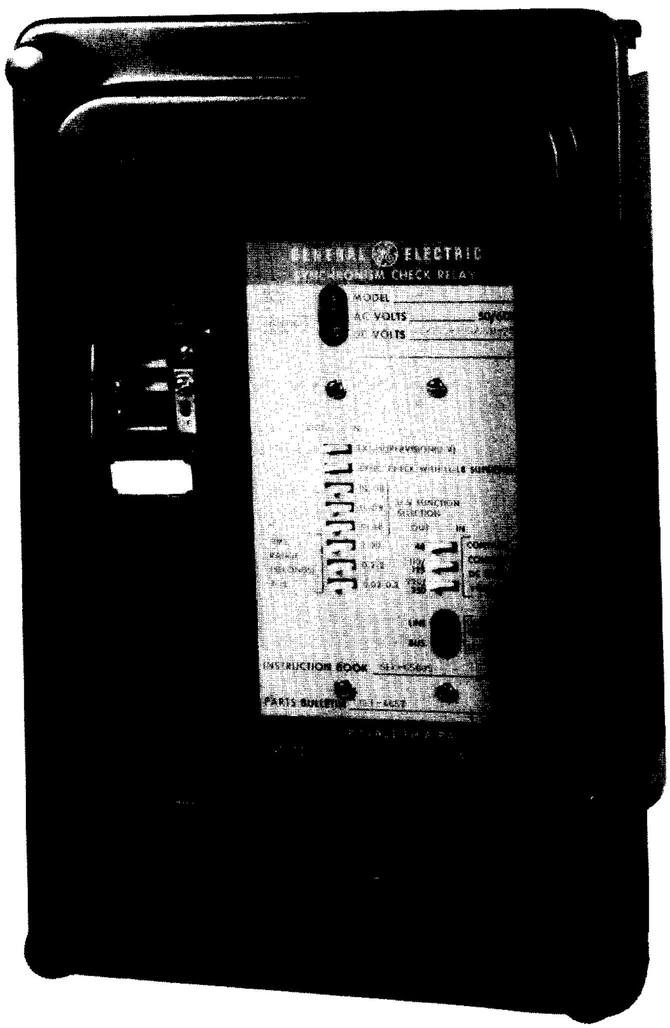
GEK-65605D

INSTRUCTIONS

STATIC SYNCHRONISM CHECK RELAY

TYPE 12SLJ21A



GE POWER MANAGEMENT
Meter and Control
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(Cover Photo 8043743)

STATIC SYNCHRONISM CHECK RELAY

TYPE 12SLJ21A

DESCRIPTION

The Type SLJ21A is a static synchronism check relay that will permit closing of a breaker only if the angle between voltages on the line and bus sides of the breaker is less than a set angle for a set period of time. This set angle is defined as the closing angle and is adjustable from 10 to 60 degrees. The set period of time is adjustable from approximately 30 milliseconds to 20 seconds. Also included is a voltage measuring unit with an output telephone type relay, to check line and bus voltage conditions.

The Type SLJ21A relay is mounted in a size S2 drawout case. The outline and panel drilling dimensions for the relay are shown in Figure 10. The internal connections for the relay are shown in Figure 1.

APPLICATION

The Type SLJ21A static synchronism check relay is intended primarily for application where the two parts of a system to be joined by the closure of a circuit breaker are interconnected at other points throughout the system. Even though the voltages on either side of the open breaker are in synchronism, there may be an angular difference between them as a result of load flow throughout the interconnected system. It is usually desirable to close the breaker even though an angular difference exists; provided of course that this difference is not great enough to be detrimental to the system or to connected equipment. Each application should be checked on an individual basis to determine the maximum angular difference for which closing can be tolerated.

Once an acceptable angular difference has been determined, the closing angle of the SLJ21A relay can be set accordingly. It is important to note that the relay is not intended to initiate the closure of a breaker, but rather to check that the angle between the voltages on the parts of the system to be joined is within the predetermined value, and then permit the breaker to be closed. If desired, some time delay can be added to insure that the system is stable and that the voltages on the parts of the system to be joined are actually in synchronism. This time delay, determined by the timer, TL2, is adjustable from 20 milliseconds to 20 seconds.

The relay is a single phase device that is connected to single phase voltages from the same phase on either side of the breaker, or the equivalent voltages in the case where a delta-wye power transformer is interposed between the two potenial sources.

Typical external connections to the relay are shown in the logic and external connections diagram in Figure 7. As shown in the diagram, the synchronism check function, via timer TL1 and AND3, is in service when the live line-live bus switch, S1, is closed, the line and bus voltages are above the set value of the voltage detecting functions, and the external supervising contact connected to contact converter CC1 is closed. If it is desired to have the synchronism check function operate independently of the external supervising contact, the input to the contact converter CC1 should be connected directly to the DC source. The closing angle of the synchronism check function is determined by the operating time setting, "C," of timer TL1. The method of calculating the required setting of TL1 is covered in a later section on **CALCULATION OF SETTINGS**.

If conditions change so that the parts of the system to be joined are not interconnected at other points in the system, it is possible that the parts of the system may not be in synchronism. In that case there will be some slip between the two parts of the system that are to be joined. If this slip is slow enough, it may appear to the SLJ relay that the two parts are in synchronism, and it will produce an output. For each combination of closing angle setting and time delay setting "E" of TL2, there is a slip frequency above which the relay will not produce an output. This is defined as the slip frequency cutoff, and its determination is described in a following section on **CALCULATION OF SETTINGS**.

In order for the synchronism check unit of the SLJ21A relay to provide an output, there must be a voltage present on both sides of the breaker and the phase angle between these voltages must be within the closing angle setting of the relay. This means that the synchronism check function alone will not permit picking up a dead line. For applications where dead line and/or dead bus operation is required, the undervoltage detecting functions can be used. These detectors, one for the bus-side and one for the line-side voltage, operate a common output telephone-type relay. Selection switches are provided on the "A" board to cause operation of this output unit for one or more of the following conditions:

1. Live line and dead bus
2. Dead line and live bus
3. Dead line and dead bus

The connections in Figure 12 show a typical application of the undervoltage function (device 27) to permit automatic or manual reclosing of the breaker for dead line and/or dead bus conditions.

RATINGS

SEISMIC

The seismic fragility level exceeds a peak axial acceleration of 6 g ZPA when tested using a biaxial multi-frequency input motion to produce a required response spectra (RRS) in accordance with ANSI/IEEE C37.98-1978, "Seismic Testing of Relays."

AC INPUT

The SLJ21A relay is rated for 120 volts at 50 or 60 hertz. Up to 120 percent of rated voltage may be applied continuously without overheating or loss of life.

DC CONTROL VOLTAGE

The relay is rated for 48, 110 to 125 or 220 to 250 volts DC supply. The supply voltage is selected by the connections to the terminals of the relay.

DC SUPERVISION VOLTAGE

The DC supervising circuit is rated for 48 volts, 110 to 125 volts, or 220 to 250 volts, DC. The voltage range is selected by a switch on the right printed circuit board.

OUTPUT CIRCUITS

The contacts of the telephone type output relays will make and carry 30 amperes for tripping duty and will carry three amperes continuously. They will interrupt the currents given in Table A.

TABLE A

VOLTS	CURRENT INDUCTIVE*	CURRENT NON-INDUCTIVE
48 DC	1.0	3.0
125 DC	0.5	1.5
250 DC	0.25	0.75
120 AC	0.75	2.0
240 AC	0.5	1.0

*Inductive refers to a L/R time constant of 0.100 seconds.

In some cases the current rating of the output circuit with a target unit is limited by the target rather than by the output relay contact ratings. The target ratings and characteristics are given in Table B.

TABLE B

TARGET UNIT TAP USED	RATING	0.2/2.0		0.6/2.0	
Carry 30 amperes for	(seconds)	0.2	2.0	0.6	2.0
Carry 10 amperes for	(seconds)	0.05	3.5	0.5	3.5
Carry continuously	(amperes)	0.45	20	5.0	30
Minimum operating	(amperes)	0.2	2.0	0.6	2.0
Maximum 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	0.65	6.2	0.65
50 hertz impedance	(ohms)	42	0.54	5.1	0.54

TEMPERATURE

The relay has been designed for operation in ambient temperatures between minus 20° C and plus 55° C, per ANSI Standard C37.90-1978. In addition, the relay will not malfunction or be damaged if operated in an ambient up to 65°C.

DIELECTRIC STRENGTH (AC HIGH POTENTIAL TEST)

For the purposes of dielectric tests, this relay is rated 600 volts. Per ANSI/IEEE C37.90-1978, the high potential test voltage is 2,200 volts for one minute. As described in the standard, relays other than new should be tested at 75 percent of this value. This relay includes surge protective capacitors which have limited AC voltage ratings. The procedures described in **ACCEPTANCE TESTS** should be followed to avoid damaging them.

ADJUSTMENTS AND RANGES (Refer to Figure 14)

AC Undervoltage Units

The AC undervoltage units have a range of adjustment from 20 to 120 volts. The adjustment is continuous by means of potentiometers, one for line voltage and one for bus voltage, which are located on the lower right portion of the nameplate.

Closing Angle

The range of closing angle adjustment is from 10 degrees to 60 degrees. The adjustment is continuous by means of a potentiometer located on the upper left portion of the nameplate.

Closing Time Delay

The range of closing time delay is 20 milliseconds to 20 seconds in three ranges: 20 to 200 milliseconds, 200 milliseconds to two seconds, and two seconds to 20 seconds. The range is selected by moving one of the three switches at the lower right of the nameplate to the right. The adjustment within the range is continuous by means of the potentiometer labelled, "CLOSING DELAY, TL2," which is located at the upper left of the nameplate.

Contact Converter

The contact converter voltage ratings are 48, 110 to 125 and 220 to 250 volts DC. The desired rating is selected by moving the correct switch on the lower right portion of the nameplate to the right. The contact converter DC voltage circuit is independent of the relay DC control voltage circuit, and may be set to a different voltage if desired.

DC CONTROL VOLTAGE (Refer to Figure 1)

The DC control voltages are 48, 110 to 125, and 220 to 250 volts. The desired range is selected by the connections to the case of the relay. The negative DC connection is to stud 14 for all voltage ranges. The positive DC connection is to stud 13 for 48 volts, to stud 12 for 110 to 125 volts, or to stud 11 for 220 to 250 volts.

OPTION SWITCHES

If it is desired to have the undervoltage output supervised by the DC supervising input, the top switch on the left of the nameplate should be moved to the right. If not, the switch should be moved to the left. The synchronism check unit is always supervised by the DC supervising input.

If it is desired to block synchronism check and leave only the undervoltage units in service, the second switch should be moved to the left. If it is desired to enable the synchronism check unit, this switch should be moved to the right.

The next three switches: dead line-dead bus (DL-DB), live line-dead bus (LL-DB), and dead line-live bus (DL-LB) select the conditions for which the undervoltage units will close the output relay. Move the switch to the right for each condition for which an output is desired. One, two or all three switches may be moved to the right.

CHARACTERISTICS

OPERATING PRINCIPLES

The SLJ21A relay measures the angle between the two input voltages, line and bus, by measuring the time during each half-cycle that both of the voltages have the same polarity. If [illegible] angle is zero, the time of coincidence is a complete half-cycle (8.33 millise[illegible]) hertz). If the phase angle is other than zero, the time of coincidence i[illegible] For example, if the phase angle is 30 degrees, then the two voltages have the same polarity for 180 degrees minus 30 degrees, or 150 degrees. If the frequency is 60 hertz, the time is 150/180 times 8.33 milliseconds, or 6.94 milliseconds. A graph of this relationship is shown in Figure 13.

