INSTRUCTIONS

STATIC VOLTAGE RELAY

TYPE SLV11A(-)A

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LIST OF ILLUSTRATIONS

STATIC VOLTAGE RELAY

TYPE SLV11A1A

DESCRIPTION

The SLV consists of three independently adjustable voltage level detectors with a common power supply. All three detectors can be set to detect overvoltage, or all three can be set to detect undervoltage. If desired, one unit can be set for overvoltage and the others for undervoltage or vice versa. The operate level of each unit is independently adjustable over the range 80% to 150% of the input level selected. Two input levels of 69 and 120 volts are jumper selectable. Thus the range of adjustment is 55 to 180 volts in two ranges. Three targets are provided to indicate tripping.

The SLV operates over a range of 47 to 63 hertz without jumper changes. It will operate from either 48 VDC or 125 VDC with jumper changes. It may be operated from 250 volts DC when connected to the external preregulator, 0138B7511. In this case, the internal power supply jumpers should be in the 125 VDC position. The pickup and dropout times are relatively independent of the initial and final AC input voltages. The dropout to pickup ratio is high at approximately 99%. The pickup time in the overvoltage mode and dropout time in the undervoltage mode can be varied from approximately 20 to 60 milliseconds by jumper selection. Filtering is provided to minimize the effects of harmonics on the trip point.

The SLV relay is mounted in an M2 case.

CAUTION

FAILURE TO SET THIS RELAY TO THE PROPER AC AND DC INPUT RANGES BEFORE POWER IS APPLIED MAY RESULT IN FALSE TRIPS AND/OR EQUIPMENT DAMAGE. UNIT IS SHIPPED SET FOR 69 VAC and 125 VDC.

APPLICATION

The SLV can be applied wherever accurate instantaneous three-phase voltage detection is required. The high (99%) dropout and immunity to overexcitation harmonics make it ideally suited for transmission overvoltage applications. In a typical line overvoltage application, one SLV is applied with an external time delay to trip at 1.1 to 1.2 per unit voltage, and a second SLV is connected to trip instantaneously at 1.3 to 1.5 per unit voltage. The SLV would usually be connected to trip the remote line terminal by direct transfer.

The SLV can be applied as a high speed voltage detector in sequential reclosing schemes, or for distance relay supervision for line fault protection. Other undervoltage applications include fault detection for line terminals with weak fault current infeed, and faulted phase selection for single pole trip and reclose schemes for line protection.

Because of its immunity to the effects of harmonics, accuracy, and extremely high dropout, the SLV can be applied for voltage control applications with shunt capacitor bank switching.

The SLV relay contains three independent voltage level detectors. Each detector can be programmed independently to detect either overvoltage or undervoltage. The operating time in the overvoltage mode and the dropout time in the undervoltage mode is independently adjustable on each detector. The dropout time in overvoltage and pickup time in undervoltage is fixed at approximately 30 milliseconds, depending on the application.

Each detector is provided with an operate level potentiometer accessible from the front. A locking dial is provided, along with a scale calibrated in percent (80-150%) of nominal voltage, which is jumper selectable at either 69 or 120 volts. This scale is sufficiently accurate (± 5%) to permit approximate setting of the operate points. However, to realize fully the relay's accuracy and stability, the operate level should be set using a voltmeter and a variable amplitude AC input signal. Operating point accuracy of ± 1% is easily obtainable and this accuracy is consistent with the stability and repeatability of the relay.

The dropout-to-pickup ratio is fixed at approximately 99%. This low hysteresis makes it possible to use the relay in a variety of applications. However, CARE MUST BE TAKEN IN APPLYING THE RELAY TO AVOID CHATTERING WHEN THE INPUT IS AT THE TRIP LEVEL. Moderate duration chatter normally will not harm the SLV, but it may damage external components. The SLV output relays could be damaged by chattering if the contacts are interrupting current to an inductive load.

The relay contacts, target connections, and available case studs are brought to taper-pin blocks so the interconnections can be configured as desired. Refer to Figures 8, 9, 10, 11, and 15.

The power supply efficiency is high on both 48 VDC and 125 VDC. This permits continuous operation with the telephone relays energized.

The relay can be used on either 50 or 60 hertz. The operate level varies by less than +10 or -2% from the 60 hertz setting over the frequency range 47-63 hertz. See Figure 1. The usable frequency range is approximately 40 to 60 hertz with less accuracy (see Figure 2). Below 40 hertz the unit will stay untripped in overvoltage mode and tripped in undervoltage mode, due to digital timing constraints. Above 65 hertz the trip level rises rapidly due to the action of the harmonic filter. The operate time is also relatively independent of frequency for a fixed input level. The result is almost constant operating time with input frequencies between 45 and 63 hertz.

RATINGS

TEMPERATURE RANGE:

Operating - 20°C to +65°C (trip point will not vary more than 2%)

Storage - 40°C to +85°C

INSULATION:

2200 volts for one minute between AC inputs and case, DC inputs and case, and between output contacts and case (NOTE: Surge capacitors must be disconnected.)

OPERATE VOLTAGE RANGE:

69V and 120V nominal - jumper selectable.

Operate level individually adjustable on each of the three detectors over the range 80%-150% of nominal (55-180 volts).

OPERATE VOLTAGE FREQUENCY RANGE:

47-63 hertz with less than +10% to -2% variation in operate level referenced to 60 hertz. Third harmonic content up to 50% of fundamental (47-63 hertz) will affect trip level by less than ± 3%.

PERMISSIBLE OPERATE OVERVOLTAGE:

The input may be 2 times the nominal value (69 or 120 VAC) for 5 minutes.

SUPPLY VOLTAGE RANGE:

48 VDC - 33.6 to 52.8 VDC
125 VDC - 87.5 to 137.5 VDC

If the supply voltage goes below the minimum value above, the relay automatically disables itself to prevent improper operation. If the voltage goes above the maximum value above, there is no effect except increased heating within the relay and reduced life. However, voltages 25% above the maximum may cause immediate failure.

Supply voltage variation within the specified range shifts the operate point less than 1%.

CONTACT CURRENT RATINGS:

Carry Continuous - 3 amp
Make for Tripping Duty - 30 amp

OPERATE TIME:

Depends on application and delay selection. See **CHARACTERISTICS** section. Normally less than 40 milliseconds.

TARGETS:

Three 0.2/2.0 targets.

BURDENS

AC: Input impedance is typically 40,000 to 70,000 ohms per phase on both the 69 VAC and 120 VAC ranges. This range includes impedance variations of the input voltage from 80% to 150% of the nominal value.

DC: The DC current required at 48 volts is:

Untripped - 125 milliamperes
All phases tripped - 320 milliamperes

On 125 volts DC the currents are: Untripped - 55 milliamperes
All phases tripped - 130 milliamperes

On 250 volts DC using preregulator: Untripped - 252 milliamperes
All phases tripped - 252 milliamperes

250 V preregulator input on terminals A-C (+) on A, output to relay on terminals B-C with (+) on B.

CHARACTERISTICS

Figures 1 and 2 indicate typical SLV relay performance under a variety of conditions.

VARIATION OF CHARACTERISTICS WITH TEMPERATURE

The operate point varies less than ± 1% from its 25°C setting over the range -20°C to +65°C. Operate times vary less than ± 2 milliseconds from the 25°C value over the same temperature range.

VARIATION OF CHARACTERISTICS WITH SUPPLY VOLTAGE

The operate point varies less than ± 1% from the value at the nominal supply voltage over the specified voltage range. Operate time varies less than ± 2 milliseconds over the same range.

OPERATE TIME

The SLV operate time in overvoltage is typically 28 milliseconds when the AC input goes from 10% below the threshold to 10% or more above the threshold.

In the undervoltage mode the operate time is typically 30 milliseconds when the AC input goes from 10% above the threshold to 10% or more below the threshold.

The maximum operate time in the overvoltage mode is 36 milliseconds, and 32 milliseconds in the undervoltage mode with the standard factory setting of a count of two half cycles.

RESET TIME

The reset time in the overvoltage mode is typically 30 milliseconds. In the undervoltage mode it is 28 milliseconds. In both cases the AC input signal is going from 10% below the threshold to 10% above, or vice versa. The maximum reset time is 38 milliseconds.

CONSTRUCTION

OPERATING PRINCIPLES

The SLV consists of three independently adjustable voltage level detectors and a common power supply. The voltage level detectors will be discussed first, followed by the power supply.

VOLTAGE LEVEL DETECTOR

Refer to Figures 13 for the overall picture, and to Figure 14 for the detail of the Threshold Card portion of it. The AC input signal is applied to tapped transformer T1. The tap is selected so an input voltage of 69 or 120 volts is transformed to 9.4 volts at the secondary. This secondary voltage is applied to a buffer limiter, U1A, through resistors R1, R2 and R3. R1 is the precision potentiometer which sets the trip level. It does this by varying the gain of the first stage. The gain of the first stage is given by the formula

$$VG = \frac{R4}{R1+R2+R3}$$

There is a fixed 5 volt threshold preceded by a fixed gain of 1.27 following this first stage. A voltage of 3.94 volts at the output of the first stage will exceed the threshold. Varying the gain of the first stage, therefore, controls the input voltage that will yield 3.94 volts at the output. Hence this varies the trip level at the input. The gain variation possible with R1 is somewhat greater than required to cover the specified input range. This accommodates manufacturing tolerances.

Diodes are provided across operational amplifier U1A's input to protect it from input transients. In addition, back-to-back 8 volt zener diodes are connected from output to input. These limit the output to 16 volts peak-to-peak. Outputs higher than this could overload the following stages and result in unpredictable performance.

This first stage is followed by four identical cascaded low pass filters. Their purpose is to provide 30 decibels rejection of third harmonics at 150 and 180 hertz. This means a 150 hertz signal into the filter will be attenuated to about 1/30 of the input value (voltage ratio) where a 50 or 60 hertzsignal would have been amplified slightly to 1.27 times the input value. The slight gain at 50 and 60 hertz is due to peaking the filter gain at 55 hertz. This peaking gives the filter a reasonably constant gain in the 47-63 hertz range. If peaking were not used, the gain would drop and the trip level would increase significantly between 47 and 63 hertz.

Each filter consists of an operational amplifier and its associated resistors and capacitors. The operational amplifier not only acts as a buffer but the feedback from its output to input via the 0.1 microfarad capacitor significantly affects the filter response curve. Four of these filters are used, since one such filter cannot provide enough rejection at 150 hertz. These filters introduce a time delay in the signal of approximately 8 milliseconds. This introduces a delay in the relay's operate time.

The output of the filter is capacitively coupled through C10 to a 'perfect' rectifier. The coupling capacitor eliminates DC offset voltages arising in the preceding direct coupled stages. The following 'perfect' rectifier is called 'perfect' because it does not exhibit the diode drop losses and nonlinearities that occur in simple diode rectifiers. The rectifier operates as follows: the input signal causes a current to flow through R13 to the inverting input of operational amplifier U3A. This produces a voltage at the input, which causes an output signal which is fed back to the input via either diode CR3 or CR4, depending on the output polarity. On positive input, diode CR3 conducts and the diode end of R14 carries a negative replica of the input. The diode end of R16 is at 0 volts. On negative inputs the situation is reversed, with the diode end of R16 carrying a positive replica of the negative input. The diode end of R14 is at 0. The output pin of operational amplifier U3A exhibits nonlinearities, as the input varies due to the drops across diodes CR3 and CR4. This nonlinearity is reduced in the half wave rectified signals at R14 and R16 by the high voltage gain of the operational amplifier (50,000 to 100,000). The negative-going half wave signal at R14 is buffered in U3B and inverted by going to the inverting input of U3D. In U3D it is summed with the non-inverted signal from R16. The output of U3D is a full wave rectified signal, derived from the input to U3A. The waveforms involved are shown in Figure 3. Resistors R66 and R17 associated with U3D give a gain of 1 from the inverting input to the output. These same two resistors give a gain of 2 from the non-inverting input of U3D to its output. Resistors R18 and R19 attenuate the signal going to the non-inverting input by one half, so the effective gain is 1. This makes the rectified output half cycles derived from positive and negative input half cycles have the same amplitude. The waveforms are shown in Figure 3.

The output of the precision rectifier goes to threshold detector U4A, through R24. The full wave rectified signal is fed to the non-inverting input, while a stable 5 volt level is fed to the inverting input.

Whenever the signal at the non-inverting input exceeds the 5 volt level, the comparator output goes positive. Feedback from the output to the input via R26 provides hysteresis to avoid oscillation when the two input levels are the same. This feedback causes a 'snap' action when the comparator trips, because the input must drop below the original trip level to 'untrip' the comparator. The comparator is an open collector device, so pull-up resistor R27 is necessary. The output of the comparator, U4A, goes to one-shot U5A. The positive transition at the comparator output triggers one-shot U5A to generate a short (40 microsecond) negative-going pulse at the $\overline{Q}$ (low-going) output. This signal goes to the count input of counter U6. U6 will count on the positive-going (trailing) edge of this pulse. Refer to Figure 4 for waveforms. Simultaneous with this negative-going pulse, the positive-going pulse at the Q output of U5A is fed to one-shot U5B. The leading edge of this pulse fires U5B and generates a 13 millisecond negative-going pulse at the $\overline{Q}$ output of U5B. This low-going pulse drives the 'reset' input of counter U6. Note that the 'reset' input to U6 is 'high' so the low-going pulse is removing the 'reset' signal, allowing the trailing edge of the count pulse to advance the count. The counter will not be 'reset' by one-shot U5B for 13 milliseconds, which is more than one-half cycle of the input.

The result of the sequence of pulses is as follows: each positive transition of comparator U4A output removes the reset signal from counter U6 by firing one-shot U5B. One-shot U5A is fired simultaneously and the trailing edge of its output pulse 40 microseconds later causes counter U6 to count. After 13 milliseconds the output of one-shot U5B will go high and clear counter U6 unless another positive transition has occurred. If a positive transition has occurred at the comparator output within 13 milliseconds (on next half cycle), then one-shot U5A will cause the counter to advance to 2 and will also retrigger one-shot U5B for another 13 milliseconds to keep the 'reset' input at the counter low (inactive). So long as there are positive comparator output transitions every half cycle, the counter will continue to count unless otherwise inhibited.

The desired counter output is picked off by a jumper to inhibit further counting and to trip the relay. Possible half-cycle counts are 1, 2, 4 and 6. The trip delay to this point is the filter delay of about one-half cycle plus the count delay of 0, 1, 3, or 5 half cycles respectively. There is no count delay associated with the count of 1. As soon as the comparator, U4A, outputs a positive transition, the count goes to 1 and an output goes to the relay driver. The output relay delay is 4-6 milliseconds. The total operate delay for each count position is therefore approximately 1, 2, 3, and 4 cycles.

The relay driver consists of inverting and non-inverting buffers U4B, U4C, and driver transistor Q1. A jumper is used to connect either U4B or U4C to the driver transistor, depending on whether overvoltage or undervoltage operation is desired. U4B is used for overvoltage and U4C for undervoltage.

