear of the cradle, as shown in Figure 6. The block below the transactors is used to set the base reach to the value determined in the **CALCULATION OF SETTINGS** section of this book. The three leads tagged A, B and C, should be connected to the desired ohmic value labeled $\emptyset A$, $\emptyset B$ and $\emptyset C$, respectively. For example, Figure 6 shows a base reach (ZR1) setting of 3.0 ohms, and leads are connected as follows:

Lead C	_____	position 1
Lead B	_____	position 4
Lead A	_____	position 7

A base tap indicator is provided on the nameplate. The knob should be rotated until the number corresponding to the base reach setting is exposed.

Figure 8 shows a front view of the relay with the nameplate removed. This view shows the target, the telephone relay, and all adjustments other than the base reach tap described above.

The dial of the restraint setting potentiometer (T) is calibrated directly in percent, with the number in the window indicating the tens digit, and the two digits on the dial indicating the units and decimal digits. An example is shown in Figure 9, with a setting of 84%. The dial can be adjusted from 10% to 100%. The lock must be disengaged (by turning the lever counterclockwise) in order to change the restraint setting, but should be re-engaged after the desired setting is made.

The other adjustments indicated in Figure 8 are trim potentiometers located on printed circuit cards. Most of these adjustments are factory set, and normally should not require readjustment. If adjustments are required, see **ACCEPTANCE TESTS** for the recommended procedures.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If 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 when unpacking the relay to assure that none of the parts are damaged or the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed, and cause trouble in the operation of the relay.

ACCEPTANCE TESTS

GENERAL

The relay should be examined and tested upon delivery to make sure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed. If examination or test indicates that a readjustment is necessary, refer to the section on **SERVICING**.

The following tests may be performed as part of the installation of the relay at the discretion of the user. Since most operating companies use different procedures for acceptance and for installation tests, the following section includes all applicable tests that may be performed on the relays.

VISUAL INSPECTION

Check the nameplate stamping to make sure that the model number and rating of the relay agree with the requisition.

Remove the relay from its case and check that there are no broken or cracked molded parts or other signs of physical damage, and that all the screws are tight.

MECHANICAL INSPECTION

Cradle and Case Blocks

Check that the fingers on the cradle and the case agree with the internal connection diagram. Check that the shorting bar makes contact with the shorting bar. Deflect each contact finger to make sure that there is sufficient contact force available. Check that each auxiliary brush is bent high enough to contact the connecting plug.

Target Unit

The target unit has an operating coil tapped at 0.6 and 2.0 amperes. The relay is shipped from the factory with the tap screw in the higher ampere position. The tap screw is the screw holding the right-hand tap plate. To change the tap setting, first remove one screw from the left hand plate and place it in the desired tap. Next remove the screw from the undesired tap and place it on the left hand plate where the first screw was removed (see Figure 18). Screw should never be left in both taps at the same time.

* TABLE XI

TARGET PICKUP CURRENTS

TAP	PICKUP CURRENT IN AMPERES
0.6	0.45 - 0.59
2.0	1.40 - 1.95

Telephone Relay

With telephone relays in the de-energized position, all circuit-closing contacts should have a gap of at least 0.015 inch, and all circuit-opening contacts should have a wipe of at least 0.005 inch. The gap may be checked by inserting a feeler gage between the contacts, and wipe can be checked by observing the amount of deflection on the stationary contact before parting the contacts. The armature should then be operated by hand, and the gap and wipe checked again as described above.

* Indicates revision

ELECTRICAL TESTS, GENERAL

All alternating-current-operated devices are affected by frequency. Since non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental frequency, it follows that alternating-current devices (relays) will be affected by the applied waveform. Therefore, in order to test alternating-current (AC) relays properly it is essential to use a sine-wave source of current or voltage.

DIELECTRIC TESTSIntroduction

The surge capacitors (C1-C9 and C15-C20) used in the Type SLY relay do not have voltage ratings to withstand AC hipot voltage; therefore, caution must be exercised when hipotting to avoid damaging these capacitors.

It is recommended that hipot tests be performed on a bench, with the relay in its case. If the relay is to be hipot tested together with other apparatus, all external connections to terminal 10 (surge ground) must be removed.

The hipot test voltage should be 1500 volts RMS, 50 or 60 hertz for new relays, or 1125 volts RMS, 50 or 60 hertz for other relays. New relays are defined as those which have not been in service, which are not more than one year old from the date of shipment, and which have been suitably stored to prevent deterioration. The duration of application of the test voltage for both old and new relays should be 60 seconds.

Hipot Tests

1. Common Mode Hipot Tests (all terminals to case):

Temporary connections should be made to tie all relay terminals, including terminal 10, together. Hipot voltage can then be applied between this common connection and the relay case.

2. Transverse Mode Hipot Tests (between circuits):

For hipot tests between circuits of the relay, the surge capacitors must be temporarily disconnected from the surge capacitor buses inside the relay. The relay terminals should be jumpered to provide the four groups of circuits shown in Table XII. Hipot voltage can then be applied between any two groups of circuits.

TABLE XIICIRCUIT GROUPING FOR TRANSVERSE MODE HIPOT TESTS

<u>CIRCUIT GROUP</u>	<u>JUMPER BETWEEN TERMINAL NUMBERS:</u>
AC Current	1, 2, 3, 4, 5 and 6
AC Potential	15, 16 and 17
DC Control Power	9, 19 and 20
Output Contacts	11, 12, 13 and 14

An alternate test using a 500 volt DC megger can be performed between the circuit groups of Table XII with the surge capacitors connected in their normal manner. While this method does not test the relay to its full dielectric rating, it will detect some cases of insulation degradation.

Restoring Relay to Service

After the hipot or megger testing is completed, the surge capacitors should be reconnected to the surge capacitor buses and all external wiring to terminal 10 should be reconnected. The reach tests described below should then be repeated.

DETAILED ELECTRICAL TESTING INSTRUCTIONSRequired Settings

Make certain all the relay settings have been made. These should be in accordance with the setting calculations. The settings are:

1. Base reach (Z_{R1}) is set on the tap block at the rear of the relay. All three phase settings should be the same. The base tap indicator on the front of the relay should be matched (manually) to that setting.
2. Percent restraint (T) is set on the precision potentiometer on the front of the relay.

Relay Base Reach Angle and Reach Check

The following procedure is recommended to check the base reach angle (\emptyset) and the relay reach setting (Z_R).

1. Make the test connections shown in Figure 20 for the particular phase being tested.
2. Adjust the load box until the ammeter indicates the desired test current (I_T). See Table XIII for the recommended test current for a desired reach.

TABLE XIII

RECOMMENDED TEST CURRENT FIVE AMPERE RATED RELAY	
BASE REACH TAP	RECOMMENDED MINIMUM TEST CURRENT
0.75	8 amps
1.5	4 amps
3	2 amps

- Adjust the phase angle for 45° (nominal base reach angle of 75° minus the PT lead angle of 30° equals 45°).
- Observe the waveform at the following test points (on OS card) with an oscilloscope.

"AOUT" for phase pair A-B

"BOUT" for phase pair B-C

"COUT" for phase pair C-A

- Set the voltage V_T on all three phases to the value given in equation 17 below

$$\dagger \quad V_T = 2 \times I_T \times Z_{R1} \times \frac{100}{T} \quad (\text{Eq.17})$$

where:

I_T = test current in amperes RMS

T = restraint voltage setting in percent

V_T = pickup voltage at the base reach angle in volts RMS

Z_{R1} = base reach tap in ohms

- † V_T should not be greater than 10% above the relay rated voltage. If V_T is greater, reduce I_T until V_T is corrected.

- As the current is raised from zero, observe the waveform at the test point designated in step 4 above. At the point where the telephone relay (K2) picks up, a slight adjustment of the phase angle and input voltage will cause the waveforms to be reduced to a null, consisting of only third and fifth harmonics. At this null point, the angle on the phase angle meter is the base reach angle, \emptyset , minus 30°, and should be within 2° of the nominal value of 45°. The current, I_T , at this null condition should be within 5% of the value calculated by equation 17*.

NOTE

The measured pickup should agree with the calculated value within 5%. If the values do not agree within these limits, it is recommended that the test setup and meter calibrations be checked before the factory settings on the relay are disturbed. A good method of checking the test setup and procedure is to repeat the tests on a duplicate relay.

- If it is desired to readjust the reach so that the measured pickup occurs at a value closer to the calculated value, this may be accomplished by

means of the trim potentiometer on the SP card. The potentiometer to be adjusted for each phase is shown in Table XIV. These potentiometers should be turned clockwise to increase the reach.

TABLE XIV

REACH ADJUSTMENT LOCATIONS	
PHASES UNDER TEST	POTENTIOMETER DESIGNATION
AB	P1
BC	P3
CA	P5

Testing Mho Characteristics

The complete mho characteristic can be measured by the same test circuit (Figure 20) as used for the preceding reach tests. The procedure is similar, except that the phase shifter is adjusted until the phase angle meter indicates the angle of interest. Increase the current until the relay picks up. The value of Z_{R1} at this point should be as shown in Figure 22 for the particular offset (R) setting.

* Note: The characteristics shown in Figure 22 are for a restraint setting of 100%. When the restraint setting is changed, the forward reach will change, but the offset will not.

Offset Tests (R setting)

The value of offset can be measured by the same test circuit (Figure 20) as used for the reach tests. The procedure is similar except that the phase shifter is adjusted until the phase angle meter indicates 225° (180° plus nominal angle of maximum reach). Increase the current until the relay picks up. The value of V_T^\dagger at this point should be as given by equation 18† $\pm 10\%$.

$$\dagger \quad V_T = 2 \times I_T \times Z_{R1} \times R \quad (\text{Eq.18})$$

where:

R = offset in per unit

† V_T should not be greater than 10% above the relay rated voltage. If V_T is greater, reduce I_T until V_T is corrected.

Integrating Timer Tests

The integrating timer (IT) card has three adjustments as indicated in Table XV.

TABLE XV

TIMER ADJUSTMENT LOCATIONS			
POTENTIOMETER DESIGNATION	POTENTIOMETER LOCATION	FUNCTION	60 HZ RELAY FACTORY SETTING (IN MS)
P1	Bottom	Transient Pickup Time	5.5
P2	Top	Steady State Pickup Time	4.16
P3	Middle	Dropout Time	5.0*

* Indicates revision

These potentiometers have been factory set and should not be adjusted unless a plot of the mho characteristics indicates an improper pickup time setting. The P1 potentiometer, used for transients operation, has been set in coordination with the P2 potentiometer at the factory and sealed. All three of these potentiometer increase the time settings when they are turned clockwise.

The test circuit of Figure 20 may be used to check the steady-state pickup time setting. A dual-trace oscilloscope should be used, with channel 1 connected to test point "AIN" on the IT card, and channel 2 on test point "OUT" on the IT card. Reduce "VIN" until the relay picks up. The output (channel 2) should go positive 4.16 milliseconds after the input (channel 1) goes positive.

The following procedure should be used to check the transient pickup time setting:

1. Remove the CL card.
2. Connect the test circuit of Figure 21.
3. With the oscilloscope trigger on positive slope, open the normally-closed contact. The channel 2 trace should step positive 5.5 milliseconds, ± 0.1 millisecond, after the channel 1 trace steps positive.

The following procedure should be used to check the dropout time setting:

1. Remove the CL card.
2. Connect the test circuit of Figure 21.
- * 3. With the oscilloscope trigger on negative slope, close the normally-closed contact. The channel 2 trace should step negative 5.0 milliseconds, ± 0.5 millisecond, after the channel 1 trace steps negative.

INSTALLATION PROCEDURE

INTRODUCTION

The relay should be mounted on a vertical surface and located in a clean, dry area that is free from dust and excessive vibration. The area should be well lighted in order to facilitate inspection and testing.

The outline and panel drilling locations for the SLY92A relay are shown in Figure 23, and internal connections are shown in Figure 2. Typical external connections for the relay are shown in Figure 3A, 3B, 4A and 4B.

SURGE GROUND AND RELAY CASE GROUND CONNECTIONS

One of the mounting studs or screws should be permanently connected to ground by a conductor not less than #12 AWG copper wire, or its equivalent. This connection is made to ground the relay case. In addition, terminal 10, designated as surge ground on the internal connections diagram, must be tied to ground in order for the surge suppression networks in the relay to perform properly. The surge ground lead should

* Indicates revision

be as short as possible to ensure maximum protection from surges (preferably 10 inches or less to reach a solid ground connection).

With terminal 10 connected to ground, surge ground is connected electrically to the relay case. The purpose of this connection is to prevent high-frequency transient potential differences from entering the solid state circuitry. Therefore, with terminal 10 connected to ground, the surge capacitors are connected between the input terminals and the case. When hipotting the relay, the procedure described in DIELECTRIC TESTS in the **ACCEPTANCE TESTS** section of this book, **must** be followed.

TEST PLUGS

The relay may be tested without removing it from the panel by using a 12XLA13A test plug. This plug makes connections only with the relay and does not disturb any shorting bars in the case. Of course, the 12XLA12A test plug may also be used. Although this test plug allows greater testing flexibility, it also requires current transformer shorting jumpers and the exercise of greater care, since connections are made to both the relay and the external circuitry. Additional information on the XLA test plugs may be obtained from instruction book GEI-25372.

INSTALLATION TESTS

Since operating companies use many different procedures for installation tests, the section on **ACCEPTANCE TESTS** contains all the necessary tests that may be performed as part of the installation procedure at the discretion of the user. The minimum suggested tests are as follows:

Visual Inspection

Repeat the items described under **ACCEPTANCE TESTS - VISUAL INSPECTION**.

Mechanical Inspection and Adjustments

Repeat the items described under **ACCEPTANCE TESTS - MECHANICAL INSPECTION**.

Target Unit

Set the target unit tap screw in the desired position. The adjustment will not be disturbed if a screw is first transferred from the left plate to the desired tap position on the right tap plate, and then the screw in the undesired position is removed and transferred to the left tap plate. Do **not** leave the relay with **two** screws in the right tap plate.

Reach Tests

Using the values selected in the **CALCULATION OF SETTINGS** section of this book, set:

- o Base reach (Z_{R1}) on the back of the relay
- o Percent restraint (T) on the front panel potentiometer
- o Percent offset reach (R) on the "CP" printed circuit card (three plugs).

Measure the relay reach at 75° as described in the **ACCEPTANCE TESTS** section of this book.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

In view of the vital role of protective relays in the operation of a power system, it is important that a periodic test program be followed. The interval between periodic checks will vary depending upon environment, type of relay and the user's experience with periodic testing. Until the user has accumulated enough experience to select the test interval best suited to his individual requirements, it is suggested that the points listed under **ACCEPTANCE TESTS** be checked at an interval of from one to two years.

