INSTRUCTIONS

Instructions

GEI-98309

Type SLY13A Relay

SWITCHGEAR DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

GEI-98309

TYPE SLY13A INSTRUCTION BOOK

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TYPE SLY13A RELAY

DESCRIPTION

The Type SLY13A relay is a transistorized relay for three-phase and phase-to-phase transmission line fault protection in a directional comparison protective scheme using a pilot channel. The relay contains circuits to produce mho-type directional characteristics for tripping (MT) and offset mho characteristics for transmitting a blocking signal (MB). The relay also contains overcurrent fault detectors (OC), and a second offset mho characteristic (MOB) for use in out-of-step blocking. The use of these last two functions is optional with the user.

The SLY13A is packaged in two separate units, as shown in Fig. 1, (1) a tap block unit, containing tap blocks and other adjustments for setting the reach and overcurrent pickup level, and (2) a card unit containing printed circuit cards, isolating transformers, links, and test push-buttons. Each of these physical units is in a metal enclosure designed for mounting on 19 inch racks. Each unit is 4 rack units high (one rack unit is 1 3/4").

These two units contain the necessary components for protecting all three phases of a power.system. Therefore, only one SLY13A relay is required per terminal of equipment.

The SLY13A requires a 16.8 volt power supply, with bias voltages, which can be obtained from a Type SSA11A power supply. The output of the SLY13A consists of low voltage signals which feed into a Type SLA12A "pilot control and trip unit."

APPLICATION

The Type SLY13A relay is for use in directional comparison pilot relaying or similar applications requiring a directional mho tripping unit (MT), an offset mho unit (MB), and an out-of-step blocking unit (M_{OB}), where the maintenance of stability requires 1 1/4-cycle relaying on 2 or 3 terminal lines. This maximum time includes the necessary delays to insure time coordination between the blocking and the trip-attempt functions performed by the respective mho units, when using a high-speed pilot channel (2 ms. starting time, 3 ms. stopping time).

A diagram of external connections is shown in Fig. 2.

RATINGS

The SLY13A relays are designed for use in an environment where the air temperature outside the relay case does not exceed 55C.

The current circuits of the SLY13A relay are rated at 5 amperes, 60 cycles, for continuous duty, and have a one-second rating of 330 amperes. The potential circuits are rated 120 volts, 60 cycles.

The range of adjustment of the function in the SLY13A relay are listed below:

MT Tripping:
0.75 to 30 ohms at 60° maximum reach angle
(0.85 to 34 ohms at 75° angle)

MB Blocking:
0.2 to 30 ohms at 75° forward reach
(along the protected line);
0.75 to 30 ohms at 75° reverse reach
(away from protected line)

M_{OB} Out-of-Step:
2 to 60 ohms at 60° forward reach
0.75 to 7.5 ohms at 60° reverse reach

Overcurrent:
3 to 12 amperes pickup range

OPERATING PRINCIPLES & CHARACTERISTICS

The SLY13A relay contains the three functions MT, MB, and MOB, all having circular "mho" characteristics as shown in Fig. 3. All measurements are made on a phase-to-phase basis (i.e., V1-2 is compared with I_1-I_2) in order to obtain the same relay reach for phase-to-phase and three-phase faults.

The mho characteristics are obtained by converting relay currents into voltage signals (IZ), combining these IZ signals with signals proportional to line voltage (V), and measuring the phase angle between the appropriate combinations to obtain the desired characteristic.

Currents are converted into IZ signals in transactors (air gap reactors with secondary windings). Transactors in this equipment are tapped on the secondary, and IZ tap blocks are marked with numbers equal to the line-to-neutral reach with 100% voltage tap. Relay reach may be increased by using voltage taps less than 100%.

The Z of the IZ quantity is the transfer impedance of the transactor, or $V_{OUT}/_{IN}$. Transactor secondaries also have loading resistors, which are adjusted to give the desired angle θ between V_{OUT} and I_{IN}. This angle determines the maximum reach angle of the mho characteristic.

MT TRIPPING

The MT function has a directional characteristic with the mho circle passing through the origin on an R-X diagram. The measurement principle is shown graphically in Fig. 4. Comparison is between the plarizing voltage V and the operating quantity (IZ_1-V). The angle (B) between these two quantities is greater than 90 for faults external to the relay characteristic, and is less than 90° for faults within the relay characteristic. For faults which cause V to terminate on the relay characteristic, the angle B is equal to 90°. This is true for any angular location of V, because V, IZ_1, and IZ_1-V form a right triangle for any point on the relay characteristic.

If the 100% voltage tap is used, the reach of the relay at the angle θ is equal to the IZ_1 tap chosen. If a voltage tap other than 100% is chosen, relay

ANGLE MEASUREMENT-OPERATING TIME

1. MB Blocking

The MB function uses a block-spike method of measuring the angle B, as shown in Fig. 7. A narrow spike is generated at the instant of voltage maximum in the polarizing voltage wave. This is compared with a block obtained from the (IZ - V) quantity. Coincidence of the spike and block (both having the same polarity) indicates that the angle between V and (IZ - V) is equal to or less than 90°. Operating time for this measurement, shown at the bottom of Fig. 7, is a function of fault incidence angle, and has a maximum time of 8.3 milliseconds, or 1/2 cycle.

2. MT Tripping

The MT function uses a block-block measuring scheme, in which both input quantities are converted to block of voltage, and the duration of their coincidence (having same polarity) is measured. This is illustrated in Fig. 8. Blocks which are 90° apart are coincident for 4.15 milliseconds. Blocks which are less than 90° apart are coincident for more than 4.15 milliseconds. Thus, the MT function consists of a circuit to detect coincidence of the two input blocks, followed by a 4.15 millisecond time measurement. In the MT unit, positive half-cycle coincidence is checked separately from negative half-cycle coincidence. Maximum operating time, shown at the bottom of Fig. 8, is 12 milliseconds, and minimum operating time is 4 milliseconds.

3. MOB Out-of-Step

The MOB functions uses a block-block timing measurement similar to that used for the MT tripping unit.

OVERCURRENT FUNCTION

The overcurrent cards are supplied with a signal proportional to the delta currents I_1-I_2, I_2-I_3, and I_3-I_1. Operating current levels are chosen on the basis of the phase-to-phase fault condition, where the two currents add together in-phase. For the 3-phase fault condition, the currents add together at a 120° angle, and these currents must be 16% higher to produce the same results. However, a 3-phase fault at the same location produces 16% more current than a phase-to-phase fault, so that the "reach" of the overcurrent function in ohms is the same for phase-to-phase and 3-phase faults.

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CHOICE AND CALCULATION OF SETTINGS

The instructions given below apply only to 2-terminal lines; see Appendix I for the details of application to 3-terminal lines.

See the section under INSTALLATION TESTS for the calculation of tap settings, etc. to provide the desired operating values in terms of reach and time.

MHO FUNCTIONS

The tripping function, MT, should be set to cover at lease 125% of the protected section in order to maintain 1 1/4-cycle operation with arc resistance.

Since the maximum-reach angle of the relay ($\theta = 60$ to 75°) should be less than the line angle ($\emptyset$) in order to provide margin for arc resistance, this difference should be taken into account in calculating the desired diamater of the relay characteristic as:

$$Z_{max} = Z_F / \cos(\emptyset - 0)$$

where: Z_F is the desired forward reach in secondary ohms at the line angle $\emptyset$.

The blocking function, MB, should be set in the direction toward the opposite terminal of the protected line with an offset equal to either 1 ohm secondary 25% of the line ohms, whichever is greater. The small values of offset are for possible applications where operation of MB on ground faults must be avoided. On the SLY13A, the settings in the two directions are independent.

The blocking function, MB, should be set in the direction away from the opposite terminal of the protected line, for not less than either:

$$ZB_{min} = Z_F - Z_0$$

or:

$$ZB_{min} = 1.25\ Z_F - Z_L$$

where: Z_F is the reach of the MT at the other end of the protected line, at the angle ($\emptyset$) of the line, ZL is the line impedance, and Z_0 is the offset ohms of MB, mentioned above, all in secondary ohms (assuming equal CT ratios at the two ends of the line).

OVERCURRENT FUNCTIONS

The overcurrent functions (I) should be set to operate at or below 80% of the minimum phase-to-phase fault current flowing to a far-end internal fault with both ends closed, if possible. Otherwise, sequential tripping may result for faults at that location if the overcurrent function (I) is connected to supervise tripping. However, it is desirable to keep the setting above load current, if possible, in order to still provide protection against false tripping due to loss of potential while carrying load.

reach is increased in inverse proportion to the voltage tap. For example, if the 50% voltage tap is used, relay operation still occurs for the same voltage applied to the measuring circuit, but since the actual line voltage is twice this amount, the relay reach is twice as great. The resulting circle has twice the reach, at any fault angle, and still passes through the origin.

Relay reach for the MT unit, at any fault angle, may be calculated from the expressions:

$$I_{max} = \frac{IZ\ Tap}{V\ Tap} \times 100 \text{ (at angle } \theta)$$

and:

$$Z\phi = \frac{X_{max}}{\cos(\phi-\theta)} \text{ (at any angle } \phi)$$

MB and MOB

The MB and MOB functions are offset mho characteristics, and their circles do not pass through the origin. This offset characteristic is obtained by adding a second IZ quantity (IZ_2) to the polarizing V quantity, as shown in Fig. 5. Angle measurements of B are made with a comparison of (IZ_1-V) and IZ_2 +V), and relay operation occurs when B = 90° as before. The resulting characteristic is a circle with diameter = $IZ_1 + IZ_2$, with a forward reach = IZ_1 and a reverse reach = IZ_2.

The graphical illustration in Fig. 5 shows the same V used with different IZ_1 and IZ_2 quantities to obtain the offset characteristic. The same effect, and a more accurate reach setting, can be obtained by adjusting the V used with IZ_1 separately from the V used with IZ_2. To accomplish this, separate 1% taps for the forward and reverse reach are provided, and the resulting characteristic is a circle passing through these two points and with its diameter along the along the transactor angle of 75° . The IZ_1 and IZ_2 tap settings may be the same, or they may be different.

This separate adjustment of MB forward and reverse reach is illustrated in Fig. 6. In the tap block unit, the forward (along the protected line) taps are identified as MB, and the reverse (away from the protected line) taps are identified as MB*. This marking applies to both the IZ (current) and V (voltage) taps. The inner circle on Fig. 6 is the characteristic obtained with the same IZ setting (0.75 ohms) and the same V setting (100%) for MB and MB*. The outer characteristic is obtained by changing the MB voltage tap to 80% and the MB* voltage tap is 40%.

The MB function has 0.2, 0.75, and 3 ohm IZ taps (MB) in the forward direction and 0.75 and 3 ohm taps (MB*) in the reverse direction. It has 1% voltage taps in both directions.

The MOB function has IZ taps (2 and 6 ohms) in the forward direction only. It has a fixed 0.75 ohm reverse reach with 100% voltage tap. Both the forward and reverse reach can be increased by 10% voltage taps, MOB (forward) and MOB* (reverse).

If the overcurrent function is not connected to supervise tripping, but if breaker failure relaying is used, the overcurrent function should be set to operate at or below 80% of the minimum phase-to-phase fault current with only this end closed, as its function then is to maintain the breaker-failure-initation function (BFI) energized until the fault is cleared.

If the overcurrent function is not connected to supervise tripping, and if breaker-failure relaying is not used, the overcurrent setting is immaterial.

OUT-OF-STEP-BLOCKING

The out-of-step blocking function, MOB, should be set at values chosen by means of a graphic solution on an R-X diagram, including swing lines for different system conditions, showing the successive values of apparent impedance at known intervals of time as the fastest swing (for each system condition) progresses. The reach of MOB should exceed the reach of MT by an amount sufficient to allow at least enough time to operate the A/0 timing unit in the logic. This A/0 unit has an adjustment range of 2-4 cycles; the 4-cycle setting is preferred unless it requires too great a reach on MOB. The times involved in choosing settings for the MOB and A/0 units are measured along the swing line intersecting the MOB and MT characteristics. If no swing study is available as a basis for these settings, the MOB setting in the direction of the protected line should be at least 125% of the setting of Mt, and the MOB offset setting in the opposite direction should be at least 25% of the setting of MT, if this will not cause MOB to operate in response to the apparent impedance presented by load conditions.

A/0 should be set to pick up in 4 cycles, unless a shorter time is necessary because of an unusually fast swing situation or because the time available for its operation has been reduced by having to set MOB for less than the 25% margin beyond MT.

CONSTRUCTION

The components of the SLY13A relay are mounted in two separate containers, (1) the tap block unit and (2) the card unit. Interconnections between these units are made by multiconductor shielded cable, as shown in Fig. 9.

TAP BLOCK UNIT

The tap block unit (see Fig. 1) contains the tap blocks for making reach settings of the MB, MT, and MOB units. It also contains rheostats for making the MT maximum reach angle adjustment, the MOB maximum reach angle adjustment, and for making the overcurrent operate level adjustment. All of these adjustments are located on the front mounting plate of the tap block unit, behind the hinged front panel.

There are three sets of reach-setting tap blocks, one for phases 1-2, one for phases 2-3, and one for phases 3-1. Each set contains voltage (V) taps on the upper 3 tap blocks, and current (IZ) taps on the lower tap block. The phase 2-3 blocks have an additional IZ tap block for MOB mounted above the other tap blocks.

The method of making reach tap settings is illustrated in Fig. 10, which shows typical settings for the phase 1-2 or phase 3-1 set of blocks. The 10% voltage taps are on the left half of the tap block arrangement, and settings are made by connecting jumpers from the fixed taps MT, MB, and MB* on the center voltage tap block to the desired 10% tap.

The 1% voltage taps appear on the right half of the voltage tap blocks, and adjustment is made by connecting two jumpers as shown in Fig. 10. This vernier adjustment, which can be adjusted up to 5% in 1% steps, is either added to or subtracted from the 10% tap setting depending on the manner of connecting the two jumpers. If the jumpers do not cross over, the difference between the two taps is the percent <u>added</u> to the basic 10% tap setting. If the leads are crossed over, the difference is the percent <u>subtracted</u> from the basic 10% tap setting. In other words, second digit settings of 6,7,8, or 9% require a cross-over of these jumpers, plus the use of the next higher 10% tap.

Tap settings between 0 and 5% are made using taps as shown below:

PERCENT	USE TAP
0	0-0
1	0-1
2	1-3
3	0-3
4	1-5
5	0-5

Current (IZ) tap settings are made as shown in Fig. 10, again connecting jumpers from the fixed tap position to the desired adjustable tap position.

The phase 2-3 tap block arrangement has two additional 10% taps for MOB and MOB*. These are connected by jumpers to the 10% tap blocks in a manner similar to that for the MT and MB settings. The IZ tap block at the top of the unit (marked MOB) provided adjustment of MOB in the forward direction only.

There are three potentiometers for "polarizing phase shift" adjustment mounted inside the tap block unit. These are factory-adjusted to produce the polarizing voltage spike at the correct angle, and should not require readjustment in the field.

Incoming currents and voltages are supplied to the tap block unit through a screw terminal block (YA) at the rear. Output voltage signals appear at five 10-point sockets at the rear for interconnection with the card or logic unit.

LOGIC UNIT

The SLY13A logic unit contains two rows of printed circuit cards plus links and push-buttons. Mounted behind the cards are a group of isolating transformers, some capacitors, and a diode board. Push-buttons on the front panel simulate operation of the carrier start MB function, and of the MT tripping function. Links on the front panel provide a choice of overcurrent fault detectors IN or OUT, and also a choice of out-of-step blocking used to block tripping (TRIP), to block reclosing (RECLOSE), or to block neither (OUT).

Printed circuit cards are indentified by a code number, such as A3, D6, L10, etc. where A means auxiliary, D means discriminator, L means logic, and T means time delay. The identification and location of individual cards is shown in Fig. 11. Individual cards and sockets are keyed to prevent inserting cards in the wrong sockets.

The logic unit has a test card in the T position (lower right-hand). Test points are numbered 1 to 10 from top to bottom on this card. The upper test point, TP1, is connected to the negative or reference bus of the transistor circuits, and the lower test point, TP10, is connected to the +15.6 volt bus. The other 8 test points are located at selected points within the logic circuitry and may be used to trace outputs and to make settings on time delay cards.