In the overvoltage mode, the positive counter output signal goes through U4B uninverted, to turn ON Q1. Q1 is used as a constant current driver. Both U4B and U4C are open collector devices. In the high state their output is pulled up by resistor R30. However, the voltage cannot go over 5.1 V due to zener CR15. Q1 will conduct but its emitter voltage cannot go above 5.1 - 0.7 = 4.4 volts, due to Q1's base emitter drop. As a result, a current of about 4.4/102 -43 milliamperes flows to the relay. This limits the relay coil heating to a safe level. With high supply voltage, Q1 will dissipate significant power since its collector voltage will not be 0 when it is conducting. For this reason, Q1 is provided with a heat radiator. A varistor is connected across the coil of relay KR1 to absorb the transient that occurs when Q1 is turned OFF. A diode is commonly used in place of this varistor, but a diode will give a slower relay dropout.

POWER SUPPLY

The power supply is a dual input voltage (48/125V jumper selectable) unit (see the first two pages of Figure 16). The positive line of the input DC is applied to the power transformer T2 center tap. The negative supply lead goes to power supply common. On 'turn-on', resistors R45 and R46 bias transistors Q2 and Q3 ON. Turn-on transients, noise, and the unbalance inherent in the circuit start Q2 and Q3 oscillating. The feedback winding on T2 provides positive feedback, with the result that one transistor turns ON and the other OFF. Assume Q2 is ON (conducting). Its collector voltage will be low, its base biased positive by the feedback winding. The base current path is through the feedback winding, resistors R44 and R44A, and then diode CR19 to DC supply common. The collector current through Q2 is the load current (transformed through T2's turns ratio) and it is a slowly increasing magnetizing current. After Q2 has been ON about 20-25 microseconds, the flux density in the core of transformer T2 will reach the saturation level. The collector current of Q2 will rise rapidly until the voltage across R47 and R48 is high enough to turn ON transistors Q6 and Q7. Q6 and Q7 act to turn OFF Q2 and Q3. (Q2 is the only one ON, so it goes OFF.) When its collector current drops, Q6 and Q7 turn OFF and the collector voltage of Q2 swings positive. This voltage swing is in the direction to turn ON Q3. Q3 turns ON and goes through the same sequence as Q2. This continues at a 19-30 kilohertz rate. The transformer T2 saturation determines the frequency. The frequency varies slightly from transformer to transformer and varies from 19-30 kilohertz with increasing temperature and DC operating voltage.

To change from 125 volt to 48 volt operation, the power supply transformer primary taps are changed. In addition, resistor R45 and R47 must be shorted out with jumpers on the power supply board.

Transformer T2 has four secondary windings. One secondary is for chopped feedback. The other three feed bridge rectifiers. The upper output winding in the figure is an 80 volt winding to operate the relays. Its output is rectified, filtered, and fed to one side of the coil of the three output relays. The return for this supply is completed by the DC supervision circuit to enable the SLV relay.

The remaining two secondary windings are identical. Both outputs are rectified, filtered, and fed to 12 volt regulators. The two regulator outputs are connected in such a way that one provides positive 12 volts and the other negative 12 volts. Filter capacitors (C17, C19) are provided on the regulator outputs to ensure regulator stability.

On the DC input, zener diodes CR29 and CR30 provide surge suppression. Diode CR28 prevents damage to the relay if the DC operating voltage is reversed.

DC SUPERVISION CIRCUIT

The purpose of the DC supervision circuit is to prevent false tripping due to DC supply transients. On the application of DC power, the circuit disables the output relays unil the threshold circuits have settled and are sensing properly. On removal of DC power, the circuit disables the output relays as soon as the DC supply voltage drops below the usable level. It operates as follows (see the third page of Figure 16):

The output of one of the 12 volt supply windings is picked off through separate rectifier diodes CR12 and CR13. The transformer winding voltage is a square wave, so the rectifier output is essentially DC. This rectified voltage goes through diode CR14 to capacitor C21 and provides the DC supervision's DC supply. This large capacitor stores enough energy to operate the DC supervision circuit during supply transients.

The output of rectifier diodes CR12 and CR13 is filtered by C20. Capacitor C20, with resistive divider R52, R53 and R54, has a short time constant of 0.2 millisecond, which is only long enough to eliminate DC chopper transients. As a result, the input to the resistive divider network follows the DC supply voltage quite closely. The output of this network goes to comparator U9A. Here it is compared to the 7.5 volts across zener diode CR17. The resistive divider is set so that when the output of diodes CR12 and CR13 exceeds the 15 volts required by the 12 volt regulators, the comparator output is positive. This drives comparator U9B so its output is high. This comparator has open collector outputs so the output being 'high' merely means the output transistor is 'OFF'. This allows capacitor C22 (in parallel with C69 in undervoltage mode) to change, through R57. The RC time constant is chosen so approximately 25 milliseconds is required in overvoltage mode for the capacitor voltage to reach half the supply voltage. At this point the next comparator, U9C, switches, so its output goes 'low', turning ON transistors Q4 and Q5. When Q5 is 'ON' it completes the output relay supply circuit and enables the SLV relay.

Two timing capacitors are provided, and they must be paralleled for undervoltage operation. This increases the delay from 25 to 100 milliseconds before the SLV relay is enabled. This provides more security in the undervoltage mode.

On turn-off or momentary supply dropout, the noninverting input to U9A drops below 7.5 volts, which immediately shorts the timing capacitor to ground through the output transistor of U9B. This immediately turns OFF Q4 and Q5, disabling the SLV relay.

RELAY WIRING

Figure 13 is a schematic of the relay wiring. It shows the interconnection between the printed circuit cards and other components.

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 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.

ACCEPTANCE TESTS

TARGET AND SEAL-IN UNIT

!. With the target reset and the phase telephone relay contacts closed, check the pickup at both the minimum and maximum ampere taps, using Direct Current. Armature should pick up with a snap action and seat itself against the pole piece. The permissible pickup ranges are given below.

TAP	GRADUALLY APPLIED PICKUP
0.2	less than 0.2A
2.0	less than 2A

2. Check that dropout of seal-in unit on 2.0 ampere maximum tap is 0.5 ampere or more.

3. Check the latching in of target by energizing the seal-in unit at rating. With unit in picked up position, check the overtravel of the orange target. Use a sharp tool such as a knife. The orange target should move at least 1/64 inch.

   De-energize the seal-in unit and tap the top of the unit several times with the handle of a screwdriver. The target should not fall down.

4. Leave the tap screw in the maximum ampere tap, 2.0, when tests are completed.

TELEPHONE RELAYS

1. Check that each normally-open contact has a gap of 0.015 inch.

2. Check that each normally-open contact has at least 0.005 inch overtravel after contact closure.

3. Check that each normally-closed contact has a gap of 0.015 inch when actuated.

4. Check that each normally-closed contact has at least 0.005 inch overtravel after contact closure.

HIGH POTENTIAL TEST (Disconnect surge capacitors)

1. Printed circuit boards must be in place with nameplate in place. Relay must be in its case with cover installed.

2. Connect all studs of case together.

3. Apply voltage from all studs connected together to metal of case.

4. Smoothly raise voltage from 0 to 2200 volts RMS at 60 hertz, hold for one second, and smoothly lower voltage to 0.

5. Any breakdowns must be corrected before proceeding with test.

INSPECTION

1. Check that all three threshold cards are programmed for overvoltage operation.

2. Check that the power supply card is set for overvoltage operation and for 125 VDC operation (as shipped), or as required for a particular installation.

3. Check that the taper-pin program blocks are properly programmed. (See Figures 9, 10, and 11.)

4. Check that the knob pointers are properly positioned. In its extreme positions the pointer should fall equal distances on either side of the last scale marks.

5. Check that the targets operate. Trip and reset by hand.

6. Check that the potential transformer jumpers are programmed for 69 VAC operation (as shipped), or as required for a particular installation.

7. Check that all printed circuit cards are properly installed.

8. Check that the locations of the fingers in the case agree with the internal connection drawing.

9. Inspect each terminal of the cradle block. Make sure the surge capacitor lead does not short to an adjacent terminal. Check that each lead is fully crimped in its terminal.

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.

CHECK TRIP LEVELS ON EACH PHASE

Connect to the following test setup, shown in Figure 5. Set relay for 69 VAC, 125 VDC, overvoltage operation, and normal relay contact conditions.

Apply 125 VDC. With the AC source at 0, meter M1 should read 0.050 to 0.065 amp. Set S1 to fed phase A. Turn the phase A trip level adjust fully counterclockwise. Increase the AC voltage slowly until the phase A target trips and the phase A light comes ON. Light D should go OFF. The AC voltage at which phase A trips should be between 49 and 56 volts. **Always reduce the DC input to 0, then reduce the AC input. If this procedure is not followed, the contacts will be damaged, since the DC current exceeds the interrupting rating of the contacts.** Turn the phase A trip-level adjust fully clockwise. Check the trip level. It should be between 101 volts and 115 volts.

Repeat for phases B and C. Note that light D should go out when any phase trips. Meter One current should be 0.080 to 0.120 amps when any phase is tripped.

If the relay has been altered for a particular installation, change the test setup as required (different AC and DC levels) and check performance against that given under **RATINGS**.

CHECK DC SUPERVISION CIRCUIT

The DC supervision circuit should disable the relay whenever the DC operating voltage falls to less than 70% of the nominal value. To test this, use the preceding circuit. Trip one phase (telephone relay energized). Decrease the DC operating voltage until the telephone relay is de-energized. This should occur with the DC operating voltage at 27-32 volts (48 volt range) or 81-86 volts (125 volt range).

INSTALLATION PROCEDURE

RELAY SETUP PROCEDURE

DC Operate Voltage Selection

The DC operate voltage is selected by four jumpers on the DC power supply card at the rear of the cradle. Refer to Figure 6 for the jumper positions for 48 and 125 VDC.

Over/Under Voltage Selection

The mode of operation is selected by jumpers on both the threshold cards and the power supply card. The jumper positions are shown in Figures 6 and 7. In the event some threshold cards are being set for overvoltage and some for undervoltage, the power supply card jumper should be set for undervoltage. If all threshold cards are set for the same mode, the power supply jumper should agree with the threshold card jumpers.

Count Setting

The threshold cards are normally set during manufacture to count two overvoltage half cycles before the relay drivers are driven. This count is jumper-selectable for counts of 1, 2, 4 and 6 half cycles. These counts correspond to operate delays of approximately 20, 30, 45 and 60 milliseconds in overvoltage. In undervoltage operation, these counts determine the dropout time. These jumper positions are shown in Figure 7. The count may be reduced to reduce operating time or increased to increase security.

AC Input Range Selection

The AC input range of 69 VAC or 120 VAC is selected by terminal strip jumpers. This terminal strip is located on the side of the cradle, as shown in Figure 8. The jumper locations are also shown in Figure 8.

Programming Relay Contact Configuration (Programming tools not supplied with relay)

The SLV relay is shipped with the relay contacts, targets, and case studs connected for normal use. Taper-pin blocks are provided so these connections can be altered. The second pages of Figures 13 and 15 show which taper-pin blocks connect to each component. The T block is the top one and the B block is the bottom one. The location of the taper-pin blocks on the cradle is shown in Figure 8. The nameplate must be removed to permit access to the blocks.

* Changing the connections on the taper-pin blocks requires special tools, GE127A7827P353 for removal, and GE269A1725G001 for insertion. Insertion is simpler if pins are inserted starting at one end of the block and proceeding to the other end.

Figures 9, 10 and 11 show the standard and two alternate output contact configurations. They can be used on either over- or undervoltage mode. Set the jumpers on the SLV relay cards to the desired mode, overvoltage or undervoltage. In overvoltage mode, an overvoltage condition will energize the output relays (shown in the de-energized position). In the undervoltage mode it is an undervoltage condition that will energize the output relays.

* Indicates Revision

In both modes, removal of DC power will cause the output relays to go to the de-energized position.

Accurate Operate Level Setting

To set the operate level accurately, set the relay for the desired mode of operation (over- or undervoltage). Set the AC input range as required (69 or 120 VAC). Use a variac or similar variable amplitude AC source to generate an AC signal of the desired amplitude. An accurate AC voltmeter is required to set this AC level. An accuracy of $\pm$ 0.5% or better is desirable. Apply this AC signal to the SLV relay input that is to be set. Verify that the AC input voltage is the one desired. Adjust the phase operate level potentiometer on the SLV relay until that relay phase just operates. Reverse this procedure for undervoltage operation. Once the potentiometer is set, vary the AC input and verify that the operate level is correct. For overvoltage operation, start with the input low and increase it until the relay just operates. Measure the input AC level. For undervoltage operation, start with the input high and decrease it until the relay trips. If necessary, readjust the operate potentiometer slightly to obtain the desired operate level. Repeat for each phase.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

It is recommended that relays in operation be tested once a year by repeating the **ACCEPTANCE TEST** procedure. Relays stored for a year or more should be tested, using the **ACCEPTANCE TEST** procedure, prior to installation.

SERVICING

TROUBLESHOOTING

In the event the relay fails to function properly, it should be removed from service and tested. It must be supplied with the appropriate DC input, 48 or 125 VDC, and the necessary AC input signals.

Test the relay to see if it works on the bench. If it does, either the relay is intermittent or the fault is in the case or the wiring to the case and not in the relay.

If the relay does not work on the bench, the troubleshooting chart in Figure 12 can be employed. Complex problems may require conventional electronic troubleshooting techniques.

RELAY INTERNAL ADJUSTMENTS

There are only two internal adjustments, excluding jumper changes, on the SLV relay. Both adjustments are on the power supply card. One adjustment sets the dropout level for the DC supervision. This sets the DC voltage below which the relay is disabled. The other adjustment sets the 5 volt reference level for the threshold detectors. The location of these adjustments is shown in Fibure 6. These adjustments are set at the factory and should not normally require readjustment in the field. Should these adjustments be changed accidentally, or if power supply circuit repairs are made, then these adjustments should be checked, and corrected if necessary.

Five Volt Reference Adjustment

This voltage is set with trimmer R22. Connect an accurate (± 0.5% or better) DC voltmeter between pin 9 (positive) and pin 10 (negative) on the power supply board. As required by the setting of the power supply jumpers, the DC input should be set to either 48 or 125 volts DC. The voltmeter between pins 9 and 10 should read 5.00 volts. Adjust trimmer R22 if necessary.

DC Supervision Dropout Level Adjustment

This adjustment is made with R53. Connect a DC voltmeter between pins 8 (positive) and 10 (negative) of the power supply. Apply a DC input to the relay from a variable voltage power supply. If the power supply is set for 48 VDC, vary the voltage from 25 to 35 volts and determine the input voltage at which the voltmeter between pins 8 and 10 goes to 50-60 volts. This voltage should be 30.5 volts (increasing) without any phase tripped. If the power supply is set for 125 VDC, vary the input from 70 to 90 volts. The voltage between 8 and 10 should go to 50-60 volts when the input is 83 volts (increasing) with no phase tripped. If these values are not obtained, adjust R53.

REPAIR SERVICE

If necessary, the relay can be returned for repair and/or adjustment. If the relay has been misused or is out of warranty, there will be a charge for this service.