Check the items described under **ACCEPTANCE TESTS**, both **VISUAL** and **MECHANICAL INSPECTION**. Examine each component for signs of overheating, deterioration, or other damage. Check that all connections are tight by observing that the lockwashers are fully collapsed.

CONTACT CLEANING

Examine the contacts for pits, arc or burn marks, corrosion and insulating films. A flexible burnishing tool should be used for cleaning relay contacts. This is a flexible strip of metal with an etched-roughened surface, which in effect resembles a superfine file. The polishing action of this file is so delicate that no scratches are left on the contacts, yet it cleans off any corrosion thoroughly and rapidly. The flexibility of the tool ensures the cleaning of the actual points of contact. Relay contacts should never be cleaned with knives, files, or abrasive paper or cloth. Knives or files may leave scratches, which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts, and thus prevent closing.

ELECTRICAL TESTS

The reach tests described in **ACCEPTANCE TESTS** should be repeated and the results compared against the desired setting. If a measured value is slightly different from that measured previously, it is not necessarily an indication that the relay needs readjusting. The errors in all the test equipment are additive, and the total error of the present setup may be of opposite sign from the error present during the previous periodic test. Instead of readjusting the relay, if the test results are acceptable, no adjustment should be made. Note the deviation on the relay test record. After sufficient test data has been accumulated, it will become apparent whether the measured deviations in the setting are due to random variations in the test conditions, or are due to a drift in the relay characteristics.

SERVICING

CAUTION

Remove **ALL** power from the relay before removing or inserting any of the printed circuit boards. Failure to observe this caution may result in damage to and/or misoperation of the relay.

A troubleshooting procedure is shown in Table XVI.

TABLE XVI
TROUBLESHOOTING PROCEDURE

PROBLEM	PROBABLE CAUSE	TROUBLESHOOTING SEQUENCE
I. Power supply monitor LED is not on	1. +15 VDC and/or -15 VDC missing 2. Defective LED, zener diode CR15, or resistor R15	1. Check +15 and -15 volt test points on PS card. If either or both voltages are not between 14 and 16 volts, check that rated DC voltage (48 or 125 VDC) is on PS card pin 40 (+) to pin 24 (-). If not, check terminals 19 (+) to 20 (-) 2. Replace PS card.
II. Relay will not pick up when it should on any of the three phases, but power supply monitor LED is on	1. Defective telephone relay (K2) or target (T1). 2. Defective reed relay (K1). 3. Defective IT card	1. Remove PS card and jumper pins 17 and 40 of the PS card. If the relay does not pick up, then K2 or T1 is defective 2. If the relay picks up with the jumper in the preceding step II-1, then remove the jumper and reinsert PS card. Remove the CL card, and the relay should pick up. If not, the K1 relay may be defective. Change the PS card. 3. If replacing the PS card in the preceding step II-2 does not cause pickup (with the CL card still removed), the IT card may be defective. Change the IT card.

TABLE IV (Cont'd)

PROBLEM	PROBABLE CAUSE	TROUBLESHOOTING SEQUENCE
III. Relay will not pick up when it should on one phase, but picks up correctly on another phase.	Defective card	Change printed circuit cards, one at a time, in the following order: IT, CL, SP, CP, OS.
IV. Out of specification in maximum reach ± 300 tests	<ol style="list-style-type: none"> 1. Incorrect steady state pickup time on IT card. 2. Defective card 	<ol style="list-style-type: none"> 1. Set steady-state pickup time potentiometer and recheck other phases. 2. Change printed circuit cards, one at a time, in the following order: SP, CP, IT, CL, OS.

RENEWAL PARTS

Sufficient quantities of renewal parts should be carried in stock to enable the prompt replacement of any that are worn, broken or damaged.

Should a printed circuit card become inoperative, that card should be replaced with a spare. A special tool (see Figure 19) is available for removing the printed circuit cards from their sockets, and this tool should **always** be used for removal. In most instances, the insertion of a spare card represents the most expeditious means of returning the equipment to service. The faulty card can then be returned to the factory for repair or replacement.

Although it is not generally recommended, it is possible with the proper equipment and trained personnel to repair cards in the field. This means that a troubleshooting program must isolate the specific component on the card that has failed. By referring to the internal connection diagram for the card, it is possible to trace through the card circuit by signal checking and, hence determine which component has failed. This, however, may be time consuming and if the card is being checked in place in its unit, as is recommended, will extend the outage time of the equipment.

CAUTION:

Great care must be taken in replacing components on the cards. Special soldering equipment suitable for use on the solid-state components must be used and, even then, care must be taken not to cause thermal damage to the components, and not to damage or bridge over the printed circuit buses. The repaired area must be re-covered with a suitable high dielectric plastic coating to prevent possible breakdowns across the printed circuit buses due to moisture or dust.

CAUTION:

Dual in-line integrated circuits are especially difficult to remove and replace without specialized equipment. Furthermore, many of these components are used in printed circuit cards that have bus runs on both sides. These additional complications require very special soldering equipment and removal tools as well as additional skills and training, which must be considered before field repairs are attempted.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of part wanted, and give the complete model number of the relay for which the part is required.

APPENDIX I

DEFINITION OF SYMBOLS

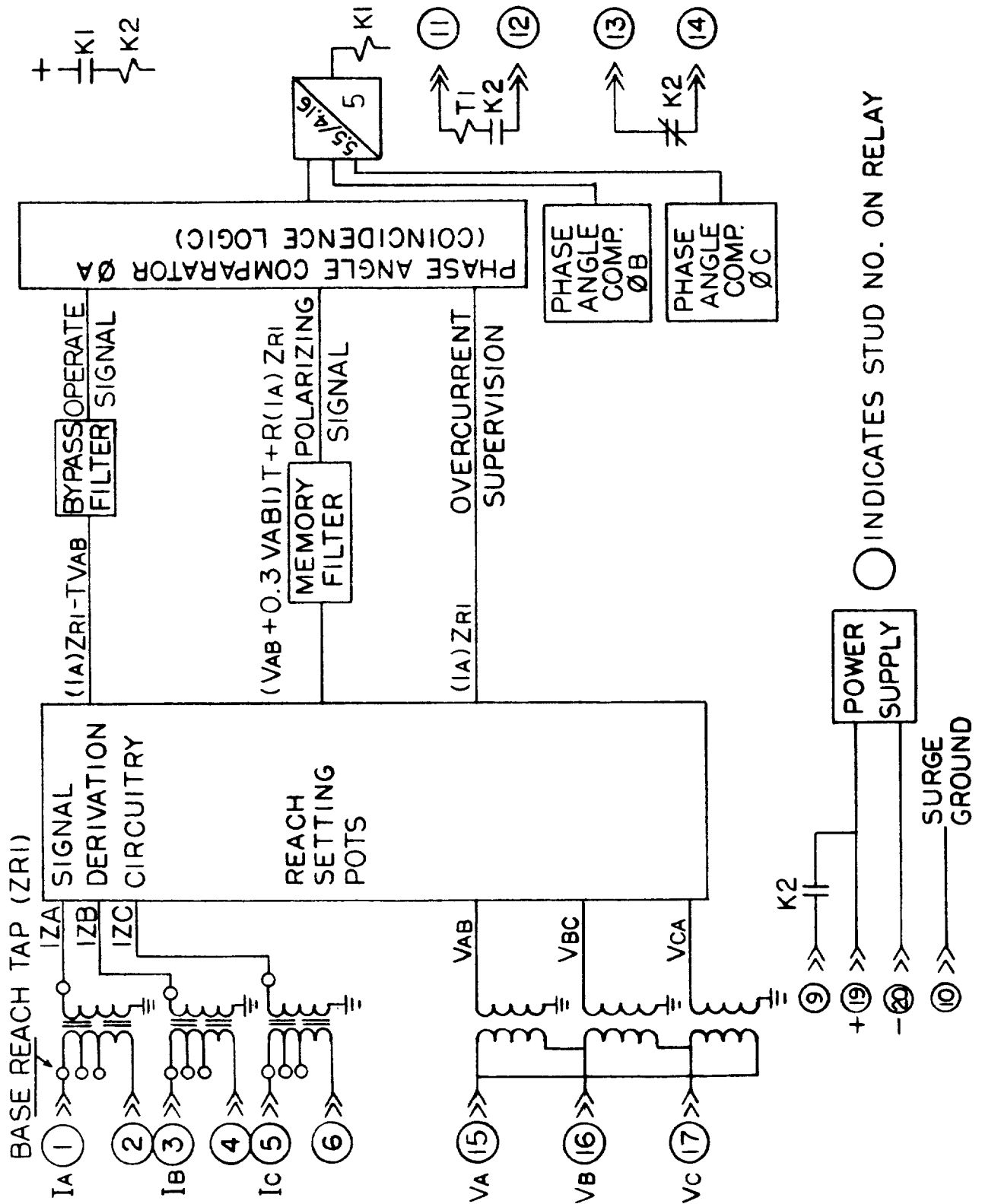
D	= design constant equal to 0.3 per unit
I _A	= total phase A current in relay in amperes, RMS
I _B	= total phase B current in relay in amperes, RMS
I _C	= total phase C current in relay in amperes, RMS
I _L	= line current
I _{PT}	= current in line side of a power transformer
I _{rated}	= relay current circuit rating in amperes
I _T	= relay current during test in amperes, RMS
K	= ratio of current I _L to I _{PT}
R	= ratio tap to provide offset in per unit
T	= relay voltage restraint setting in percent
V _{AB}	= phase A to phase B voltage in volts, RMS
V _{AB1}	= positive sequence of V _{AB} voltage in volts, RMS
V _{BC}	= phase B to phase C voltage in volts, RMS
V _{BC1}	= positive sequence of V _{BC} voltage in volts, RMS
V _{CA}	= phase C to phase A voltage in volts, RMS
V _{CA1}	= positive sequence of V _{CA} voltage in volts, RMS
V _H	= voltage on high side of transformer
V _L	= voltage on low side of transformer
V _{LL}	= faulted phase voltage
V _T	= relay voltage during tests in volts, RMS
X	= ratio of actual relay reach to nominal relay reach
Z	= impedance seen by the relay in ohms
Z _F	= system impedance between relay location and fault location in ohms
Z _L	= line impedance in ohms
Z _R	= relay reach in ohms
Z _{R1}	= base reach tap in positive-sequence ohms
Z _T	= power transformer impedance in ohms referred to high side
Z ₁	= system positive-sequence phase-to-neutral impedance in ohms
Z _{1L}	= line positive-sequence phase-to-neutral impedance in ohms
Z _{1S}	= source positive-sequence phase-to-neutral impedance in ohms
Z _{2L}	= line negative-sequence phase-to-neutral impedance in ohms
Z _{2S}	= source negative-sequence phase-to-neutral impedance in ohms
Ø	= relay base reach angle in degrees

LIST OF TABLES

<u>TABLE</u>		<u>PAGE</u>
I	Available Reaches	5
II	Interrupting Rating in Amperes of Output Circuits	6
III	Characteristics of Target and Seal-in Units	6
IV	Overcurrent Adjustment Range	8
V	Current Circuit Burdens	9
VI	DC Control Circuit Burdens	9
VII	External Connections	10
VIII	Outputs from SP Card	10
IX	Inputs to CL Card	11
X	Internal Connections for Cards	12
XI	Target Pickup Currents	17
XII	Circuit Grouping for Transverse Mode Hipot Tests	19
XIII	Recommended Test Current	20
XIV	Reach Adjustment Locations	21
XV	Timer Adjustment Locations	21
XVI	Troubleshooting Procedure	25

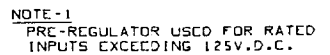
LIST OF ILLUSTRATIONS

<u>FIGURE</u>		<u>PAGE</u>
1	Functional Block Diagram	31
2	Internal Connections Diagram for the Type SLY92A Relay	32
3A	External Connections for the Type SLY92A Relay	33
3B	External Connections for the Type SLY92A Relay	34
4A	Typical External Connections for SLY92A Relay When Used for Carrier Start (Voltage on Relay Side of Bank Lags Voltage on Other Side by 30 Degrees)	35
4B	Typical External Connections for SLY92A Relay When Used for Carrier Start (Voltage on Relay Side of Bank Leads Voltage on Other Side by 30 Degrees)	36
5	Typical High-voltage Bus in Generating Station	37
6	Rear View of Long-Reach Model, Out of Case	38
7	Front View of Type SLY92A Relay, Out of Case	39
8	Front View of Relay, Out of Case with Nameplate Removed	40
9	Restraint Setting Dial (Set at 84 Percent)	41
10	Reach Versus Faulted Phase Voltage	41
11A	Internal Connections for Signal Processing Card (SP)	42
11B	Card Layout for Signal Processing Card (SP)	42
12A	Internal Connections for 60 Hertz Combined Polarizing Card (CP)	43
12B	Card Layout for Combined Polarizing Card (CP)	43
13A	Internal Connections for 60 Hertz Operate Signal Card (OS)	44
13B	Card Layout for Operate Signal Card (OS)	44
14A	Internal Connections for Coincidence Logic Card (CL)	45
14B	Card Layout for Coincidence Logic Card (CL)	45
15A	Internal Connections for Integrating Timer Card (IT)	46
15B	Card Layout for Integrating Timer Card (IT)	46
16A	Internal Connections for 125 Volt DC Rated Input Power Supply Card (PS)	47
16B	Card Layout for 110-125 Volt DC Rated Input Power Supply Card (PS)	47
17A	Internal Connections for 48 Volt DC Rated Input Power Supply Card (PS)	48
17B	Card Layout for 48 Volt DC Rated Input Power Supply Card (PS)	48
18	Cradle Block and Terminal Block Cross Section	49
19	Printed Circuit Card Extracting Tool	50
20	Test Circuit for Reach Tests	51
21	Timer Card Test Circuit	52
22	Mho Characteristic for Timer Setting of 3.5 Milliseconds (60 Hertz Basis)	53
23	Outline and Panel Drilling Dimensions for Type SLY92A Relay	54