CIRCUIT DESCRIPTION

Internal connections for the tap block unit are shown in Fig. 12. Input currents and voltages are identified at the left of the drawing, where numbers within squares represent YA terminal block numbers. Output signals are represented by the double-arrow connector symbol and corresponding wire or socket pin number at the right of the drawing.

Output signal leads for the MT and MB functions are grouped together in interconnecting cables by phases. All signals for phases 1-2 are in the C011 calbe (having leads 11 to 20), those for phases 2-3 are in the C021 cable, and those for phases 3-1 are in the C031 cable. All over-current output signals are in the C041 cable, and all MOB signals are in the C051 cable.

Internal connections for the SLY13A logic units are shown in Fig. 13, and a legend of symbols used in this and other static relay drawings is shown in Fig. 14. All inputs to the SLY13A logic unit are from the tap block unit, except the supply voltage from the power supply, and all outputs are connected to a Type SLA pilot logic and trip unit.

A schematic representation of the a-c circuits for phases 1-2 is shown in Fig. 15. This drawing combines the parts of the circuit that are in the tap block unit with the parts that are in the logic unit to give a better understanding of the input signals to the logic unit cards. Phases 2-3 and 3-1 are similar in arrangement except for the addition of MOB in phases 2-3.

The MT card is supplied with a polarizing voltage taken directly from the relay input voltage, V1-2, and passed through a series L-C memory circuit and an isolating transformer. The other input to the MT card is (IZ - V), with the IZ component coming from the MT transactor TG, and the V portion coming from the MT tap on the tapped autotransformer TA. The (IZ - V) voltage is limited by diode-clippers on the primary of the 1:6 transformer feeding the D11 card.

In the MB function, the polarizing input voltage is (IZ V), with the IZ portion coming from the MB* tap on transactor TD, and the V portion from the MB* tap on autotransformer TA. This circuit contains a series L-C memory circuit, and an R-C polarizing phase shift circuit, the latter a necessary part of the block-spike measuring scheme. The (IZ - V) circuit is similar to that for MT, except that it is obtained from MT taps on the autotransformer and on transactor TD.

The MB transactor voltage is also used to supply a signal, proportional to $I_1 - I_2$, to the overcurrent level detector, D13, in the logic unit.

Referring now to the logic diagram of Fig. 13, outputs of the three MB cards are paralleled and connected to a P/9 "pulsestretcher" which converts the spike output of the D3 card to a continuous output signal. This output can be monitored at TP8, and is passed to the "pilot logic and trip" SLA12A through lead 63 in cable C061.

Each of the MT cards has two outputs, one for each polarity, and these are supplied to 4/9 timers (4.15 millisecond operat, 9 millisecond reset) to produce the mho characteristic. All 4/9 outputs are connected in parallel to test point TP2 and to lead 66 in the C061 cable.

The MOB function measures on phases 2-3 only and uses a single 4/9 timer. Its output is available at TP7. During a power swing condition, when the apparent impedance seen by the relay passes first through the MOB and later through the MT characteristic, the blocking output is obtained if the swing is slow enough for the A/0 timer to operate before MT operates. The fact that MT has not operated permits A/0 to begin timing, because of the NOT input to the AND-3 card. If the A/0 card does produce an output before MT operates, this A/0 output is fed back to the AND-3 input so that later MT operation does not interrupt the A/0 output.

The MT tripping circuit consists of MT output at TP2, followed by a 4 millisecond delay and the circuit of AND-2. The 4 millisecond delay, when added to the minimum MT operating time of 4 milliseconds, gives a minimum MT operating time of 8 milliseconds, which is equal to the maximum MB operating time. The AND-2 card produces an output if there is an (MT + 4) output, an OC (overcurrent) output, and NOT an MOB output. (The circle on pin 4 signifies NOT). If the overcurrent fault detectors are taken out of the circuit by moving the OC link to the OUT position, a plus voltage signal is applied continuously to the pin 6 input of the AND-2 card, permitting an output for (MT + 4) AND NOT MOB.

The function of AND-1 is to provide a seal-in signal to maintain the output trip signal even though the fault voltage is so low that MT does not maintain an output signal throughout the fault duration (polarizing voltage must be present for an MT output, and memory maintains it for approximately 2 cycles). Once a phase trip signal appears in the SLA12A relay, this signal is fed back through cable lead 65, through the 4/0 timer to AND-2 and the output signal is maintained. The overcurrent input to AND-1 breaks the seal-in when the breaker clears and the current drops to zero.

INSTALLATION TESTS

NECESSARY ADJUSTMENTS

The following adjustments should be made by the user, in accordance with the instructions given below, before putting the relays into service.

(1) Reach IZ taps, MT, MB, MB*, and MOB.
(2) MT reach by voltage tap setting.
(3) MB and MB* reach by voltage tap setting.
(4) MOB and MOB* reach by voltage tap setting, is used.
(5) Overcurrent operate level, if used.
(6) A/0 time setting, if MOB used.
(7) MT phase angle, if other than 60°.
(8) MOB phase angle, if other than 60°.

Connect all interconnecting cables from tap block to logic units, and from logic unit to power supply, before beginning tests.

GENERAL TESTING INSTRUCTIONS

1. Input Circuits

The SLY13A tap block unit has a 10-point terminal block on the rear of the unit, identified as the YA terminal block. Where the drawout case test facility is used, this is connected to the YA block on the tap block unit by a 10-conductor cable and input currents and voltages can be supplied through the standard Type XLA test plug. Where other test facilities are used, input currents and voltages should be applied to test points which connect to the same YA terminal points as those shown on the test circuit diagrams.

2. Output Signals

The SLY13A logic unit has a test card in the T position. This test card has 10 pin jacks mounted on the outer edge of the card and numbered 1 to 10 from top to bottom. These jacks are the test points shown as TP1 to TP10 on the SLY13A logic diagram, Fig. 13.

Output signals are measured with respect to the reference bus, or TP1, the upper jack on the test card. Outputs are continuous signals of approximately + 10 to + 15 volts for the ON condition, and 0 volts for the OFF condition. This output can be monitored with an oscilloscope, a portable high impedance d-c voltmeter, or with the test panel voltmeter if available. When the test panel voltmeter is available, the voltmeter negative terminal will normally be connected to the reference bus, and placing the relay test lead in the proper test point pin jack will connect the meter for testing.

Where time delay cards (T2, T4, etc.) are to be adjusted or checked, an oscilloscope which can display two traces simultaneously and which has a calibrated horizontal sweep should be used.

CAUTION: It is a design characteristic of most electronic instruments that one of the signal input terminals is connected to the instrument chassie. Since the SLY13A reference voltage, which normally will be connected to the ground input of the instrument, is near the (+) station battery voltage level, the instrument chassie must be insulated from station ground. If the instrument power cord contains a third lead, that lead must NOT be connected to station ground. However, if the input to the oscilloscope is a differential amplifier and neither incoming signal lead is tied directly to the instrument ground, it is not necessary to observe the above precautions.

DETAILED TESTING INSTRUCTIONS-REQUIRED ADJUSTMENTS

1. Reach Tap Settings

The arrangement of the reach-setting tap blocks is described under the section on CONSTRUCTION, and the choice of tap settings. is discussed under the section on APPLICATION. Make tap settings in accordance with those instructions, moving only the knurled screws (and associated jumpers) to get the desired relay reach setting.

The IZ tap block for MT has two taps, 0.75 and 3 ohms. The 0.75 ohm tap should be used for reach values between 0.75 and 2.9 ohms, and the 3 ohm tap for values between 3 and 30 ohms. All of these values are line-to-neutral ohms.

The IZ tap block for MB provides the same choice of taps in both the reverse, or MB* direction, and the forward direction. It also provides a 0.2 ohm tap in the forward direction. This is intended for use where only a very small amount of forward reach is desired, and can be used for MB settings between 0.2 and 0.75 ohms.

The IZ tap block for MOB provides a choice of two taps, 2 and 6 ohms. The 2 ohm tap should be used for reach settings between

6 and 60 ohms.

For details of voltage tap settings, see the section headed CONSTRUCTION.

2. Testing Mho Characteristics

The mho characteristics may be checked over a portion of their range by using the test circuit shown in Fig. 16. This circuit uses the test box (102L201), test reactor (6054975) and test resistor (6158546) described in GEI-44236. Combinations of resistor and reactor taps may be chosen to provide 30° and 60° angles between the voltage and current supplied to the relay. The resistor alone supplies a 0° angle, and the reactor alone gives an angle near 90°. Therefore, four points in the first quadrant may be checked using this equipment. In addition, the voltage connection to the relay may be reversed, and four points in the third, or reverse, quadrant checked.

At any given test angle, the impedance of the test resistor-reactor combination must be more than twice the phase-to-neutral reach of the relay at that angle, because the test simulates a phase-to-phase fault where the relay sees twice the phase-to-neutral ohms. If the test box selector switches are reduced from 100% until a steady-state relay output (10 to 15 volts) is observed, the selector switch setting indicates the relay phase-to-phase reach as a percentage of the resistor-reactor ohms. For example, if the resistor-reactor ohms are 12 ohms, and the selector switch setting is 75, the relay reach at that angle is 75% X 12 = 9 ohms phase-to-phase, or 1/2 (75% X 12) = 4.5 ohms phase-to-neutral.

NOTE: The use of the test box may produce a transient output from the MB or other functions because the test box removes all voltage as the knobs are switched from one tap to another. This is not an indication of transient overreach, and therefore only the steady-state output should be used in determining the relay characteristic.

Input connections for checking any of the mho characteristics should be made in accordance with Fig. 16 and Table I. These connections provide measurements in the forward direction (along the protected line).

TABLE I

	CONNECT YA TERMINALS TO POINTS IDENTIFIED BY LETTERS IN FIG. 16					
	A	B	C	D	E	F
PH 1-2	YA-2	YA-3	YA-5	YA-6	YA-8	YA-7
PH 2-3	YA-3	YA-4	YA-7	YA-8	YA-10	YA-9
PH 3-1	YA-4	YA-2	YA-9	YA-10	YA-6	YA-5

Output signals are used at the test points shown in Table II. In addition, certain cards should be removed (or pulled forward far enough to disengage the pins) in order to be sure that the output observed is from the phase being checked.

TABLE II

	MT		MB		MOB
	OUT-PUT	REMOVE CARDS	OUT-PUT	REMOVE CARDS	OUT-PUT
PH 1-2	2	AJ,AM	8	F,G	-
PH 2-3	2	AF,AM	8	E,G	7
PH 3-1	2	AF,AJ	8	E,F	-

A more complete relay characteristic may be obtained by using the test circuit of Fig. 17, which contains a phase-shifter and phase-angle meter. The connections of Tables I and II apply to Fig. 17 as well as to Fig. 16.

3. Overcurrent Function Operate Level

The three overcurrent fault detector cards (D13 cards in J, K, L position) can be tested, and their operating level can be adjusted in the following manner. Apply current, through a rheostat, to the terminals shown in Table III, and read output at test point TP5. Output voltage is + 10 to + 15 volts when unit operates. To adjust operate level, turn rheostat on tap block front panel, using the appropriate rheostat for the phase pair being checked. Turn rheostat CLOCKWISE to increase operate level. Increase current slowly to check operate level. Decrease current slowly to check reset level.

TABLE III

	YA TERMINALS			
	IN	OUT	JUMPER	OUTPUT
PH 1-2	5	7	6-8	TP5
PH 2-3	7	9	8-10	TP5
PH 3-1	9	5	10-6	TP5

NOTE: This test corresponds to a phase-to-phase fault where the two currents involved are in phase. The operating level for 3-phase faults is 16% higher than the value observed in this test.

4. OB Function Time Setting

The out-of-step time delay card, A/0, is in the R position. It can be adjusted for an operate delay in the range of 2 to 4 cycles (33 to 67 milliseconds) and has no delay on resetting. TP7 can be used for the input signal and TP6 can be used to monitor the output. Connect a switch between TP10 and TP7 to supply the proper input signal, and use this signal to trigger the sweep of an oscilloscipe. Connect the TP6 output voltage to the oscilloscope (with TP1 connected to oscilloscope ground) and observe the time from beginning of trigger to rise of output voltage. Adjust potentiometer on TP7 card in R position to change time delay, turning potentiometer clockwise to increase delay.

5. MT Phase Angle Rheostat

The MT phase angle rheostats, located on the front panel of the tap block unit, are normally adjusted to produce a 60° maximum reach angle of the MT characteristic. These rheostats are loading resistors on the secondaries of transactors in the (IZ-V) circuit for the MT function. A 60° maximum reach angle results when the transactor secondary voltage leads the transactor primary current by 60°. If it is desired to increase the maximum reach angle to 75°, or to any angle between 60° and 75°, this can be done by unloading the transactor to make its transfer impedance angle, 0, equal to the desired maximum reach angle.

A preliminary adjustment can be made using the circuit of Fig. 18, which applied approximately 5 amperes to the primary of the transactor and measures output angle at the MT card input. Set the voltage tap to zero for the phase being checked, so that the (IZ - V) output is IZ only. Remove the MT card on the phase being checked and insert a test card to gain access to the pin 3 and pin 5 points in the card socket. Connect to a dual trace oscilloscope as shown.

The Channel A voltage, taken across the 24 ohm tap of a 6054975 test reactor, provides a reference voltage that leads the transactor primary current by 87.5°. The output voltage will be a flat-topped wave, whose zero-crossings can be compared with the reference voltage to determine the output voltage angle 0. The calibrated horizontal sweep of the oscilloscope can be used to measure time between zero-crossings, which can be converted to degrees by the constant 1 millisecond = 21.6°. The following table may be helpful in converting time measurements to angle measurements:

0	87.5 - 0	Time
60	27.5	1.27 ms
65	22.5	1.04 ms
70	17.5	0.81 ms
75	12.5	0.58 ms

The angle 0 can be changed by adjusting the MT phase angle rheostat, being careful to adjust the proper rheostat for the phase being checked. Turn the rheostat adjusting screw clockwise to increase phase angle.

After this adjustment has been made, the MT characteristic should be checked, using the test circuit described above under REQUIRED ADJUSTMENTS. If the resulting maximum reach angle is not close enough to the desired maximum reach angle, the difference in degrees should be noted, and a second adjustment of the MT phase angle rheostat by this amount should be made to obtain the desired characteristic.

6. MOB Phase Angle Rheostat

Since the MOB function is used with the MT function, it may be desirable to adjust the MOB characteristic whenever the MT characteristic is changed. The phase shift can be checked as described above for MT, using the phase 2-3 input connection, and checking output at the N position. Check MOB characteristic as described above under TESTING MHO CHARACTERISTICS.

Additional Adjustments and Tests

The following information covers items which have been covered in factory tests. This information is supplied for use in trouble shooting or in checking overall performance of the various SLY13A functions.

1. T11 (4/9) Time Delay Cards

These cards should have a 4.15 millisecond delay on operate time and a 9 millisecond delay on reset time. The 4.15 millisecond time is important in making the 90° measurement and affects the shape of the mho characteristic: times longer than 4.15 milliseconds tend to narrow the characteristic and times shorter than 4.15 milliseconds tend to widen the characteristic. The 9 millisecond reset time is provided to overlap the next half-cycle measurement and produce a continuous output.

To check the 4/9 timers in the MT circuits, connect the test circuit used above for checking MT characteristic, and reduce the applied voltage until the fault condition applied to the relay is within the relay characteristic. Consider phase 1-2 first. Remove the MT cards in the other phases (AJ and AM positions) and the 4/9 card from the AG position. Use a card adapter with the AE position card to get access to its input terminal, AE-6. Connect the input to this card to one channel of a dual trace oscilloscope and the output (TP2) to the other channel.

Typical waveshapes for this test are shown in Fig. 19. The AE card receives the pin 7 output from the MT card, and this output should be blocks greater than 4 milliseconds long, with gaps longer than 8 milliseconds. Changing applied fault voltage changes the width of the block. The 4/9 timer should operate 4.15 milliseconds after the beginning of each pin 7 output block, and should drop 9 milliseconds after the end of the pin 7 block. If adjustments are necessary, use the potentiometer screws on the 4/9 card to make changes. Turn the inner potentiometer CW to increase operate time, and turn the outer potentiometer CW to increase reset time. These potentiometers can be turned approximately 20 turns for complete travel from one end to the other.