Both positive and negative half-cycles are used to operate the coincidence timer so that the measurement of phase angle for a given angle setting can take as little as the time shown on Figure 13, and will never take longer than one cycle, even for the most unfavorable moment of application of the AC voltage.

The fastest operation is achieved when the AC and DC voltages are applied to the relay, either continuously or several seconds before the synchronism check output is needed, and the synchronism check process is started by closing the supervisory input to studs 9 and 10. Because the measuring unit of this relay is solid-state, the AC inputs and the DC control power can be applied continuously without causing any moving parts to wear. The output relays will not operate until the supervisory input is energized. The supervisory input can also be energized continuously, but this will cause the internal time delay timer TL2 to time out and the output relay to pick up. If a system distrubance then occurs and the two voltages move out of phase beyond the relay setting, the output contacts will remain closed for the relay's dropout time.

UNDERVOLTAGE UNITS

Separate adjustable undervoltage circuits monitor the line and bus voltages. The circuits block the synchronism check output whenever either or both voltages drops below the settings. In addition, the undervoltage circuits provide outputs which may be selected by switches to operate a separate undervoltage output relay. This output relay may be set to operate for any of the following conditions by means of switches on the front panel:

1. Live line-dead bus (LL-DB)
2. Dead line-live bus (DL-LB)
3. Dead line-dead bus (DL-DB)

The undervoltage output has no intentional time delay.

DC SUPERVISION TIMER

To prevent incorrect operation during the transient interval when DC control power is turned on or off, a DC supervision timer blocks the outputs for a fixed period after the DC control power comes on. This time is not a part of the normal operating time. When fast operation is desired as in some bus transfer schemes, the DC should be applied to the relay before the synchronism check function is needed to allow this timer to time out. The DC supervision timer has a fixed, non-adjustable setting.

CIRCUIT DESCRIPTION

Power Supply (B Board)

Refer to the relay internal connections diagram, Figure 1, and the B board internal connections diagram, Figure 4.

The positive DC voltage enters the relay on stud 11 (250 volts), stud 12 (125 volts) or stud 13 (48 volts). It passes through the appropriate number of series resistors (R1, R2, R3) to ZD1, then through pin 5 onto the B board, through D12 and D13 on the B board, out pin 3, and exits the relay via stud 14 to the negative pole of the DC supply. Pin 5 of the B board is approximately 15 volts more positive than pin 6 and pin 3 is approximately one volt negative with respect to pin 6. On the B board, R12 and D11 provide a voltage at pin 4 which is approximately one-half volt positive with respect to pin 6.

AC Input Circuit (B Board)

The two AC inputs enter the relay via studs 16 and 17 (line voltage) and 18 and 19 (bus voltage) and go directly to the B board, where they energize the primaries of T1 and T2, respectively. These transformers provide isolation and lower the voltage by a ratio of 10:1.

Refer to the B board internal connections diagram, Figure 4. The output of each transformer goes to two circuits. The first circuit, embodied by U1, produces a signal at pin 8 which is low when the two AC input voltages have the same instantaneous polarity, and high otherwise. The second circuit, embodied by U2, is an undervoltage circuit which produces a high output at pin 17 if the line voltage is below the set point, and a low voltage otherwise. Pin 18 is high when the bus voltage is below the set point and low otherwise. The upper potentiometer, labeled P11 on the diagram, sets the line voltage set point, while the lower potentiometer, labeled P12, sets the bus voltage set point. Clockwise rotation increases the set point.

Supervising Input Contact Converter (B Board)

The DC external supervising signal enters the relay by stud 9 (positive) and stud 10 (negative). The signal goes directly to pin 14 (positive) and pin 15 (negative) of the B board. The switches SW11, SW12 and SW13 select the correct number of resistors for the supervising voltage. Only one of the three switches should be to the right: the top switch for 220/250 volts, the middle switch for 110/125 volts, or the bottom switch for 48 volts. If more than one switch is thrown to the right, the effect is the same as if only the lowest voltage switch were thrown. When the external supervising voltage is applied and the correct switch is to the right, reed relay RY1 operates, connecting pin 16 to the positive supply voltage (pin 5).

Phase Angle Timer (A Board)

Refer to the A board internal connections diagram, Figure 2.

The output of the coincidence detector (pin 8 of B board) connects to pin 5 of the A board which is the input of the phase angle timer. If the two AC voltages are out of phase by more than the angle of the set point, (TL1 - set by the upper potentiometer - labeled P1 on the diagram) the output of the timer will be low. The output appears as the voltage on U51 pin 13. A low output blocks the output circuit and resets the time delay timer TL2 via the output of U52 pin 1 and the collector of Q52. If the two AC voltages move closer in phase angle so that the phase angle between them is less than the set point, the output of U51 at pin 13 will go up, permitting operation of the time delay timer. Rotating P1 clockwise decreases the angle over which the relay will close its output contacts.

Detailed Description of the Operation of the Phase Angle Timer (A Board):

The input to the timer is pin 5 of the A board. It is high when the two AC voltages have the same instantaneous polarity, either positive or negative, and low otherwise. When pin 5 is high, the output of U51 at pin 2 is unclamped, which allows C51 to charge through R51 and P1. If the AC inputs are closer in phase than the timer setting, C52 will charge enough to cause the comparator to switch, clamping U51 pin 1 low. This sudden drop in voltage is transmitted through C53, causing the next comparator to switch. The output of this comparator at U51 pin 14 is released momentarily, which allows Q51 to turn on, rapidly discharging C54. C54 is unable to recharge enough to cause the last comparator to switch before the next pulse discharges it, so the last comparator's output stays high. This permits reclosing.

Time Delay Timer (A Board)

The time delay timer consists of the one quarter of U55 with its output at pin 1 and the associated parts shown at the lower left of the internal connections drawing. If Q61 (the DC supervision timer) is off and Q52 is off, their collectors, which are connected together, will be pulled up by R58. This will allow the time delay timer to begin timing. The range of the time delay timer is chosen by the bottom three switches on the A board. Moving the top switch handle to the right selects the long time delay range of two to 20 seconds. The middle handle to the right selects the middle range of 0.2 to two seconds, and the bottom handle selects the short time range of 0.02 to 0.2 seconds. Moving more than one handle to the right causes the time ranges selected to add. TL2, the lower potentiometer at the top of the board, labeled P2 on the internal diagram, selects the time delay within the range selected. Rotating TL2 clockwise increases the delay time.

When the two transistors, Q58 and Q62, are both off, the timing begins. The selected capacitor - C55, C56 or C57 - charges toward positive through P2. When the voltage on the capacitor exceeds the voltage set by R60 and R61, the comparator switches, unclamping its output. This allows base current to turn on Q54, which pulls the emitter of Q55 low, turning it on. Q55 pulls card pin 10 low, which energizes the 25 output relay.

DC Supervision Timer (A Board)

The DC supervision timer, shown on the internal connections diagram at the lower right, blocks the operation of the output relays for a fixed time after the DC control power is applied to the relay. The timer prevents incorrect operation of the output relays during momentary interruptions in the DC control power.

When the relay is energized, C59 is initially discharged. Q58 and Q59 are off, and Q60 and Q61 are on. Q60 diverts current from the bases of Q53 and Q54 thus blocking both output relay drivers, while Q61 holds down the input of the delay timer and discharges its timing capacitor.

When pin 3 goes negative indicating that DC has been applied, Q56 turns on, which turns off Q57 and allows C59 to charge. When the voltage on C59 rises enough to turn on ZD3, Q59 turns on, turning off Q60 and Q61. Upon any interruption of the DC supply, the voltage at pin 3 disappears at once, Q56 turns off and Q57 turns on (the positive supply remains for a moment due to C11). This discharges C59 so that the full time delay is available when the DC power returns. The time delay of this timer is not added to the operating time unless the synchronism-check process is started by applying DC to the relay. The relay may be continuously energized with AC and DC and the synchronism-check process started by energizing the supervisory input on studs 9 and 10. This avoids the additional time delay of the DC supervision timer.

Undervoltage Logic (A Board)

The line undervoltage signal from the level detector enters the A board via pin 7. The bus signal enters via pin 6. Each of these pins is high when the AC input is below the set point and low when the input is above the set point.

Five conditions are necessary for the synchronism check output relay to operate:

1. The two AC voltages must have a phase angle within the setting which is indicated by U52 pin 2 being high.

2. The external supervising input must be energized as indicated by U52 pins 4 and 5 being high.

3. The line and bus voltages must each be above their respective under-voltage level detector settings as indicated by U54 pin 3 being high.

4. The synchronism-check switch, SW2 on the A board, must be closed as indicted by U52 pin 3 being high.

5. The time delay timer must have timed out as indicated by U51 pin 1 being high.

When the line voltage is above the undervoltage set point and the bus voltage is below its set point (LL-DB), a high signal is present at switch four. Similarly, a dead line-dead bus (DL-DB) produces a high signal at switch six. If the switch is closed, this signal will appear at the input of OR U56 and through it to the input of AND U52. The second input to the AND is connected to the first if the external supervision switch is in the out position. If this switch is in the in position, then the external supervision input must also be energized to provide the second input. If both of these inputs are present, then the 27 relay operates.

PICKUP TIME

The pickup time consists of three parts:

1. The coincidence timer, TL1
2. The time delay timer, TL2
3. The output telephone-type relay, 25.

The time required for TL1 to give an output can vary from a minimum of the TL1 setting (refer to Figure 13) to a maximum of the setting plus one half-cycle, depending on the phase of the two voltages when the phase difference passes into the operating region.

The time delay timer TL2 has a minimum time setting of 20 milliseconds and a maximum setting of 20 seconds.

The output telephone-type relay has an operating time which depends on the DC control voltage rating, on the value of the control voltage within the range, and on the adjustment of the output relay. Typically for the 125 volt rating and 100 percent of rated voltage, the operating time will be five to seven milliseconds.

The minimum pickup time, as measured from the application of the AC voltages to the closing of the output contacts, is approximately 30 milliseconds. The minimum pickup time, as measured from the energizing of the supervision input to the closing of the output contacts, is approximately 26 milliseconds.

DROPOUT TIME

Dropout time is composed of the dropout time of the three units: TL1, TL2 and the output relay. The dropout time of TL1 is fixed at 12 milliseconds or less. The dropout time of TL2 is less than four milliseconds. The dropout time of the output relay is six to ten milliseconds. The total dropout time is approximately 24 milliseconds.

CLOSING ANGLE VARIATIONS WITH AC VOLTAGE

The closing angle setting varies less than two degrees over the range of 20 to 120 volts. The angle decreases as the voltage decreases. From 20 to ten volts, there is an additional decrease of two to three degrees. It is recommended that the undervoltage units not be set below 20 volts.

BURDENS

AC CIRCUIT (Each input) (at rated voltage)

Volt-amperes	0.25
Watts	0.25
Vars	0.0

DC CIRCUIT (Studs 11 through 14)

48 volts	110 milliamperes	5.25 watts
125 volts	110 milliamperes	14 watts
250 volts	85 milliamperes	22 watts

The DC burden does not change appreciably when the output relays operate.