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.

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

The following spares are recommended (one each:

	Part Number
Threshold card	0184B5619
Power supply card	0184B2618
Potential transformer	0367A0265G048
Potentiometer	0246A9131P103A
Telephone relay	006418025P261
Target	L-6293203G471
Target	L-6293203G472
Taper-pin block	0127A7827

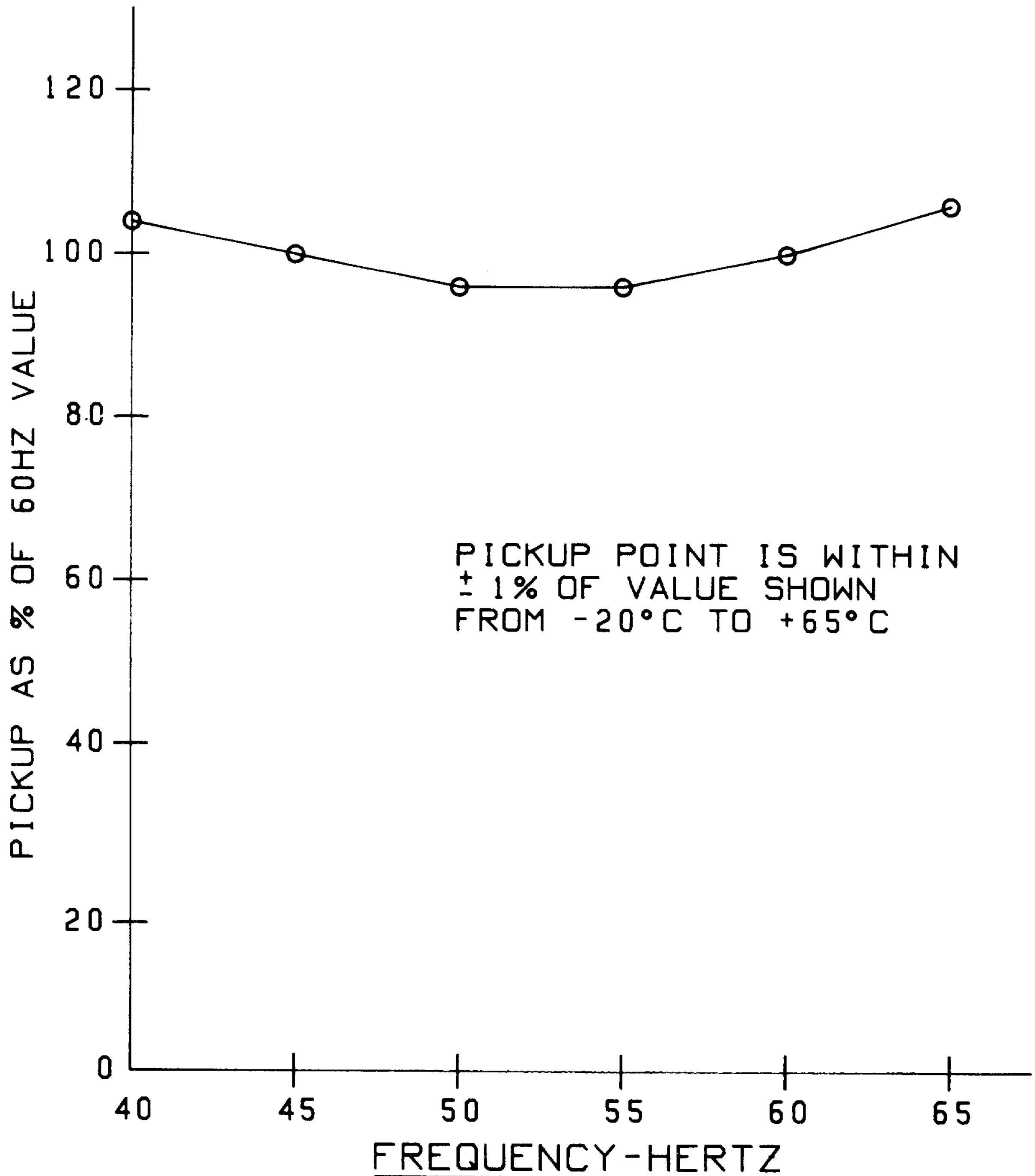


Figure 1 (0275A4323) Pickup Voltage Versus Frequency

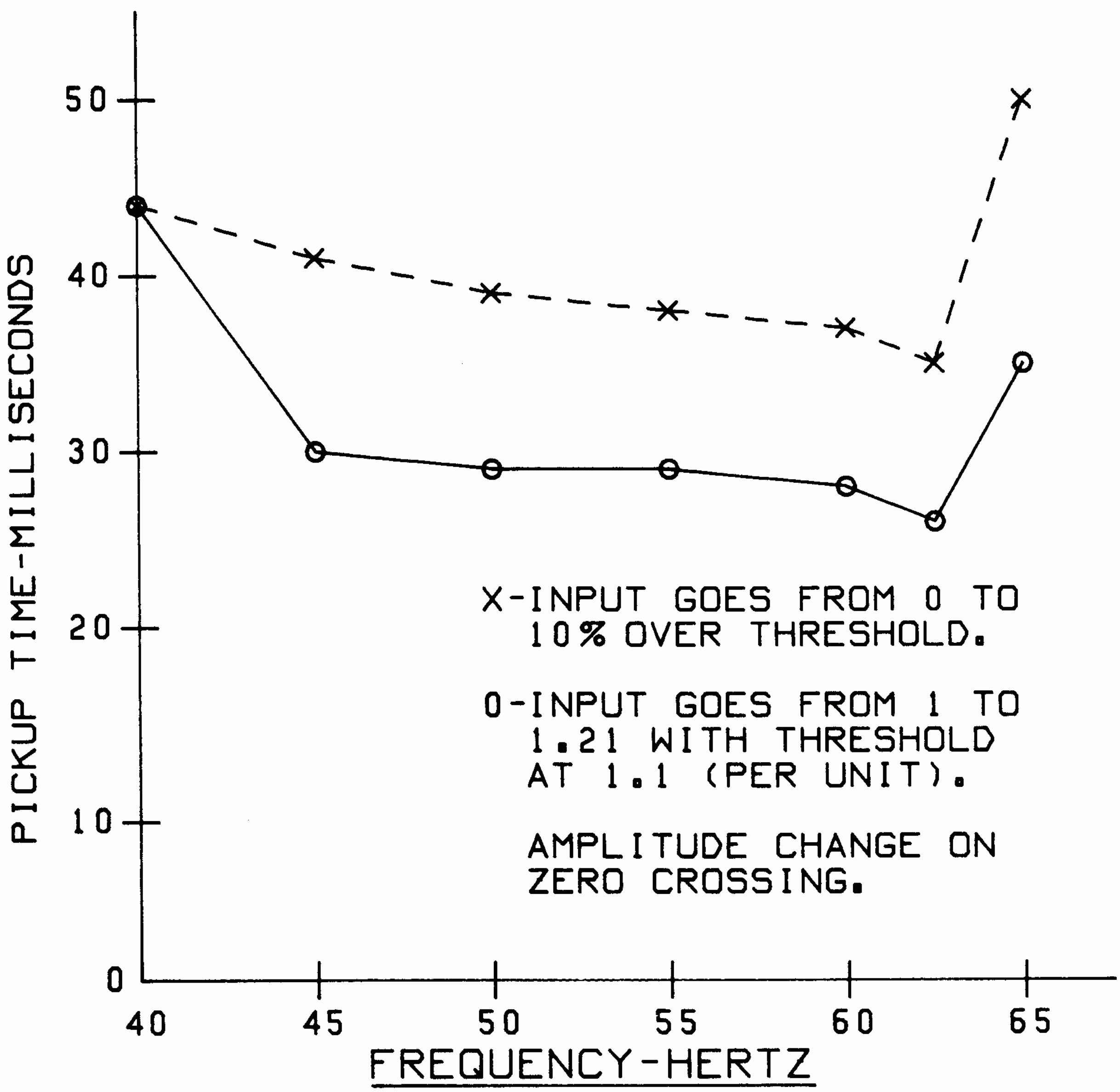