Place the card adapter in the AG position and place the AG position 4/9 card in the adapter. Repeat the procedure described above to check and adjust this card. The input to this card is the pin 8 output from the MT card, and appears on the opposite half cycle to that for the pin 7 output.

Replace both 4/9 cards (AE and AG) and check TP2 output to be sure that output is continuous.

Repeat this procedure for the phase 2-3 and phase 3-1 circuits, in each case removing the MT cards from the other two phases, and applying input current and voltage to the proper terminals for the phase pair being tested. Refer to Fig. 13 for identification of 4/9 cards.

As a final check on the accuracy of the 4.15 millisecond setting, the MB characteristic may be rechecked and compared with the desired characteristic. If half-cycle output is observed at the threshold of operation, this can be corrected by a finer adjustment of the two 4/9 timers on the phase being checked.

The 4/9 card in the MOB circuit requires a different procedure, since the two outputs of the MOB card are connected together and only one 4/9 card is used. Connect current and voltage inputs as described under TESTING MHO CHARACTERISTICS for clocking phase 2-3 relay characteristic, and place P position 4/9 card in card adapter. Connect 4/9 card input (pin 6) to one channel of oscilloscope, and 4/9 card output (TP7) to the other channel.

Refer to Fig. 20 for wave shapes for this test. Input to 4/9 card should be blocks slightly longer than 4 milliseconds (adjust applied a-c voltage, if necessary, to obtain this). These blocks occur every half-cycle, however, and gaps are less than 4 milliseconds long. In order to observe the operate delay time, the reset time must be reduced (turn outer pot CCW) so that 4/9 output resets each half cycle. The 4.15 millisecond operate time can be checked and adjusted with this short reset time (turn inner pot CW to increase operate time) and then the reset time can be increased until output becomes continuous (turn outer pot CW to increase reset time).

2. <u>T4 (4/0) Time Delay</u>

This card is in the AP position, and should produce a 4 millisecond delay on operation and no delay on reset. It can be checked using the MT card to generate blocks slightly longer than 4 milliseconds by connecting the relay characteristic circuit of Fig. 16, using connections for phase 1-2, removing the AE and AG position cards, and connecting a jumper from AE-6 to TP2. The AE-6 point can be made accessible by placing a test card in the AE position. Connect the 4/0 card input, TP2, to one channel of an oscilloscope, and the 4/0 card output, TP3, to the other channel. Adjust input a-c voltage so that input blocks at TP2 are longer than 4 milliseconds.

Typical wave shapes for correct operation are shown in Fig. 21 Output should begin 4 milliseconds after beginning of input block, and end at the same time that input block ends. If adjustment is necessary, turn pot on 4/0 card CW to increase operate time delay.

3. <u>T2 (P/9) Pulse Stretcher</u>

The purpose of these pulse stretchers is to convert the output of the MB cards to a continuous output. Pulses occur every 8 milliseconds (1/2 cycle) and the 9 millisecond reset time provides overlap from one pulse to the next.. The reset time does not have to be exact, but it should be long enough to produce continuous output without being excessively long.

To check the P/9 operation, connect relay characteristic circuit of Fig. 16, using connections for phases 1-2 and reduce voltage until MB output is indicated at TP8. Reduce reset time of P/9 card by turning potentiometer screw CCW until gaps begin to appear in MB output. Then turn screw CW to increase reset time until output is continuous again.

MAINTENANCE

PERIODIC TESTS

NOTE: For any periodic testing of the SLY13A, the trip coil circuit of the circuit breaker should be opened by removing one of the connection plugs in the SLA relay test and connection receptacle, or by opening other test switches provided for this purpose. Removing the connection plug at the YA test and connection receptacle does not open the trip circuit.

Reach of the MT, MB, and MOB functions and overcurrent operate level may be checked at periodic intervals, using the instructions under "INSTALLATION TESTS". Cable connections between the SLY13A and the SLA relay may be checked by using push-buttons in the SLY13A to produce CARRIER START and TRIP outputs. The CARR. START button should start a pilot channel blocking signal. The TRIP button should produce a tripping output from the SLA and light the PH target light in the SLA. Tripping output from the SLA can be checked by an actual circuit breaker trip operation, by operating an auxiliary relay (HEA), or by energizing a resistive load (less than 3 amperes).

TROUBLE-SHOOTING

Test points are provided at selected points in the SLY13A card unit and may be used to observe outputs if trouble-shooting is necessary. The use of a card adapter will make all the pins on any one card available for testing.

All output voltages at the test points are measured with respect to the reference bus, TP1, and under normal conditions are less than 2 volts. When an output appears at any test point, the voltage at that point switches to a continuous ON signal (+ 10 to + 15 volts).

The test points in the SLY13A relay are identified below:

TEST POINT	FUNCTION
TP1	REFERENCE (0 Volts)
TP2	MT Output
TP3	MT + 4 ms Output
TP4	Phase Trip (from SLA)
TP5	Overcurrent Output
TP6	A/O Timer Output
TP7	MOB output
TP8	MB Output
TP9	Local Phase Trip Output
TP10	+ 15.6 VOLT BUS

The physical location of components (transactors, transformers, etc.) in the tap block unit is shown in Fig. 22. The location of components behind the printed circuit card area in the logic drawings refer to components shown on internal connection diagrams, Figs. 12 and 13.

SPARE CARDS

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

1 spare for 1 to 25 cards
2 spares for 26 to 75 cards
3 spares for 76 to 150 cards

The following table lists the quantity of each type of printed circuit card used in the SLY13A relay and the part numbers to be used in ordering spare cards. These numbers are stamped on the individual cards.

CODE	PART NUMBER	QUANTITY
D11	0116B6773G1	4
D13	0116B6775G1	3
D18	0128B1371G1	3
L3	0116B4989G1	1
L4	0116B6777G1	1
L6	0116B6666G1	1
T2	0116B6642G1	1
T4	0116B4945G1	1
T7	0116B4947G1	1
T11	0116B6648G1	7

CARD DRAWINGS

Details of the circuits of the printed circuit cards are shown in Fig. 24.

OUTLINE DRAWINGS

Outline drawings are shown in the following Figs:

Fig. 25 - Tap Block Unit
Fig. 26 - Logic Unit
Fig. 27 - Test & Connection Receptacle

Revised: July 7, 1964

APPENDIX I

3-Terminal Applications

The ideal performance of a line relaying system for either a 2-terminal or a 3-terminal line may be defined in very broad and simple terms, as follows:

> Trip all terminals simultaneously for any INTERNAL fault at any location with any expected distribution of current contributions.
>
> Trip no terminal for an EXTERNAL fault at any location with any expected distribution of current contributions.

It is the choice of settings for the MT, and MB units which needs to be analyzed in detail in order to insure that both of these requirements will be met. These requirements are <u>not peculiar</u> to static relaying, but apply equally to electro-mechanical relaying.

1. In order to provide simultaneous tripping of all three terminals, it is necessary to use reach settings of the mho units MT, large enough to insure that all three terminals will respond with margin, for an INTERNAL fault at any terminal with all three closed, regardless of the possible outage of some adjacent external line connection two terminals either directly or indirectly, or outage of some external source forming part of the system near a given terminal.

2. It is necessary to choose reach settings of the blocking mho units MB at the fault terminal (s) large enough to insure that the blocking relay at one or the other fault terminal will respond with margin, for any external fault at the limit of reach of the tripping units.

3. It is necessary to check the resulting R-X characteristics of the blocking units MB to insure that they will not be operated by the maximum emergency loading unless:

    (a) Continuous carrier is permissible, for this condition, and
    (b) Out-of-step blocking can be omitted at this terminal, and
    (c) The minimum apparent impedance of a load swing is not small enough to trip MT at this terminal.

These points will all be considered in the order just listed.

It may not prove to be feasible to meet the first requirement, of obtaining response of all terminals for every fault, if there are external ties between the source and the fault terminals, or if one of the terminals lacks a source of generation; and in such cases, some special provision must be made if simultaneous tripping is required. It is even possible to have fault current flowing out of one terminal through an <u>external</u> tie, to an <u>internal</u> fault near another terminal; and in such a case, special provision must be made in order even to <u>permit</u> the tripping of the obher two terminals.

MT Settings

The calculation of the apparent impedance resulting from infeed to the junction J (Fig. 284) requires knowledge of the maximum current contributions from other terminals, and, therefore, requires a fault study that takes into account possible outages of lines or generation or both, external to the protected line. With this data at hand, the apparent impedances for terminal A can be calculated from the relations:

$$I_{AB} = I_{AJ} + Z_{JB} \quad (I_{AJ} + I_{CJ}) \quad / I_{AJ}$$

and:

$$Z_{AC} = Z_{AJ} + Z_{JC} \quad (I_{AJ} + I_{BJ}) \quad / I_{AJ}$$

Similar relations, except with the subscripts interchanged, apply for the two apparent impedances seen by the relays at B for faults at C or A, and by the relays at C for faults at A or B. These six results can all be tabulated, like those in Table A-1, which were calculated for a specific case where one of the line terminals included a power transformer. The actual current is also tabulated for convenience in setting the overcurrent fault detectors, if used.

TABLE A-1

APPARENT OHMS & ACTUAL CURRENT SEEN BY RELAY TERMINAL FOR FAULTS AT:	A		B		C	
RELAY TERMINAL	Z_{APP}	$I_{\phi-\phi}$	Z_{APP}	$I_{\phi-\phi}$	Z_{APP}	$I_{\phi-\phi}$
A	0	69.0	1.96	19.8	4.46	10.4
B	4.82	8.6	1.70	19.1	4.50	9.0
C	6.56	5.3	1.34	10.8	0	16.0

In each horizontal row, representing conditions seen by a given relaying terminal, the higher of the two values for faults at the other terminals is underlined. This is the value on which the forward reach setting Z_F should be based, and the MT reach suggested for 3-terminal lines is 1.25 X the apparent impedance:

$$Z_F - 1.25\ Z_{APP}$$

MT Settings

Since the line angle $\emptyset$ will probably exceed the maximum-reach angle θ of MT by an appreciable amount, this difference should be taken into account by using the following expression to determine the restraint tap setting which fixes the diameter:

$$T_R = \frac{100\ Z_{MIN}}{\frac{Z_F}{\cos\ (\emptyset-\theta)}}$$

MB Settings

The calculation of this setting for a given terminal may take either one of two different forms, depending on the nature of the external circuits and sources. One method of calculation applied where there is no external condition which can cause the terminal under calculation to act as a single source terminal, supplying current simultaneously through the other two terminals to an external fault on some line between them; this is identified as "1 Fault Terminal".

The other method of calculation applied where a single source terminal can, under some conditions, supply fault current simultaneously through both of the other two terminals as fault terminals feeding a single fault within some range of location along an external tie between these two terminals; this is identified as "2 Fault Terminals".

MB Setting, 1 Fault Terminal

If the setting of MB at terminal A is being calculated for an external fault outside terminal A, and if there is no external fault condition which will cause both terminals A and B to act as fault terminals (such as an external tie between them), then one minimum reach setting of MB and A can safely be calculated on a 2-terminal basis, from the line impedance Z_{BJ} Z_{AJ} and the forward reach of MT at B, by the following relation, which gives 25% reach of MB(A) beyond MT(B):

$$MB(A) = 1.25\ \ MT(B) - (Z_{BJ} + Z_{AJ})$$

Likewise, if the setting of MB at terminal A is being calculated for an external fault outside terminal A, and if there is no external fault condition which will cause both terminals A and C to act as fault terminals (such as an external tie between them), then the other minimum reach setting of MB at A can safely be calculated on a 2-terminal basis, from the line impedance $Z_{CJ} + Z_{AJ}$ and the forward reach of MT at C, by the following relation, which gives 25% reach of MB(A) beyond MT(C):

$$MB(A) = 1.25\ MT(C) - (Z_{CJ} + Z_{AJ})$$

For MB(A) use the greater of the two minimum reach settings calculated above.

For MB(B) setting, follow a similar double procedure with subscripts interchanged, B, C, and A instead of A, B, and C respectively.

For MB(C) setting, follow a similar double procedure with subscripts interchanged, C, A, and B instead of A, B, and C respectively.

MB Setting, 2 Fault Terminals

With an external tie between terminals, the location of the fault on that external tie may be such as to divide the contribution from the single source terminal equally between two fault terminals giving a parallel impedance of the two branches (Fig. 28B) still low enough to cause the tripping mho unit MT at the source terminal to respond to the fault. The settings chosen for the blocking fault detectros at the two fault temminals must be such that for any external fault beyond them, one or the other will respond. In order to provide margin for blocking, at least one MB should respond for any fault that would be within the reach of an MT unit with a reach 1.25 times as great as the actual value.

MB Setting, 2 Fault Terminals, No Help From Infeed

To arrive at MB seetings which are safe for this particular 2-fault terminal condition with a minimum of calculations, it may be assumed that the external loop BC is just long enough to permit MT(A) to reach every portion of the loop in the absence of infeed at B or C; if it were any longer, or if there were a reliable minimum infeed at B or C, there would be a dead zone D with limits D(B) and D(C), between which any fault that occurred would not operate MT(A) with its reach increased by 25%. Then minimum reach settings of MB(B) and MB(C) may be chosen, each of which will just reach the dead point D of the loop JBDCJ including the 25% margin on the setting of MT(A). For a fault at D, MB(B) and MB(C) will both provide blocking. For a fault nearer B or C, only MB(B) or MB(C) will provide blocking, but that is sufficient. If the external tie is open at either end, there is only a single fault terminal, and the impedances seen by MT(A) will be higher because it is all single-circuit impedance, not partially parallel-circuit impedance, and the settings chosen for MB(B) and MB(C) on the basis of 2 fault terminals will be more than adequate to provide blocking of A.

On the above basis, the minimum safe reach settings of MB at B or C with respect to A can be calculated from the following expressions, which include the 25% margin factor on the reach of MT(A):

$$\text{MIN (A) MB(B)} = 2.5\ \text{MT(A)} - 2Z_{AJ} - Z_{BJ}$$

$$\text{MIN (A) MB(C)} = 2.5\ \text{MT(A)} - 2Z_{AJ} - Z_{CJ}$$

where MB and MT are in units of ohms along the line.

It should be borne in mind that the minimum reach settings determined for MB(B) or MB(C), for the condition of A acting as the source terminal, may be lower than the minimum settings for MB(B) with C as a source terminal, or for MB(C) with B as a source terminal. Therefore, two calculations must be made for the minimum MB settings at any given terminal, and the higher minimum must be used.

MB Setting, 2-Fault Terminals with Infeed

If this results in specifying an underirably long reach of MB at either B or C from the standpoint of load capability, and if there is some minimum value of infeed that can be relied upon at B or C for a fault on the lowest-impedance tie between them, then it is possible to take advantage of this infeed to reduce the reach of MB at B or C or both, and yet maintain the desired 25% margin. This is true because the infeed increases the apparent impedance of the circuits leading from B and/or C toward the fault (Fig. 28C).

In the presence of infeed at B and/or C the apparent impedance at A for a fault at F on the lowest-impedance tie between B and C is given by the following expressions:

$$Z_A = (I_{AJ}Z_{AJ} + I_{JB}Z_{BJ} + I_{BF}Z_{BF})\ /I_{AJ}$$

or:

$$Z_A = (I_{AJ}Z_{AJ} + I_{JC}Z_{CJ} + I_{CF}Z_{CF})\ /I_{AJ}$$

The assumed location of the fault along the tie affects the apparent impedance because it affects the values of Z_{BF} and Z_{CF} directly, and the values of I_{BF} and I_{CF} indirectly. There is some fault location which gives a minimum value of Z_A, but this does not necessarily permit the most desirable combination of settings of MB at B and C. If some fault location is found, which permits using settings that are satisfactory from the standpoint of load capability, or shorter than those required for some other condition on the 3-terminal line, then there is no need in trying other fault locations.