DC SUPERVISING CIRCUIT (Studs 9 and 10)

48 volts	15 milliamperes	0.6 watts
125 volts	12 milliamperes	1.5 watts
250 volts	12 milliamperes	3.0 watts

CALCULATION OF SETTINGS

The closing angle of the SLJ21A relay is determined by adjusting the operation time, "C," of the TL1 timer shown in Figure 7. To determine the required time setting "C" for a particular closing angle, use the following equation:

$$C = M \times 10^{-3} (180 - D)$$

where: C = time setting of TL1 in milliseconds
D = closing angle in degrees
M = 46.3 for 60 hertz, 55.5 for 50 hertz

Conversely if the time setting "C" of TL1 is known, the following equation can be used to determine the closing angle:

$$D = 180 - \frac{C}{M \times 10^{-3}}$$

It should be noted that because of the nature of the relay circuitry, the closing angle "D" calculated from the above equation for a time setting "C" is approximate. Precise settings for a desired closing angle should be made by means of test procedures described in a later section.

The required timer settings "C" in milliseconds for some typical closing angles, "D," are listed in the following table.

"D"	"C"	
	60 Hertz	50 Hertz
10	7.83	9.44
20	7.39	8.87
30	6.94	8.33
40	6.47	7.76
50	6.01	7.21
60	5.55	6.66

The slip frequency cutoff function is provided primarily by the timer TL2, but is affected to a degree by the closing angle timer, TL1. The slip cutoff is determined by the following equation.

$$S = \frac{D\ (1000)}{180\ T}$$

where: S = slip cutoff in hertz
D = closing angle setting in degrees
T = total time for TL1 and TL2 in milliseconds (C + E)

This equation is not affected by system frequency. A graph of the slip frequency cuttoff versus time delay is shown in Figure 11.

CONSTRUCTION

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner blocks. This cradle is held firmly in the case with a latch at the top and the bottom, and by a guide pin at the back of the case. The cases and cradles are so constructed that the relay cannot be inserted in the case upside down. 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 fastened to the case by thumbscrews, holds the connecting plugs in place.

To draw out the relay unit, the cover is first removed, and the plugs drawn out. The latches are then released, and the relay unit can be easily drawn out. To replace the relay unit, the reverse order is followed.

A separate testing plug can be inserted in place of the connecting plug to test the relay on the panel, either from its normal source of power or from other sources. Or, the relay unit can be withdrawn for testing and replaced by a spare relay unit. The test plug is described in the test plug instruction book, GEI-25372.

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 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 Apparatus Sales Office.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured 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.

CASE

The case is suitable for either surface or semi-flush panel mounting, and an assortment of hardware is provided for either. The cover attaches to the case and also carries the reset mechanism when one is required. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at both ends for the external connections. The electrical connections between the relay units and the case studs are made through spring-backed contact fingers mounted in a stationary molded inner and outer block, 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 the terminals for the internal connections.

ACCEPTANCE TESTS

Immediately upon receipt of the relay, an inspection and acceptance test should be made to insure that the relay has not been damaged in shipment and that the relay calibrations have not been disturbed. These tests may be performed as part of the receiving acceptance tests or as part of the installation procedure, or both. Since operating companies use several different procedures for acceptance tests and installation tests, the following section includes all the tests required for both acceptance and installation.

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.

VISUAL INSPECTION

Check the nameplate stamping to insure 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 screws are tight.

MECHANICAL INSPECTION

Cradle and Case Block

Check that the fingers on the cradle and the case agree with the internal connection diagram (Figure 1). Check that the shorting bars are in the correct position, and check that each finger with a shorting bar makes contact with the shorting bar. Deflect each contact finger to insure that there is sufficient contact force available. A force of approximately one pound (450 grams) should be required to open the connection between the shorting bar and the contact strip. Check that each auxiliary brush is bent high enough to contact the connection plug. Refer to Figure 15.

Hi-Seismic 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 position. Next remove the screw from the undesired position and install it in the left-hand plate where the first screw was removed. Screws should never be left in both taps at the same time.

TAP	PICKUP CURRENT IN AMPERES	DROPOUT CURRENT IN AMPERES
0.2	0.12 - 0.2	0.05
0.6	0.35 - 0.6	0.15 or more
2.0	1.15 - 2.0	0.50 or more

The backing strip should be so formed that the forked end (front) bears against the molded strip under the armature. Since mechanical adjustments may affect the seismic fragility level, it is advised that no mechanical adjustments be made if seismic capability is of concern.

Telephone Relays

With telephone relays in the de-energized position, all circuit closing contacts should have a gap of 0.015 inch and all circuit opening contacts should have a wipe of 0.005 inch. The gap may be checked by inserting a feeler gage, 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 again checked as described above.

ELECTRICAL TESTS - GENERAL

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

Target Unit

The target unit may be tested without applying DC control or AC power to the relay. Connect an adjustable external source of DC current to studs 1 and 2. Manually operate the upper telephone relay and increase the current until the target unit picks up. The current should be within the limits given in the table. Then decrease the current until the target unit drops out. The current must be above the limit given. If desired the unit may be tested on the other tap also.

DIELECTRIC TESTS

Introduction

The surge capacitors used in this relay can be damaged by AC high potential test voltages unless the procedures below are used. Caution must be exercised when testing to avoid damaging these capacitors.

Relays are most conveniently high-potential tested on a bench, and in their cases. If a relay is to be hipotted together with other apparatus in an equipment, all external connections to surge ground (terminal 15) must be removed.

The hipot test voltage should be 2,200 volts RMS, 50 or 60 hertz for new relays, or 1,650 volts RMS for other relays. The duration of application of the test voltage should be 60 seconds. New relays are defined by ANSI C37.90-1978 as those which have not been in service, which are not more than one year old from date of shipment, and which have been suitably stored to prevent deterioration.

High Potential Tests

Common Mode Tests: (All terminals to case)

External temporary connections should be made to tie all the relay terminals, including terminal 15, together. Hipot voltage can then be applied between this common connection and the relay case.

Transverse Mode 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 groups of circuits listed in the following table. Hipot voltage then can be applied between any two groups of circuits.

CIRCUIT GROUPS FOR TRANSVERSE MODE TEST

CIRCUIT GROUP	CONNECT THESE TERMINALS TOGETHER TO FORM A GROUP
Contact group A	1 and 2
Contact group B	3 and 4
Contact group C	5 and 6
Contact group D	7 and 8

CIRCUIT GROUPS FOR TRANSVERSE MODE TEST (Cont'd)

CIRCUIT GROUP	CONNECT THESE TERMINALS TOGETHER TO FORM A GROUP
DC Supervision	9, 10
DC control power	11,12,13,14
Surge ground	15
Line voltage	16 and 17
Bus voltage	18 and 19

If it is inconvenient to disconnect the surge capacitors, an alternate test may be performed using a 500 volt DC Megger® with the capacitors connected in the normal manner. While this method does not test the relay to its full dielectric rating, it will detect some cases of degraded insulation.

Tests Across Open Contacts:

Voltage may be applied across each contact, as there are no surge capacitors on the contact leads. The most common cause of failure in this test is insufficient contact gap.

Restoring Relay to Service

After the high potential testing is completed, the surge capacitors should be reconnected to the surge capacitor buses and all external wiring to terminal 15 (surge ground) should be reconnected. A check of calibration should be performed after high potential testing.

UNDERVOLTAGE UNITS

1. Set all switches to the left. Apply DC control power to the appropriate studs (plus 250 volts on terminal 11, or plus 125 volts on terminal 12, or plus 48 volts on terminal 14 and negative on terminal 14). Set the external supervision switch to the "out" position (to the left) and the dead line-dead bus DL-DB switch to the "in" position (to the right). The undervoltage telephone-type output relay 27 (the lower one) should operate. If it does not, the undervoltage level detectors may be set below zero. Turning both undervoltage level pots (located at the lower right) fully clockwise will set the level detectors to the maximum voltage. This will also wipe out any setting that was on the level detectors. The lower telephone relay should now be picked up.

2. Apply rated AC voltage to the line input terminals 16 and 17. The undervoltage output relay should now drop out. If the undervoltage level pots were moved in the previous step, turn the line undervoltage pot counterclockwise until the undervoltage output relay drops out. If desired, the line undervoltage setting can now be made by applying the desired voltage and adjusting the pot so the telephone relay just operates.

3. With the undervoltage output telephone relay dropped out (line voltage higher than line undervoltage set point) close the live line-dead bus LL-DB switch to the

right. The telephone relay should now pick up. Remove and reapply the line voltage. The telephone relay should remain picked up.

4. Remove the line voltage and apply rated bus voltage to the bus voltage input terminals 18 and 19. The undervoltage output telephone relay should drop out. If it does not, the bus undervoltage level detector may be set too high. Turn the bus undervoltage level pot counterclockwise until the telephone relay drops out. If desired the bus undervoltage setting can now be made by applying the desired bus voltage and adjusting the bus undervoltage pot until the telephone relay just operates.

5. Apply rated bus voltage and the undervoltage output relay should drop out. Move the dead line-live bus DL-LB switch to the right, and the undervoltage output relay should pick up.

SUPERVISION INPUT

Move the EXTERNAL SUPERVISION (U-V) switch to the right. The undervoltage output relay should drop out. Check that the switches on the right are set for the proper supervision control voltage, and then apply the supervision voltage to the supervision input, terminals 9 and 10 (positive on 9 and negative on 10). The undervoltage telephone relay should pick up.

SYNCHRONISM CHECK UNIT

1. With the undervoltage units set for a voltage below rated as described in the previous section, set the nameplate switches as follows:

1 -	EXTERNAL SUPERVISION (U-V)	- left
2 -	SYNC CHECK WITH LL-LB SUPERVISION	- right
3 -	DL-DB	- right
4 -	LL-DB	- right
5 -	DL-LB	- right
6 -	2-20	- left
7 -	0.2-2	- left
8 -	0.02-0.2	- right

9 - CONTACT CONVERTER DC INPUT VOLTAGE - Move the switch corresponding to the available supervision voltage to the right and move the other two to the left.

2. Apply DC voltage to the supervising input and to the control voltage input. Apply rated AC voltage to both the line input terminals (16 and 17) and to the bus input terminals (18 and 19) with zero phase angle. (One way to do this is to tie 16 and 18 together and to one side of the AC source, and tie 17 and 19 together and to the other side of the AC source.) The lower telephone-type output relay should drop out and the upper output relay should pick up. If the upper relay does not pick up, the synchronism check phase angle setting may be less than zero. In this case, turn the phase angle pot TL1 counterclockwise until the upper output telephone relay picks up.

   If desired the synchronism check angle can now be set by applying voltage to the line and bus input terminals with the desired phase angle separation, and adjusting phase angle pot TL1 until the proper operation is achieved.

TIME DELAY UNIT

To verify that the time delay unit TL2 is functional, move the time range switch, 0.2-2, to the right and the other two time range switches to the left. Then with the DC control voltage and the DC supervision voltage already applied, suddenly apply the AC voltage. A distinct delay in the pickup of the upper output relay should be noticed.

To verify that the time delay setting is correct, or to set the time delay, use the following procedure. Arrange a timer so that it will start when AC voltage is applied to the relay and will stop when the output contacts (terminals 1 and 2) close. Apply DC control and DC supervising voltage. Suddenly apply the AC voltages to the relay and read the operating time from the timer. When setting or checking short times, there will be a variation due to the point on the AC wave where the switch is closed. Five or ten readings will show this variation.