Figure 2 (0275A4324) Pickup Time Versus Frequency

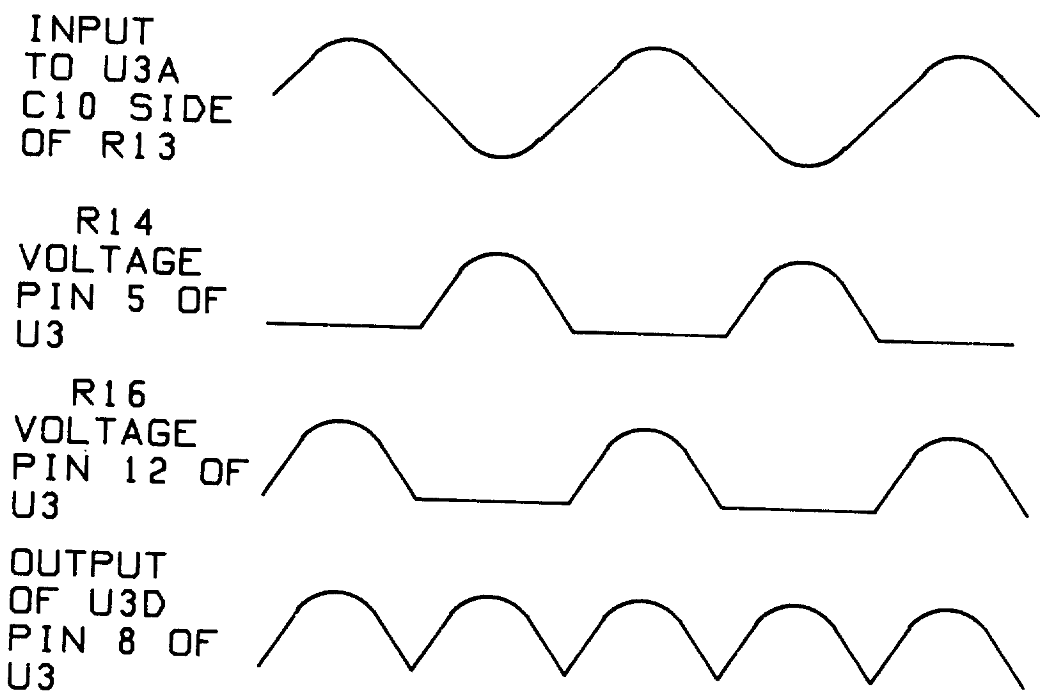


Figure 3 (0275A4400) Perfect Rectifier Operation

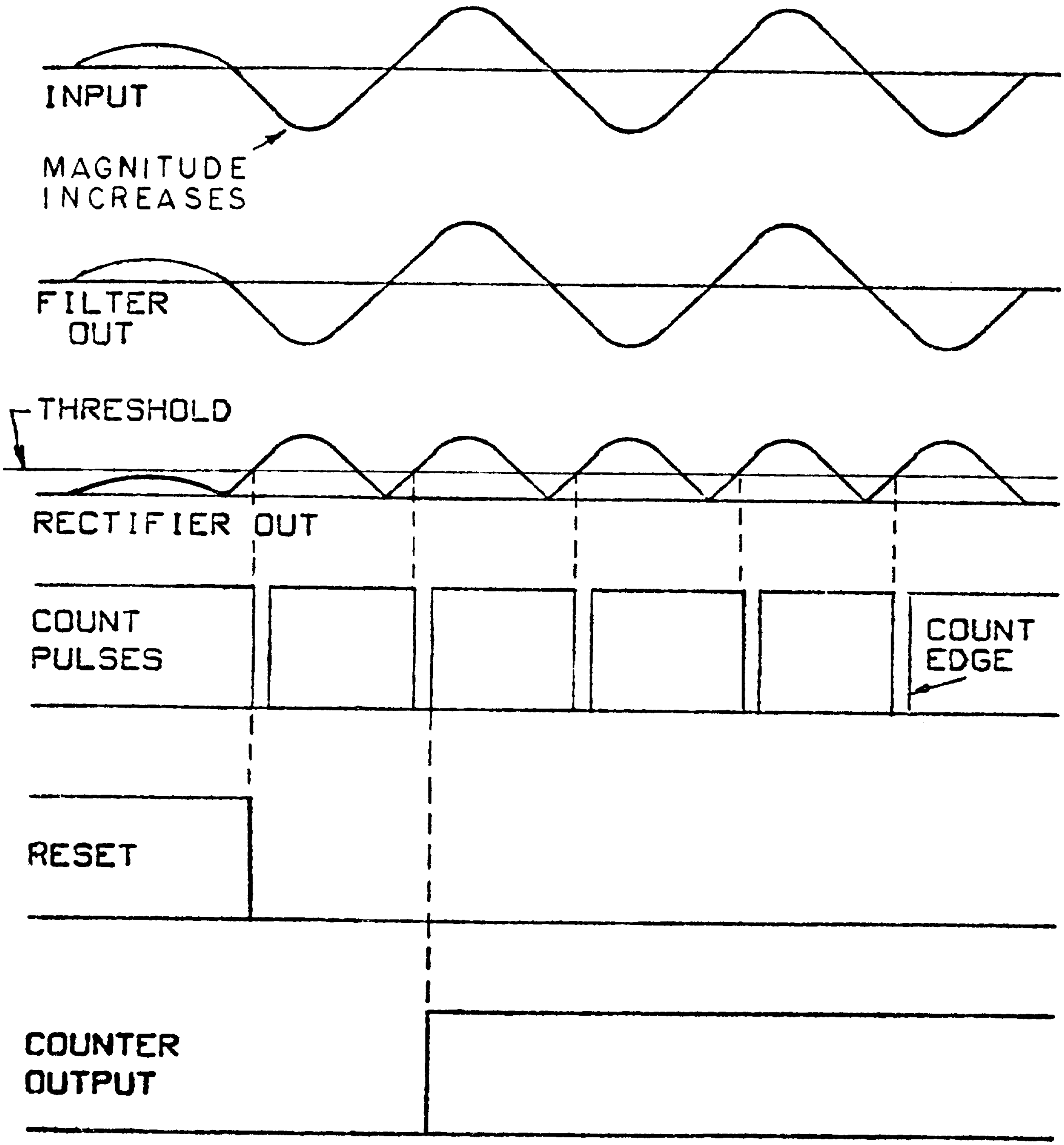


Figure 4 (0275A4401-2) SLV Waveforms

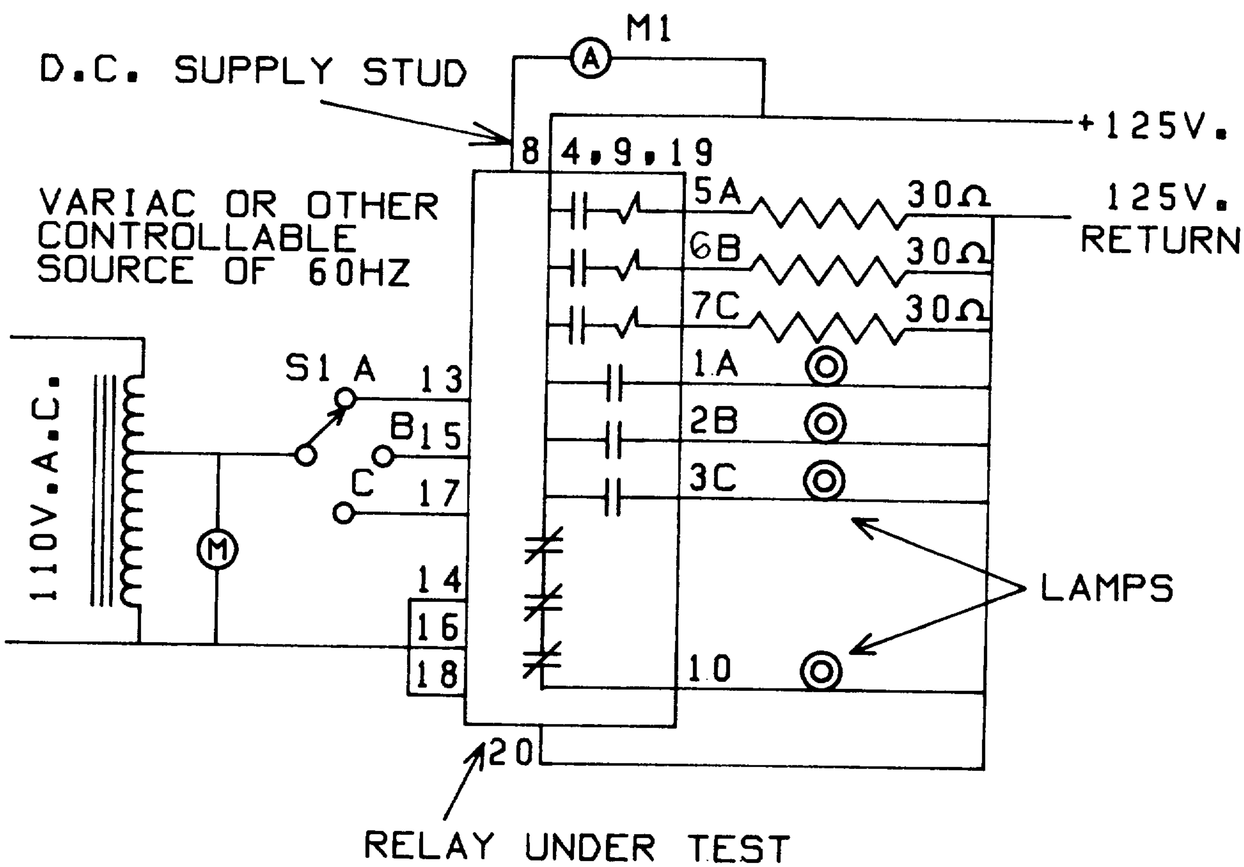


Figure 5 (0275A4402-1) Trip Level Test Circuit

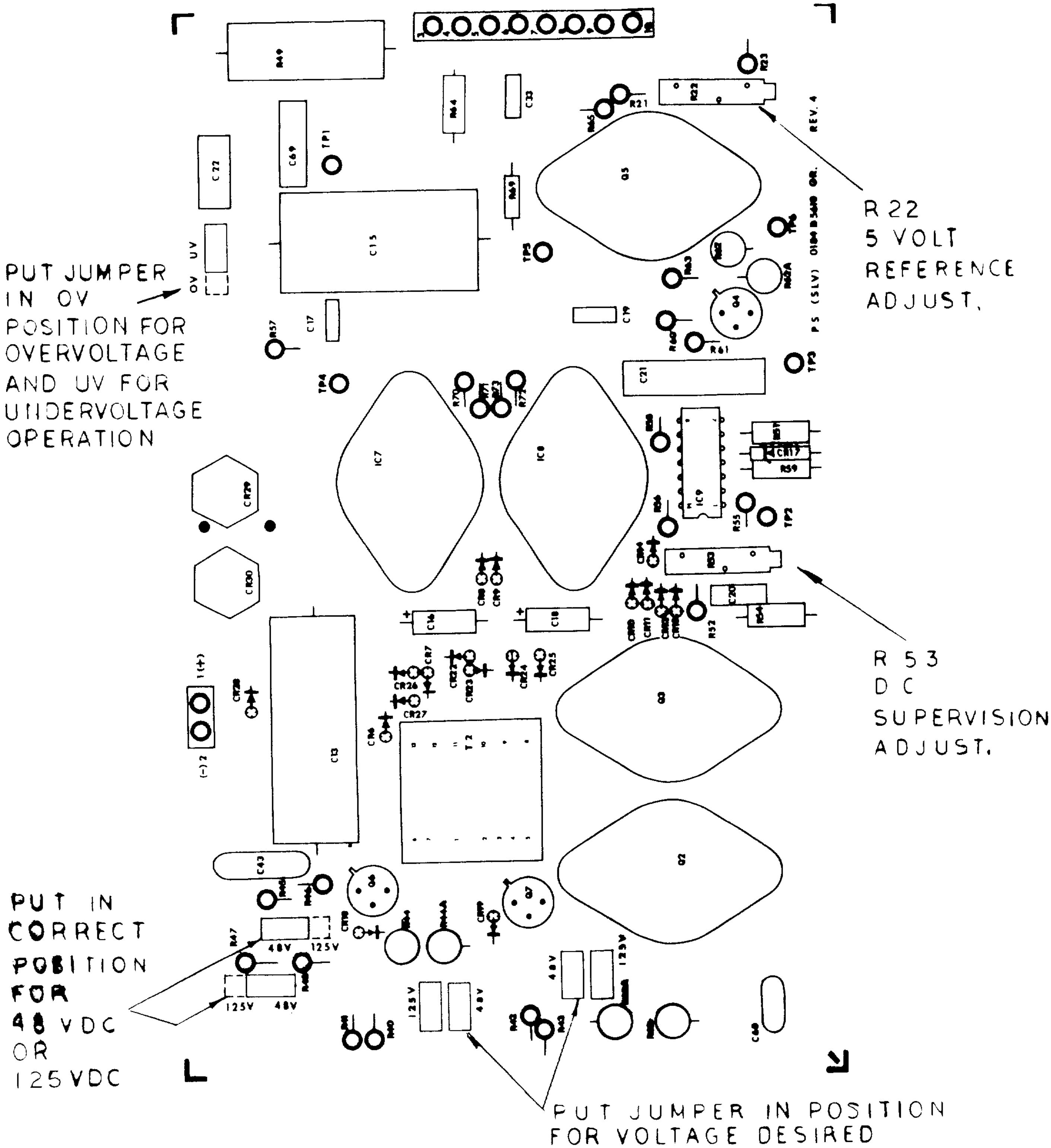


Figure 6 (0275A4415-1) Power Supply Jumper Locations

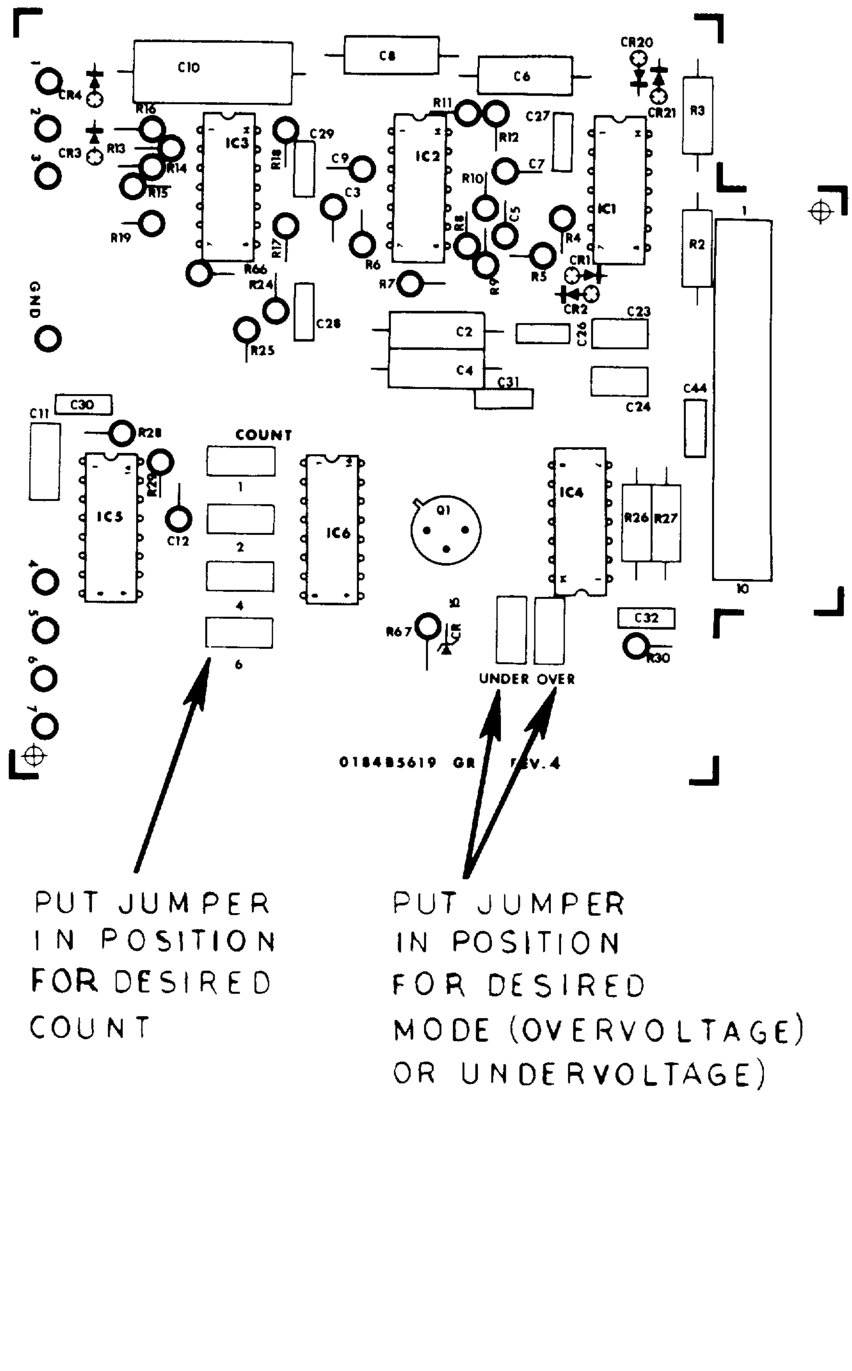


Figure 7 (0275A4416) Threshold Card Jumper Locations