* Indicates revision

* Figure 1 (0285A6756 [1]) Functional Block Diagram



NOTE - 2

REF (♣) IS PIN 51 ON ALL CARDS
+15V. IS PIN 9 ON ALL CARDS
-15V. IS PIN 43 ON ALL CARDS
♣=SHORT FINGER

32

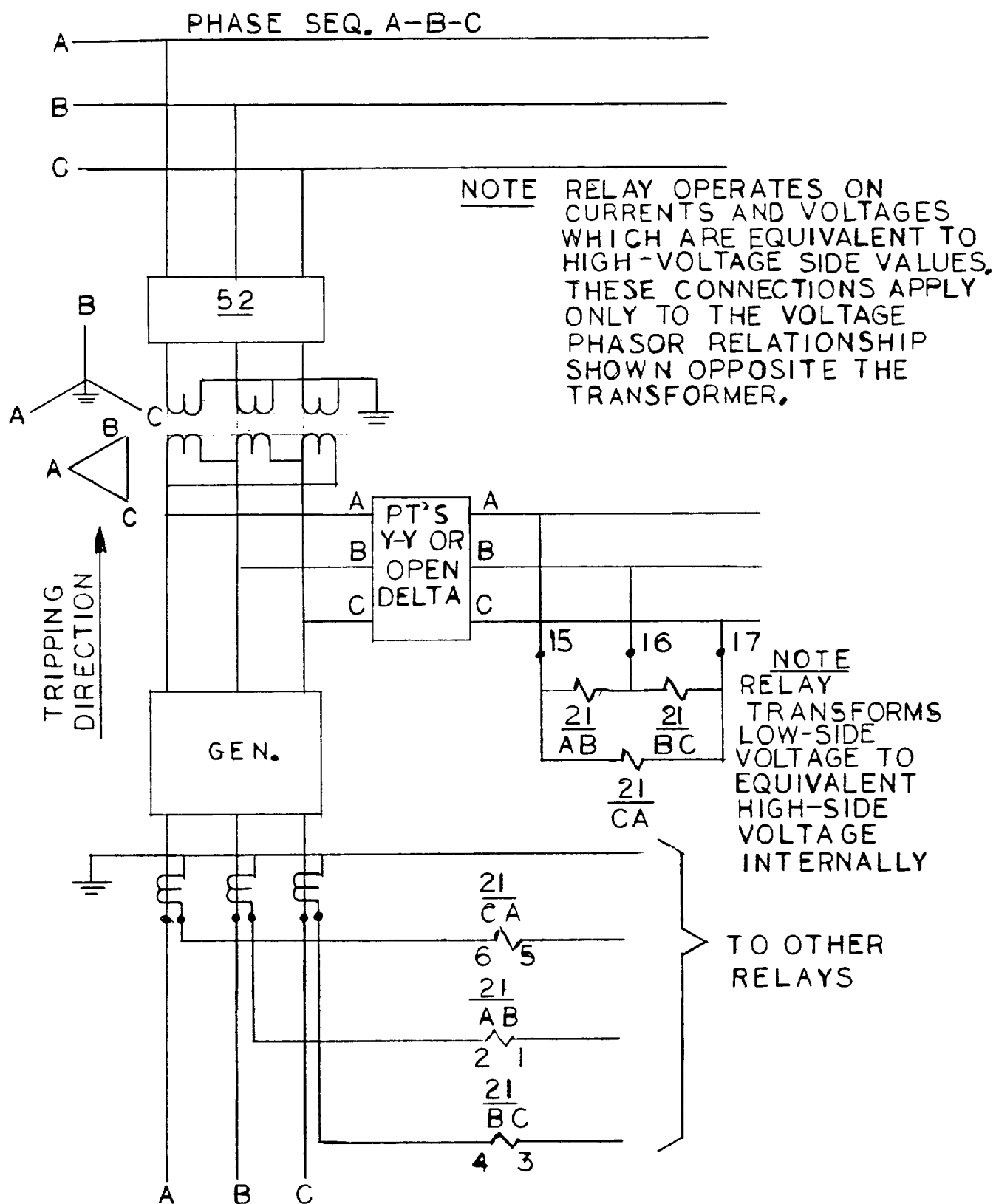
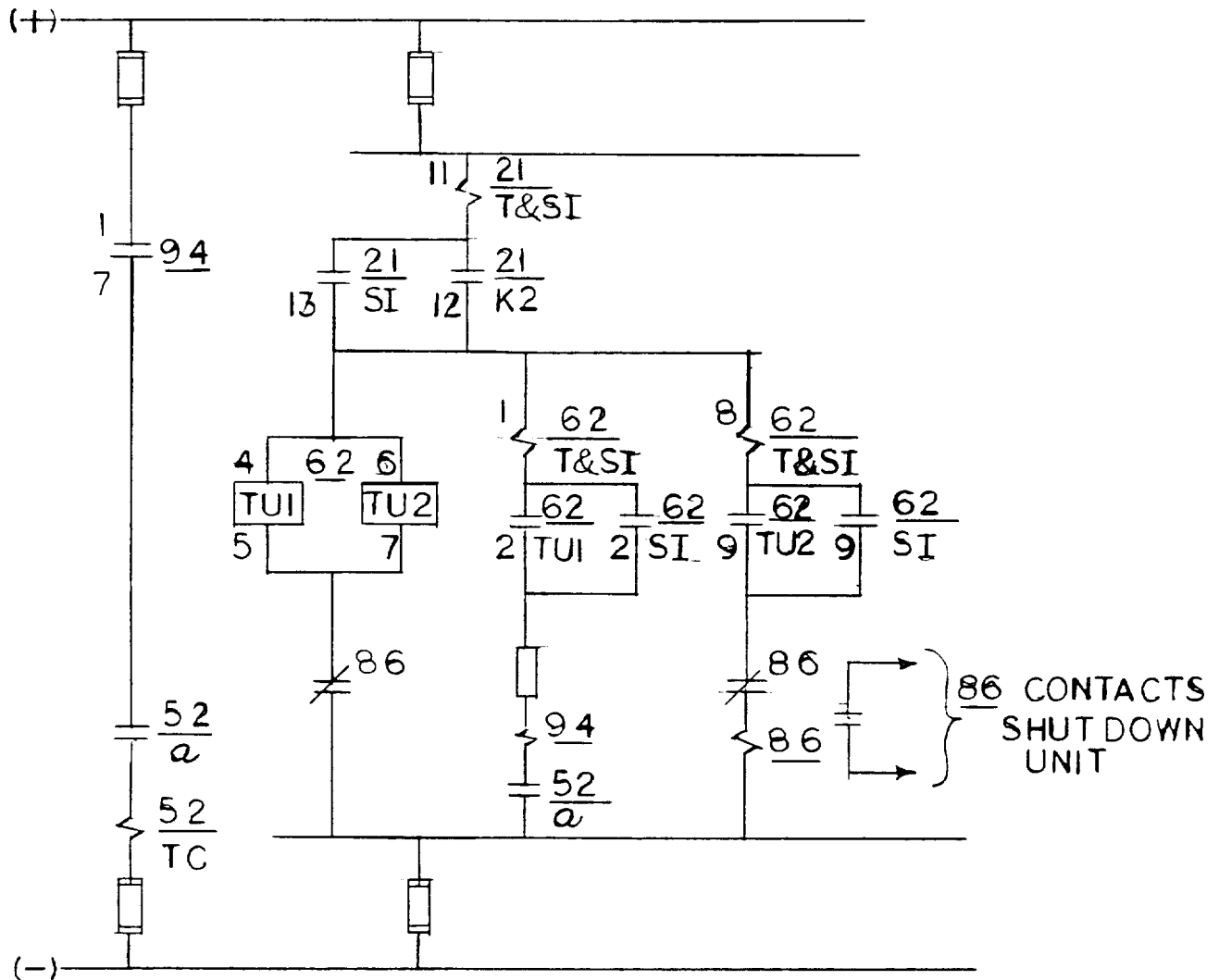


Figure 3A (0285A6666-0, Sh. 1) External Connections for the
Type SLY92A Relay



DEV. NO.	DEV TYPE	FUNCTION	INTERNAL	OUTLINE
21	SLY92A	BACK UP DIST. RELAY	0179C6279	0178A7336
62	SAMI3C	TIMING RELAY	0208A2425	006209271
86	HEA	LOCKOUT RELAY		
94	HGA14AM OR-AL	AUX TRIPPING RELAY	006400533 0377A0139	006400533 0377A0139

Figure 3B (0285A6666-0, Sh. 2) External Connections for the Type SLY92A Relay

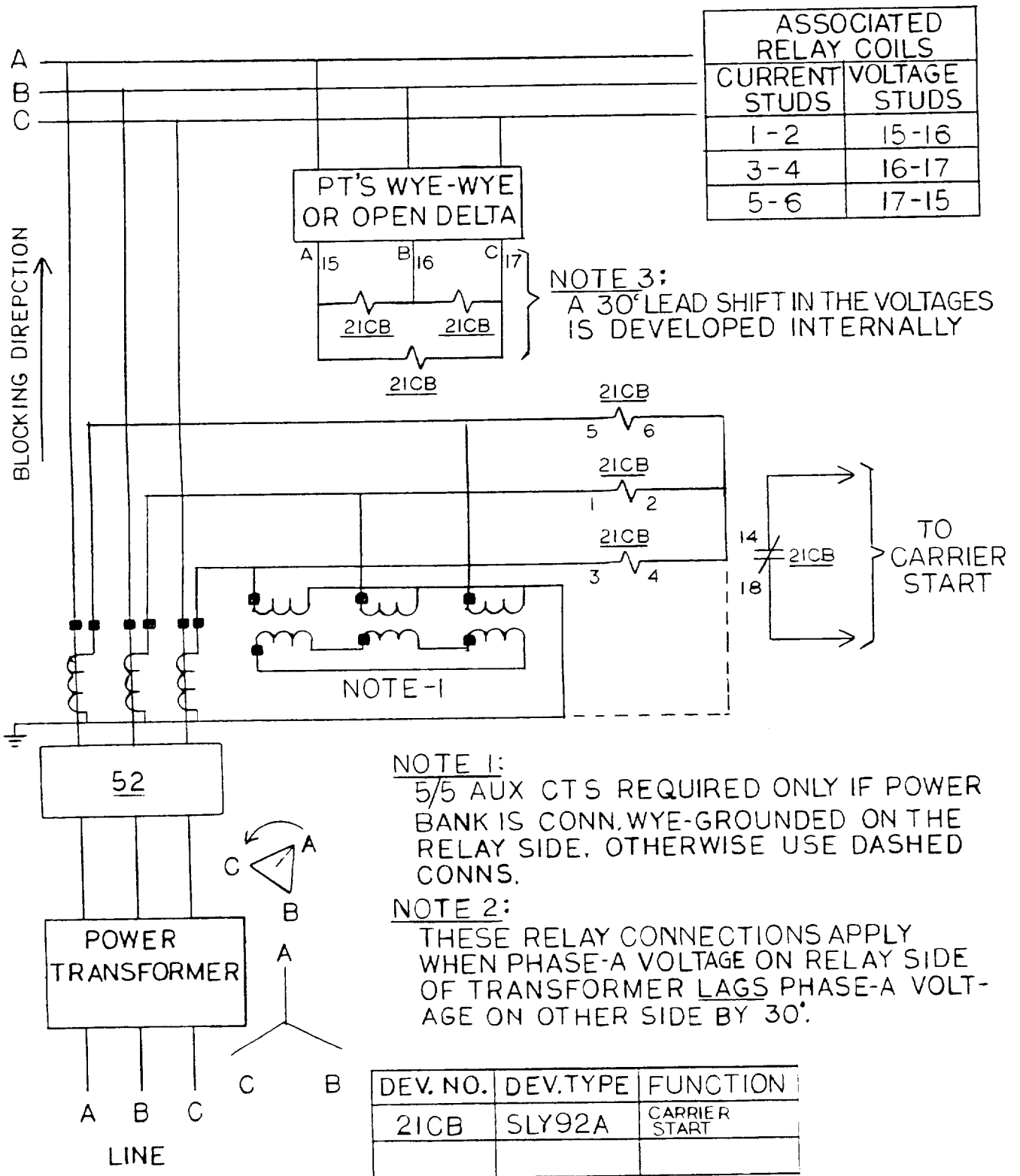


Figure 4A (0285A7130, Sh. 1) Typical External Connections for SLY92A Relay When Used for Carrier Start (Voltage on Relay Side of Bank Lags Voltage on Other Side by 30 Degrees)

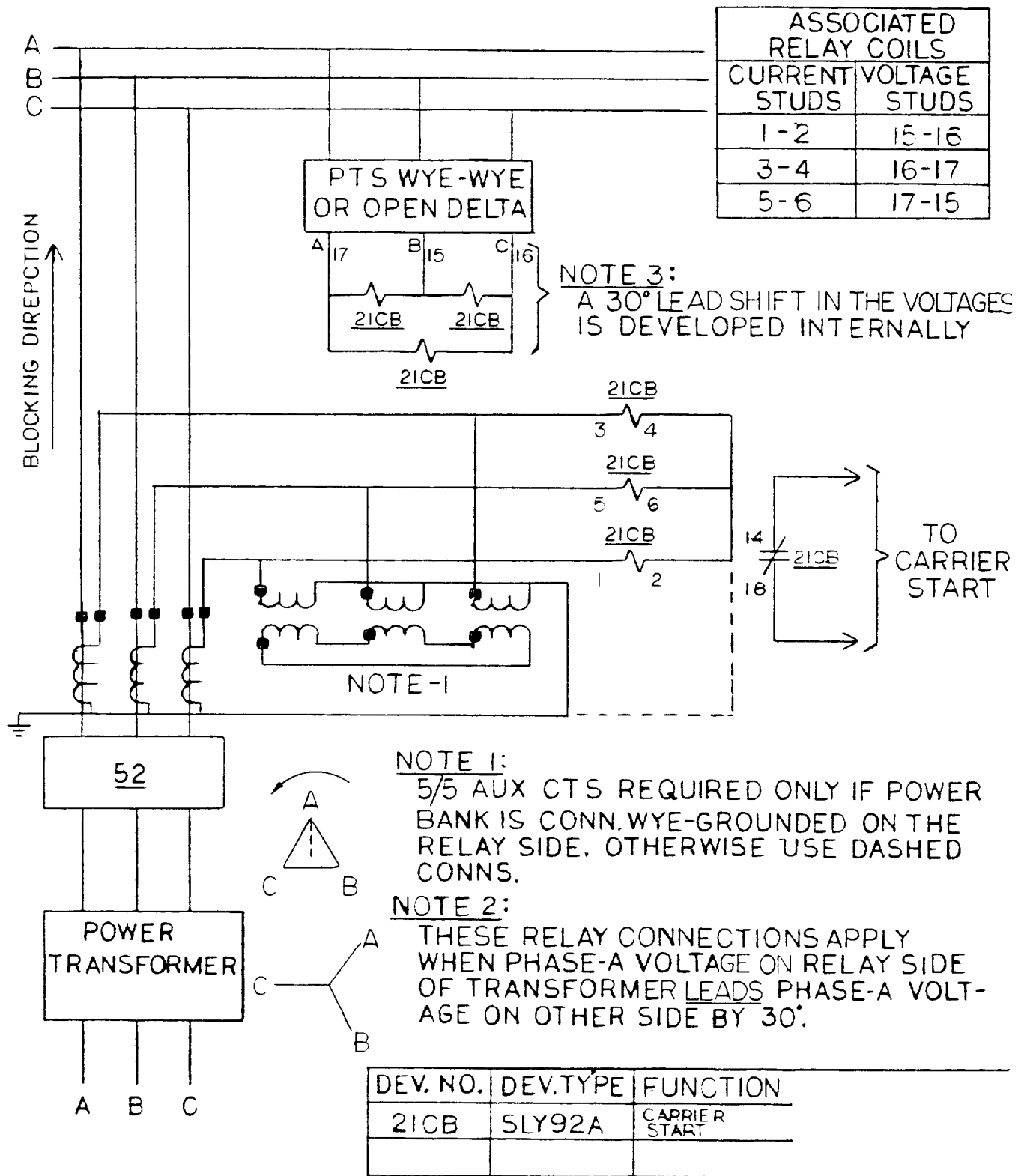


Figure 4B (0285A7130, Sh. 2) Typical External Connections for SLY92A Relay When Used for Carrier Start (Voltage on Relay Side of Bank Leads Voltage on Other Side by 30 Degrees)