If the time delay setting is to be changed, the range is set by moving the desired range switch of the three switches at the lower right of the nameplate to the right, and settings within the range chosen are made by adjusting the TL2 pot, which is the lower pot of the pair at the upper left of the nameplate.

The time delay measured from the switching of the supervision input will be up to one cycle less than the time measured from the switching of the AC voltages. In some applications, it may be preferable to set the operating time of the relay using this input.

INSTALLATION PROCEDURE

INTRODUCTION

Mount the relay on a vertical surface in a clean, dry, and well lighted location, to afford accessibility for cleaning, inspection and testing; and where it will not be subjected to excessive vibration or heat.

SAFETY GROUND

The case should be dependably grounded through a mounting stud or screw with a conductor of No. 12 AWG copper or larger or the equivalent, to a reliable ground. When the relay is mounted on a steel panel which effectively grounds the case of the relay, the separate ground connection may be omitted.

SURGE GROUND

In order to achieve the highest surge withstand capability, the surge ground terminal (terminal 15) must be connected to the relay case at a mounting stud or screw by a jumper. The jumper should be No. 12 AWG copper or larger, and be as short as possible.

VISUAL INSPECTION

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

MECHANICAL INSPECTION

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

HI-SEISMIC TARGET UNIT

Set the target unit tap screw in the desired position using the procedure described in **ACCEPTANCE TESTS** - HI SEISMIC TARGET UNIT.

DC CONTROL VOLTAGE

The DC control voltage is selected by the connections on the terminals of the case. For 220 to 250 volts DC, the positive connection should be on terminal 11, for 110 to 125 volts DC, terminal 12, and for 48 volts DC, terminal 13. For all voltages, the negative connection should be on terminal 14. The presence of the correct voltage on the correct stud can be conveniently checked using the XLA12A test plug, which is described in instruction book GEI-25372.

The remaining settings are located on the relay nameplate.

CONTACT CONVERTER DC INPUT VOLTAGE

Set the desired contact converter DC input voltage (supervision voltage) by moving the switch corresponding to the desired voltage to the right. Only one of this group of three switches should be to the right.

The contact converter DC input voltage may be set to be different than the DC control voltage.

TIME DELAY TIMER

Set the desired range using the three switches at the bottom of the left hand group by throwing the switch corresponding to the desired range to the right. Only one switch of the bottom three should be to the right. The setting within the time delay range is made using the lower of the two potentiometers at the top of the left group. This setting should be made using an external timer. Turning the control clockwise increases the time setting.

When setting short time delays (less than 100 milliseconds) the estimated telephone relay pickup time should be subtracted from the measured time for greater accuracy in setting the time delay. When setting these short times, small errors in time correspond to large errors in slip cutoff frequency. If it is desired to limit maximum slip frequency, it is preferable to measure the slip cutoff frequency directly by applying two AC sources with an adjustable slip. Set the applied slip frequency just above the desired cutoff and adjust the time delay potentiometer until the upper telephone-type relay just fails to close its contacts. Then lower the slip slightly and the output relay's contacts should just close. Note that for these test conditions, the contacts are closed outside the closing angle due to the dropout time of the TL1 timer and the output relay.

PHASE ANGLE

The phase angle is set using the upper potentiometer of the the two at the top of the left-hand group. The setting is made using an external source of variable phase angle voltage and a phase angle meter. Turning the control clockwise increases the angle setting; that is, it increases the angular range over which the relay will close its sync-check output contact. Most relays will have a range of angle setting greater than the stated range of 10 to 60 degrees, but settings below ten degrees are not recommended.

UNDERVOLTAGE SETTINGS

The line and bus undervoltage settings each have their own adjustment potentiometer, which is located at the lower right of the nameplate. Clockwise rotation increases the setting. They may be set using an external source of variable AC voltage and a voltmeter. The XLA12 test plug described earlier is also useful for making this setting.

UNDERVOLTAGE FUNCTION SELECTION

The conditions for which the undervoltage output relay will close its contacts are set by the three undervoltage function selection switches in the middle of the right group. When one of the switches is moved to the right, the undervoltage output relay will close its contacts when the condition corresponding to the switch label occurs. The switches are labeled:

DL-DB Dead line-dead bus
LL-DB Live line-dead bus
DL-LB Dead line-live bus

None, one, two or three of these switches may be moved to the right.

EXTERNAL SUPERVISION OF THE UNDERVOLTAGE UNIT

This switch is the top switch in the left group. When moved to the right, the undervoltage unit is supervised and cannot close its output relay contacts unless the supervision input (terminals 9 and 10) is energized. When moved to the left, the undervoltage unit is not supervised by the supervision input, and will close its contacts whenever the set undervoltage condition(s) occur.

SYNCHRONISM CHECK WITH LIVE LINE-LIVE BUS SUPERVISION

This switch is the second from the top in the left group. When moved to the right, the synchronism-check function is enabled. The sync-check unit is always supervised both by the undervoltage units and by the supervision input. When moved to the left, the sync-check function is blocked, leaving only the undervoltage functions.

DIELECTRIC (HIPOT) TESTS

The recommended dielectric test for installation is the common mode test. When performing this test, remove the connection from terminal 15 (surge ground) to the case and connect all terminals, including terminal 15, together before applying hipot voltage. This is to avoid the application of excessive voltage to the surge capacitors, which could damage them.

Hipotting between circuits is not recommended, as it will in general apply excessive voltage to the surge capacitors. If it is necessary to hipot between circuits, refer to the procedure in **ACCEPTANCE TESTS** - DIELECTRIC TESTS.

The recommended AC hipot voltage is 2,200 volts for new relays and 1,650 volts for other relays. The duration of the test voltage should not exceed one minute.

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. It is recognized that 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 below be checked at an interval of from one to two years.

CONTACT CLEANING

For cleaning relay contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched-roughened surface, resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet it will clean off any corrosion thoroughly and rapidly. The flexibility of the tool insures the cleaning of the actual points of contact. Do not use knives, files, abrasive paper or cloth of any kind to clean relay contacts.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken or damaged.

Should a printed circuit card become inoperative, it is recommended that this card be replaced with a spare. In most instances, the user will be anxious to return the equipment to service as soon as possible and the insertion of a spare card represents the most expeditious means of accomplishing this. 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 which 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 DELICATE 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 RECOVERED WITH A SUITABLE HIGH DI-ELECTRIC PLASTIC COATING TO PREVENT POSSIBLE BREAK-DOWNS ACROSS THE PRINTED CIRCUIT BUSES DUE TO MOISTURE OR DUST.

ADDITIONAL 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 WHICH 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 the part wanted, and the complete model number of the relay for which the part is required.