For any assumed fault location, there are three possibilities; Z_A may be less than, equal to, or greater than 1.25 X $MT_{(A)}$. MB Setting, 2 Fault Terminals with Infeed, $Z_A > 1.25 \text{ X } MT_{(A)}$

If the value of Z_A calculated for the assumed fault location is less than 1.25 X $MT_{(A)}$, it is necessary to choose minimum settings of MB at B and C which will each barely block with a fault impedance Z_F added to Z_A so that Z_A Z_F equals 1.25 X $MT_{(A)}$.

With this added impedance, the desired reach settings for $MB_{(B)}$ and $MB_{(C)}$ respectively are given by the following expressions:

$$MB(B) = (1.25MT(A)-Z_A)\ (I_{BF}+I_{CF})\ /I_{BF}+Z_{BF}(I_{BF}/I_{JB})$$

$$MB(C) = (1.25MT_{(A)}-Z_A)\ (I_{BF}+I_{CF})/I_{CF}+Z_{CF}(I_{CF}/I_{JC})$$

Z_{BF} and Z_{CF} are measured to the assumed fault location, not including the fault impedance.

MB Setting, 2 Fault Terminals with Infeed, $Z_A = 1.25$ X $MT_{(A)}$

If Z_A equals 1.25 X MT(A), the desired settings are:

$$MB(B) = Z_{BF}I_{BF}/I_{JB}$$

$$MB_{(C)} = Z_{CF}I_{CF}/I_{JC}$$

MB Setting, 2 fault Terminals with Infeed, $Z_A > 1.25$ X $MT_{(A)}$

Under this condition, for any chosen fault location F along the external tie BC, the following minimum reach settings must be observed:

$$MB_{(B)} = (1.25\ MT_{(A)} - Z_{AJ})\ \frac{I_{JB}+I_{JC}}{I_{BF}} - \frac{Z_{JB}\ I_{JB}}{I_{BF}}$$

$$MC_{(C)} = (1.25\ MT_{(A)} - Z_{AJ})\ \frac{I_{JB}+I_{JC}}{I_{CF}} - Z_{JC}\ \frac{I_{JC}}{I_{CF}}$$

These settings are not necessarily safe for some other fault location along the external tie BC, so enough different fault locations must be calculated to permit plotting curves of the minimum settings of the two units, bearing in mind that it is sufficient if only one of them operates for any given location. However, if sufficient points are calculated, there will be some balance point where both units will operate.

If calculations for this situation of $Z_A > 1.25$ X $MT_{(A)}$ are too tedious, it may be feasible not to take advantage of the effect of infeed.

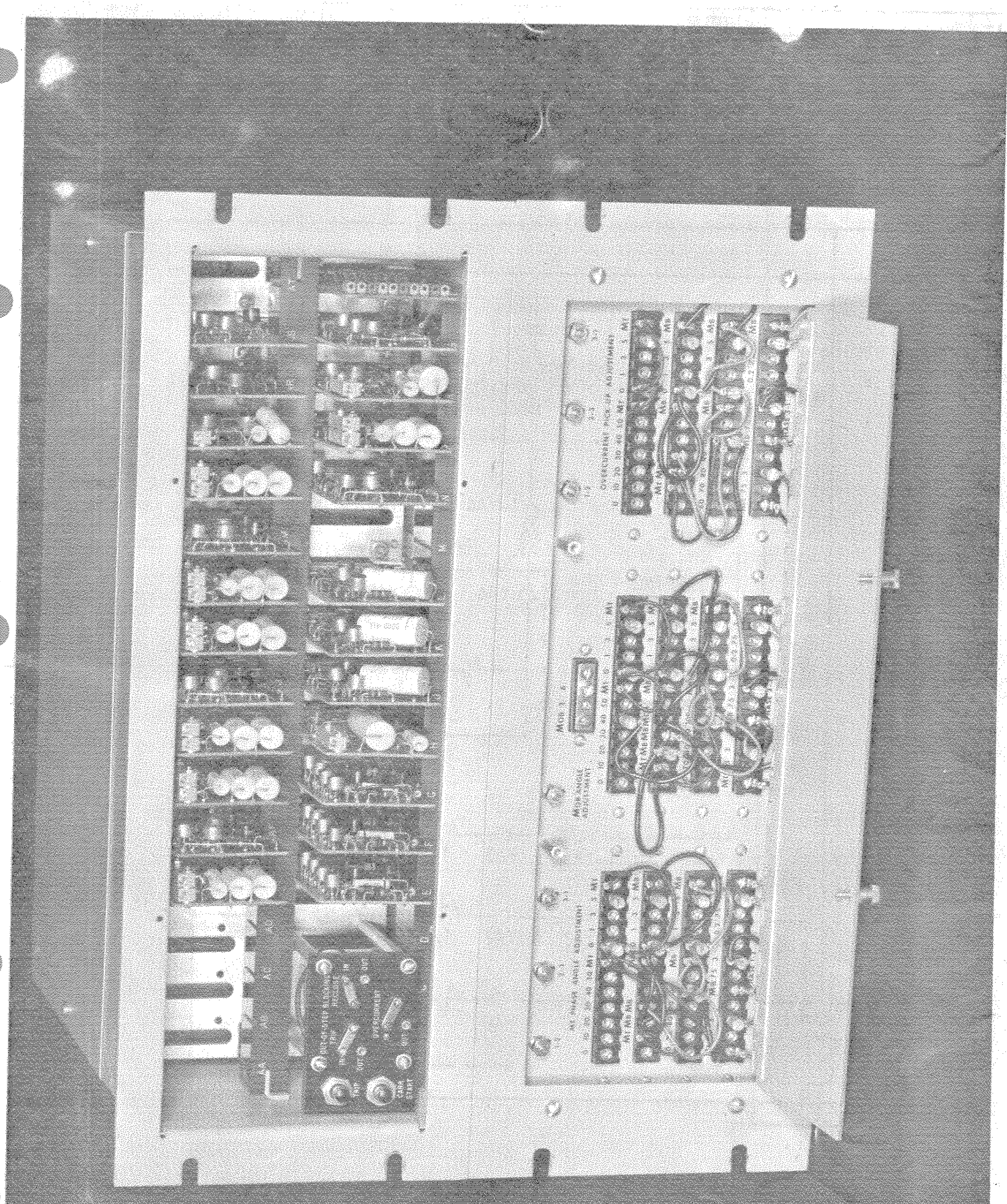
MB Setting, Comparison with Maximum Emergency Load

The clearest way to make this comparison is to convert the maximum emergency MW and MVAR values into apparent secondary impedance at rated voltage, and plot it on the same R-X diagram with the tripping and blocking mho characteristics.

Continuous carrier from a given terminal may be permissible on some lines, as outlined under 3, in this Appendix. Otherwise, some tradeoff between the MB settings of two terminals may be possible for the purpose of increasing the load capability while still obtaining blocking by one or the other of these two fault terminals, for any possible fault location within the reach of MT at the third (source) terminal.

MB Setting

After the reach setting of each MB has been chosen, make the settings by the procedure described under "2 Terminal Applications".



CLASS A

GENERAL ELECTRIC

0178A7010

CONT ON SHEET SH NO.

REV. NO. -)-

0178A7010

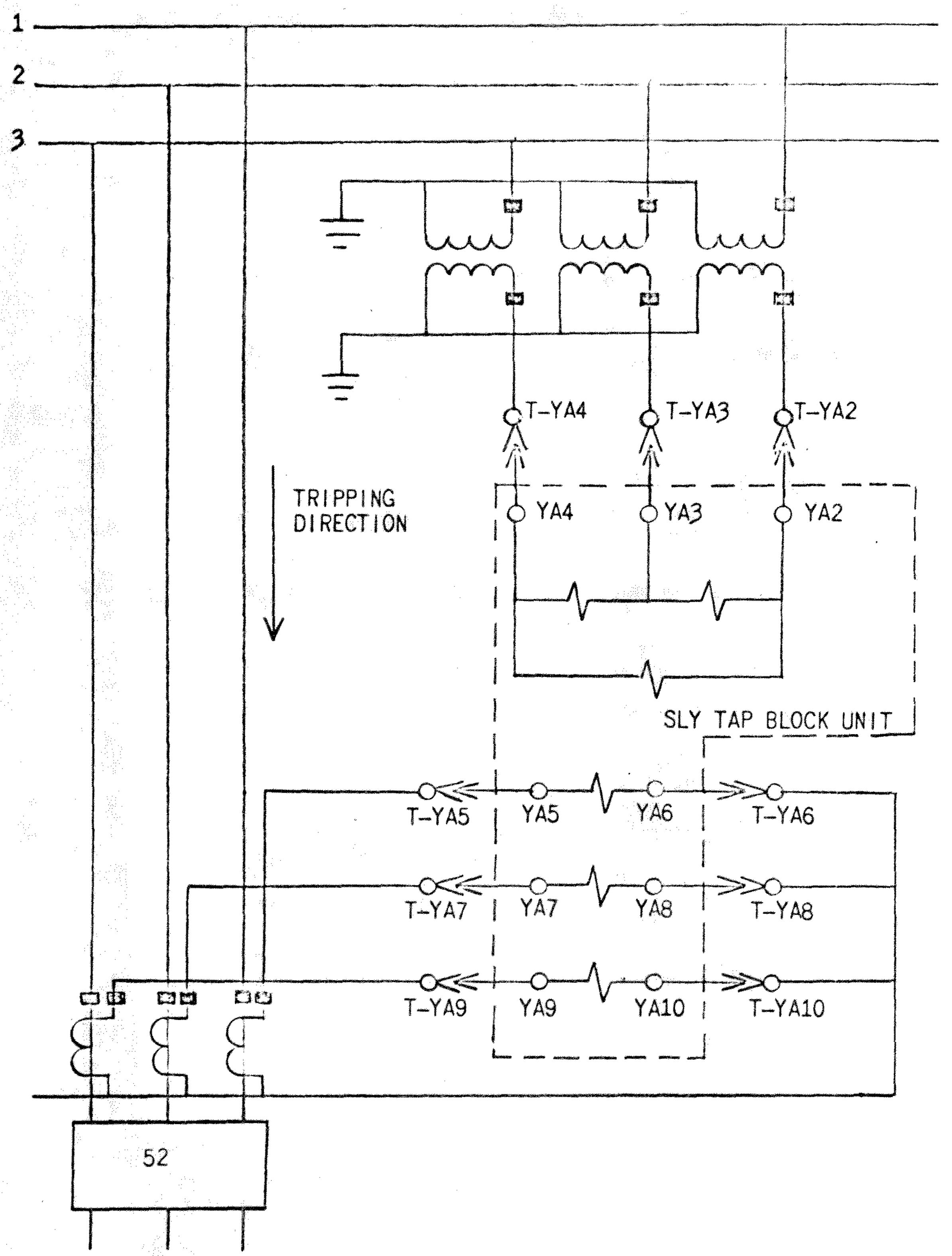
CONT ON SHEET SH NO.

TITLE
EXTERNAL CONNECTIONS
TYPE SLY11B RELAY

FIRST MADE FOR

FIG-2

REVISIONS



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MADE BY A. Mc... March 19, 1964
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APPROVALS Cam

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PHILADELPHIA — LOCATION

0178A7010

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FF-803-WA (6-63)

GENERAL ELECTRIC 0178A7011

REV NO. -1-

0178A7011

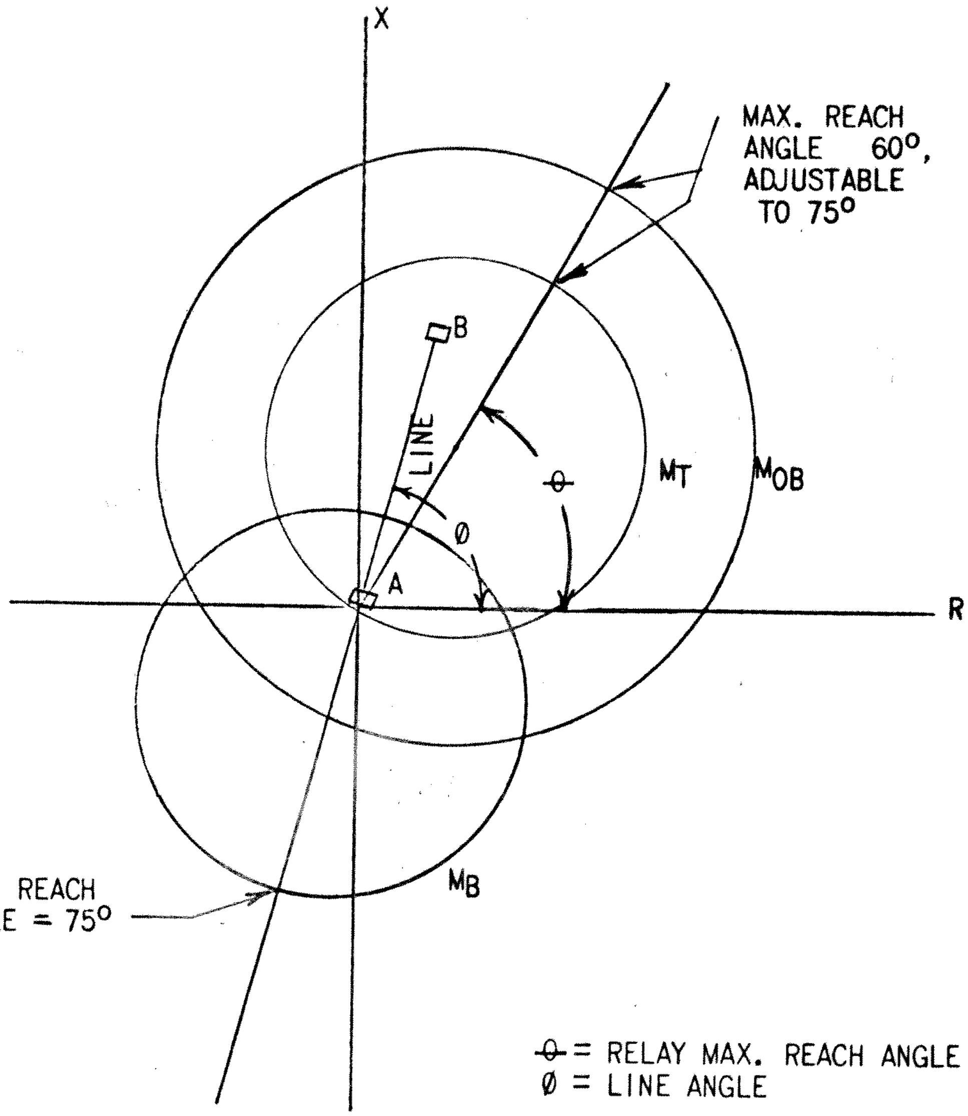
CONT ON SHEET SH NO.

TITLE TYPICAL RELAY CHARACTERISTICS
TYPE SLY13A RELAY

FIRST MADE FOR GEI-98309

FIG-3

REVISIONS



θ = RELAY MAX. REACH ANGLE
∅ = LINE ANGLE

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GENERAL ELECTRIC

0165A7661

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REV NO. 1-2-3-4-5

0165A7661

CONT ON SHEET SH NO.