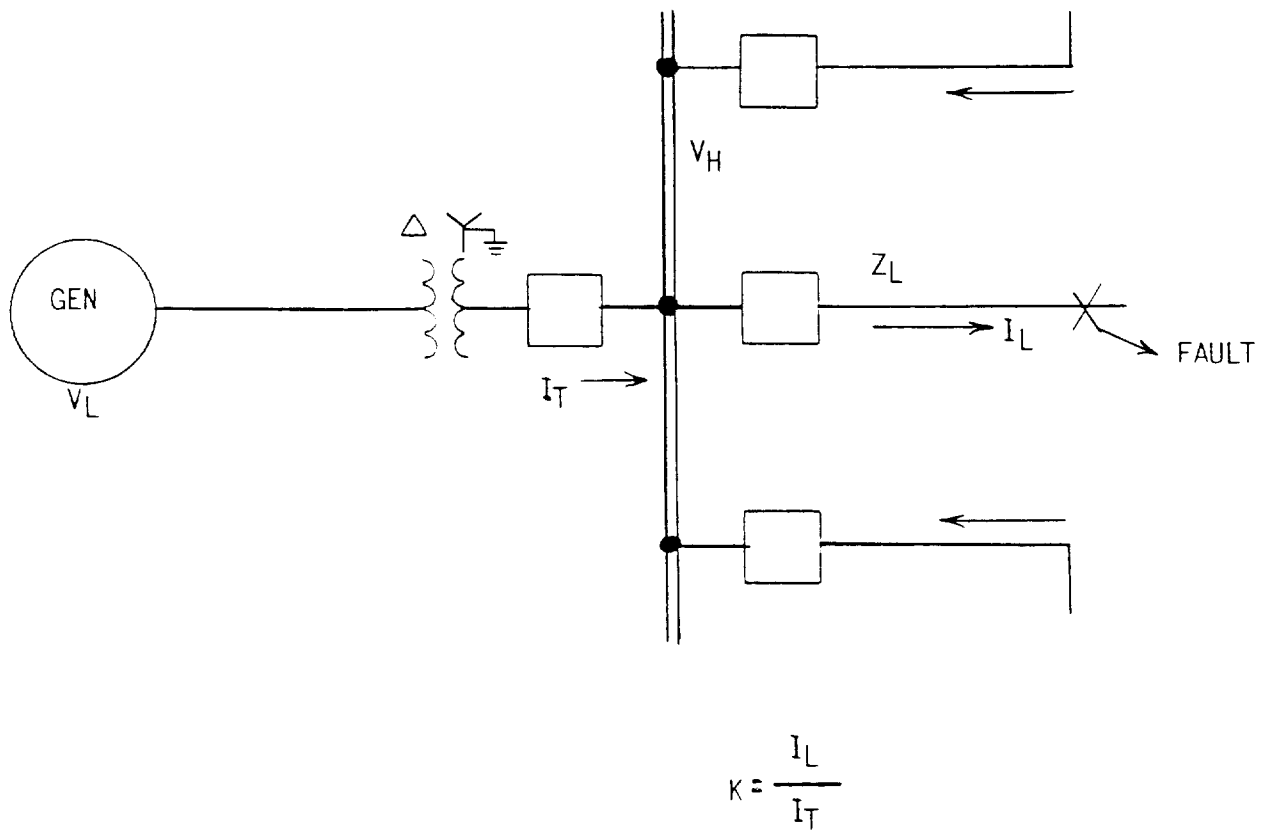


Figure 5 (0165A7772-1) Typical High Voltage Bus in Generating Station

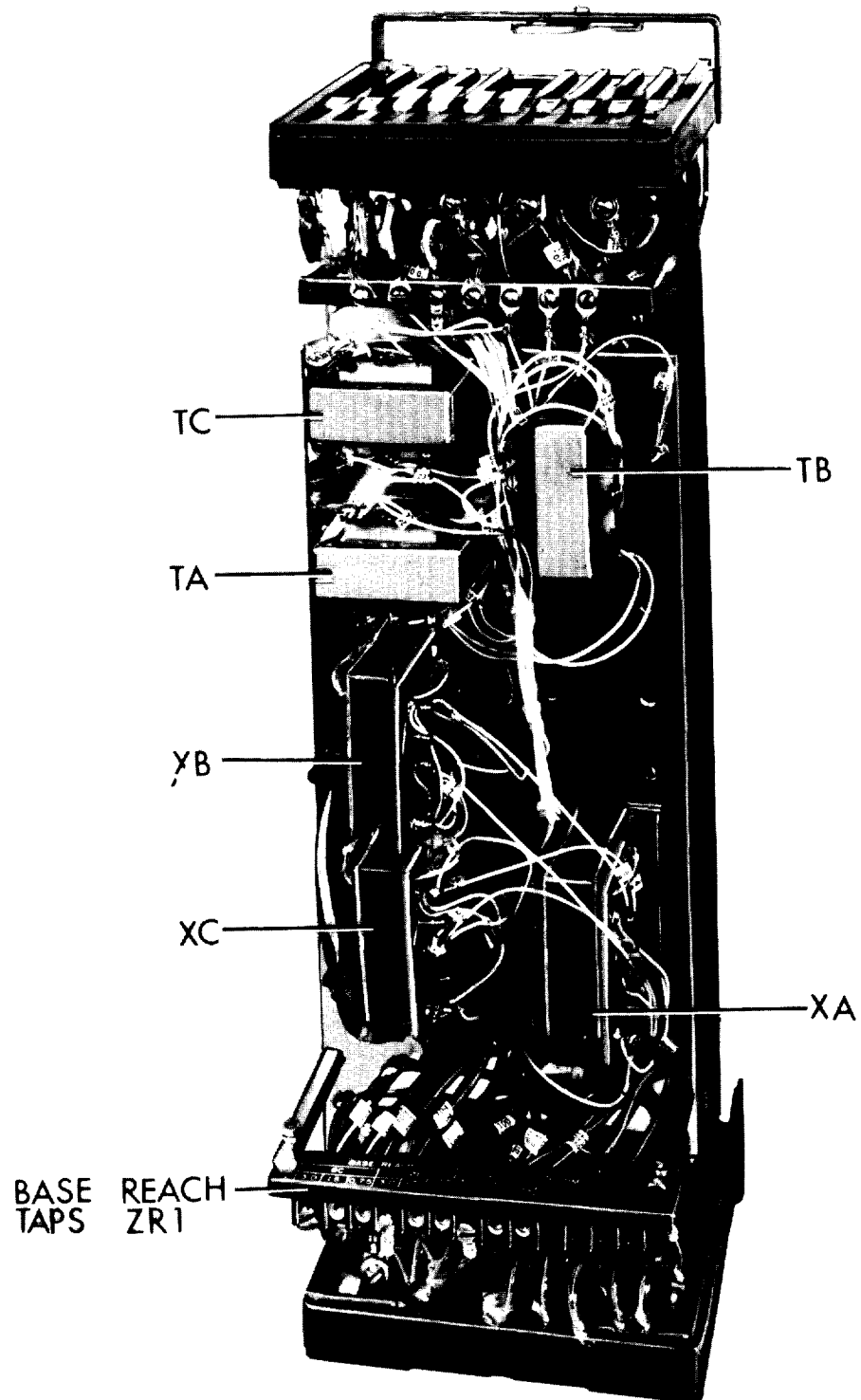


Figure 6 (8043397) Rear View of Long Reach Model 1,
Type SLY92A Relay, Out of Case

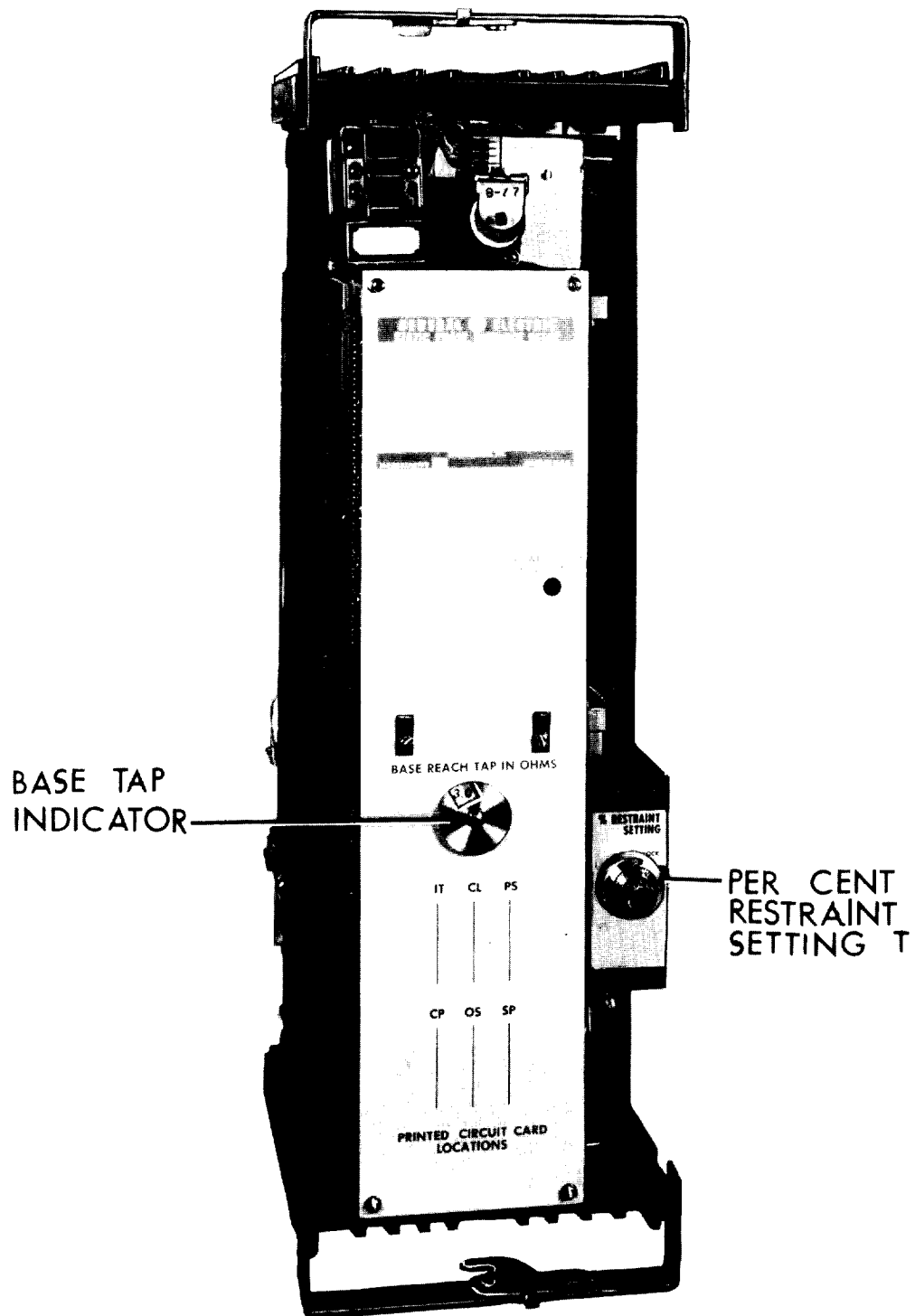


Figure 7 (8043395) Front View of Type SLY92A Relay, Out of Case

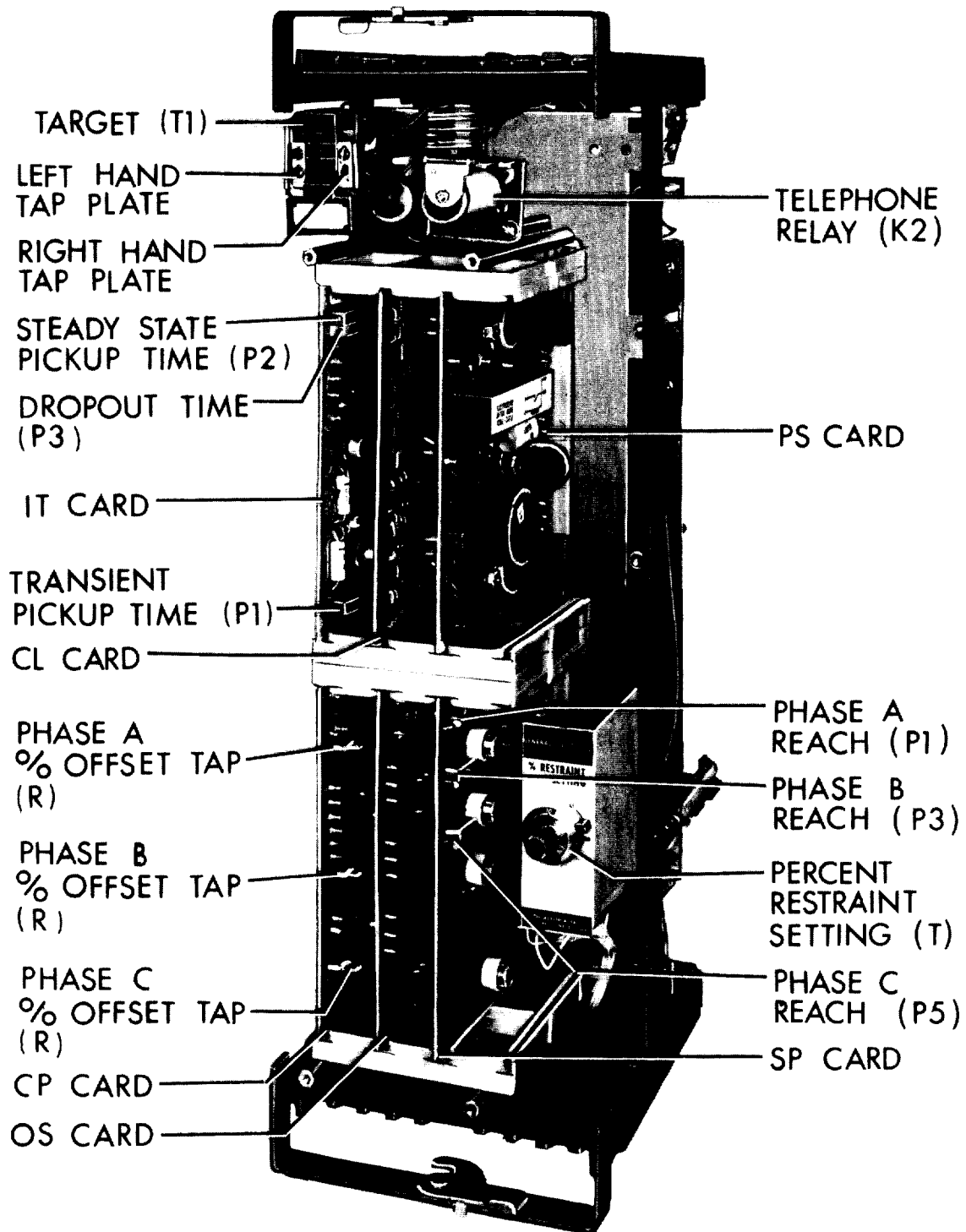


Figure 8 (8043396) Front View of Relay, Out of Case with Nameplate Removed

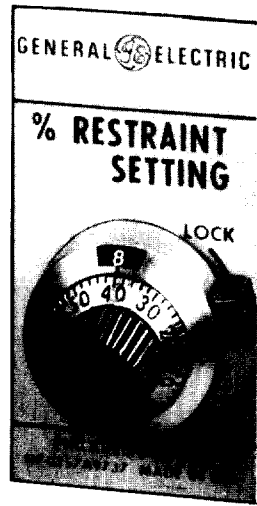


Figure 9 (8042986) Restraint Setting Dial (Set at 84 Percent)