LIST OF FIGURES

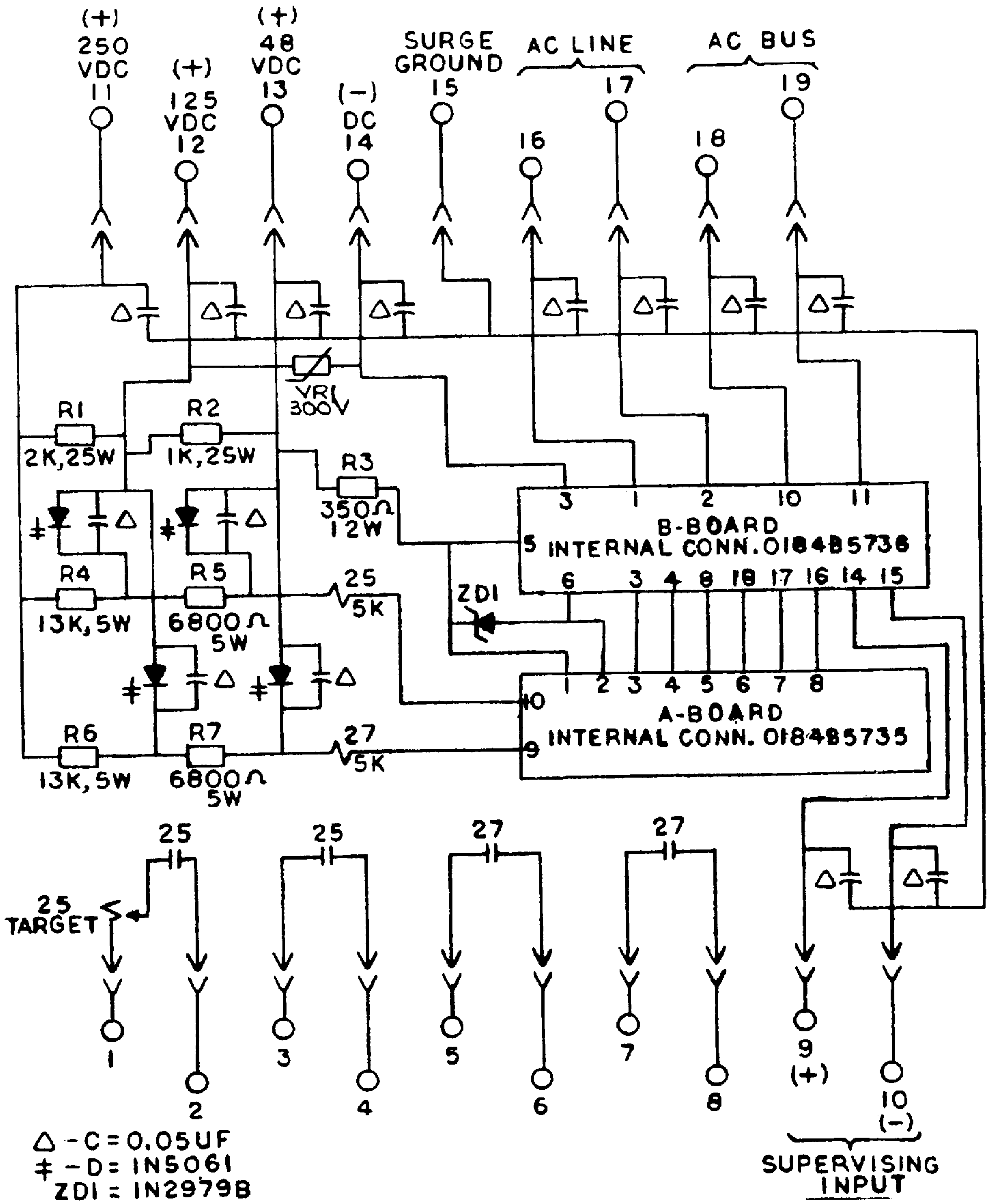


Figure 1 (0285A5766 [2]) Internal Connections Diagram for the Type SLJ21A Relay

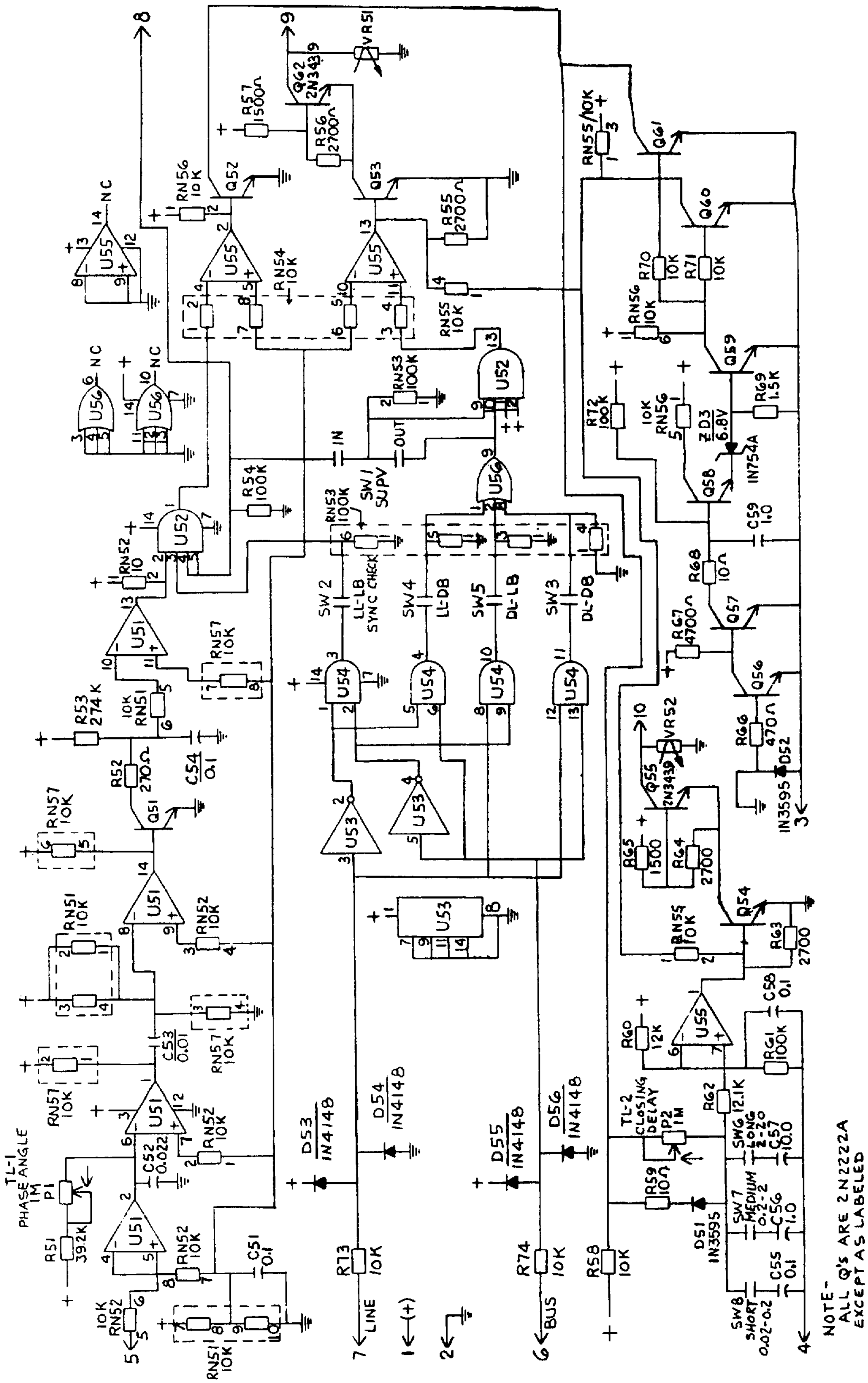


Figure 2 (0184B5735 [2]) Internal Connections Diagram for Printed Circuit Card "A"

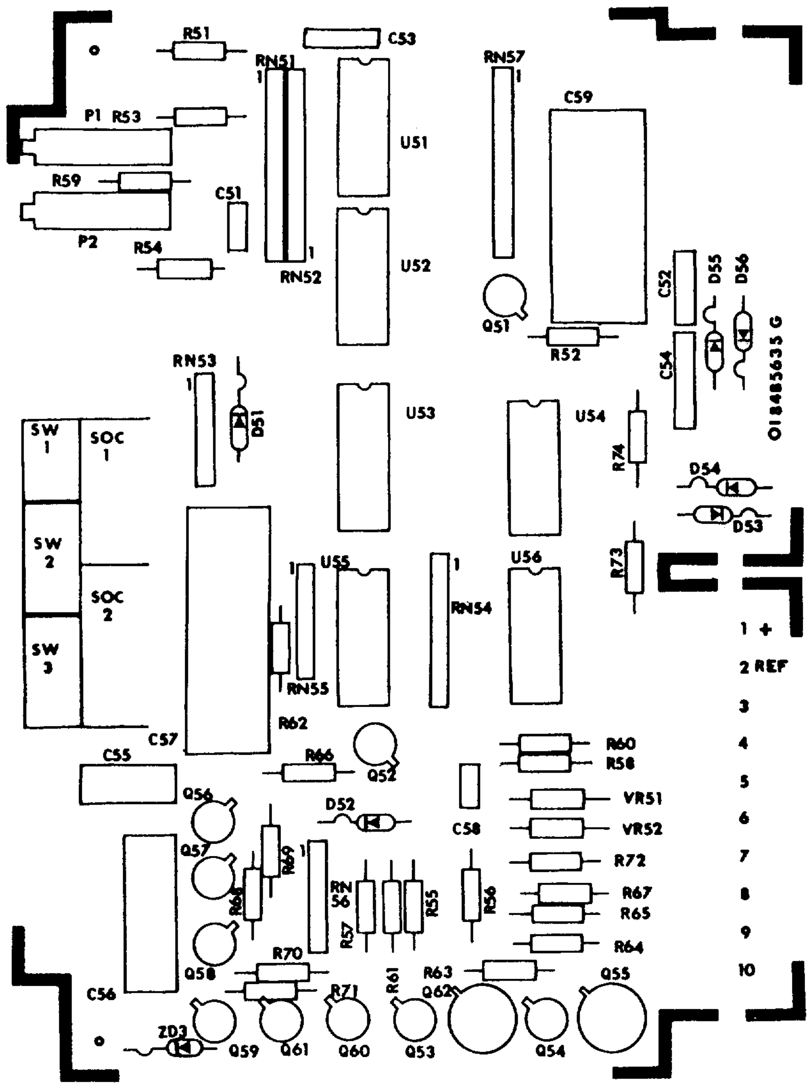


Figure 3 (0184B5635 [3]) Physical Parts Location Diagram of Printed Circuit Card "A"

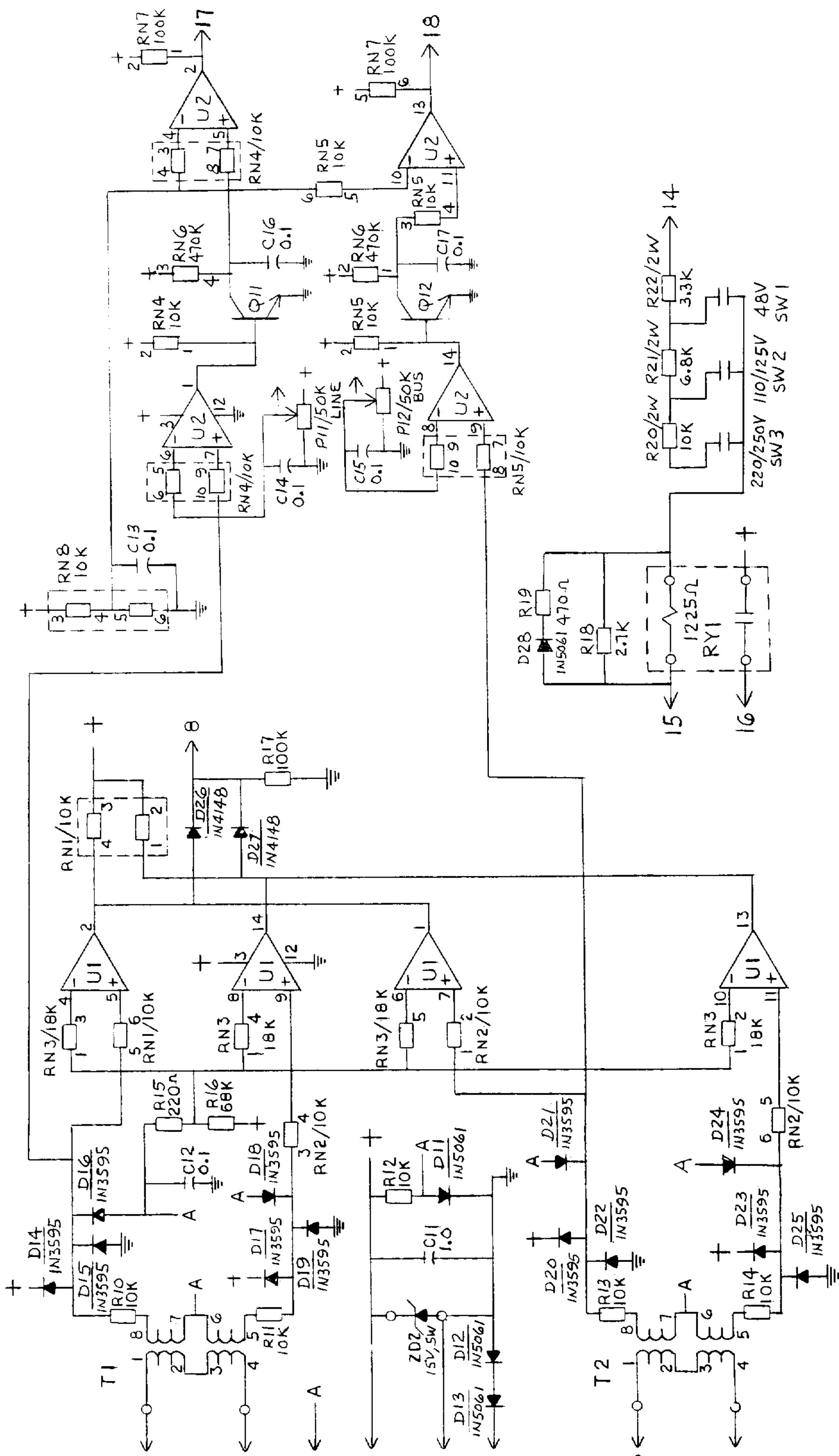


Figure 4 (0184B5736-0) Internal Connections Diagram for Printed Circuit Card "B"