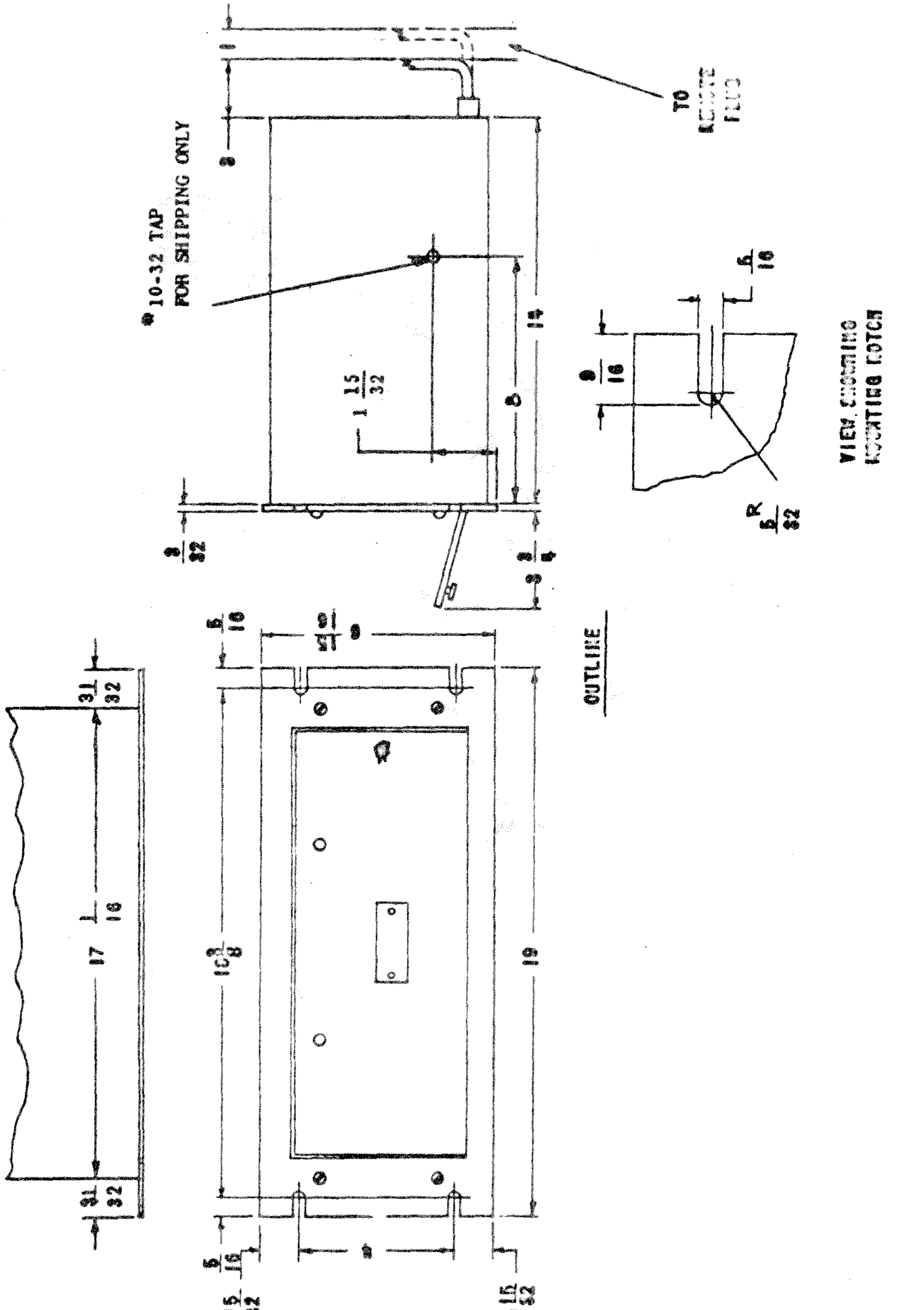
TITLE

OUTLINE & MOUNTING DIMENSIONS

FIRST MADE FOR 4 RACK UNIT (TAP BLOCK)

FIG-3A

REVISIONS



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FF-003-WX (1-63)

GENERAL ELECTRIC

0178A7024

CONT ON SHEET SH NO.

REV NO.

0178A7024

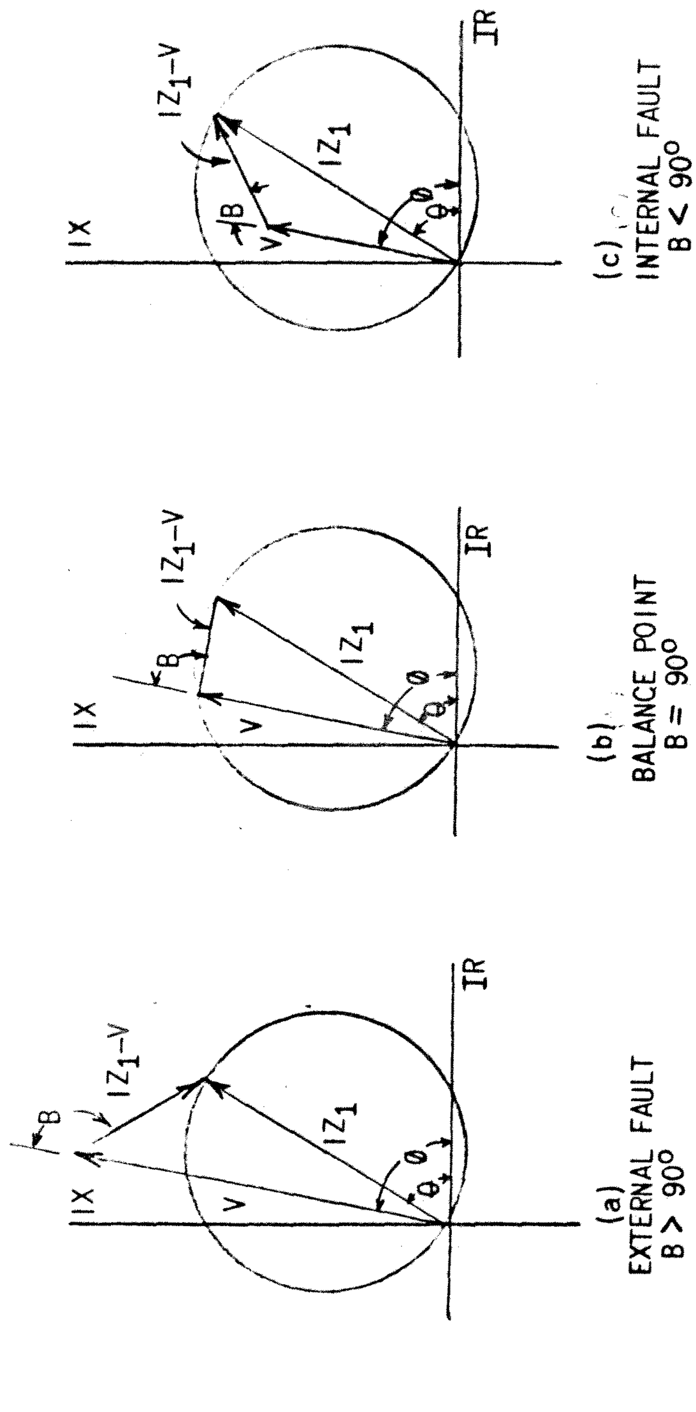
CONT ON SHEET SH NO.

TITLE MHO CHARACTERISTIC BY PHASE-ANGLE MEASUREMENT

FIRST MADE FOR GEI-98309

FIG-4

REVISIONS



PRINTS TO

MADE BY	APPROVALS	SWITCHGEAR DIV OR DEPT.	0178A7024
ISSUED		PHILADELPHIA LOCATION	CONT ON SHEET SH NO.

FF 803 WA (6-63) PRINTED IN U.S.A.

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CODE IDENT NO.

GENERAL ELECTRIC

0178A7023

CONT ON SHEET SH. NO.

REV. NO. 1

0178A7023

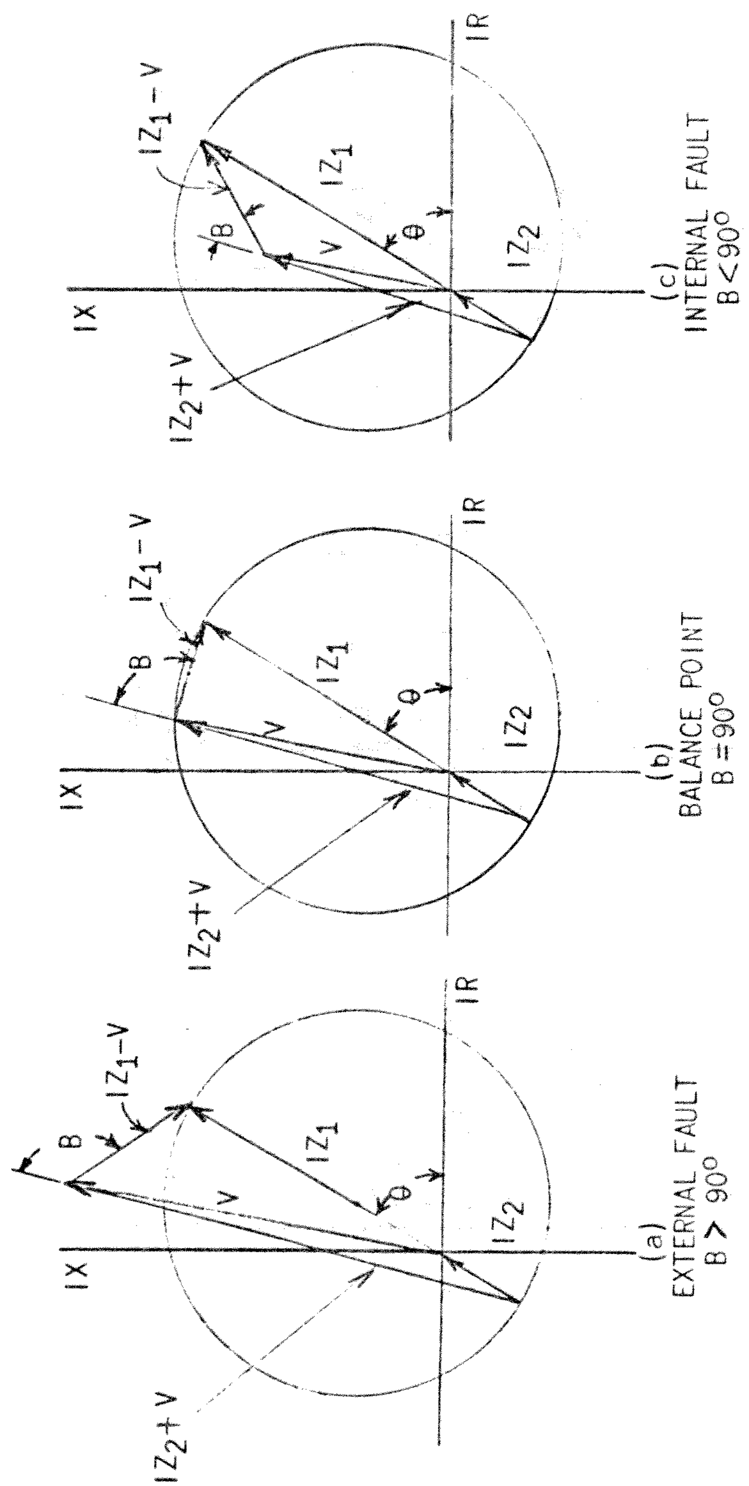
CONT ON SHEET SH. NO.

TITLE OFFSET MHO CHARACTERISTIC BY PHASE-ANGLE MEASUREMENT

FIRST MADE FOR GEI-98309

FIG-5

REVISIONS



2	
1	

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MADE BY A. Durkin March 6, 1962

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0178A7023

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CODE A

GENERAL ELECTRIC

0178A7022

CONT ON SHEET SH NO.

REV NO. 0178A7022

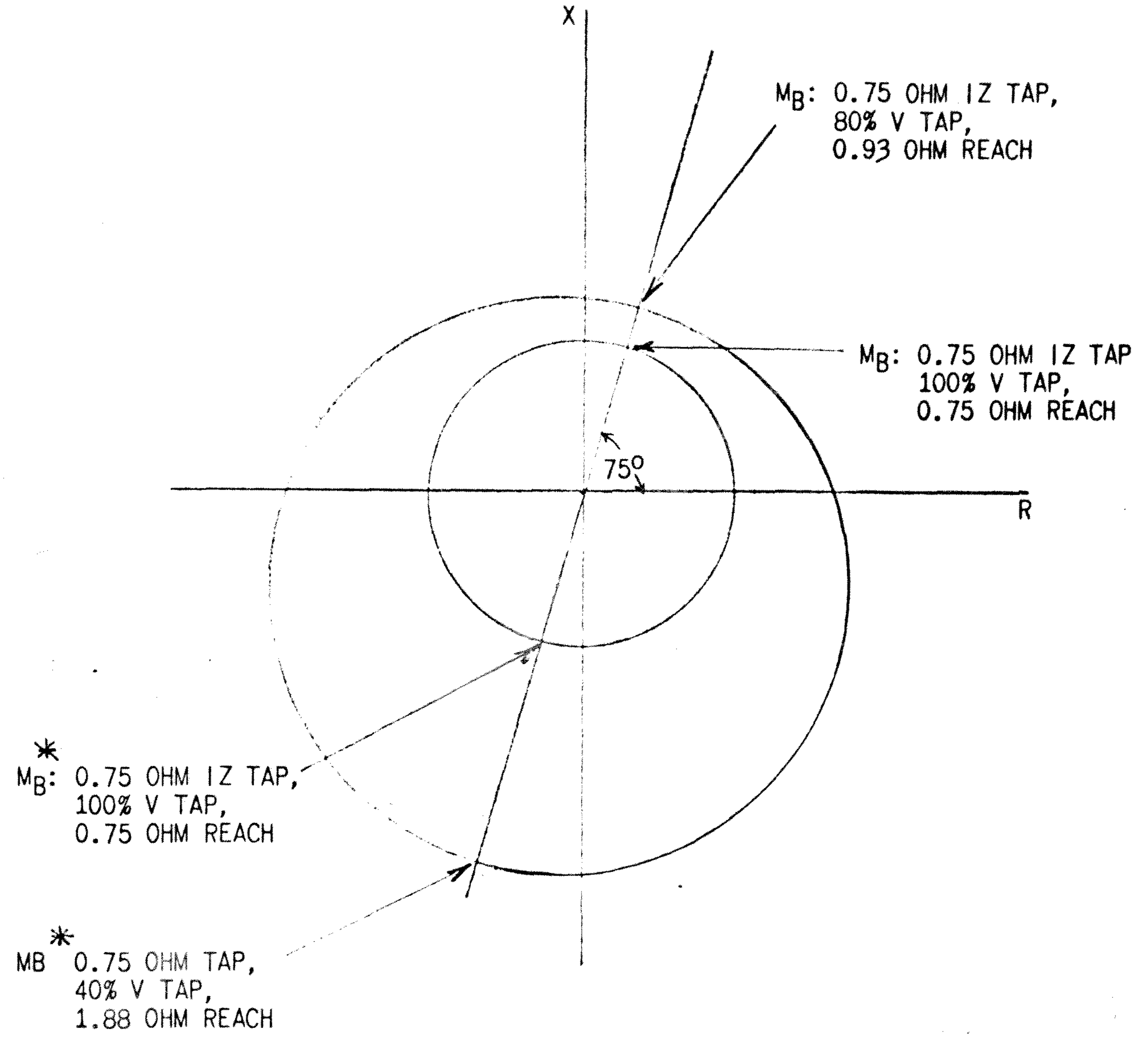
CONT ON SHEET SH NO.

TITLE M_B OFFSET MHO CHARACTERISTIC

FIRST MADE FOR GEI-98309

FIG-6

REVISIONS



PRINTS TO

MADE BY [signature] Nov 6, 1964

ISSUED [illegible]

APPROVALS Crw

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7022

CONT ON SHEET SH NO.