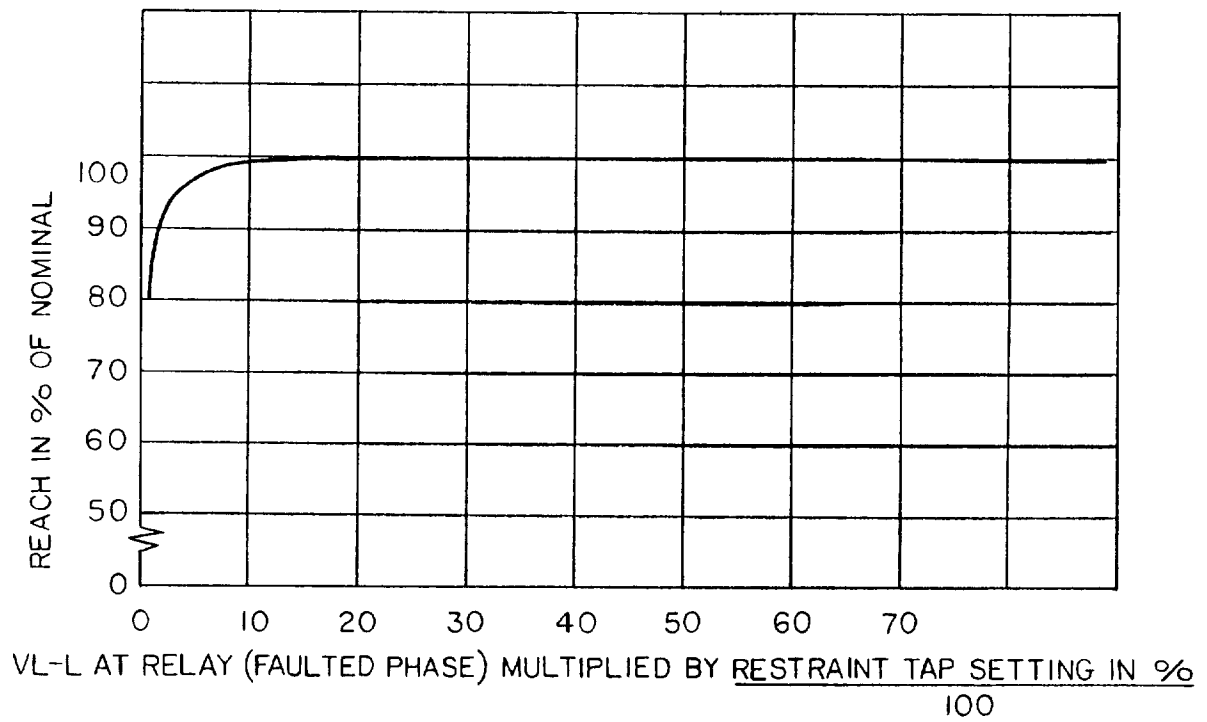


Figure 10 (0273A9096-0) Reach Versus Faulted Phase Voltage

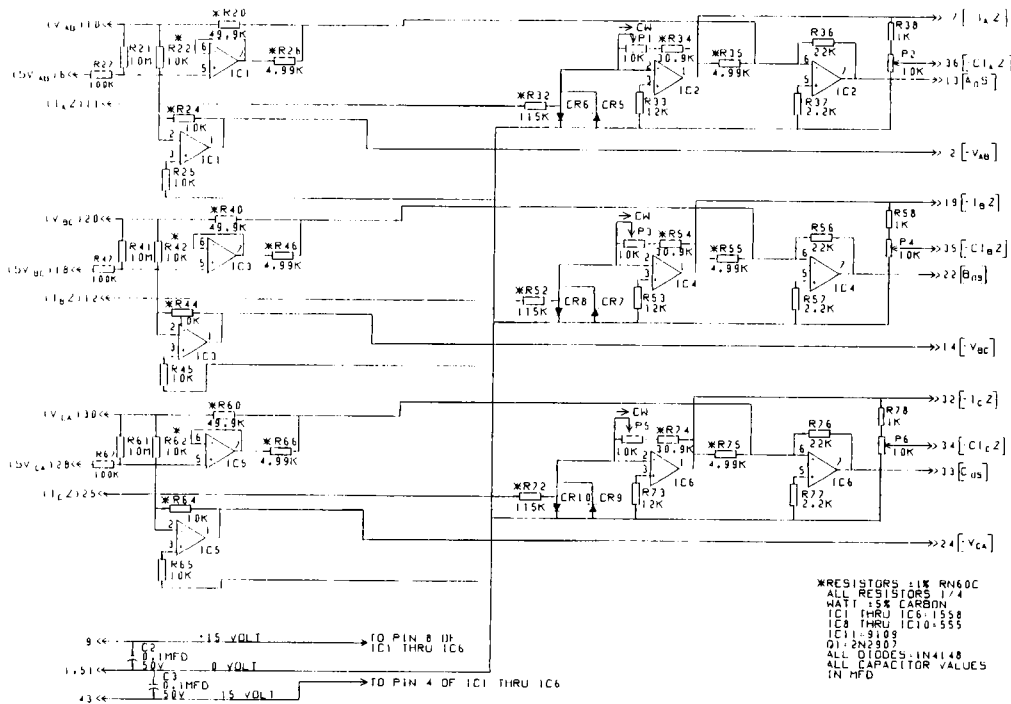


Figure 11A (0152C8463, Sh.4) Internal Connections for Signal Processing Card (SP)

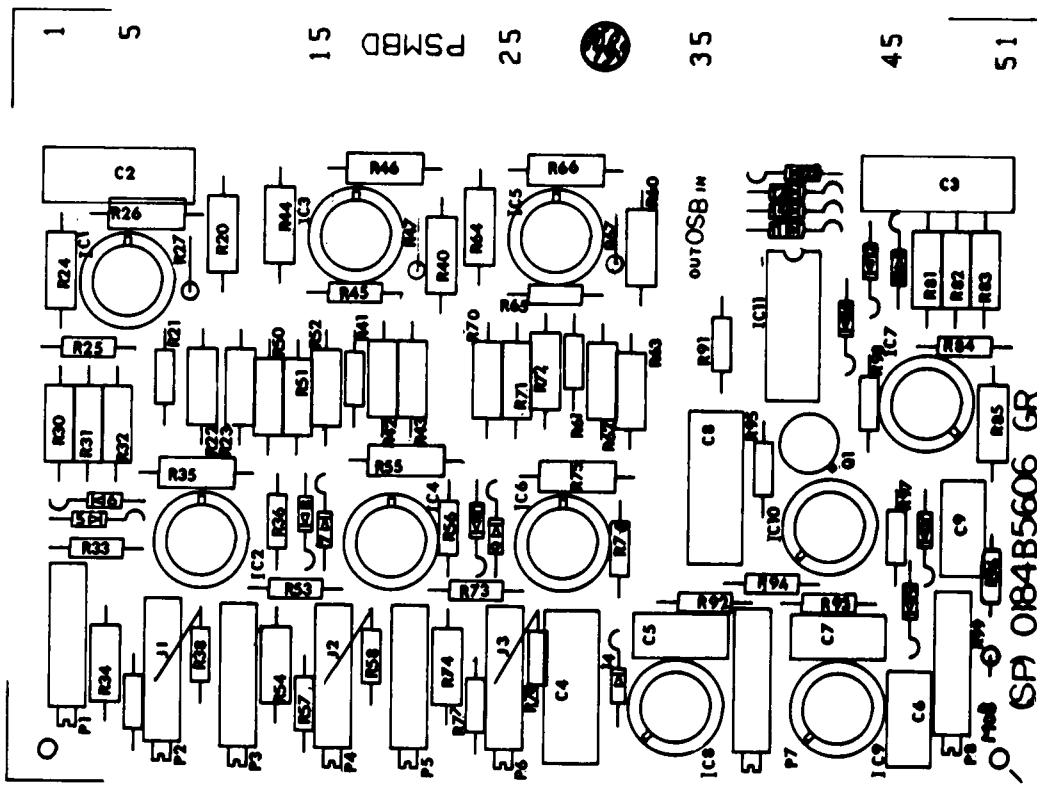


Figure 11B (0171C8706 [7]) Card Layout for Signal Processing Card (SP)

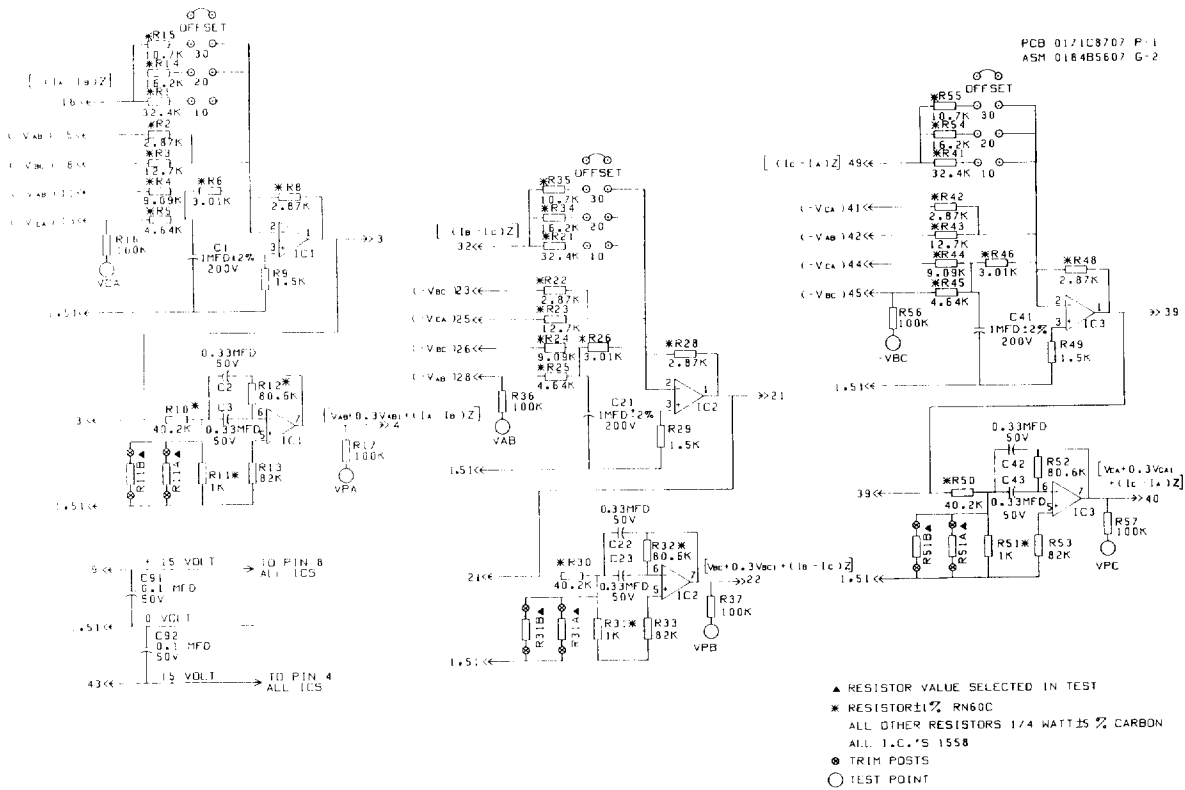


Figure 12A (0152C8464-0, Sh. 2) Internal Connections for 60 Hertz Combined Polarizing Card (CP)

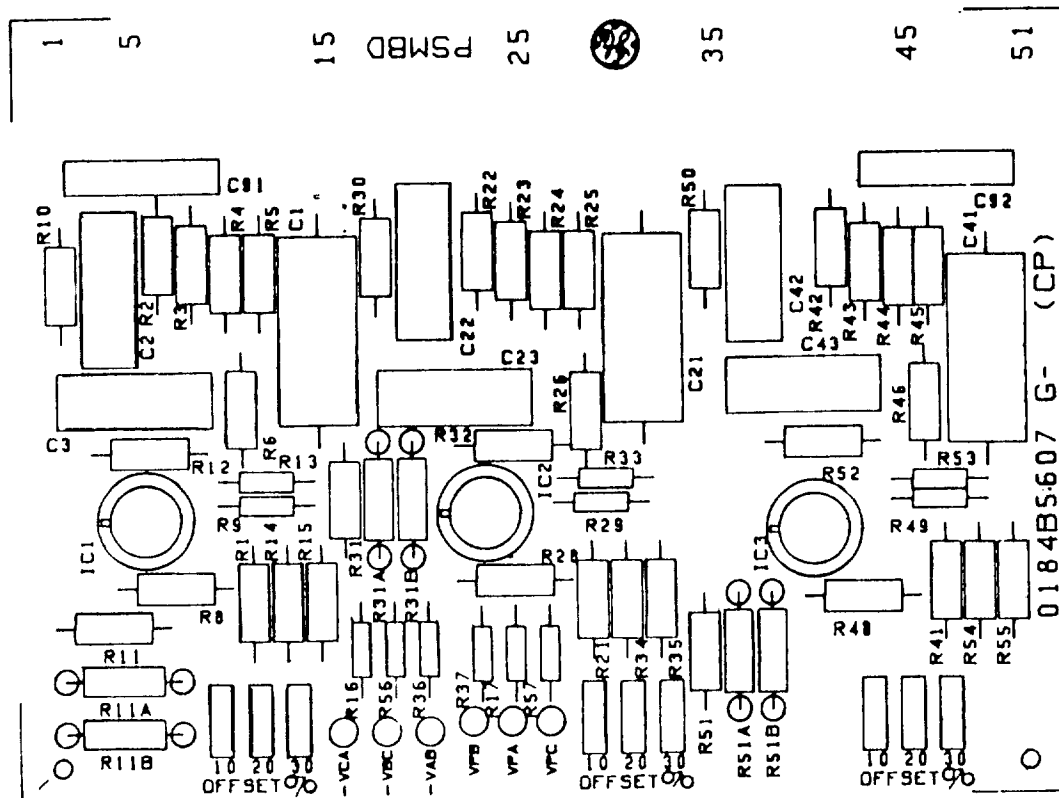


Figure 12B (0171C8707-0) Card Layout for Combined Polarizing Card (CP)