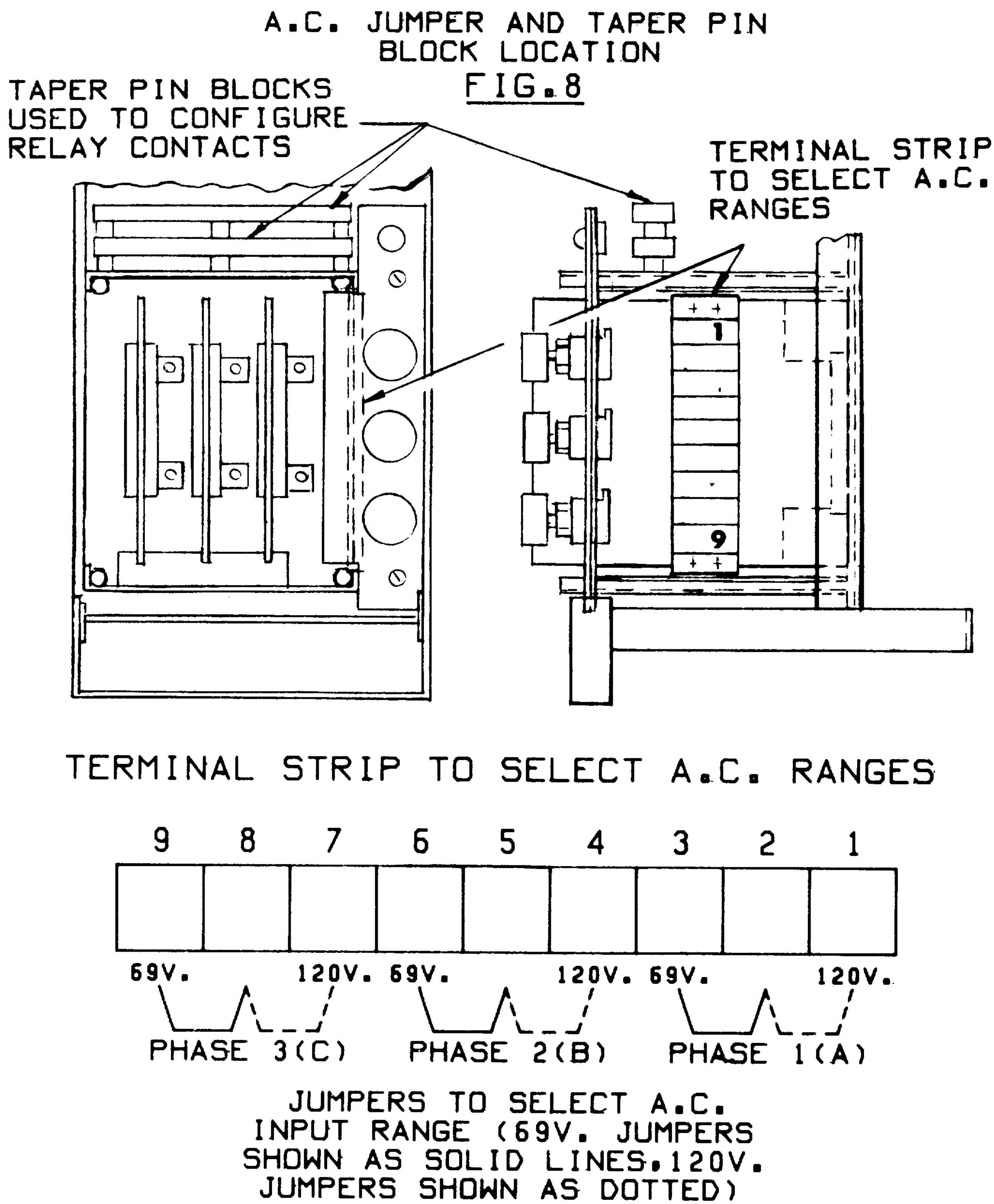


Figure 8 (0275A4414) AC Jumper and Taper-Pin Block Locations

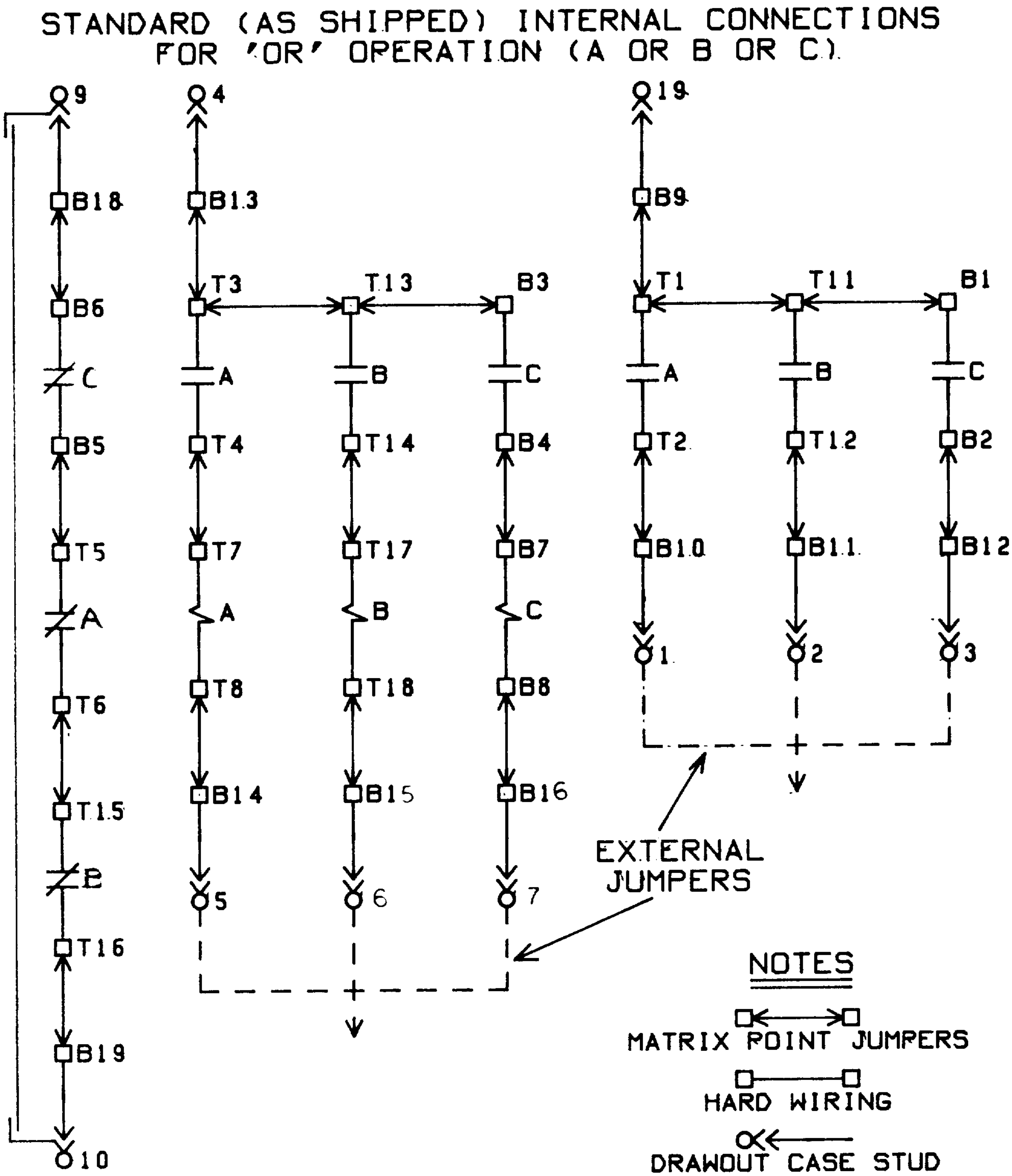


Figure 9 (0275A4320-2) Standard "OR" Contact Connections

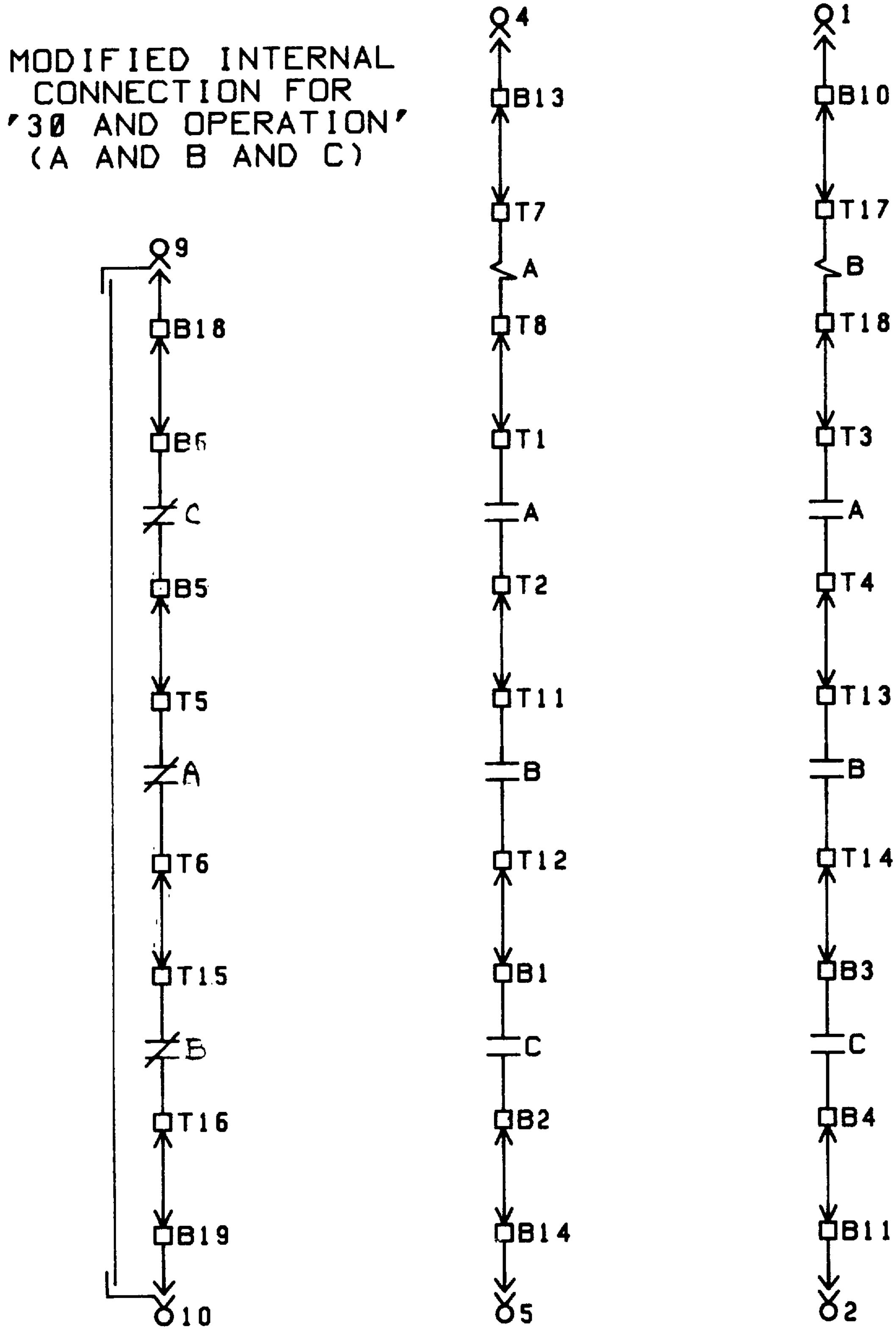


Figure 10 (0275A4322-1) Modified "Three Phase AND" Connections

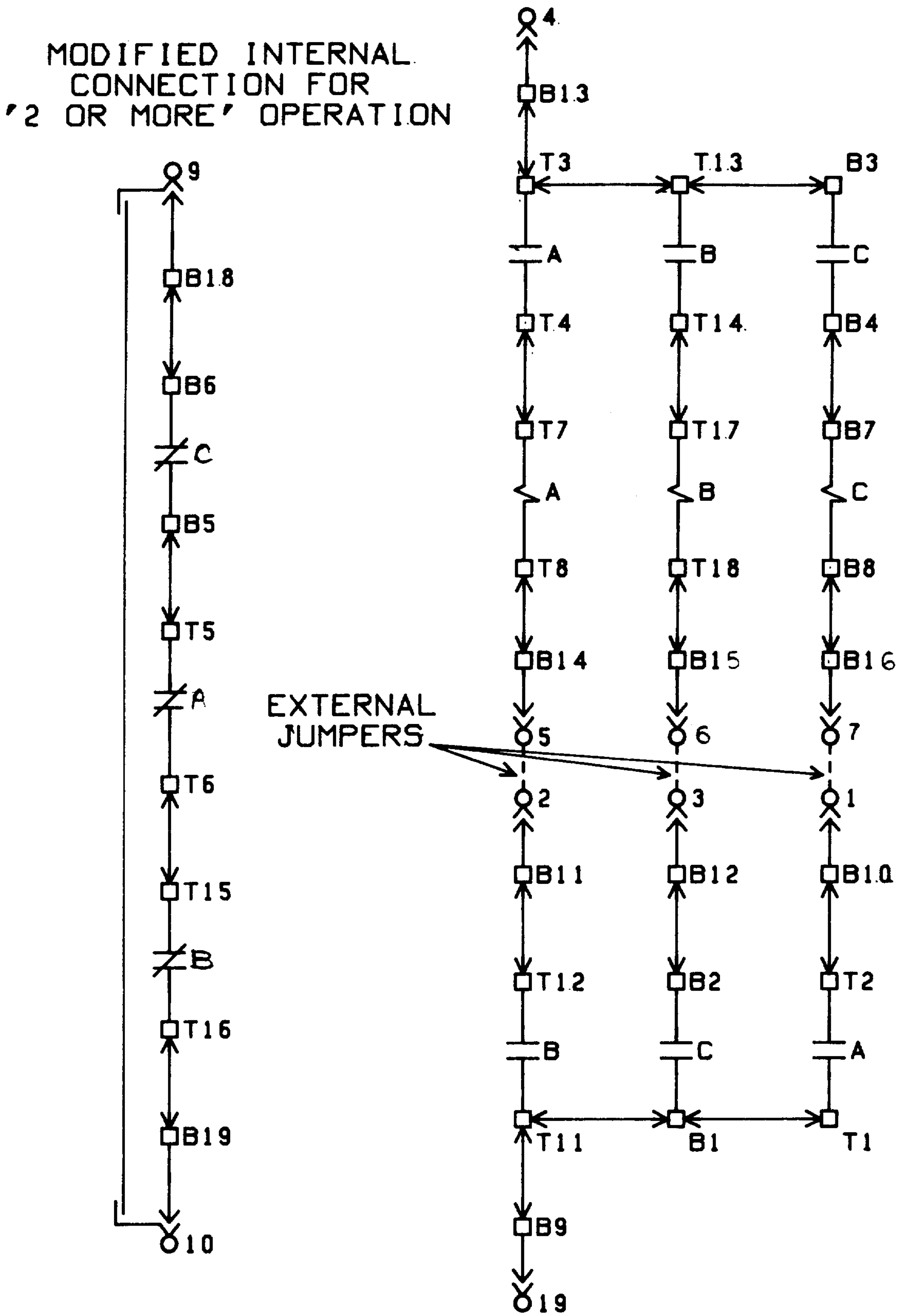


Figure 11 (0275A4321-2) Modified "Two or More" Connections

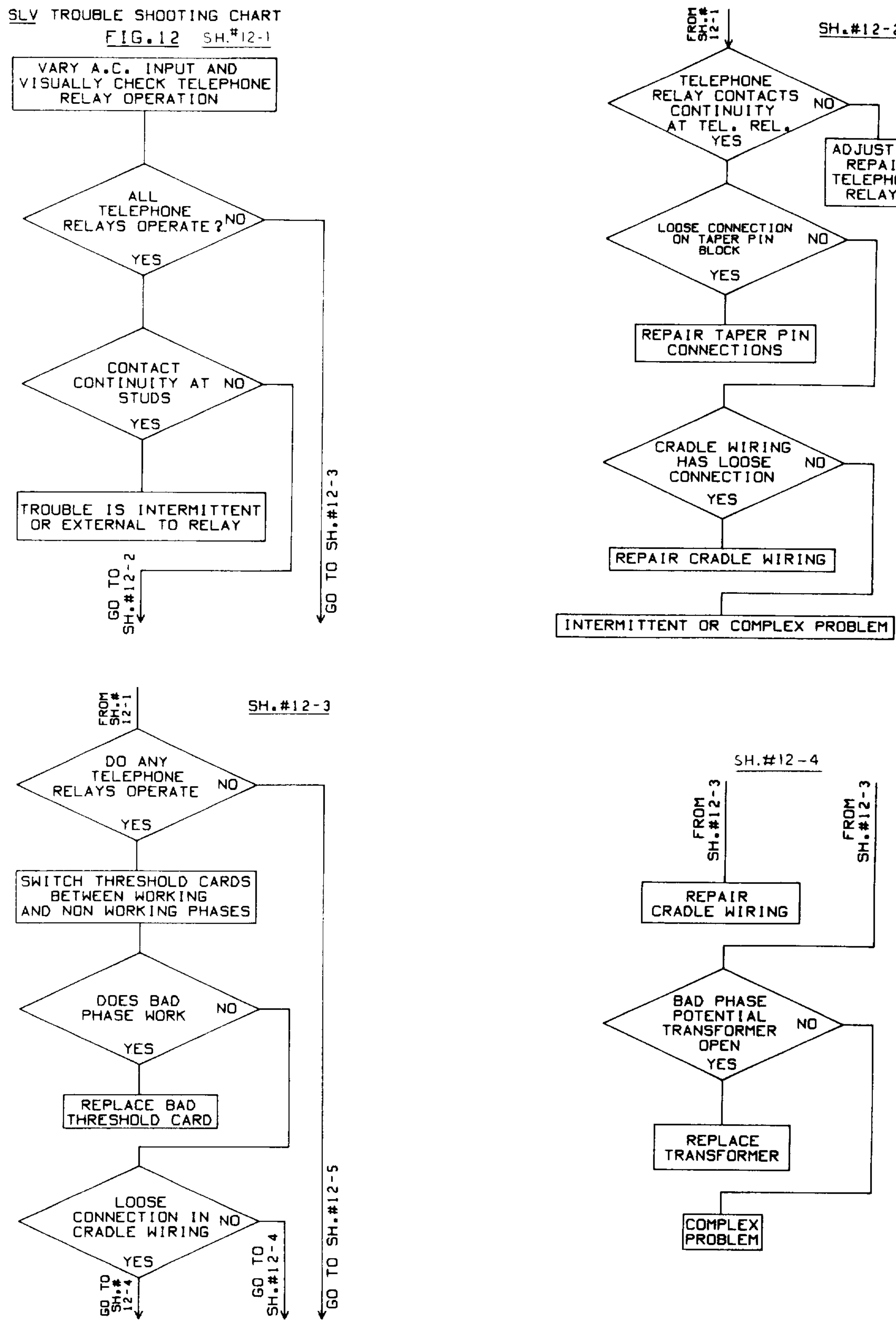


Figure 12 (0275A4403 Sh. 1-4 [1]) Troubleshooting Chart (continued next page)