FF 803 WA (6-63)

GENERAL ELECTRIC

0178A7025

REV NO. -1-

0178A7025

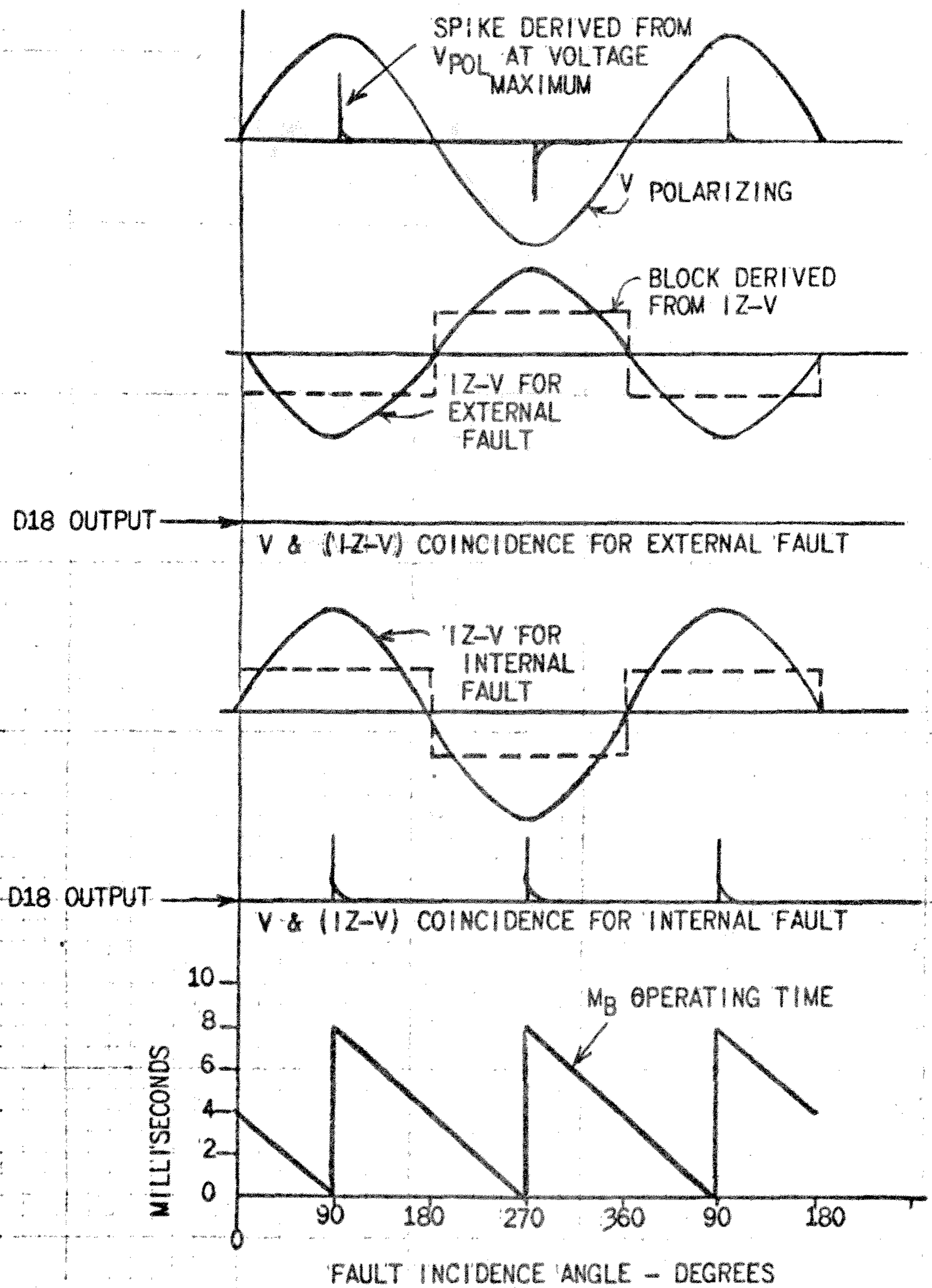
CONT ON SHEET SH NO.

TITLE M_B MEASUREMENT PRINCIPLES & OPERATING TIME CHARACTERISTIC

FIRST MADE FOR GEI-98309

FIG-7

REVISIONS



PRINTS TO

MADE BY A. Frederick March 10, 1964

ISSUED March 13, 1964

APPROVALS Cam

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7025

CONT ON SHEET SH NO.

LSP-R

CODE IDENT N

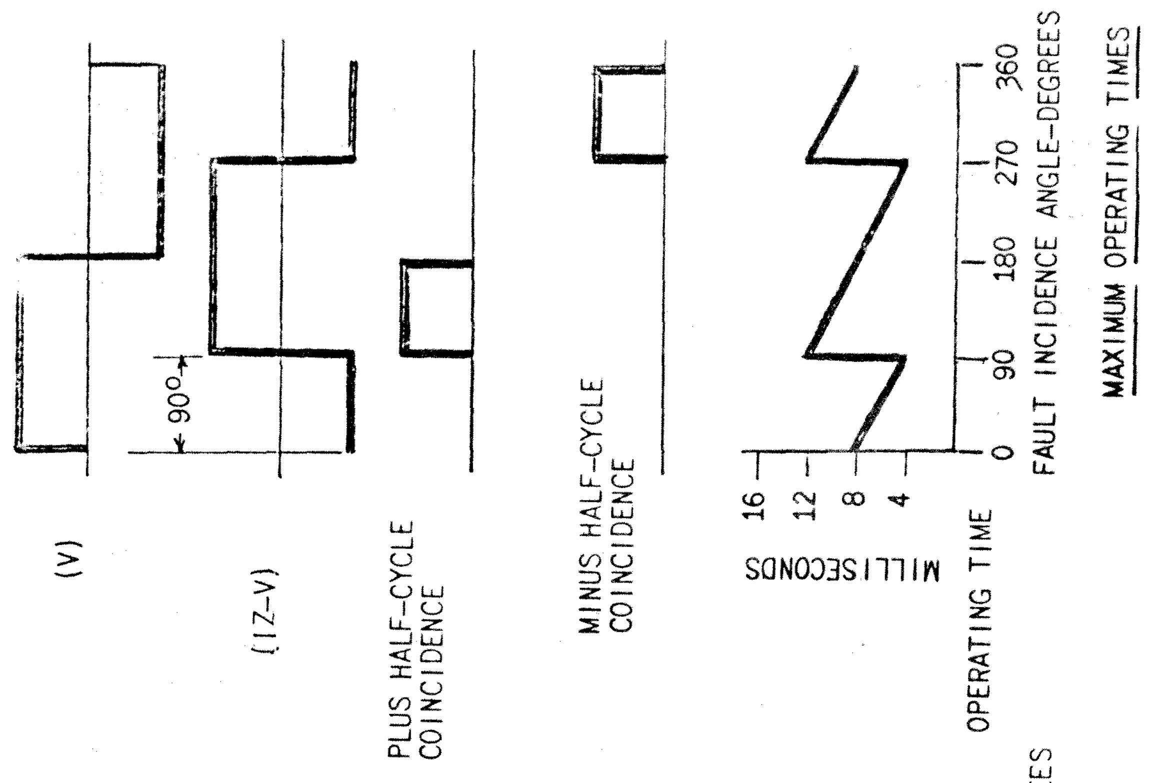
FF-803-WA (6-63) PRINTED IN U.S.A.

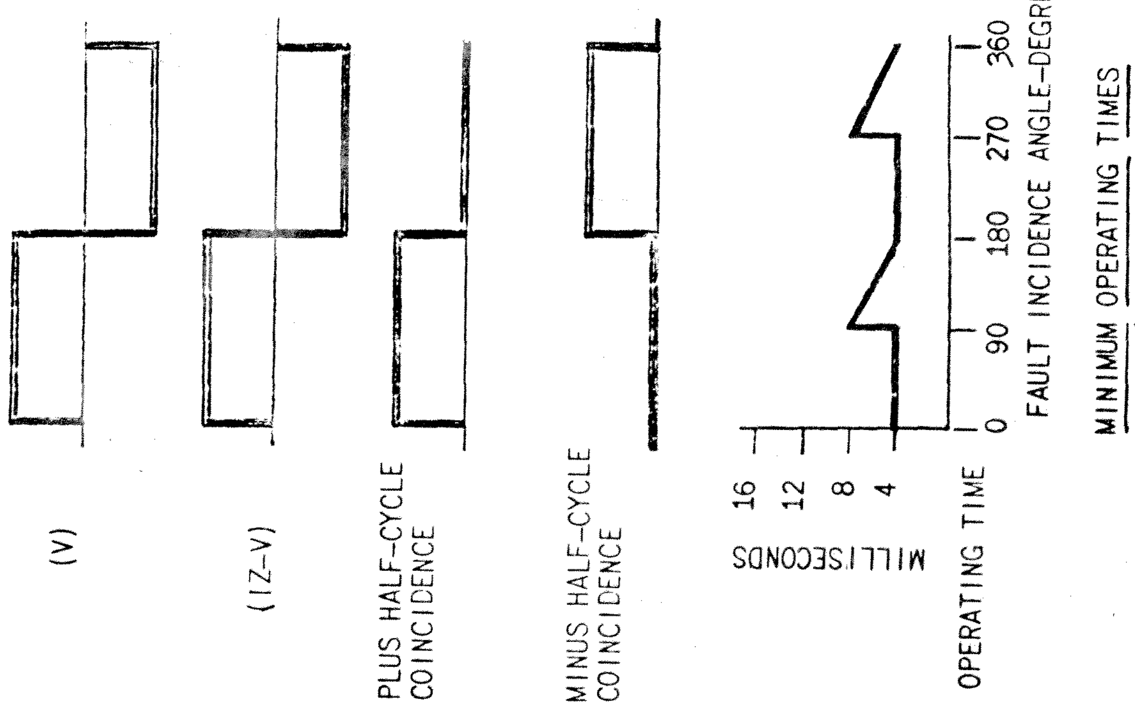
GENERAL ELECTRIC

REV NO. 0178A7021	TITLE M_T MEASUREMENT PRINCIPLES & OPERATING TIME CHARACTERISTICS	0178A7021
CONT ON SHEET / SH NO.	FIRST MADE FOR GEI-98309	CONT ON SHEET / SH NO.

FIG-8

REVISIONS





PRINTS TO

MADE BY [illegible] 1964	APPROVALS	SWITCHGEAR — DIV OR DEPT.	0178A7021
ISSUED [illegible]		PHILADELPHIA — LOCATION	CONT ON SHEET / SH NO.

FF 803 WA (6 63)
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Copy A

GENERAL ELECTRIC

0178A7012

CONT ON SHEET | SH NO.

REV NO. -1-

0178A7012

CONT ON SHEET | SH NO.

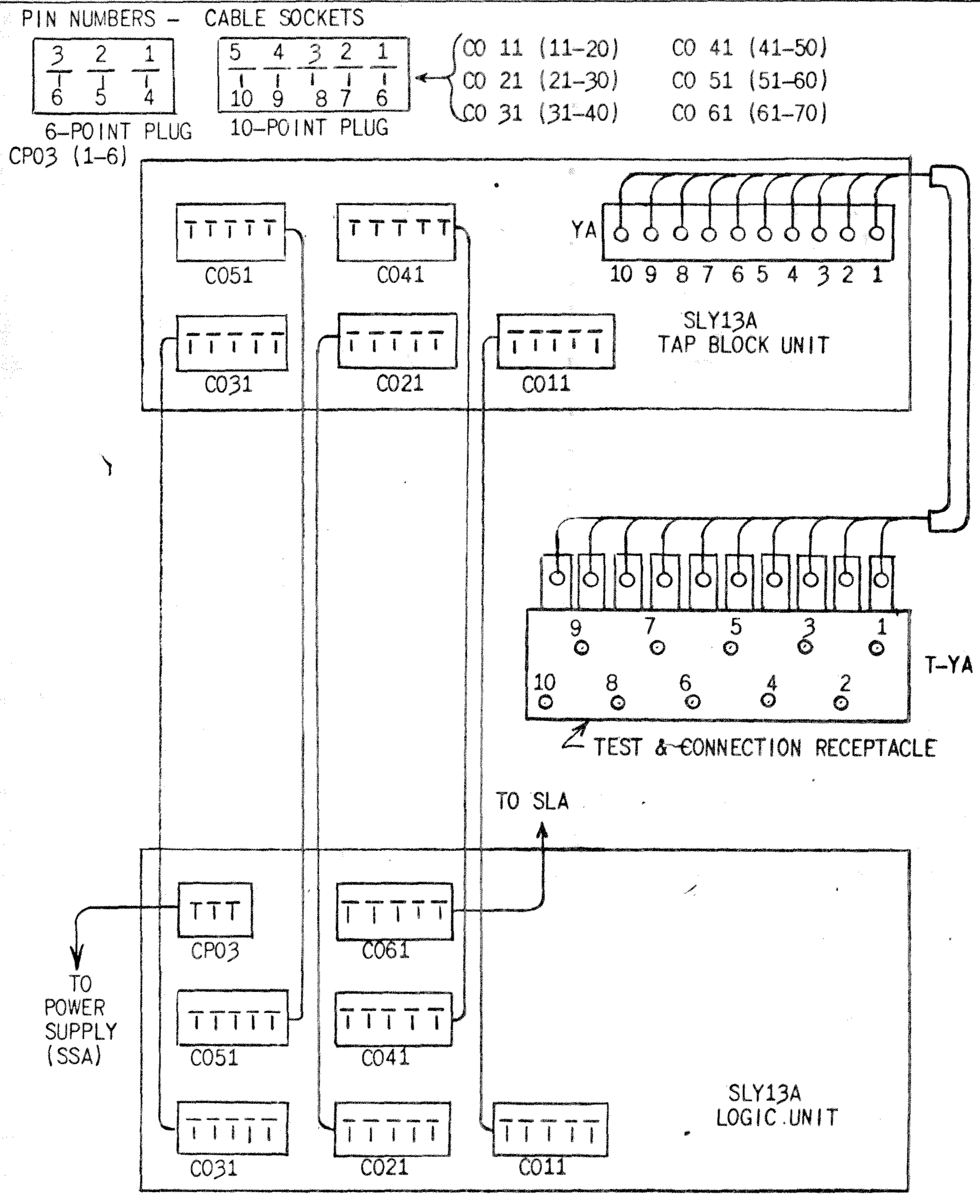
TITLE TYPE SLY13A RELAY
REAR VIEW-INTERCONNECTIONS

FIG-9

FIRST MADE FOR

REVISIONS

1 | 4 Added B 1-11-67 R.F. Grate



REAR VIEW

PRINTS TO

MADE BY Original March 6, 1964

ISSUED March 13, 1964

APPROVALS Cbm

SWITCHGEAR | DIV OR DEPT.

PHILADELPHIA | LOCATION

0178A7012

CONT ON SHEET | SH NO.

FF-803-WA (6-63)

A 3109

GENERAL ELECTRIC

0178A7007

CONT ON SHEET SH NO.

REV NO. 1

0178A7007

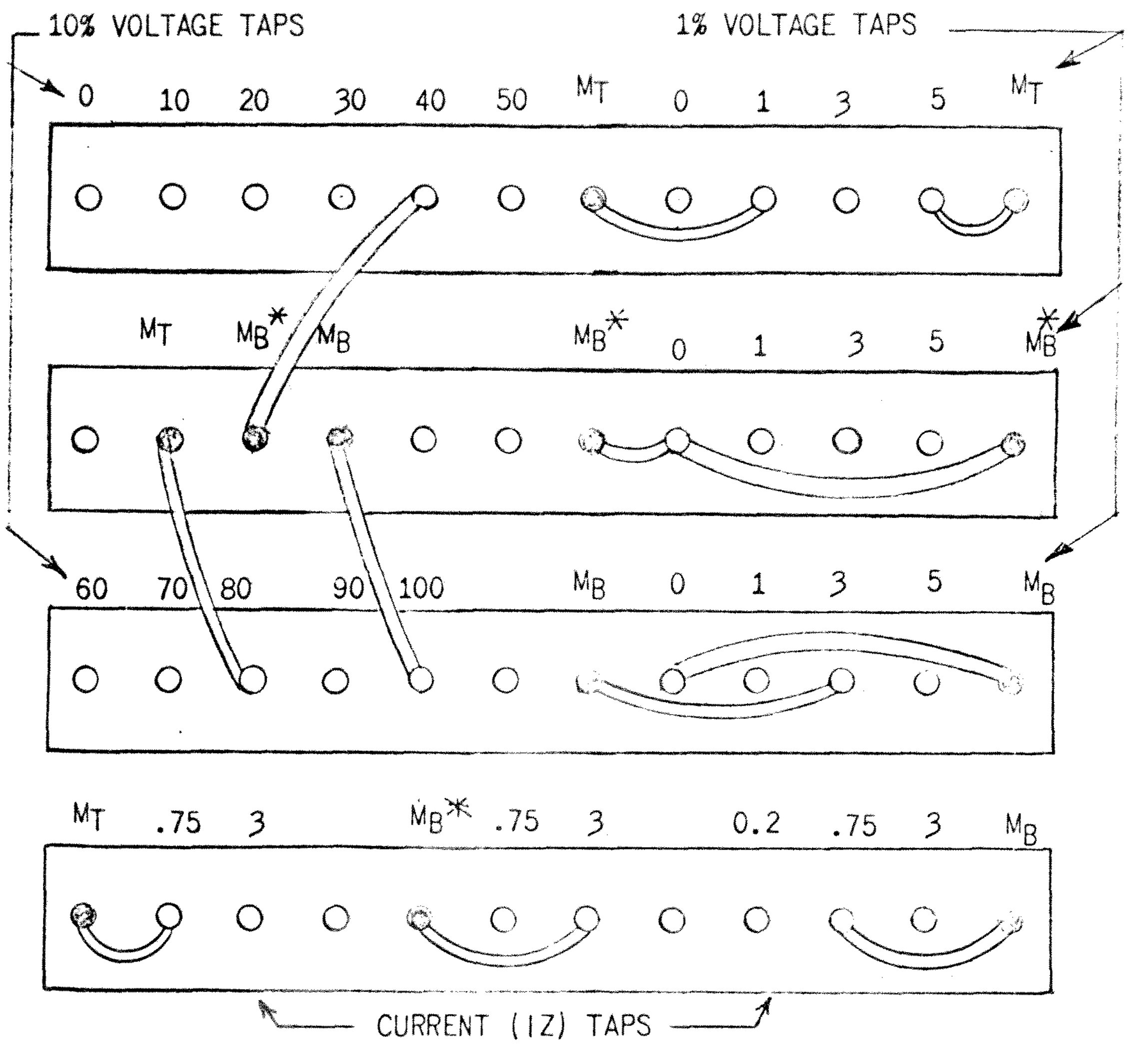
CONT ON SHEET SH NO.