GEK-86040

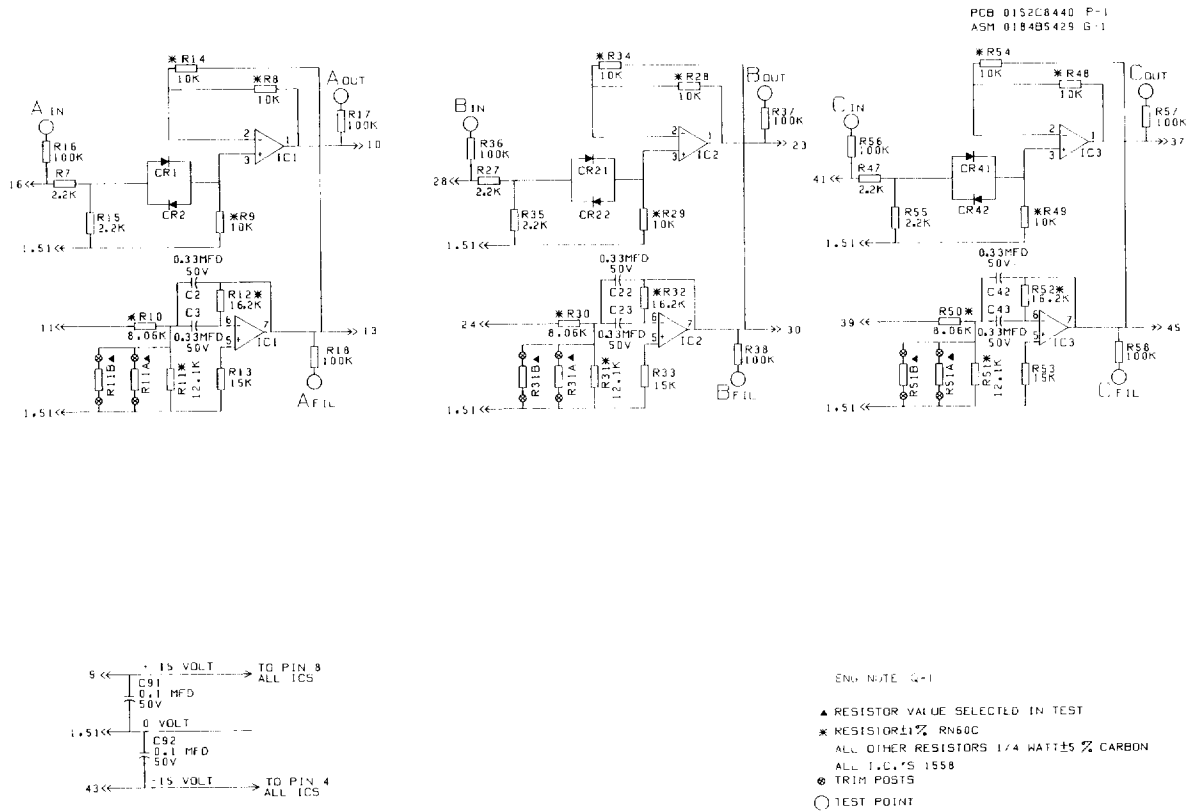


Figure 13A (0152C9087 Sh.1[2]) Internal Connections for 60 Hertz Operate Signal Card (OS)

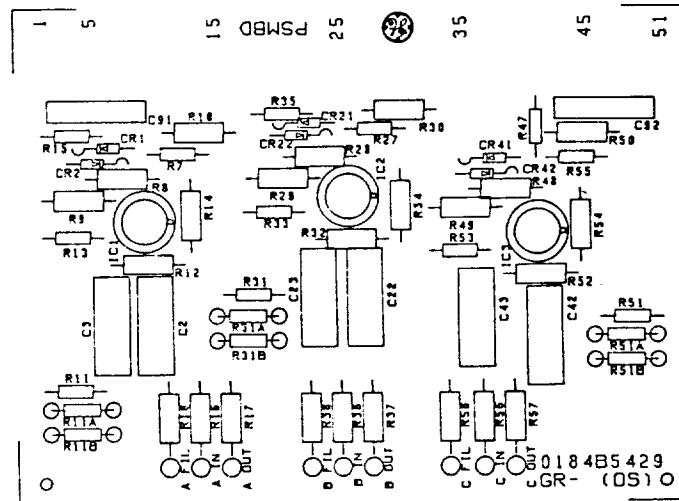
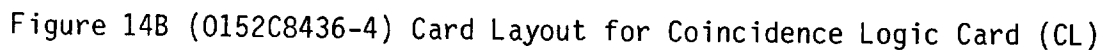
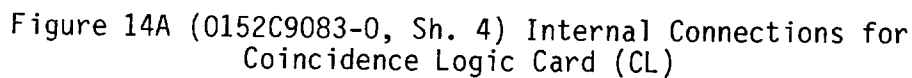


Figure 13B (0152C8440, Sh.1[3]) Card Layout for Operate Signal Card (OS)



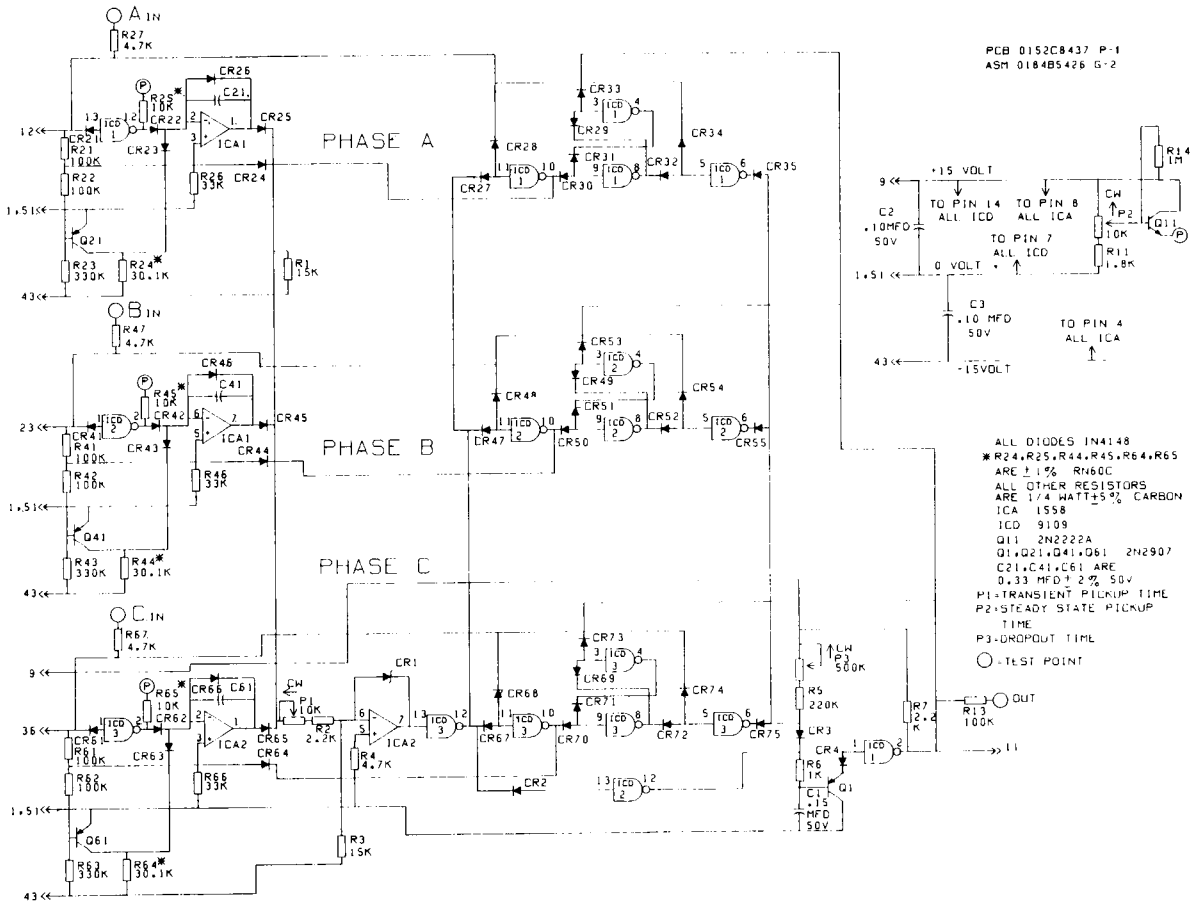
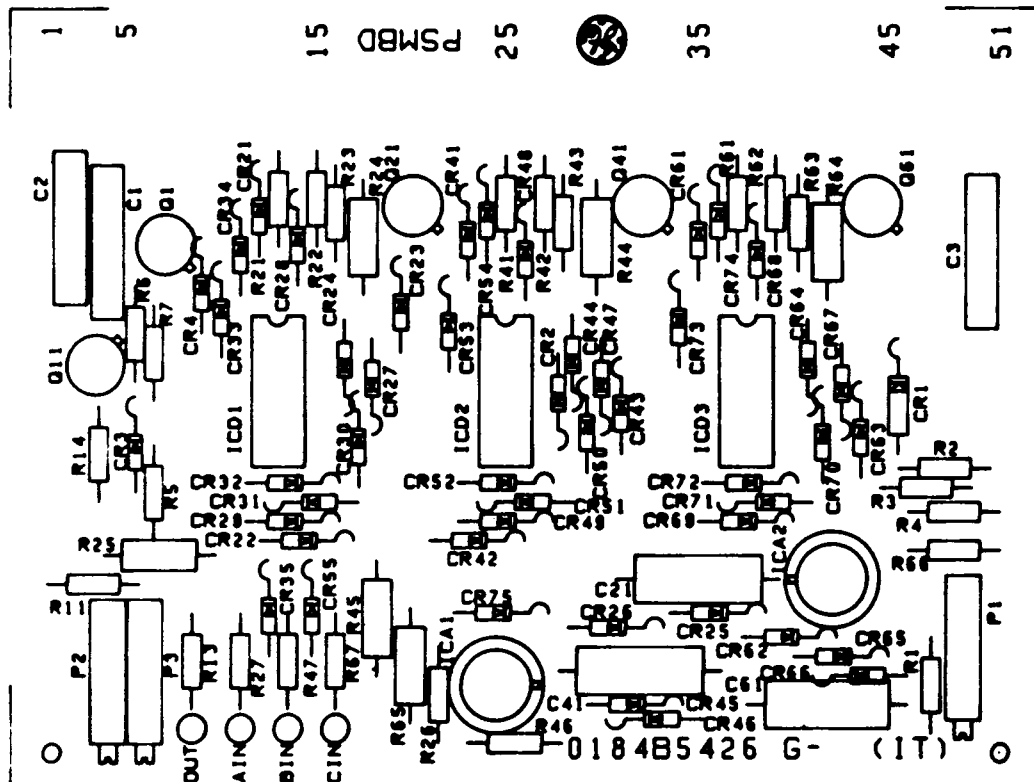
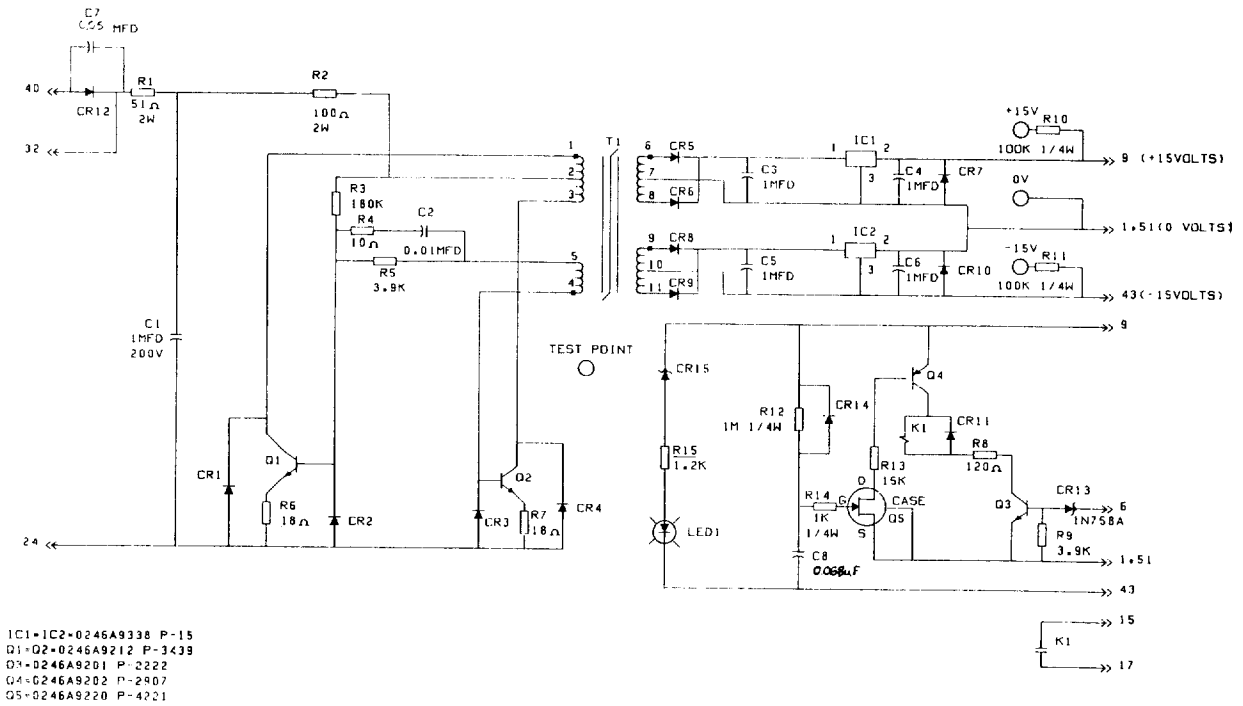