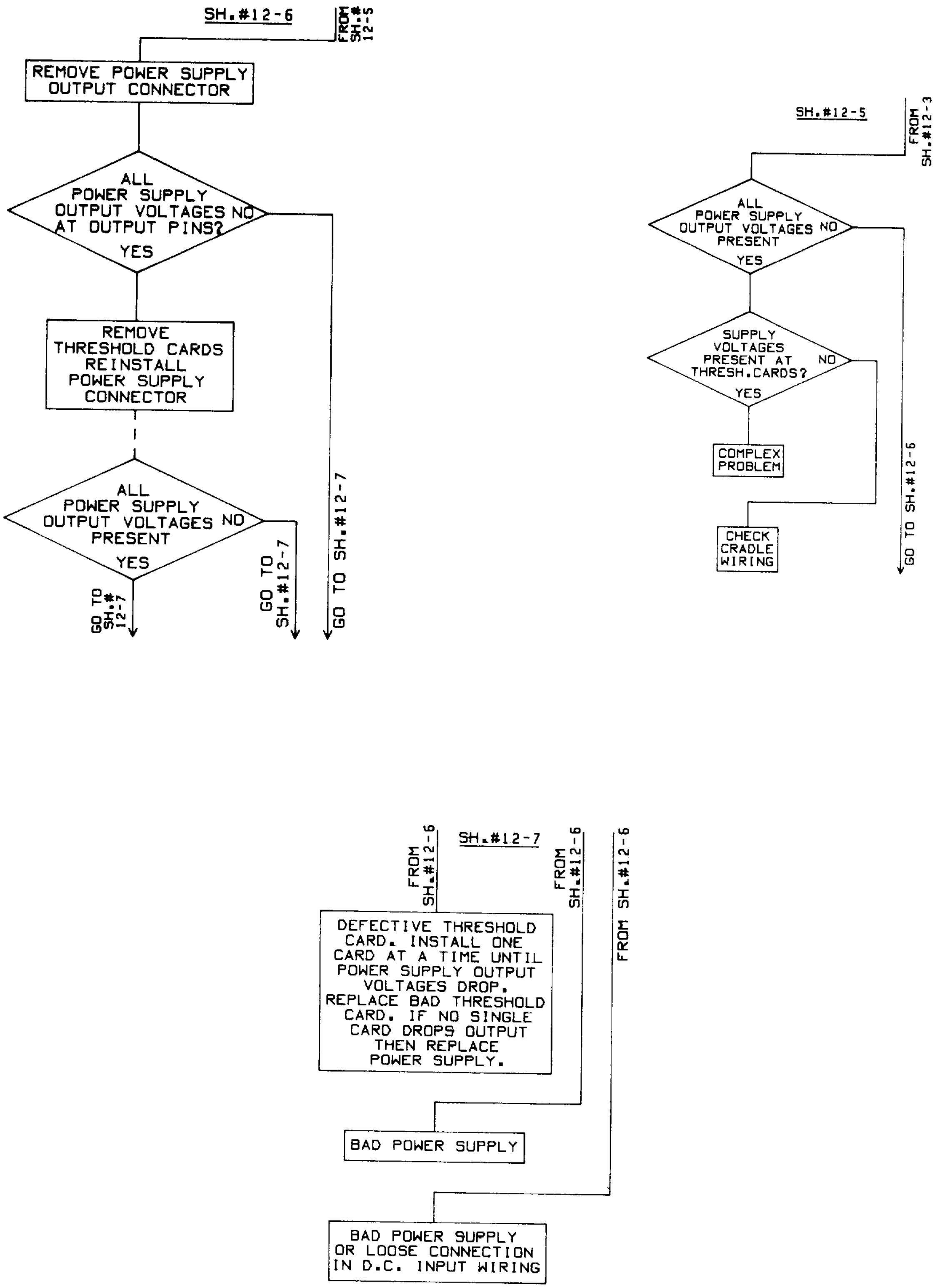


Figure 12 (0275A4403 Sh. 5-7) Troubleshooting Chart
(continued from previous page)

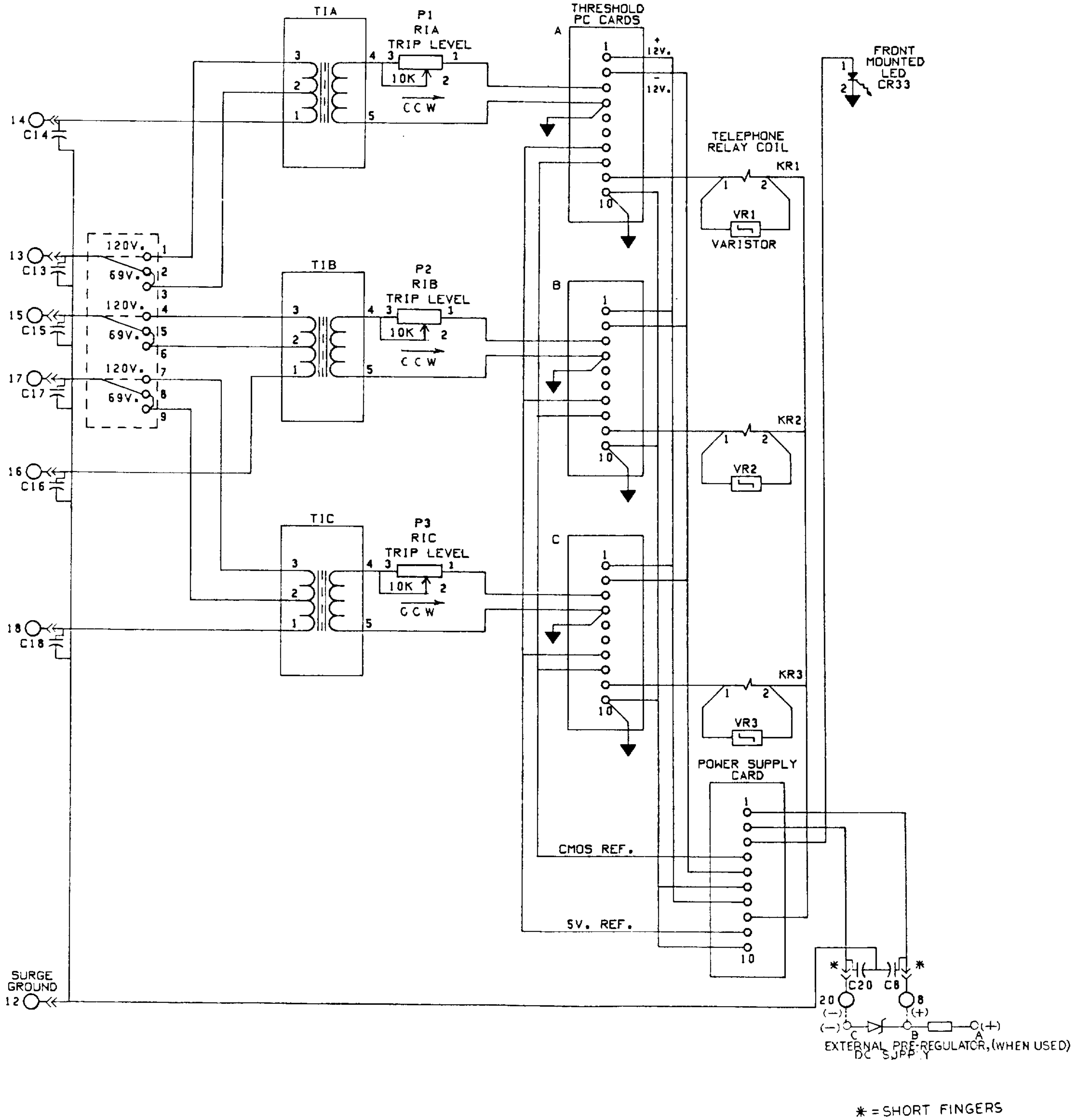


Figure 13 (0152C8591-3) SLV Relay Internal Connections
(continued next page)

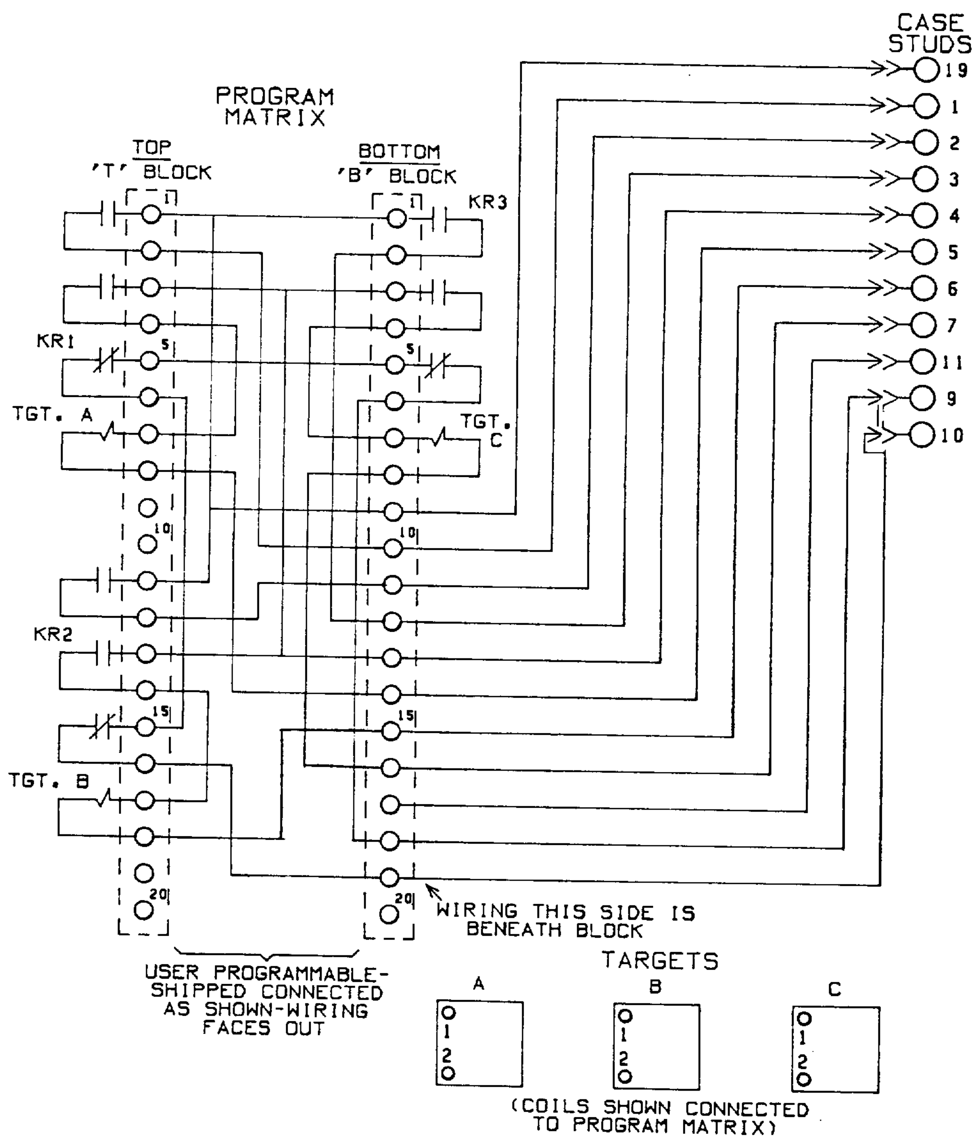


Figure 13 (0152C8591-3) SLV Relay Cradle Wiring Connections
(continued from previous page)

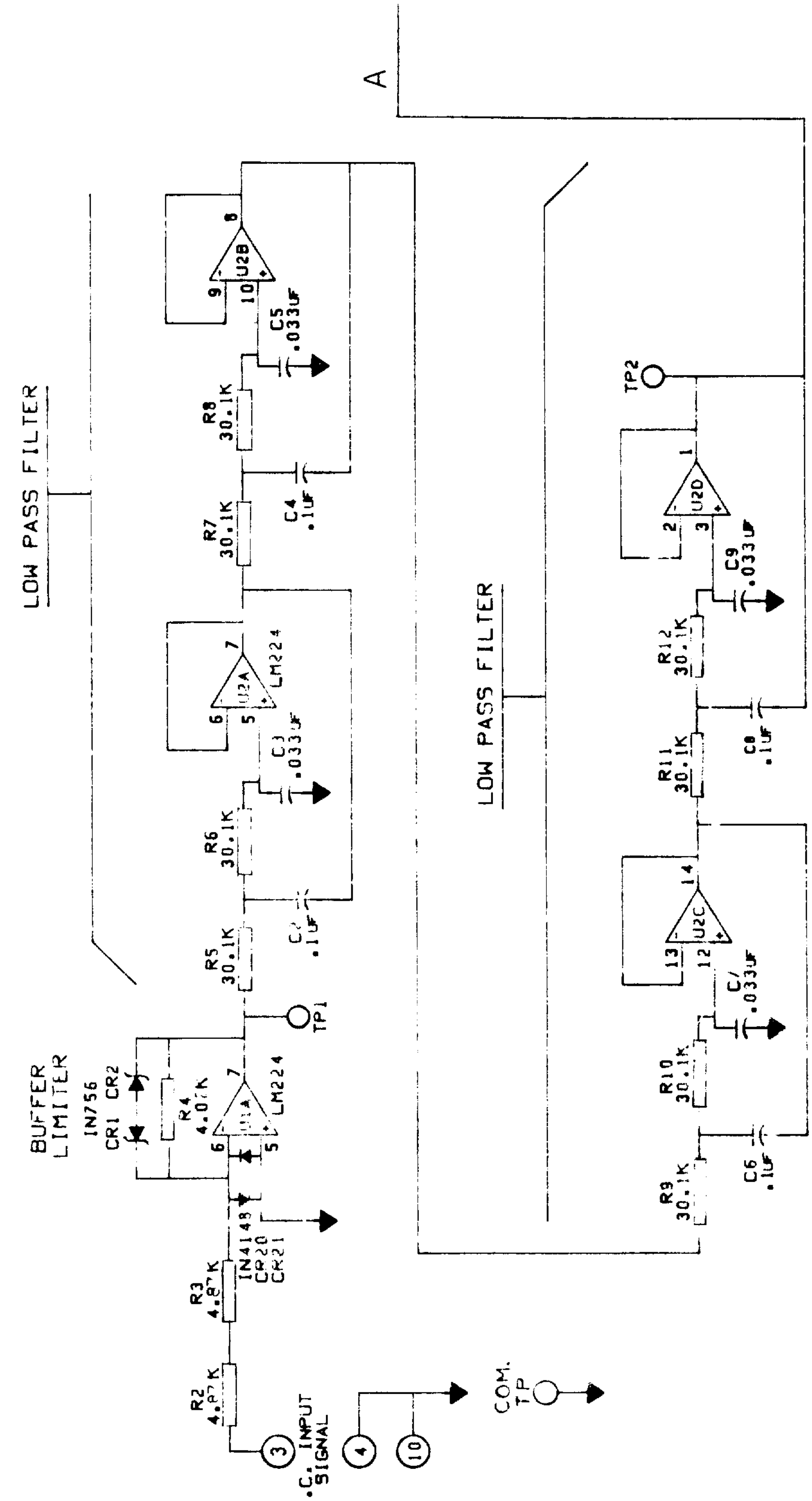
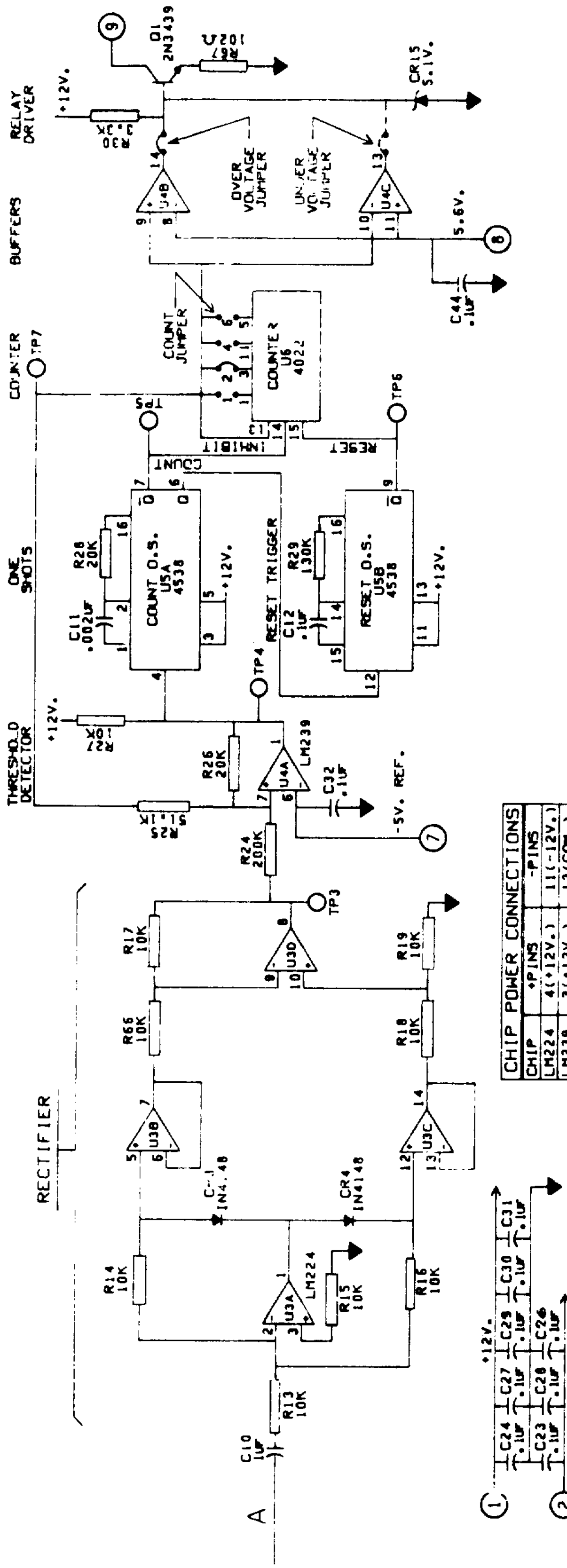