TITLE SLY13A TYPICAL TAP BLOCK CONNECTIONS, PHASE 1-2 OR 3-1

FIRST MADE FOR GEI-98309

FIG-10

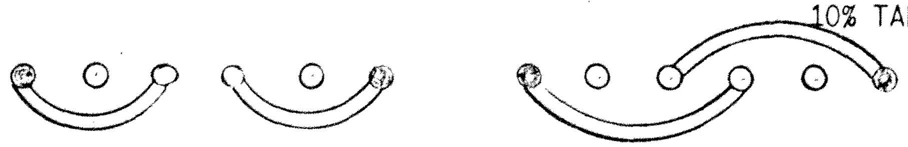
REVISIONS



TAP SETTINGS ILLUSTRATED ABOVE;

VOLTAGE	CURRENT
M_T: 80 + 4 = 84%	M_T: 0.75 OHMS
M_B: 100 − 3 = 97%	M_B: 0.75 OHMS
M_B*: 40 + 0 = 40%	M_B*: 3 OHMS

1% VOLTAGE TAPS: IN-LINE, ADD TO 10% TAP CROSSED OVER, SUBTRACT FROM 10% TAP



LEGEND: ● FIXED TAP: ROUND HEAD SCREW

○ ADJUSTABLE TAP: KNURLED HEAD SCREW

PRINTS TO

MADE BY A. Fredrick March 5, 1966

ISSUED March 12, 1966

APPROVALS Carr

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7007

CONT ON SHEET SH NO.

FF-803-WA (6-63)

GENERAL ELECTRIC

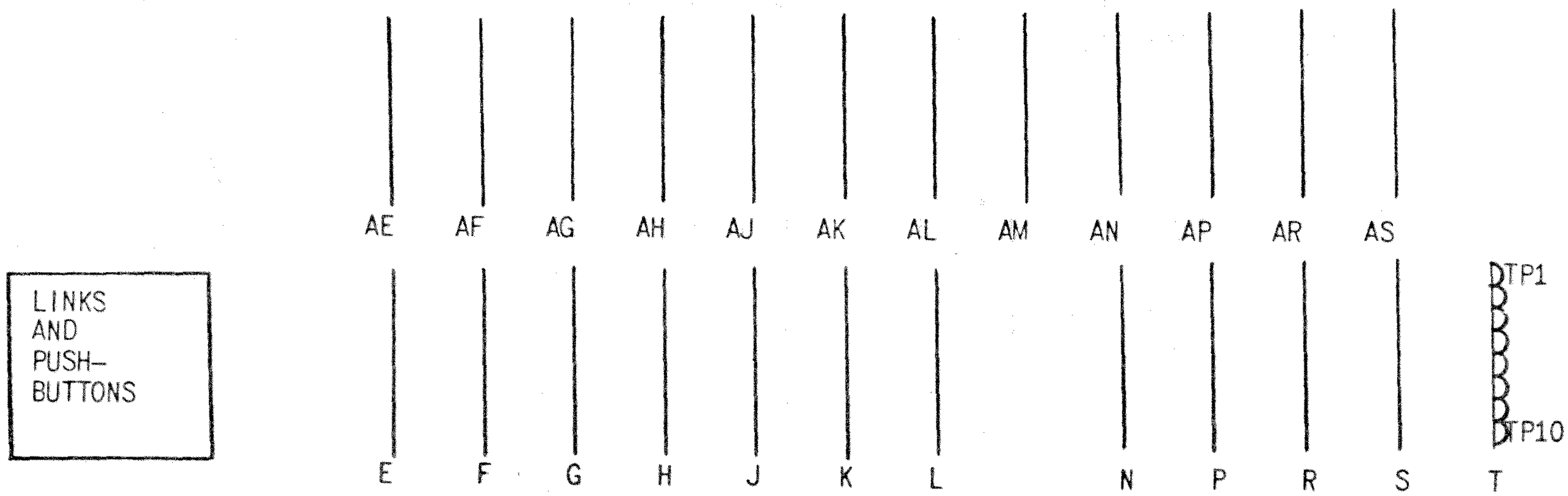
REV NO. 0-12

0178A7008 CONT ON SHEET / SH NO.

TITLE CARD LOCATION
SLY13A LOGIC UNIT

FIRST MADE FOR GEI-98309

FIG-11



UPPER ROW

POS.	CODE	CARD	NUMBER
AE	T11	4/9	0116B6648G1
AF	D11	BLOCK-BLOCK (MT)	0116B6773G1
AG	T11	4/9	0116B6648G1
AH	T11	4/9	0116B6648G1
AJ	D11	BLOCK-BLOCK (MT)	0116B6773G1
AK	T11	4/9	0116B6648G1
AL	T11	4/9	0116B6648G1
AM	D11	BLOCK-BLOCK (MT)	0116B6773G1
AN	T11	4/9	0116B6648G1
AP	T4	2-8/0	0116B4945G1
AR	L4	3 INPUT AND	0116B4939G1
AS	L3	COMPARER	0116B4989G1

LOWER ROW

POS.	CODE	CARD	NUMBER
E	D18	BLOCK-SPIKE(MB)	0128B1371G1
F	D18	BLOCK-SPIKE(MB)	0128B1371G1
G	D18	BLOCK-SPIKE(MB)	0128B1371G1
H	T2	P/9	0116B6642G1
J	D13	OVERCURRENT	0116B6775G1
K	D13	OVERCURRENT	0116B6775G1
L	D13	OVERCURRENT	0116B6775G1
N	D11	BLOCK-BLOCK(MOB)	0116B6773G1
P	T11	4/9	0116B6648G1
R	T7	32-64/0	0116B4947G1
S	L6	RB	0116B6666G1
T	TEST	TEST	0116B6672G1

REVISIONS

2	Aug. 27, 1964
1	July 8, 1964 RE CREATED

PRINTS TO

MADE BY A. Fredrick March 15, 1964
ISSUED March 16, 1964

APPROVALS

SWITCHGEAR — DIV OR DEPT.
PHILADELPHIA — LOCATION

0178A7008 CONT ON SHEET / SH NO.

LSP-R

CODE IDENT NO.

FF-803-WA (9-63) PRINTED IN U.S.A.

0116B6829

NOTE: TRANSFORMER AND TRANSACTOR LEADS MARKED "S" ARE CONNECTED TO PIN NO.1, ALL PLUG SOCKETS

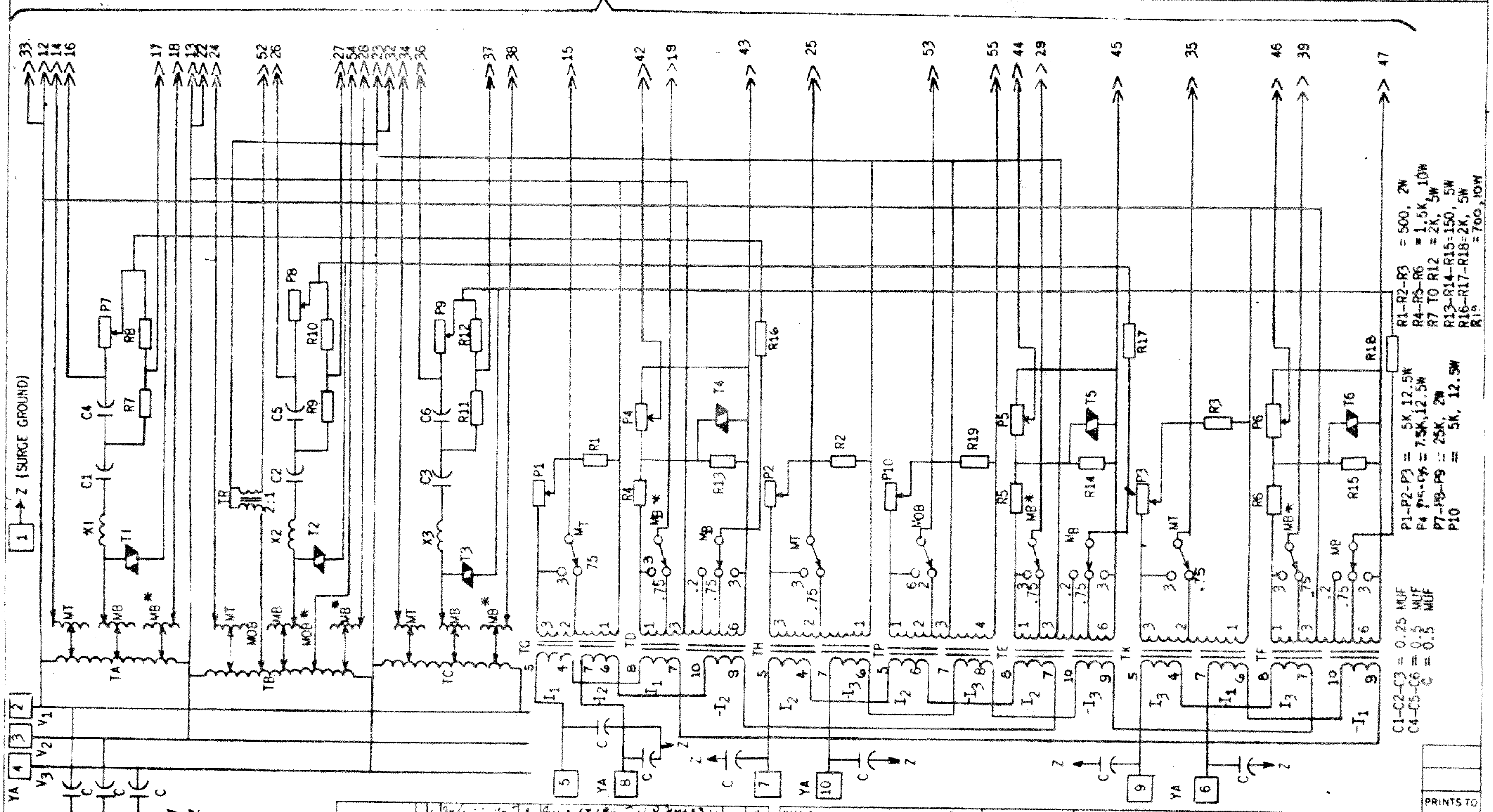
GENERAL ELECTRIC

0116B6829

TITLE
TAP BLOCK UNIT INTERNAL CONNECTION FOR TYPES SLY13A,B & SLYL13A.

FIRST MADE FOR REQ S.O.

FIG-12



PRINTS TO

SWITCHGEAR DIV
PHILADELPHIA WORKS

0116B6829

LSP-R

GENERAL ELECTRIC

0 1 1 6 B 6 8 3 0

REV NO X-2-3-5-6-

0 1 1 6 B 6 8 3 0

TITLE INTERNAL CONNECTIONS - TYPE SLY13A RELAY
MHO CARRIER LOGIC UNIT

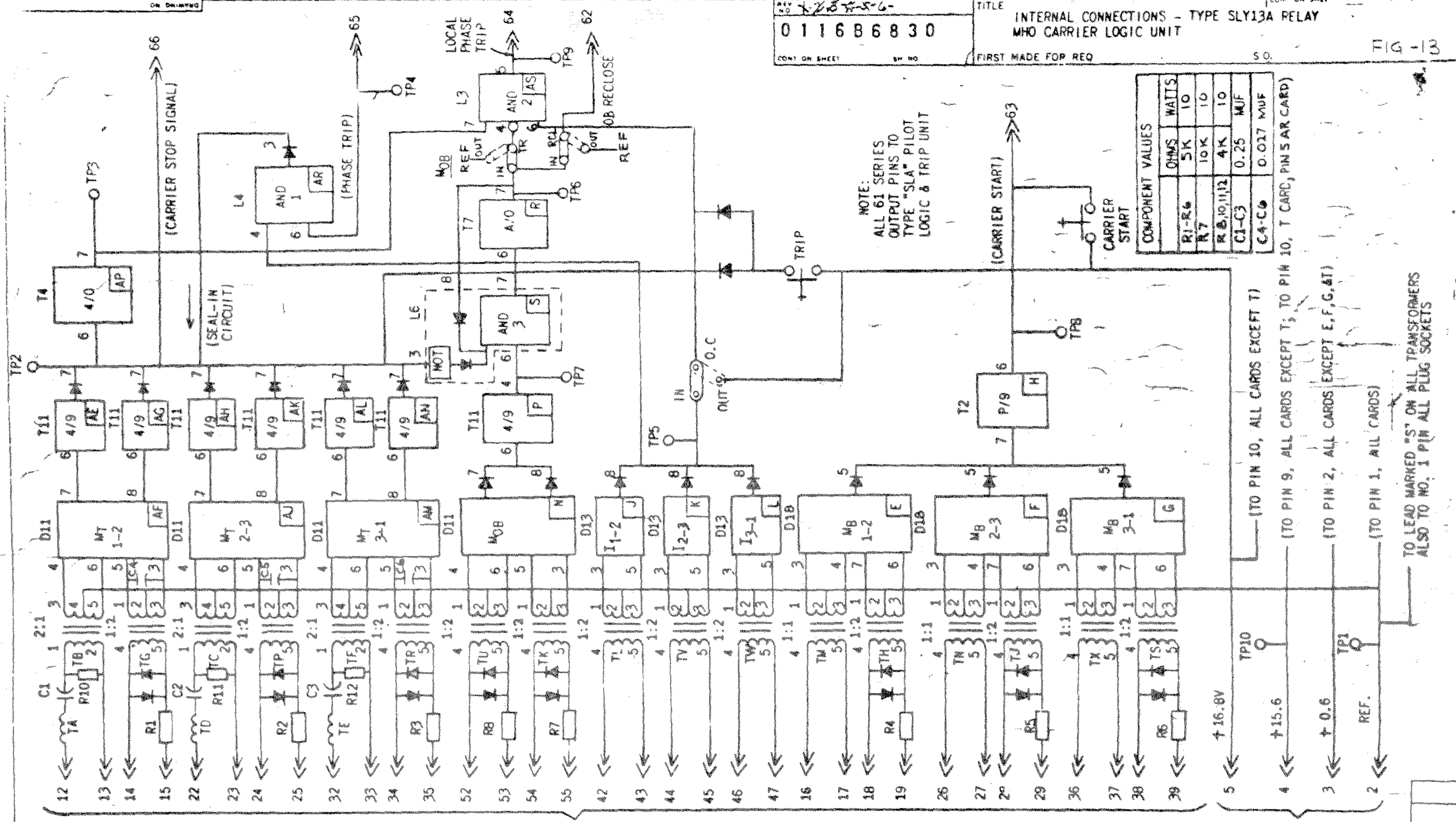
FIRST MADE FOR REQ

S.O.