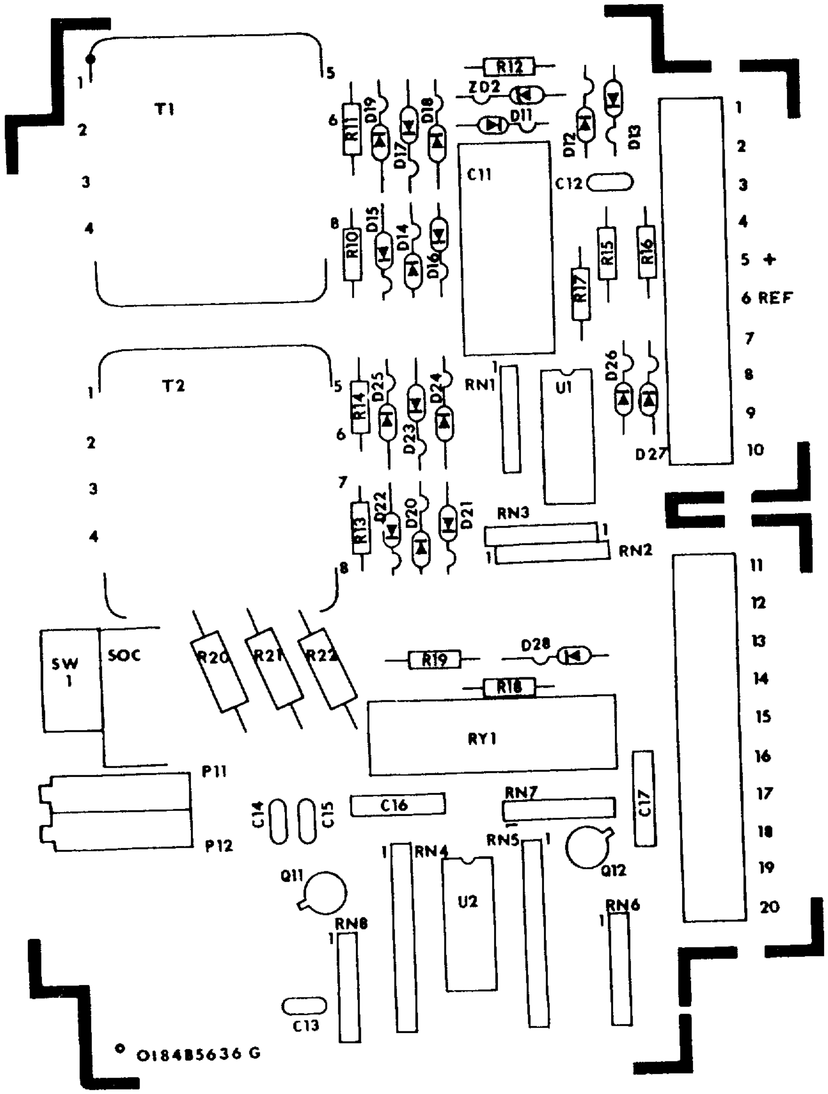


Figure 5 (0184B5636 [3]) Physical Parts Location Diagram of Printed Circuit Card "B"

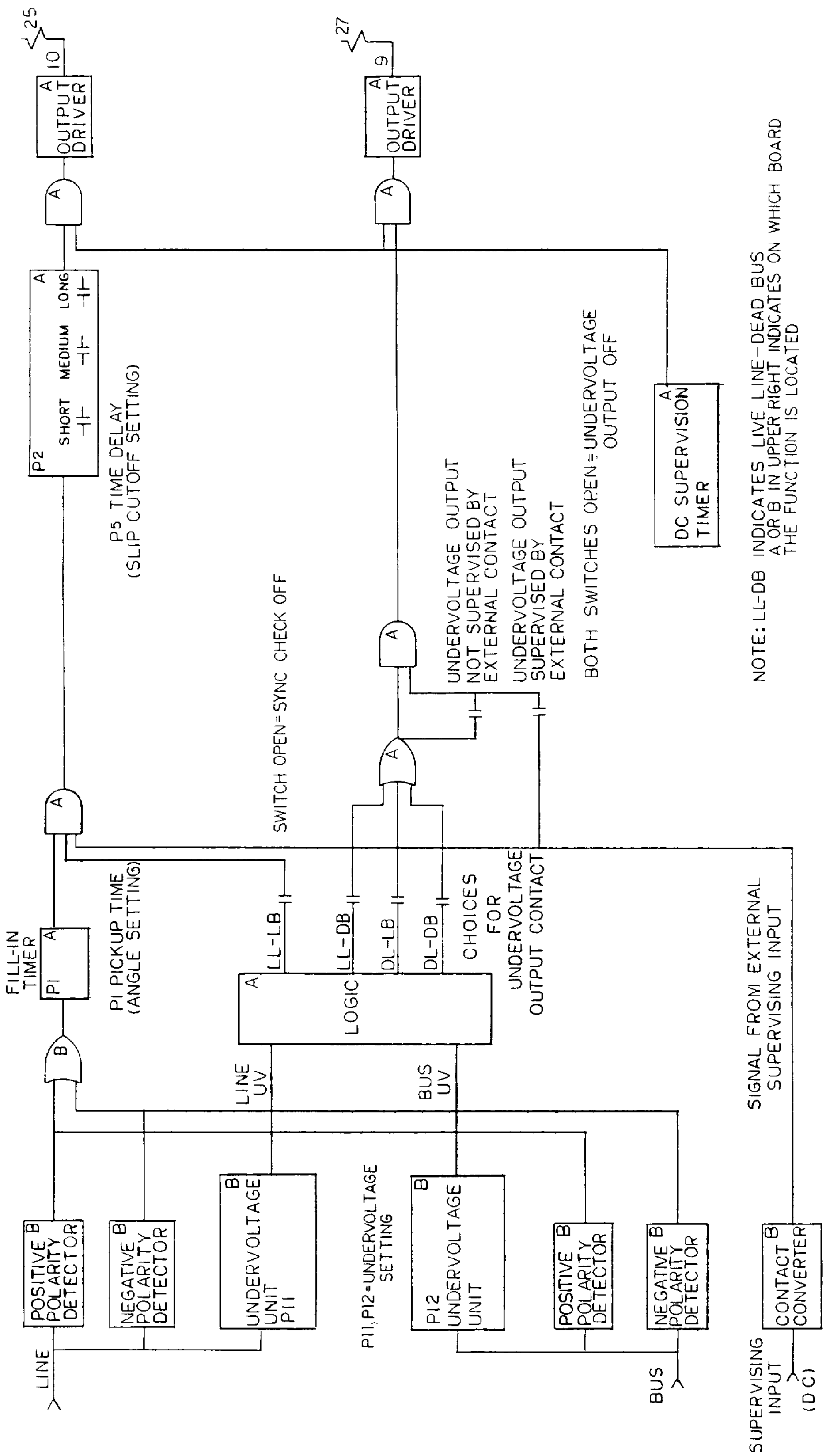


Figure 6 (0138B7532-0) Functional Block Diagram for Type SLJ21A Relay

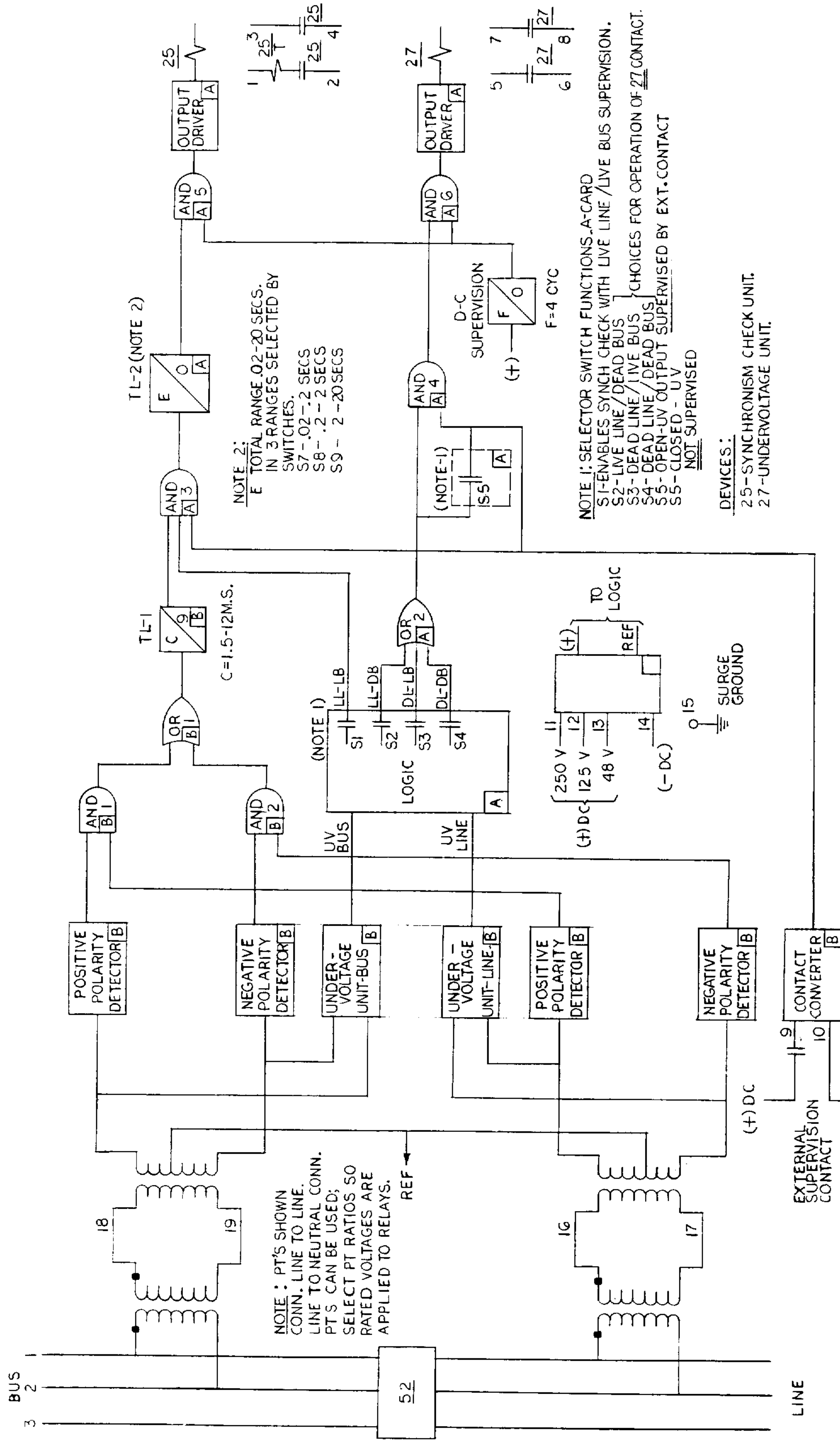


Figure 7 (0138B7608-1) External Connections and Logic Diagram for Type SLJ21A Relay

Figure 8 (8043744-0) Type SLJ21A Relay, Removed from Case (Front View)

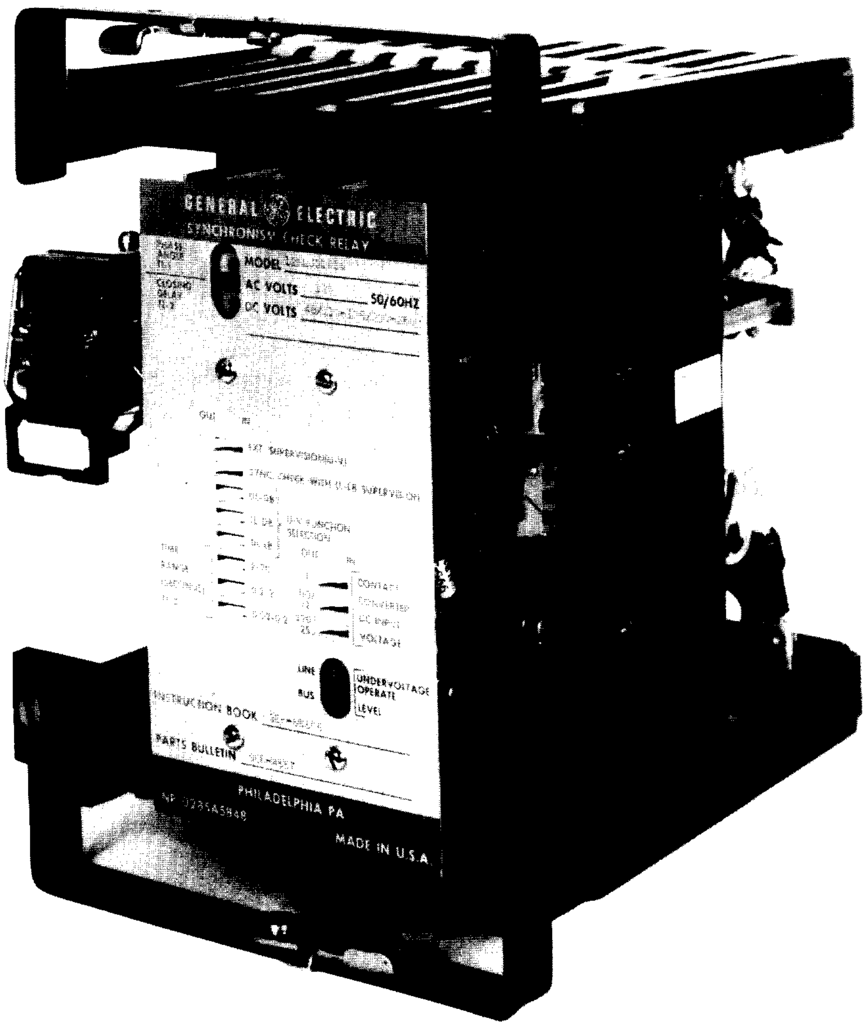


Figure 9 (8043745-0) Type SLJ21A Relay, Removed from Case (Rear View)