Figure 14 (0164B9719 [1]) SLV Threshold Card (continued next page)



CHIP POWER CONNECTIONS

CHIP	+PINS	-PINS
LM224	4(+12V.)	11(-12V.)
LM239	3(+12V.)	12(COM.)
4538	16(+12V.)	1,8,15(COM.)
4022	16(+12V.)	8(COM.)

Figure 14 (0164B9719 [1]) SLV Threshold Card (continued from previous page)

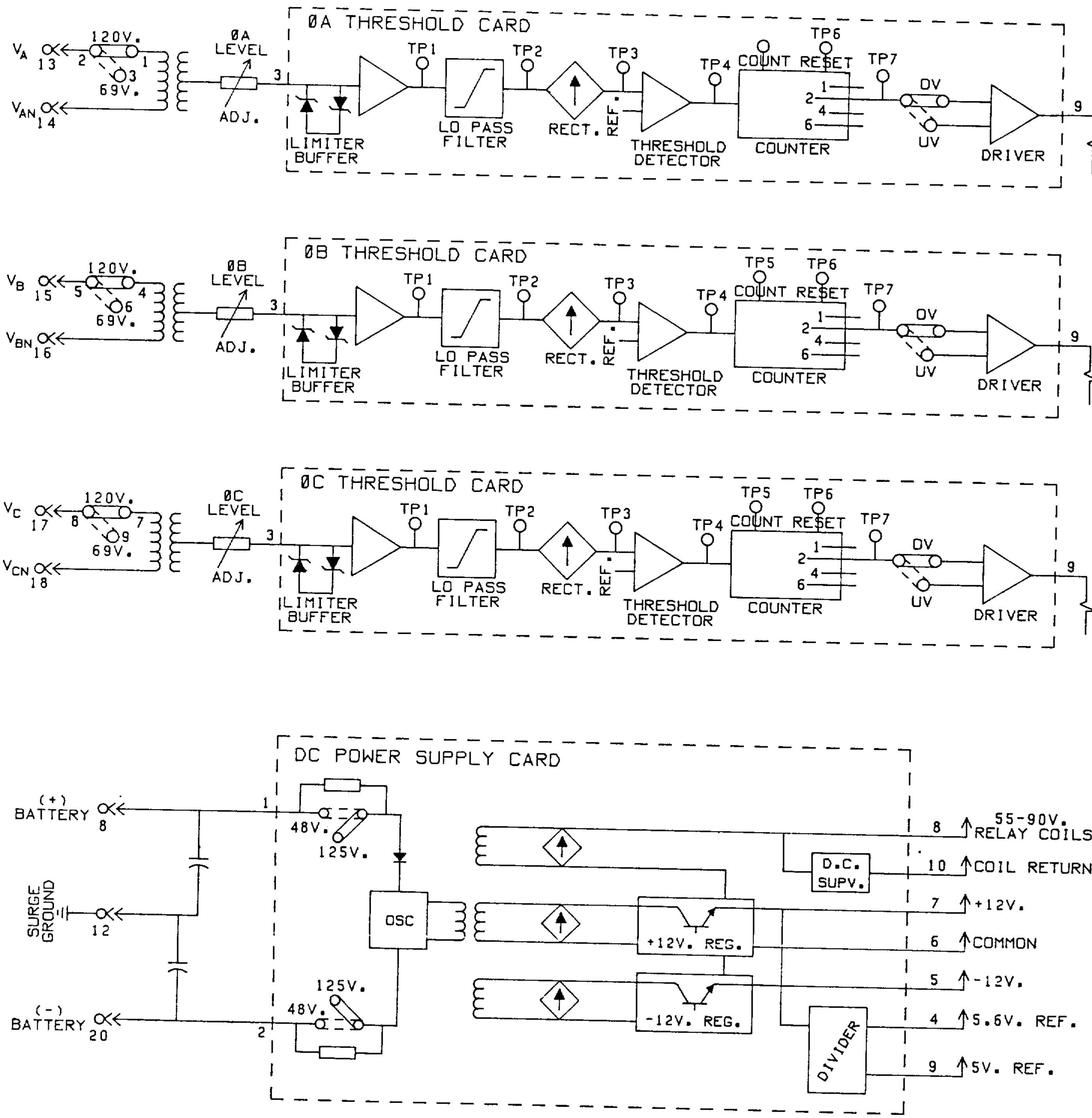


Figure 15 (0172C5100-1) SLV Relay Connection Diagram
(continued next page)

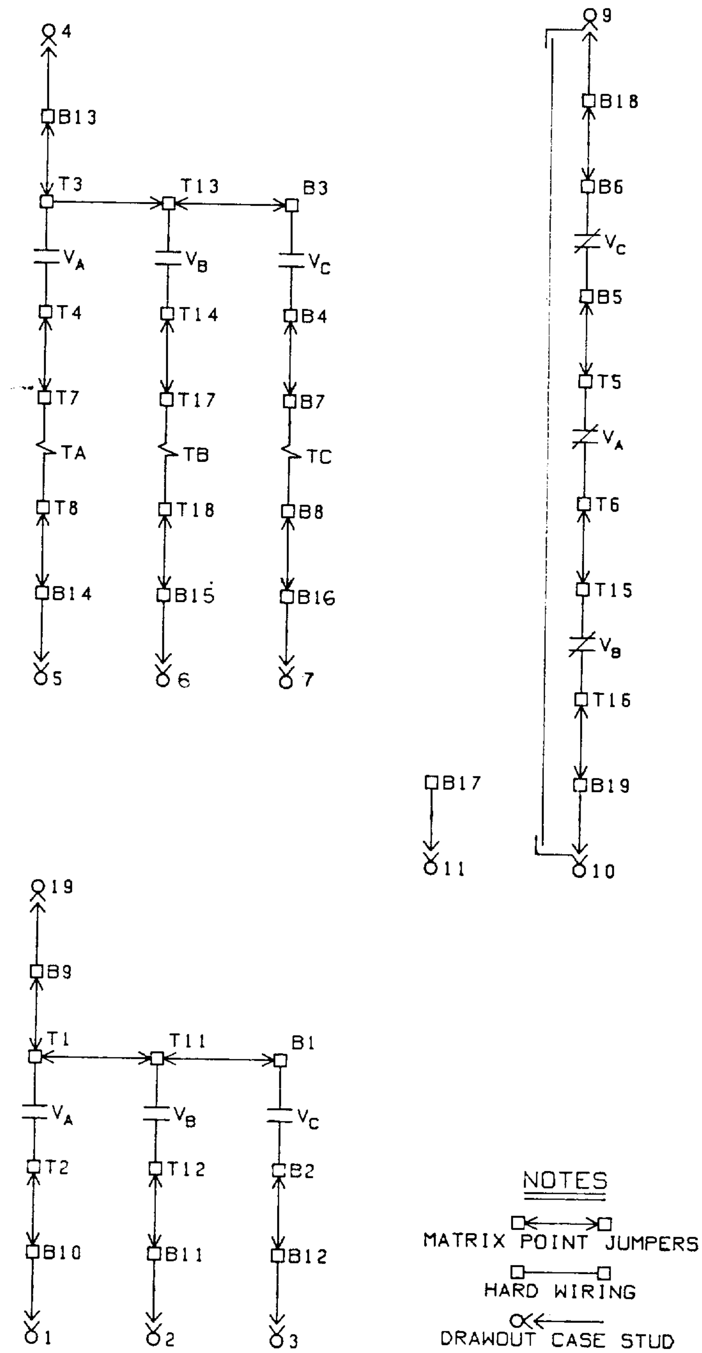
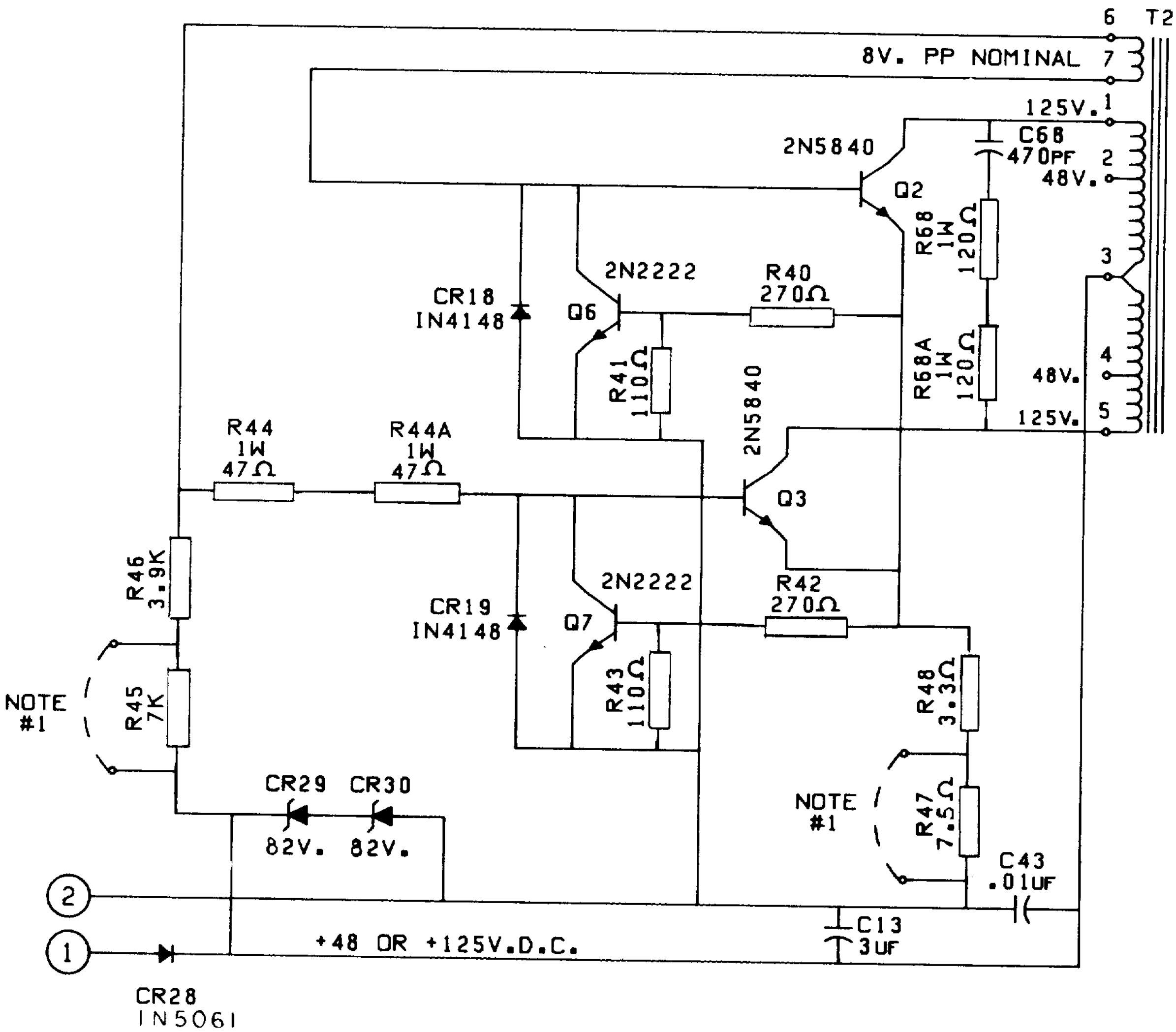


Figure 15 (0172C5100-1) SLV Relay Functional Diagram
(continued from previous page)

D.C. TO D.C. CONVERTER



NOTE#1 - JUMPERS USED FOR 48V. OPERATION. IT IS ALSO NECESSARY TO CHANGE TRANSFORMER T2 PRIMARY TAPS.

NOTE#2 - JUMPER USED FOR UNDER-VOLTAGE OPERATION.