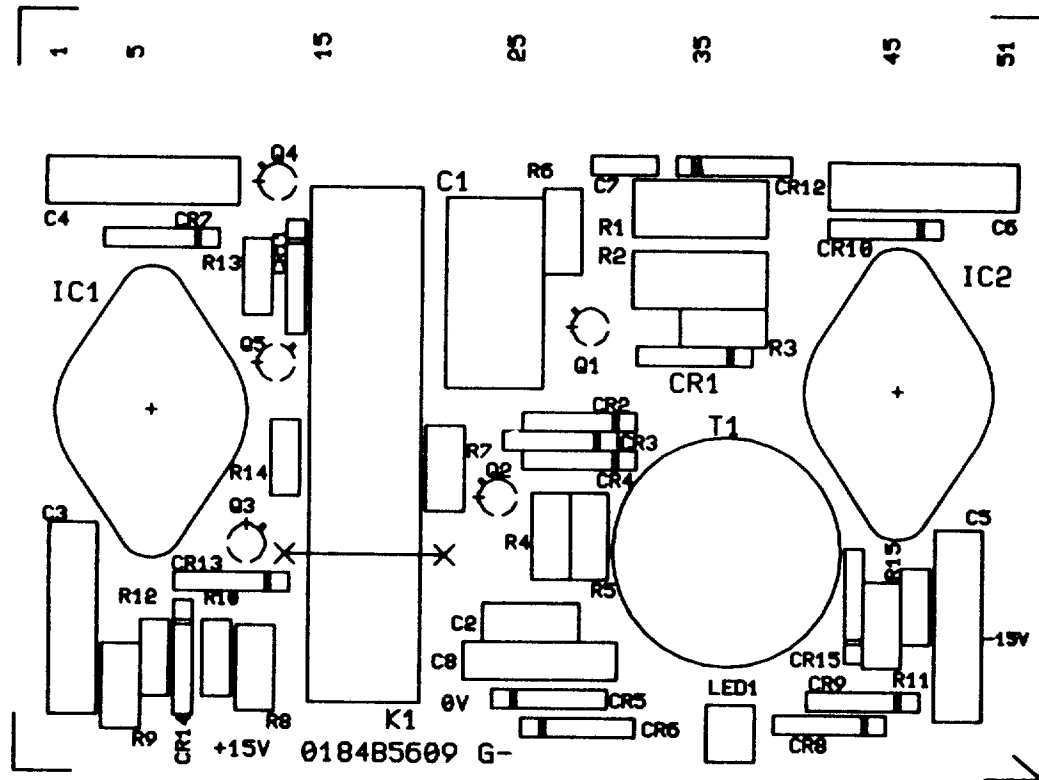
Figure 15A (0152C9084 Sh.2[3]) Internal Connections for Integrating Timer Card (IT)



* Figure 15B (0152C8437 [6]) Card Layout for Integrating Timer Card (IT)



* Figure 16A (0152C8465 Sh.1[4]) Internal Connections for 125 Volt DC Rated Input Power Supply Card (PS)



* Figure 16B (0184B5609 Sh.1[8]) Card Layout for 110-125 Volt DC Rated Input Power Supply Card (PS)

* Indicates revision

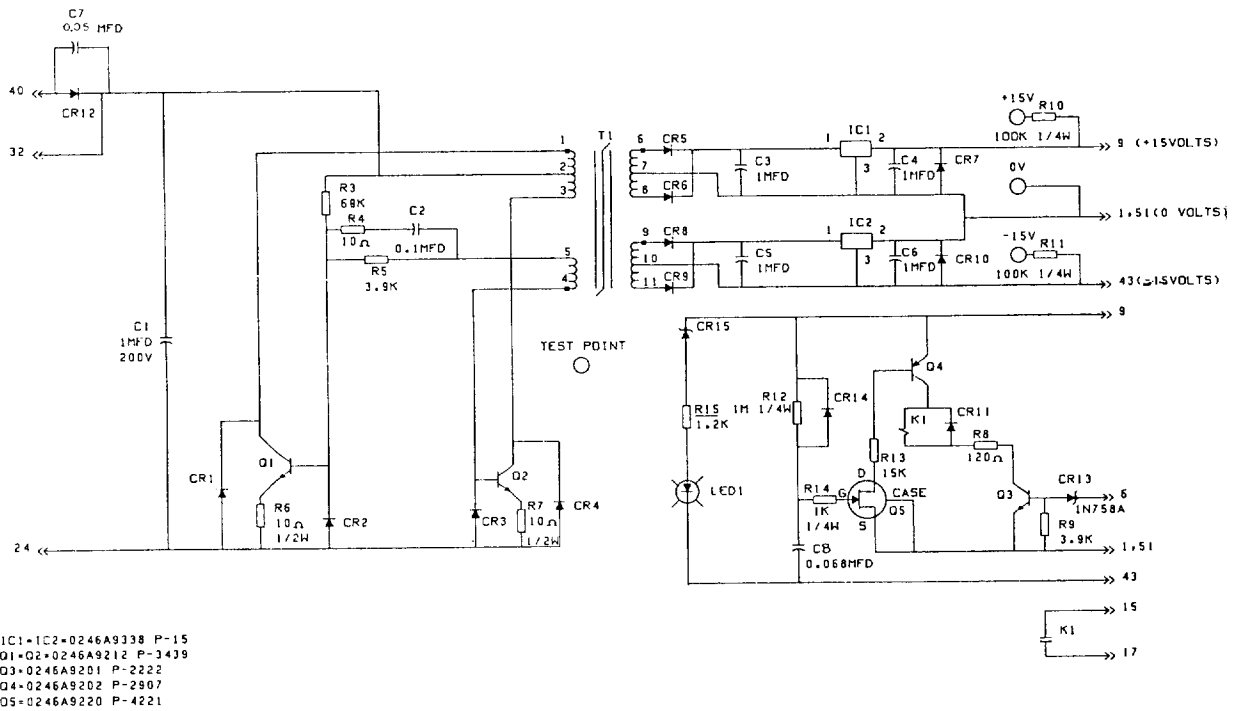


Figure 17A (0152C8465 Sh.2[2]) Internal Connections for 48 Volt DC Rated Input Power Supply Card (PS)

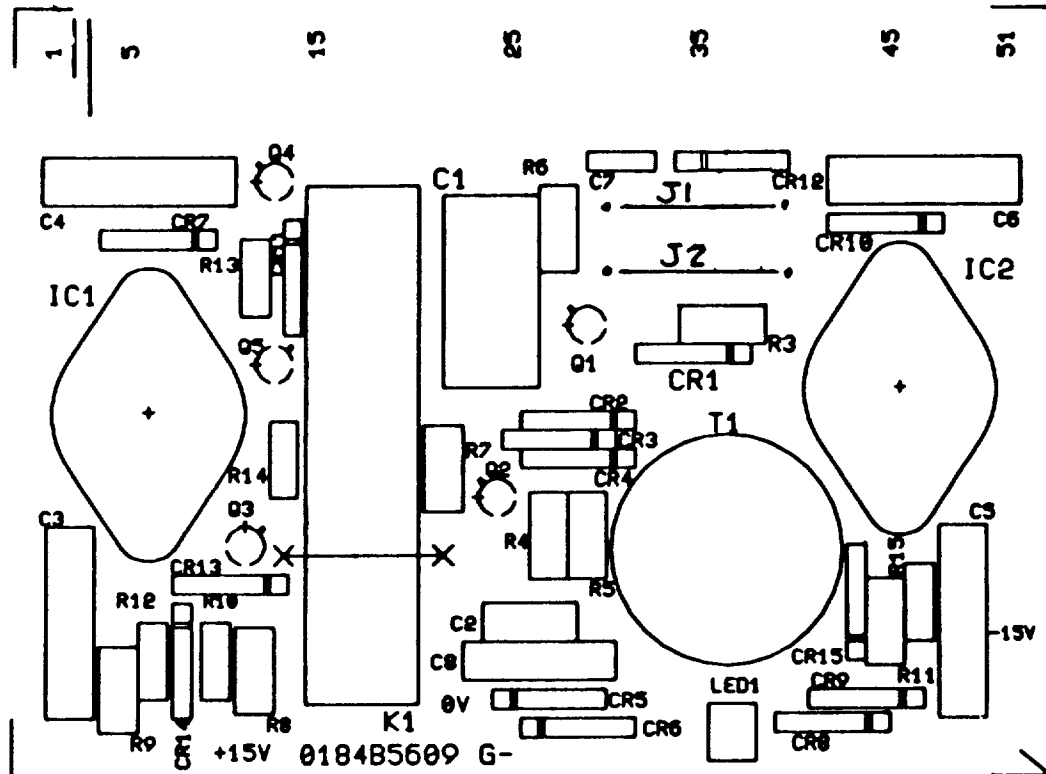
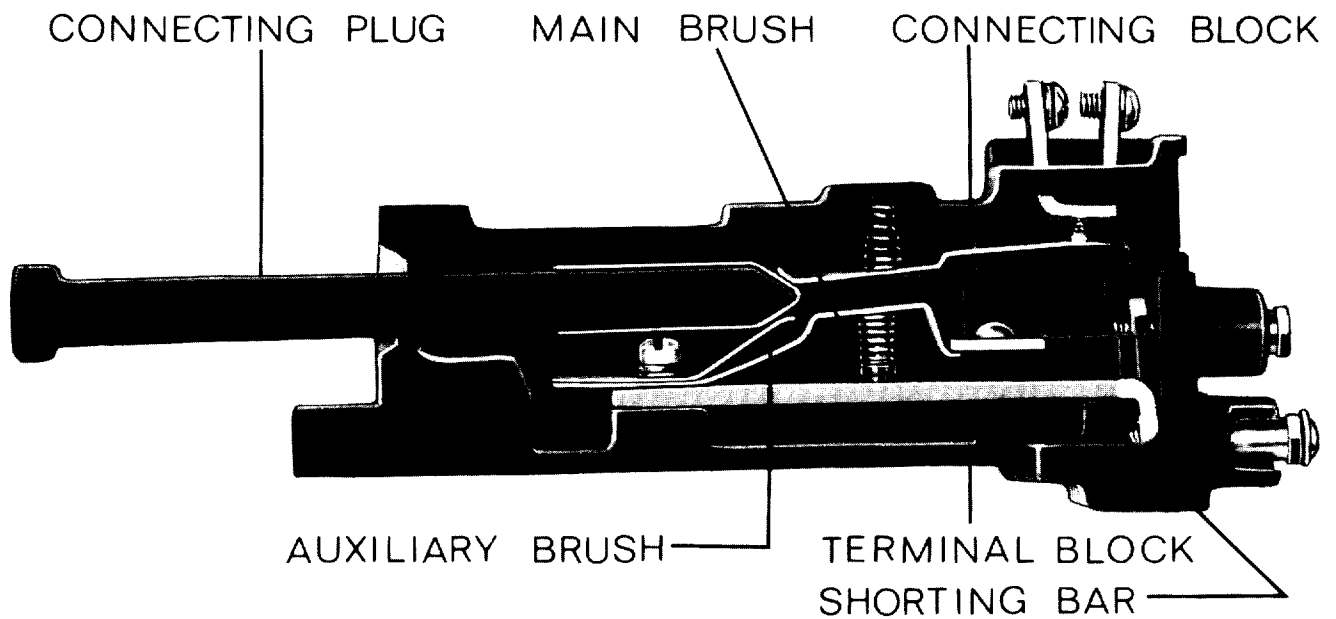


Figure 17B (0184B5609 Sh.2[1]) Card Layout for 48 Volt DC Rated Input Power Supply Card (PS)



NOTE: AFTER ENGAGING AUXILIARY BRUSH CONNECTING PLUG TRAVELS $\frac{1}{4}$ INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK

Figure 18 (8025039) Cradle Block and Terminal Block Cross Section

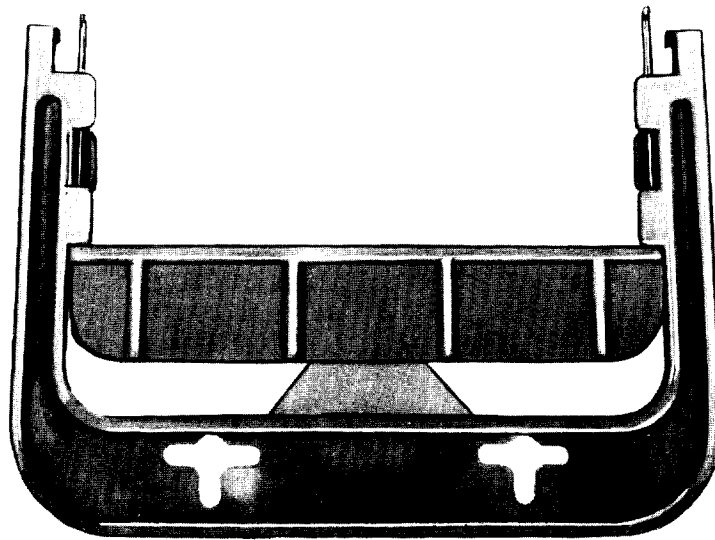


Figure 19 (8043016) Printed Circuit Card Extracting Tool

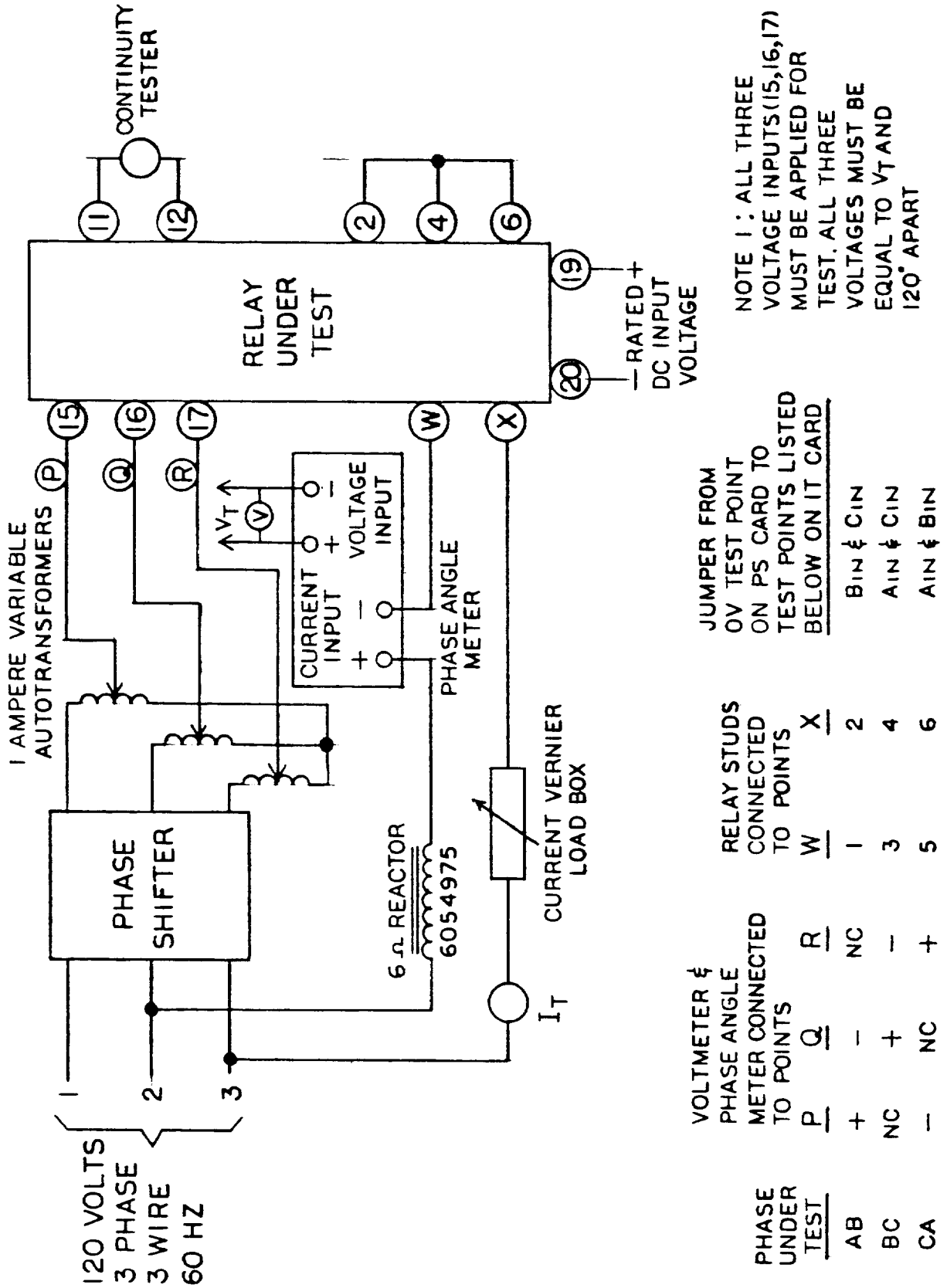
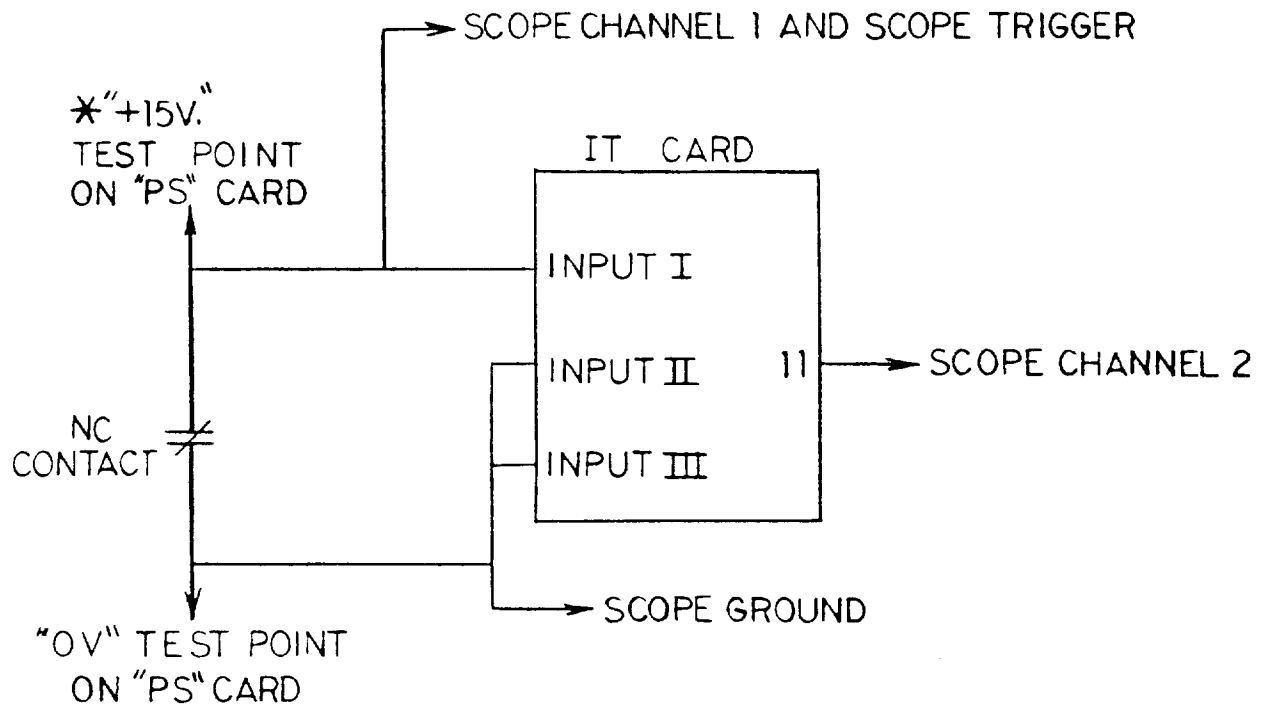


Figure 20 (0285A6755) Test Circuit for Reach Tests

* THE "+15V." TEST POINT HAS A 100K OHM CURRENT LIMITING RESISTOR MOUNTED ON THE "PS" CARD.



PHASE UNDER TEST	PIN No. OF CARD		
	<u>INPUT I</u>	<u>INPUT II</u>	<u>INPUT III</u>
AB	12	23	36
BC	23	12	36
CA	36	12	23

Figure 21 (0273A9099-0) Timer Card Test Circuit

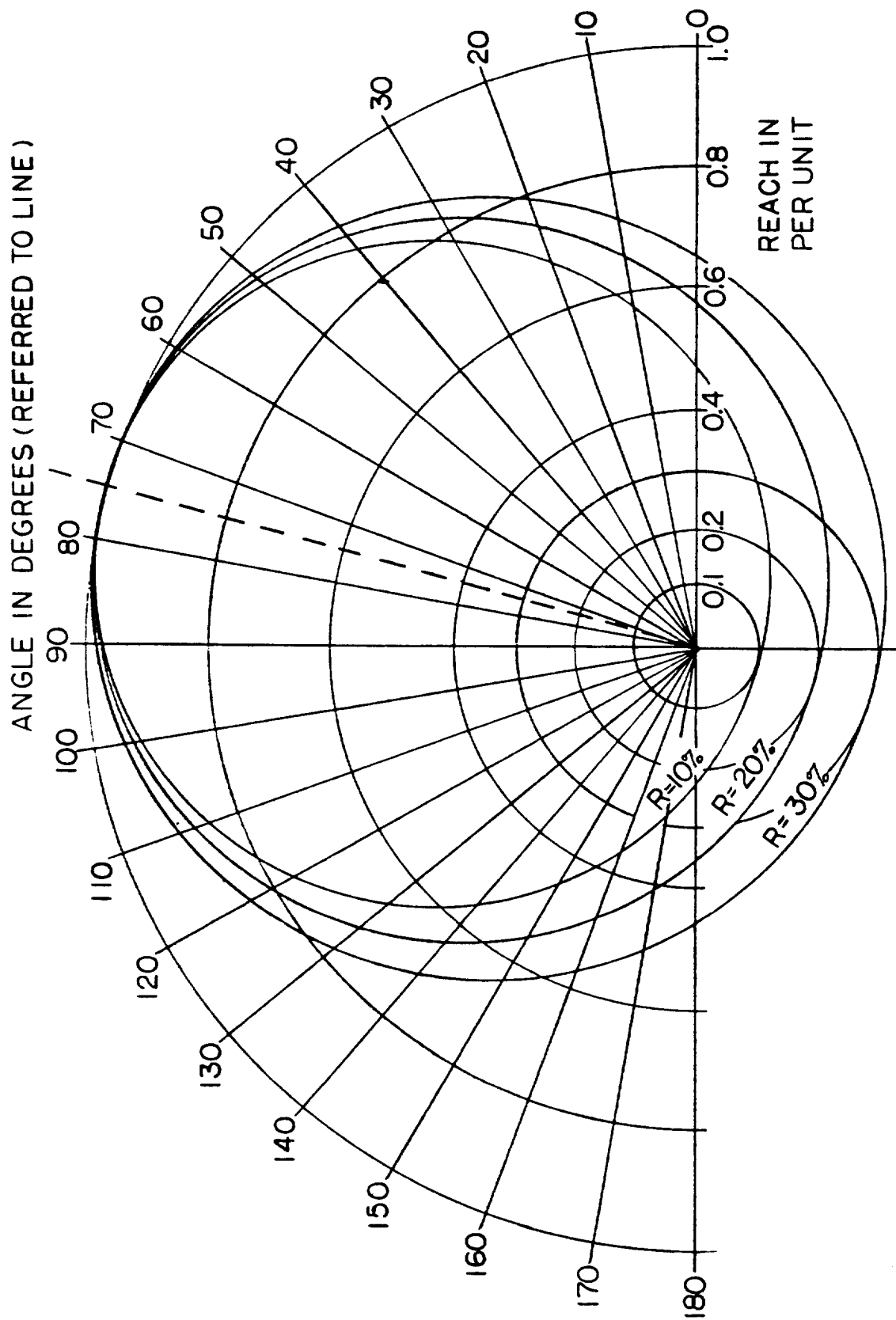


Figure 22 (0285A6754) Mho Characteristic for Timer Setting of 3.5 Milliseconds (60 Hertz Basis) with T equal to 100% *

* Indicates revision

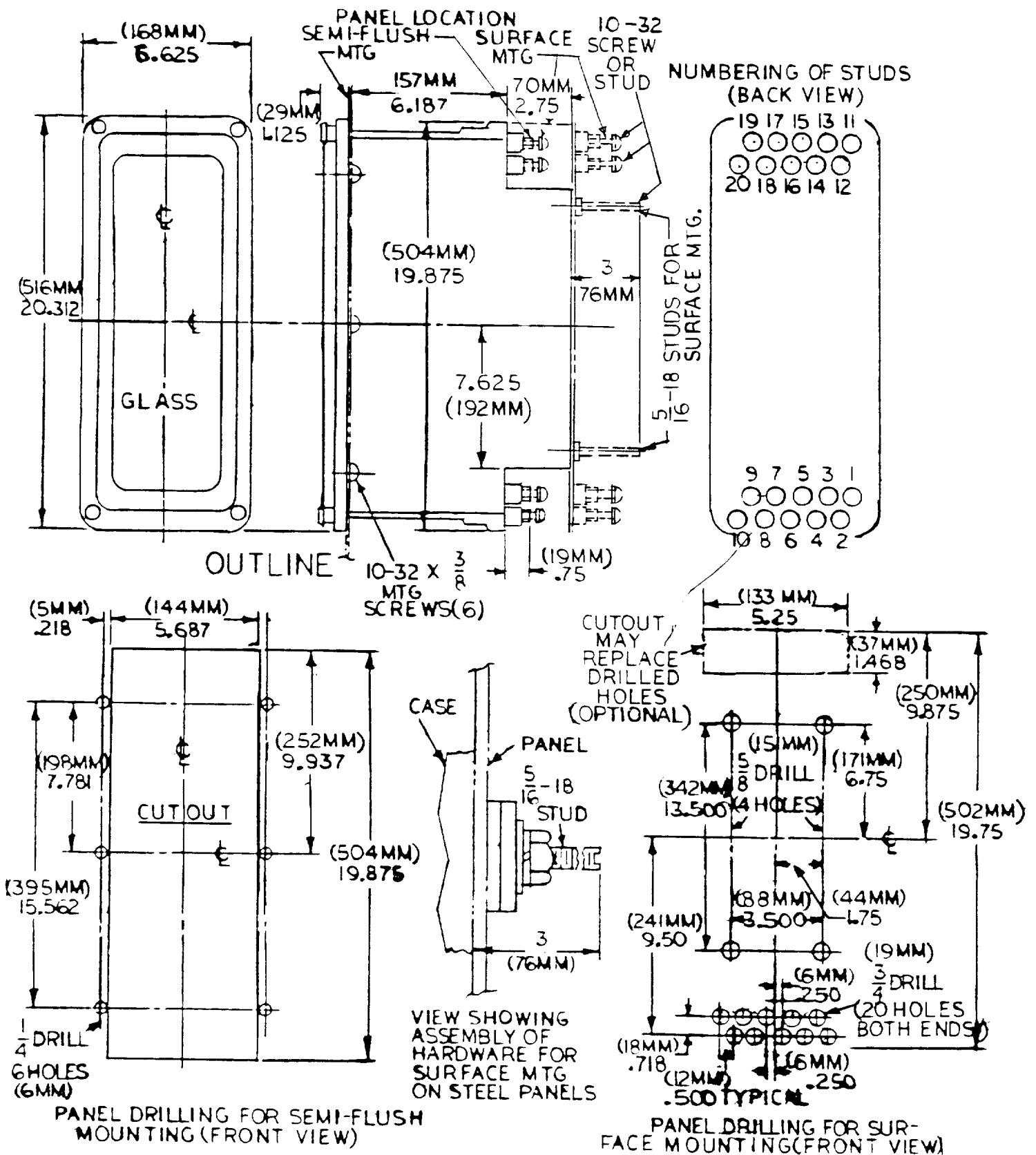


Figure 23 (0178A7336-4) Outline and Panel Drilling Dimensions for the Type SLY92A Relay



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ADDENDUM to GEK-86040

This Addendum contains information that relates to the latest version of the SLY92A relays. This Addendum is an update to the instruction book, not a replacement. The SLY92A relay series has expanded to include a model that is rated for 1-Amp operation. The following tables have been updated to include this 1-Amp rating and should replace the corresponding tables in the GEK-86040 Instruction Book.



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TABLE I
AVAILABLE REACHES

Relay Current Circuit Rating Amperes	Base Reach Tap In Positive Sequence Ohms Z_{R1}	Impedance Range In Positive Sequence Ohms Z_R	Offset Range in % of Z_R
5	0.75	0.75 to 7.5	0 / 10 / 20 / 30
5	1.5	1.5 to 15.0	
5	3.0	3.0 to 30.0	
1	3.75	3.75 to 37.5	0 / 10 / 20 / 30
1	7.5	7.5 to 75.0	
1	15.0	15.0 to 150.0	

TABLE V
CURRENT CIRCUIT BURDENS

Relay Current Rating	5 Amperes	1 Ampere
Current Circuit	Phase	Phase
Impedance, Z, in ohms	0.030	0.210
Resistance, R, in ohms	0.027	0.200
Reactance, X, in ohms	0.002	0.065

TABLE XII
RECOMMENDED TEST CURRENT

5 Ampere Rated Relay		1 Ampere Rated Relay	
Base Reach Tap	Recommended Minimum Test Current	Base Reach Tap	Recommended Minimum Test Current
0.75	8	3.75	1.6
1.5	4	7.5	0.8
3	2	15.0	0.4