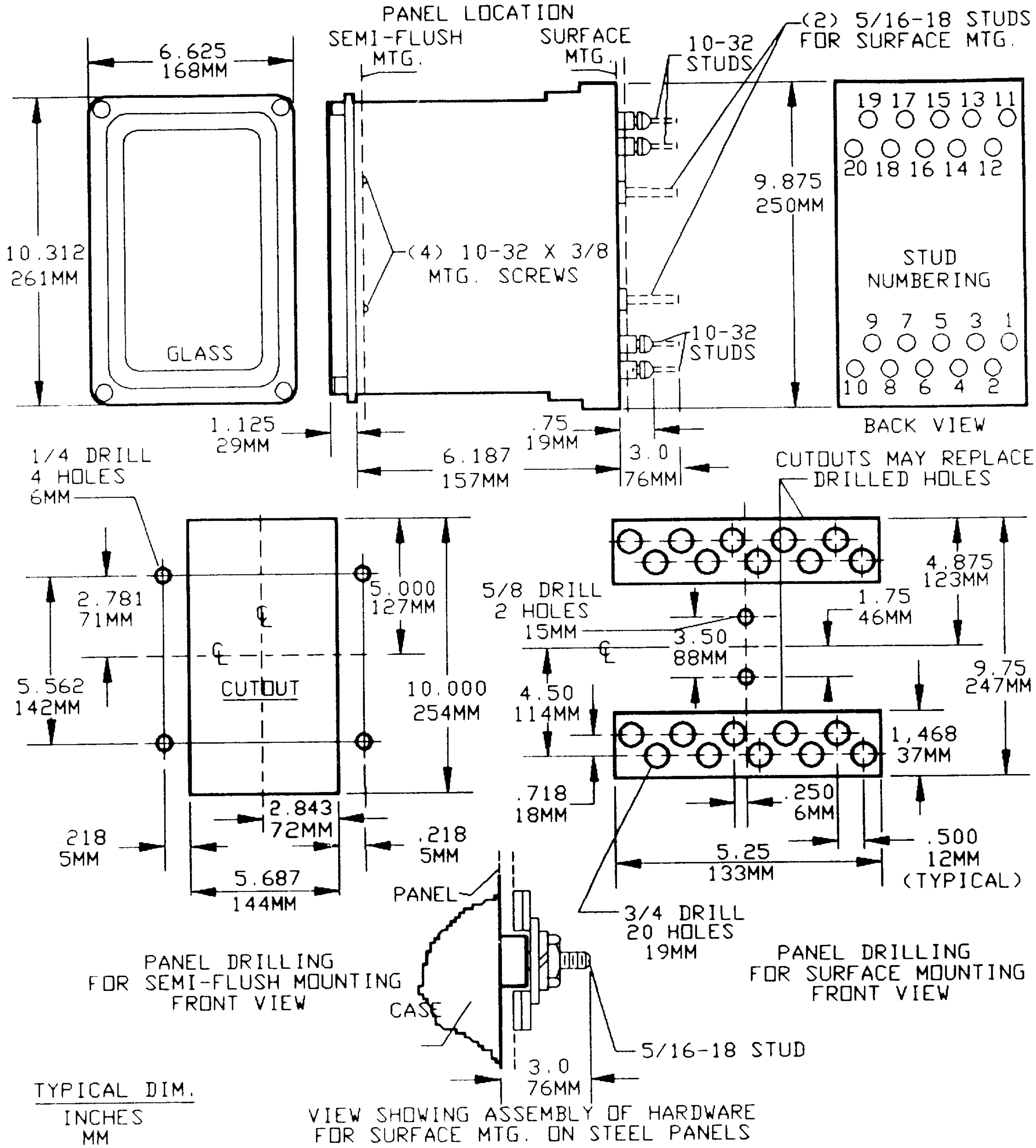


Figure 10 (K-6209272 [7]) Outline and Panel Drilling Dimensions for the Type SLJ21A Relay

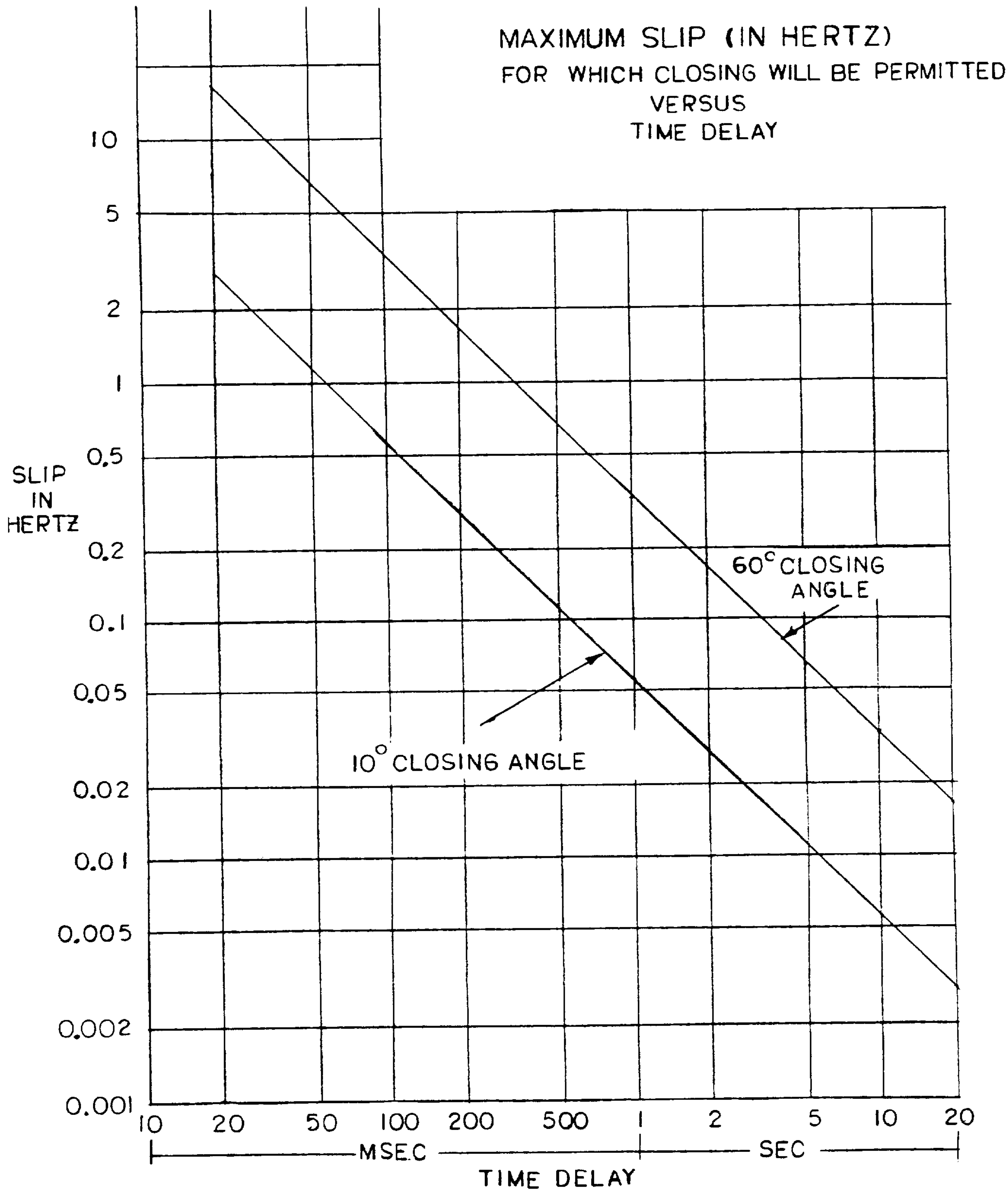
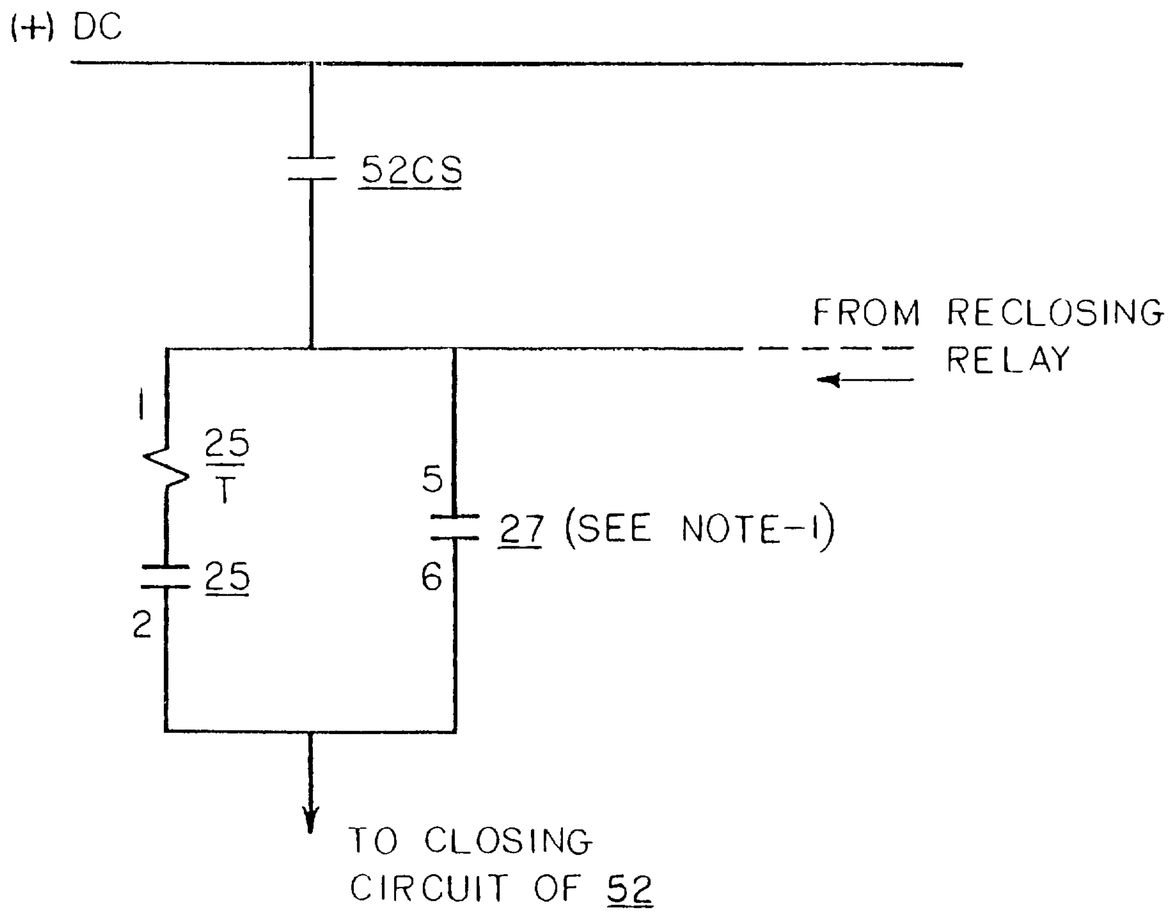