Figure 16 (0164B9718) SLV Power Supply and DC Supervision
(continued next page)

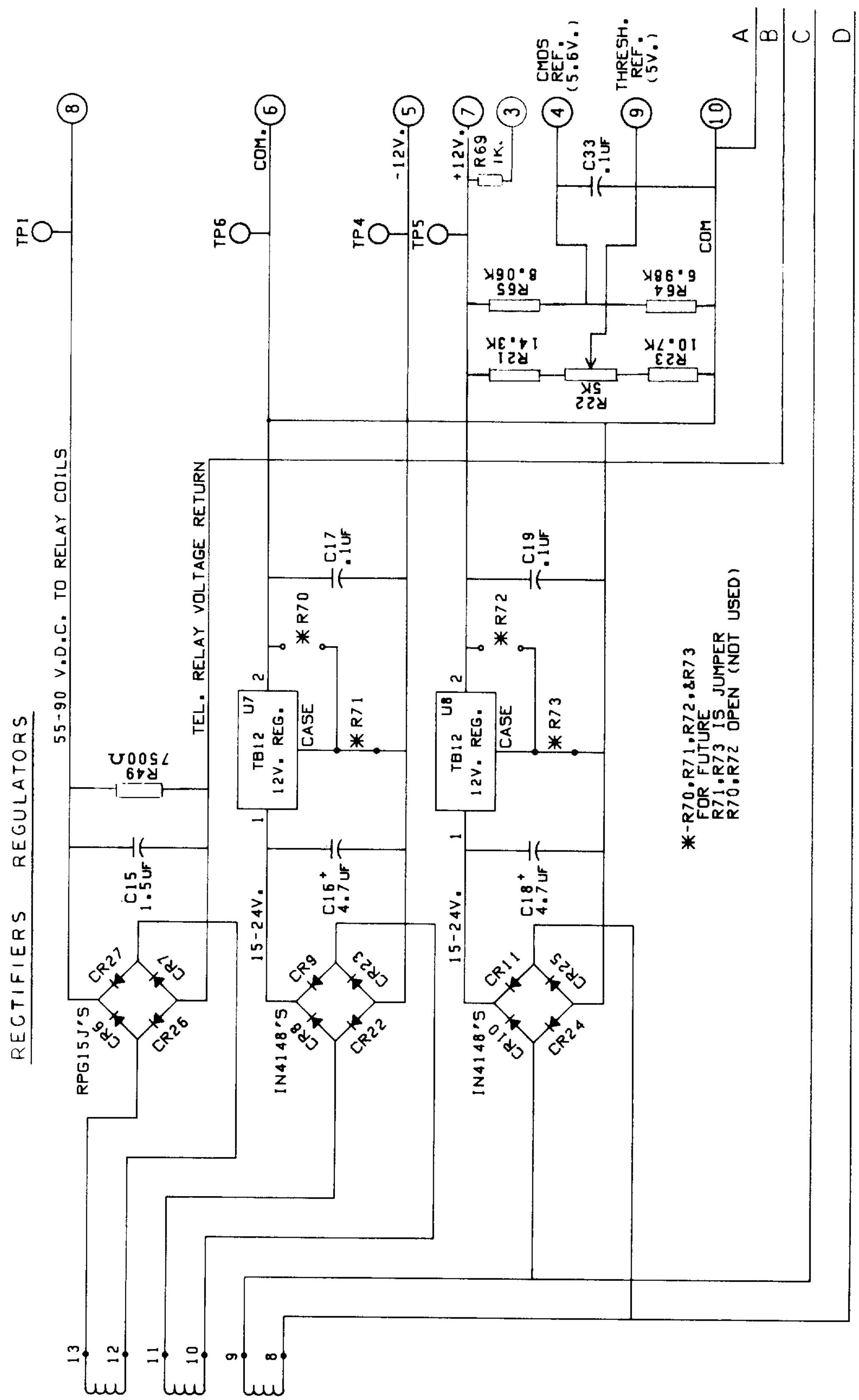


Figure 16 (0164B9718) SLV Power Supply and DC Supervision
(continued next page)

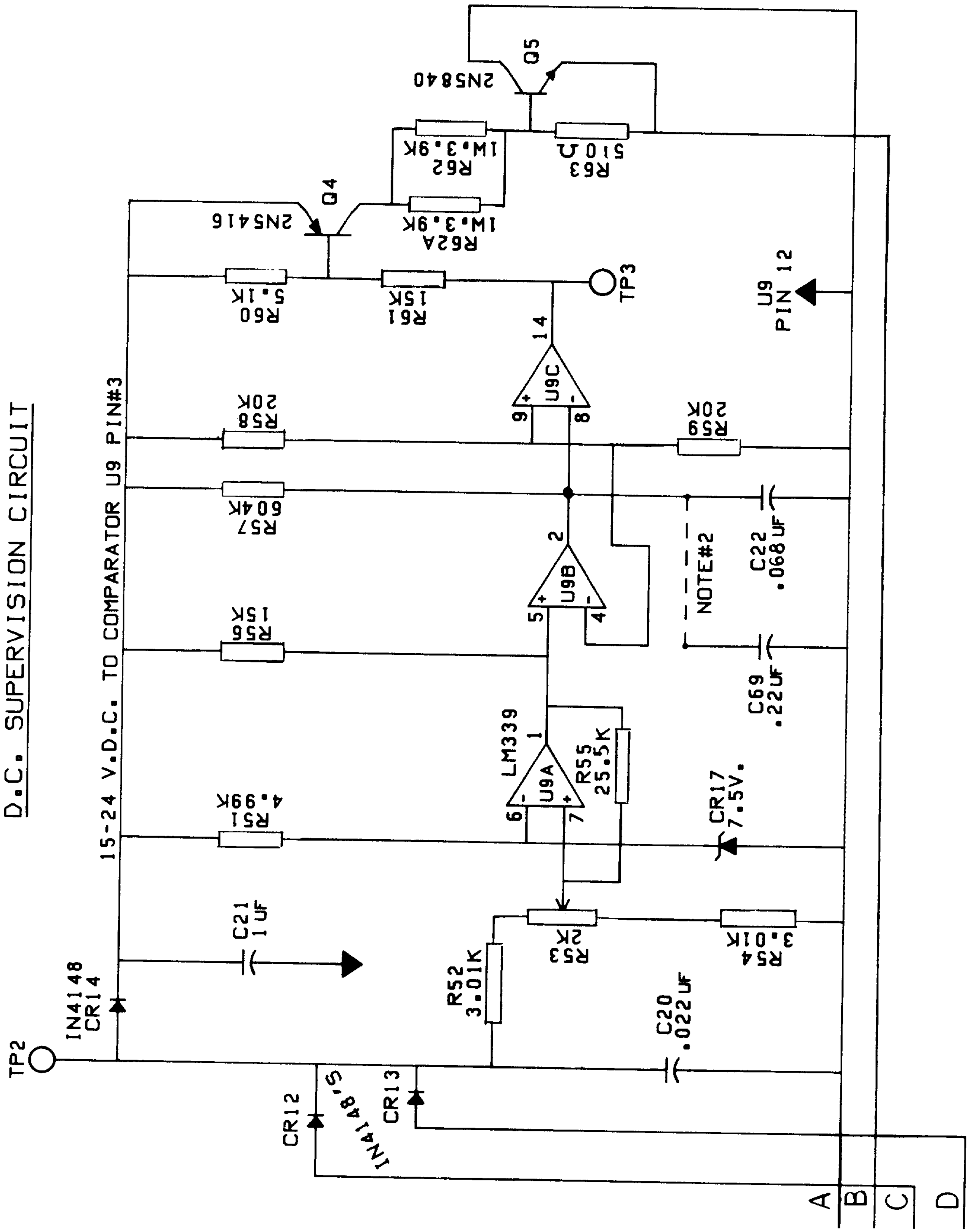


Figure 16 (0164B9718) SLV Power Supply and DC Supervision
(continued from previous page)

EXTERNAL A.C. POTENTIAL CONNECTIONS FOR SLV

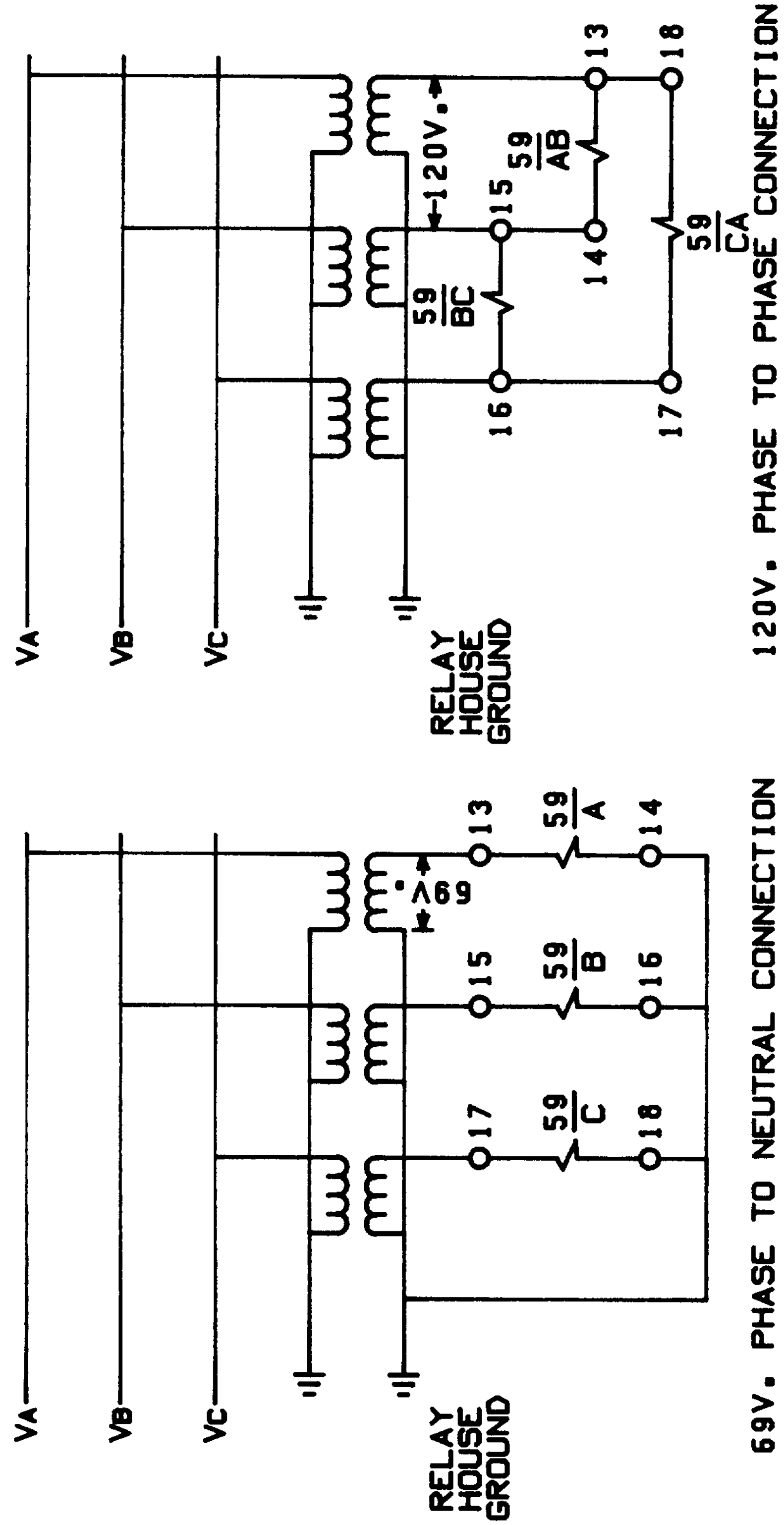
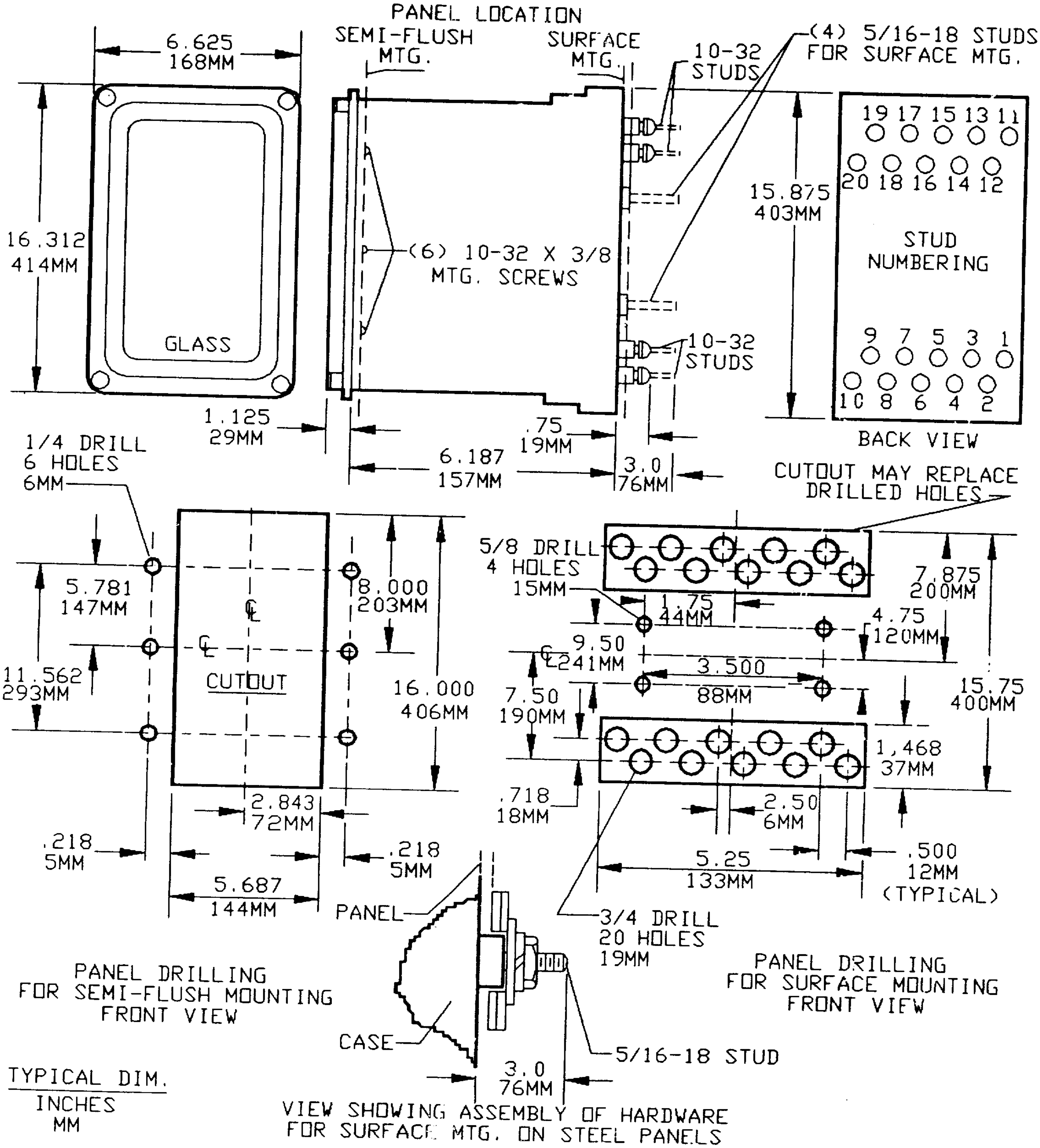


FIG. 17

Figure 17 (0275A4417) External AC Potential Connections



* Figure 18 (K-6209274 [6]) Outline & Panel Drilling

* Indicates revision

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