Figure 11 (0285A5886-0) Graph of Slip Cutoff versus Time Delay



NOTE-1: SELECTION SWITCHES ARE PROVIDED IN THE SLJ21A TO CAUSE THE BY-PASSING 27 CONTACT TO CLOSE FOR ONE OR MORE OF THE FOLLOWING CONDITIONS:

1. LIVE-LINE AND DEAD-BUS
2. DEAD-LINE AND LIVE-BUS
3. DEAD-LINE AND DEAD-BUS

Figure 12 (0285A6636-0) Typical Application Diagram for the Type SLJ21A Relay

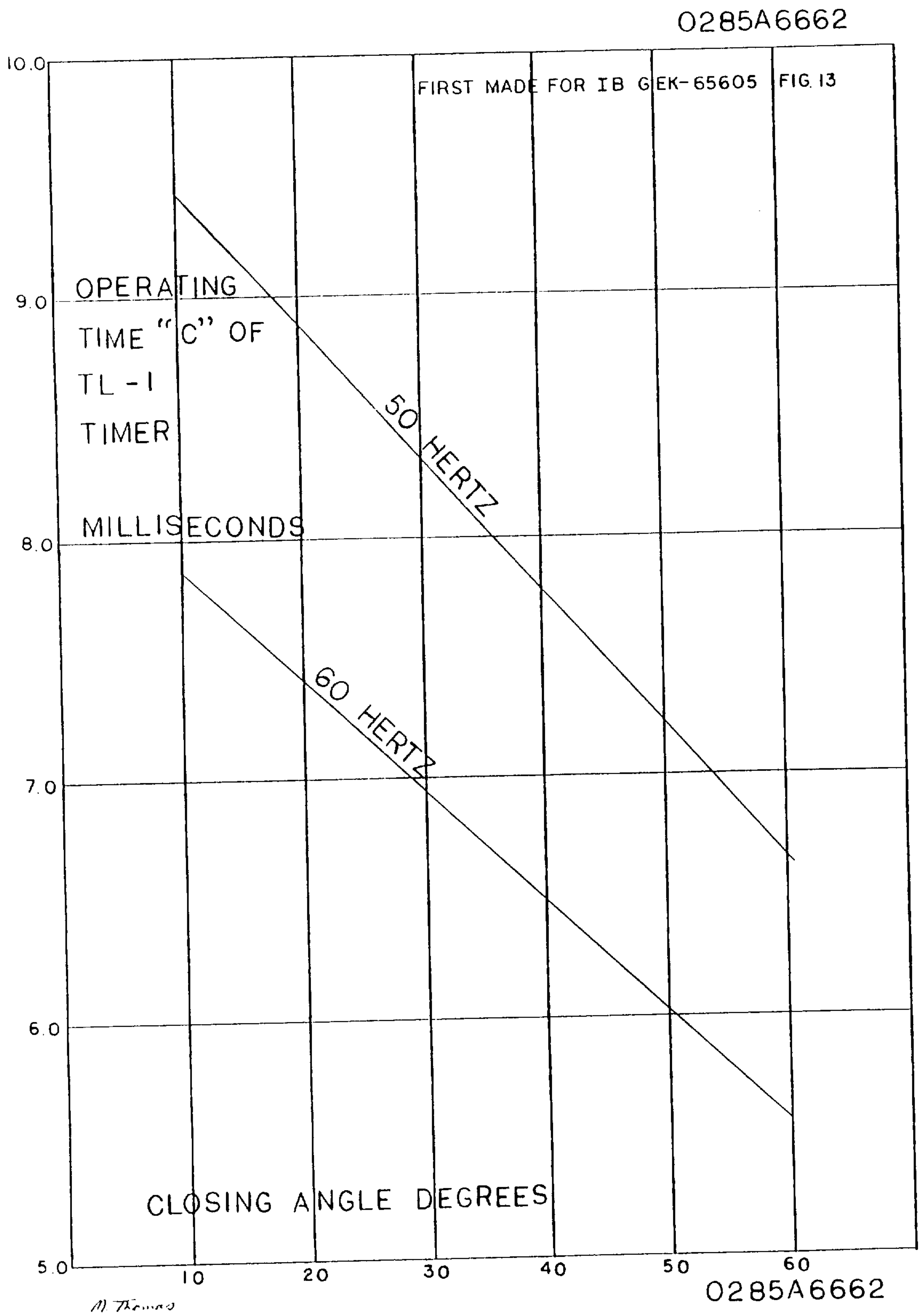


Figure 13 (0285A6662-0)Graph of Timer Setting TL1 versus Closing Angle

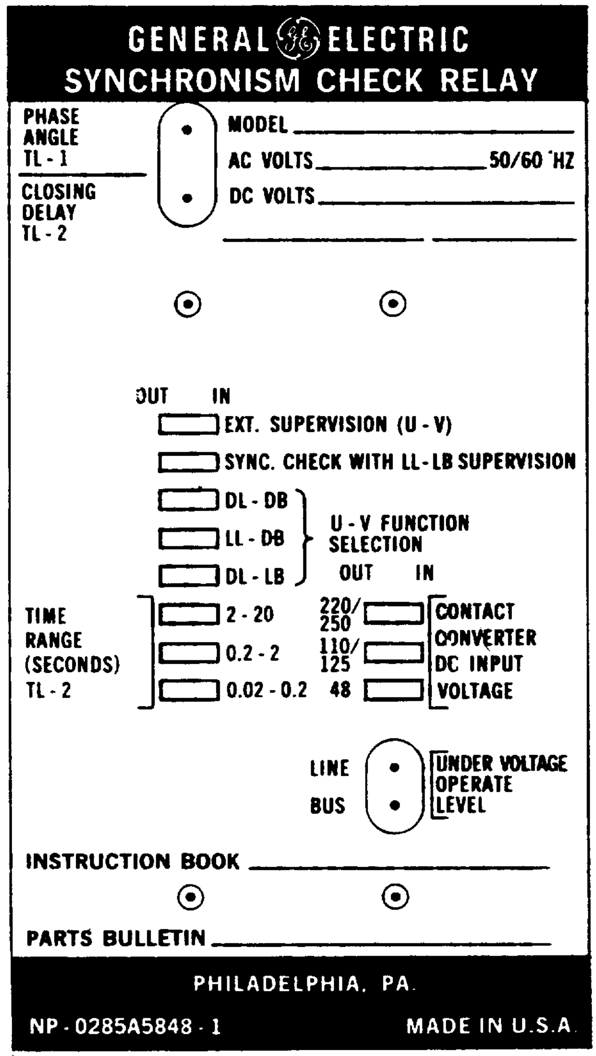


Figure 14 (NP-0285A5848-1) Nameplate for the Type SLJ21A Relay

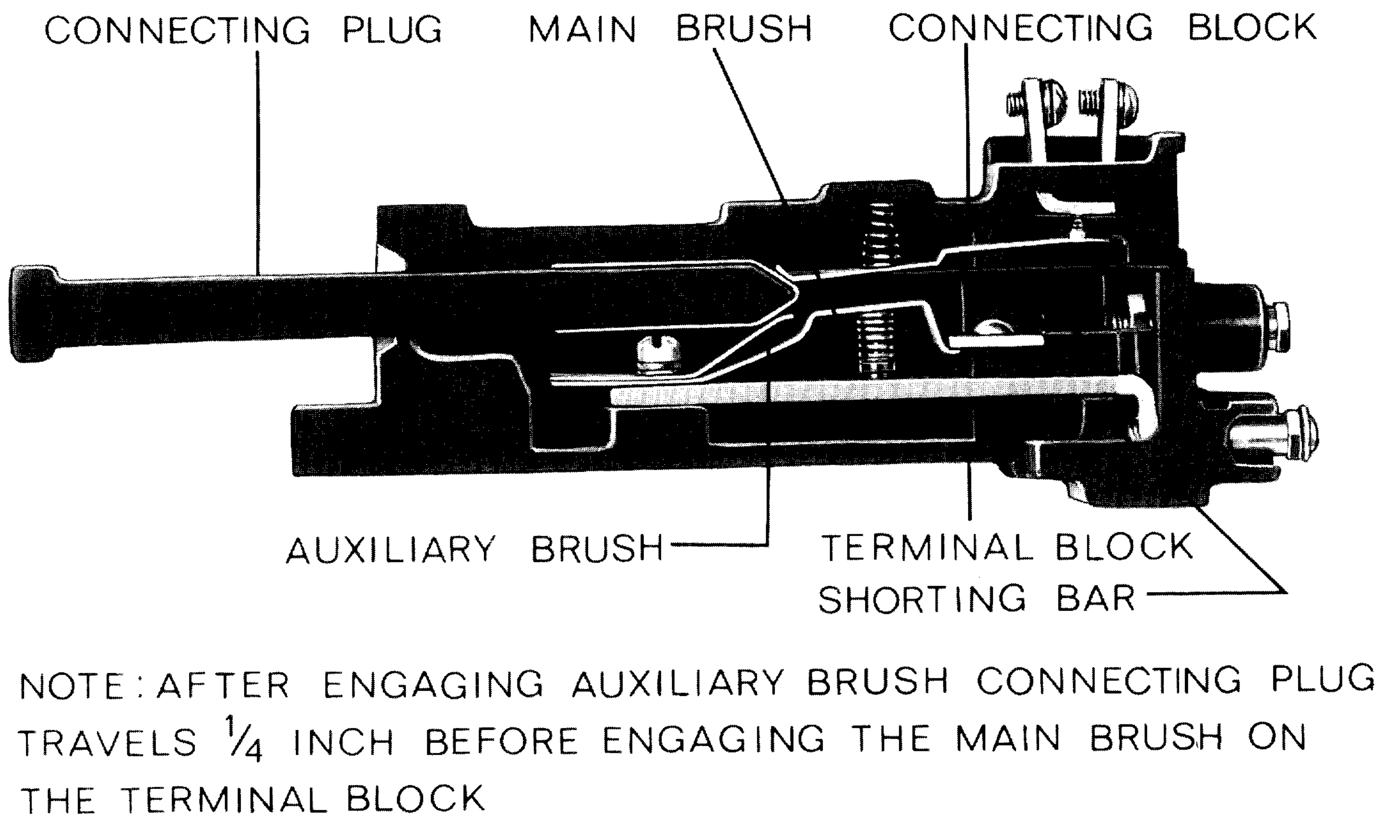


Figure 15 (8025039-0) Cut-Away View of Drawout Case Showing Position of Auxiliary Brush

Since the last edition, changes have been made in the following places:
p.14, ACCEPTANCE TESTS
Figure 10

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