FIG-13

COMPONENT VALUES	OHMS	WATTS
R1-R6	5K	10
R7	10K	10
R8,10,11,12	4K	10
C1-C3	0.25	MUF
C4-C6	0.017	MUF

NOTE:
ALL 61 SERIES
OUTPUT PINS TO
TYPE "SLA" PILOT
LOGIC & TRIP UNIT



REVISIONS

NAME A. Fredarick Feb. 26, 1964

APPROVALS

SWITCHGEAR
PHILADELPHIA

0 1 1 6 B 6 8 3 0

PRINTS TO

ISP-R

CODE A

GENERAL ELECTRIC

0178A7026

CONT ON SHEET

REV NO. -1-

0178A7026

CONT ON SHEET SH NO.

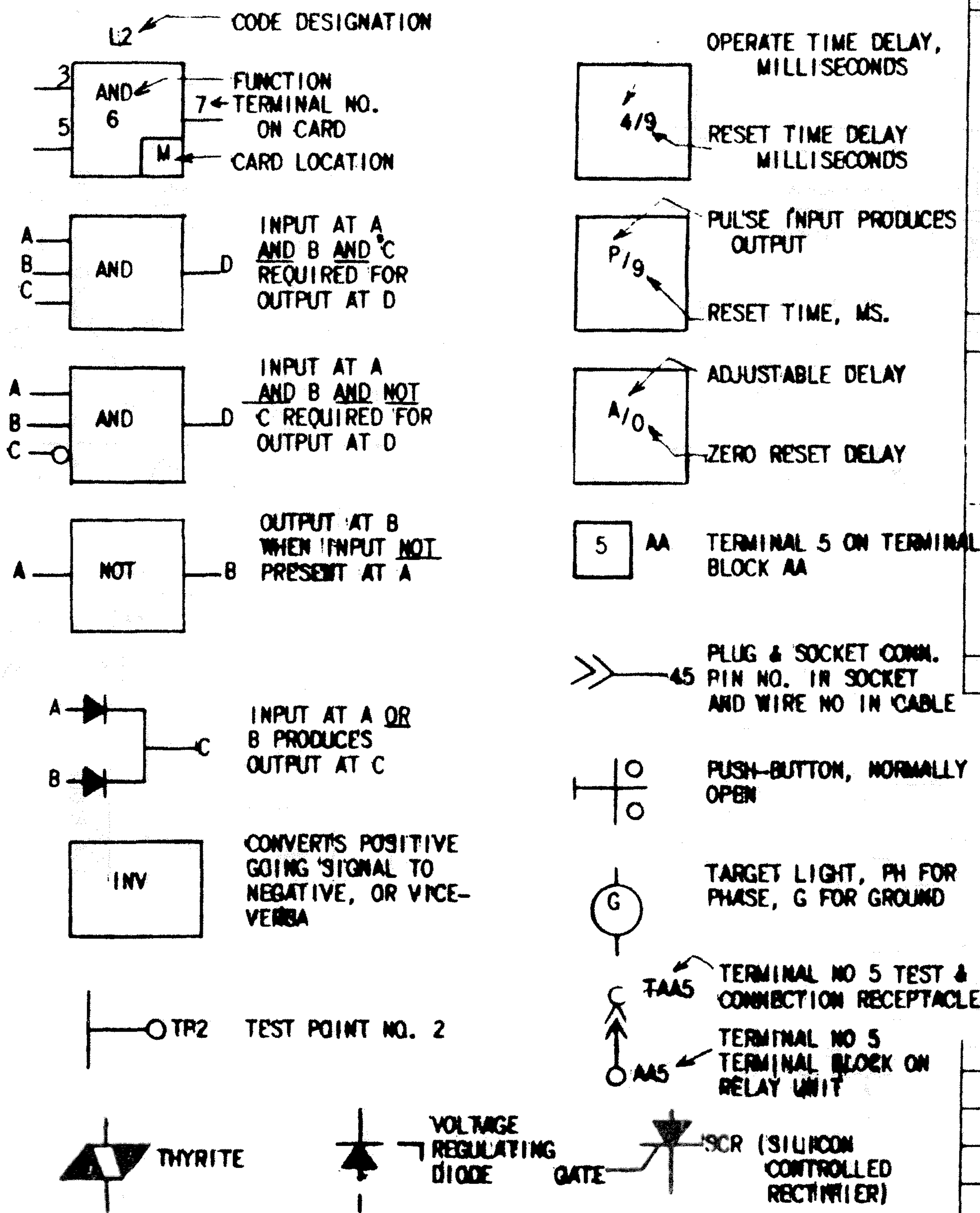
TITLE

LEGEND FOR SYMBOLS USED ON STATIC RELAY LOGIC DIAGRAMS

FIRST MADE FOR

FIG - 14

REVISIONS



1 Oct 29 1969 R. Ahrens

PRINTS TO

MADE BY A. Fudala March 10, 1969

ISSUED March 13, 1969

APPROVALS Chan

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7026

CONT ON SHEET SH NO.

PF-088-9A (6-60)

GENERAL ELECTRIC 0178A7013

REV NO. 1-2-3-4-5-6

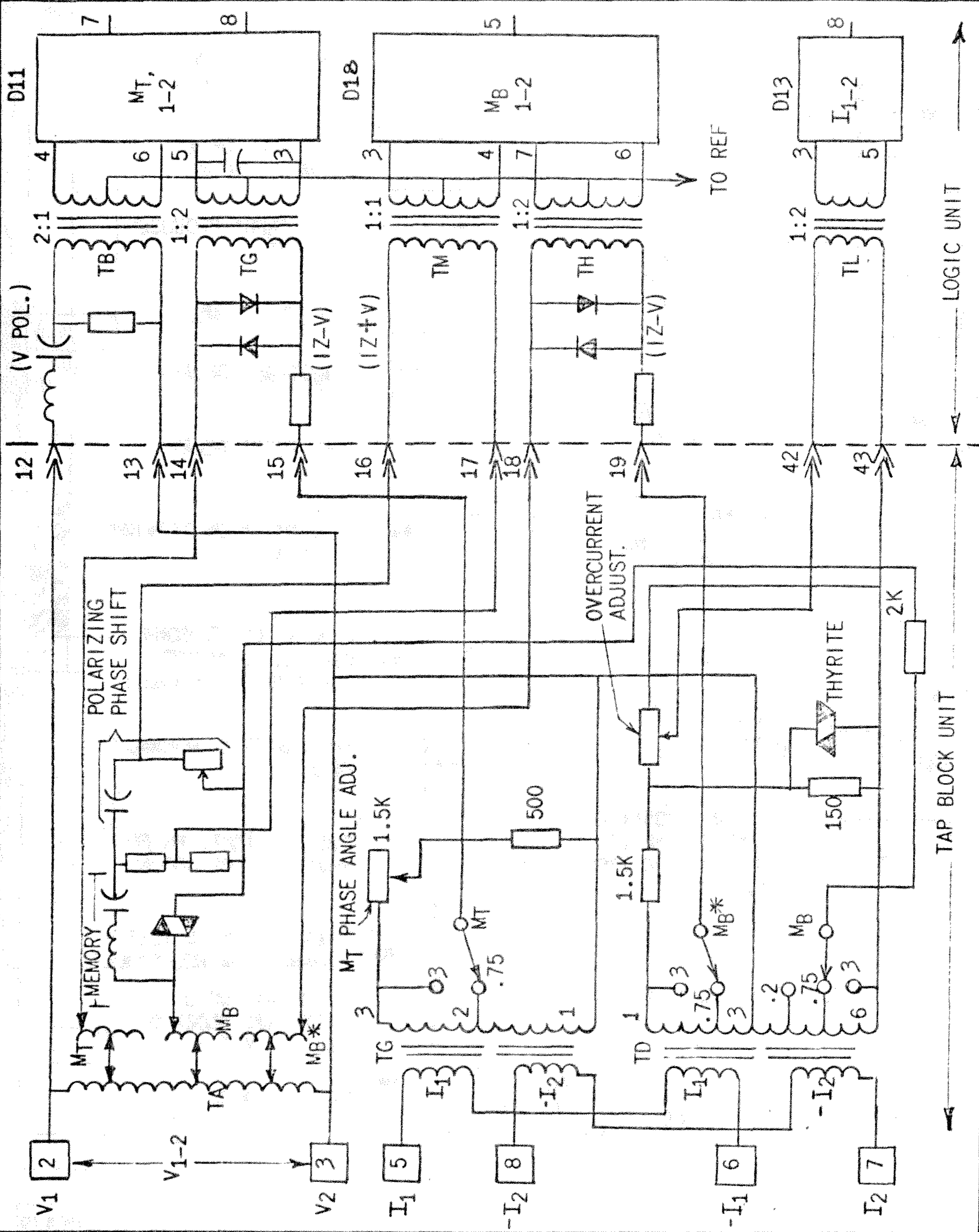
0178A7013

CONT ON SHEET SH NO.

TITLE TYPE SLY13A RELAY
SCHEMATIC A-C CIRCUIT FOR PHASES 1-2

FIRST MADE FOR

FIG-15



REVISIONS

PRINTS TO

MADE BY

ISSUED March 12, 1964

APPROVALS

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7013

CONT ON SHEET SH NO.

FF-803-WA (6-63)
PRINTED IN U.S.A.

LSP-R

CODE IDENT NO.

CODE A

GENERAL ELECTRIC

0178A7028

CONT ON SHEET SH NO.

REV NO. -2-

0178A7028

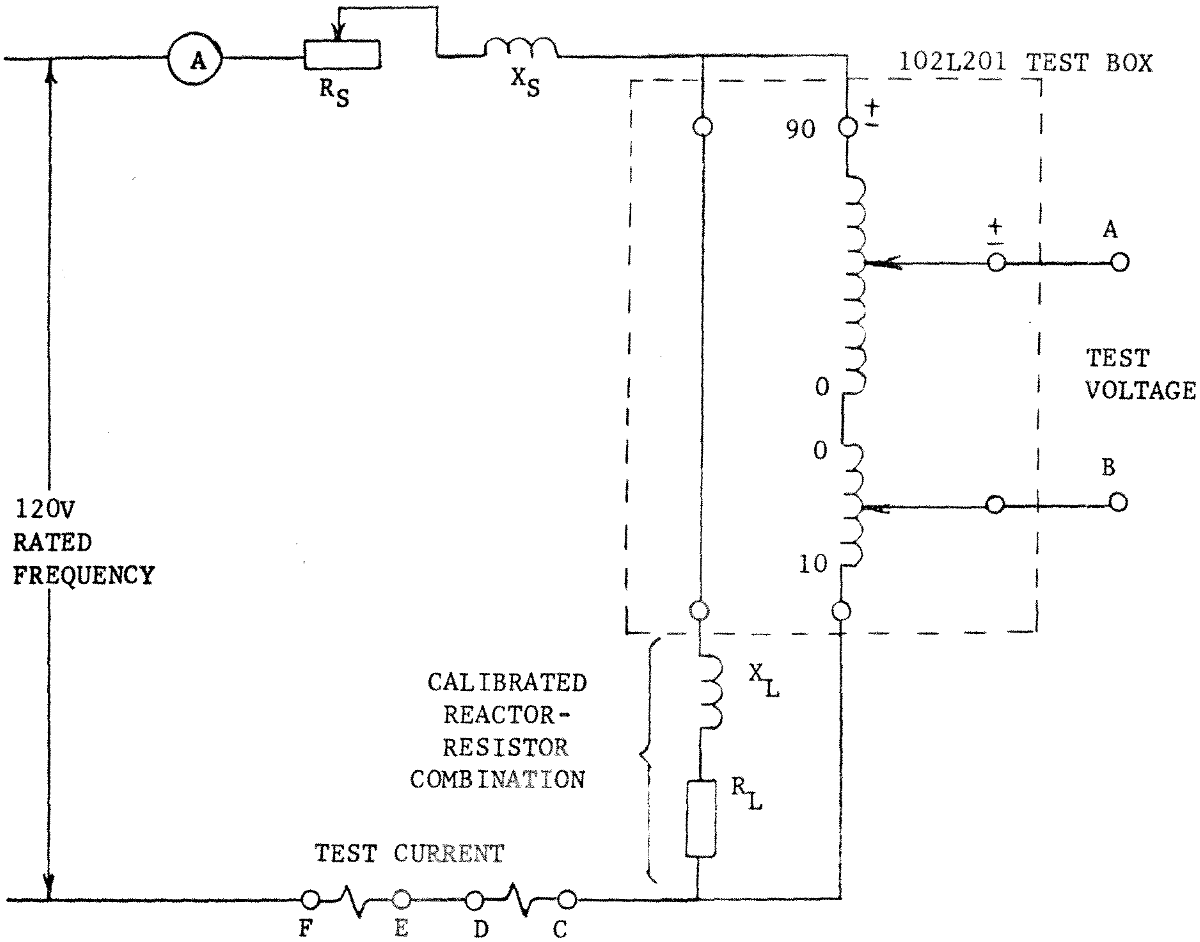
CONT ON SHEET SH NO.

TITLE TEST CIRCUIT FOR CHARACTERISTIC CHECK USING TEST BOX TEST REACTOR AND TEST RESISTOR METHOD.

FIRST MADE FOR

FIG-16

REVISIO[NS]



PRINTS TO

MADE BY	APPROVALS			
A. FREDERICK 3/17/64		SWITCHGEAR	DIV OR DEPT.	0178A7028
ISSUED MARCH 23, 1964		PHILA.	LOCATION	CONT ON SHEET SH NO.

CODE IDENT NO.

FF-803-WA (4-66)
PRINTED IN U.S.A.

CODE A

GENERAL ELECTRIC

0 1 7 8 A 7 0 2 9

CONT ON SHEET SH NO.

REV NO. 2

0 1 7 8 A 7 0 2 9

CONT ON SHEET SH NO.

TITLE

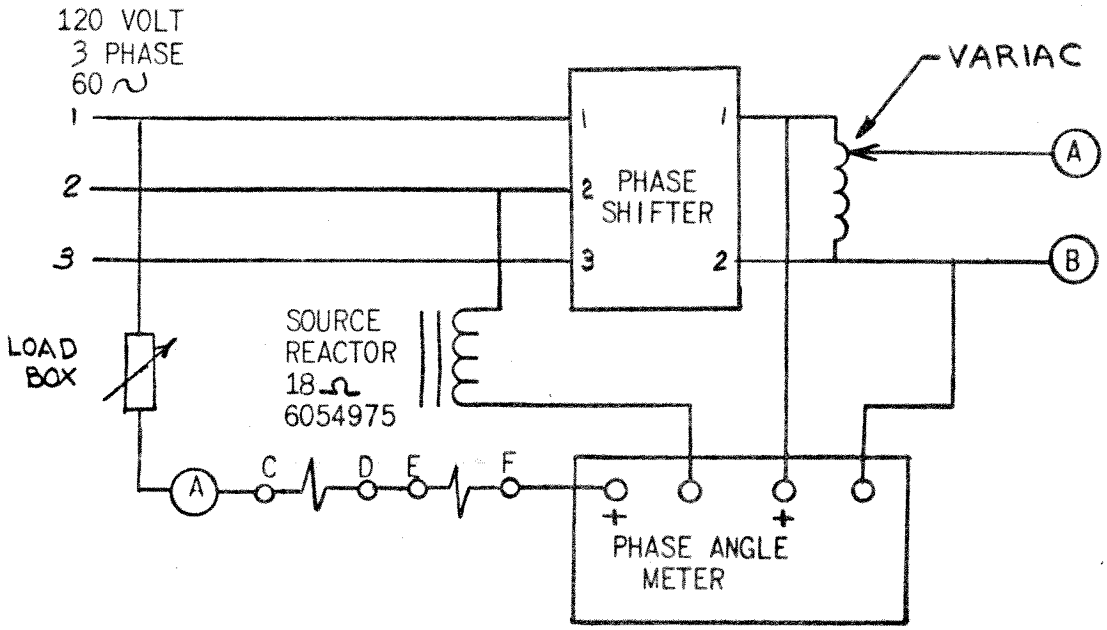
PHASE SHIFTER TEST CIRCUIT

FIRST MADE FOR GEI 93826 (SLZ)

FIG-17

REVISIONS

2	7-10-67	Kreider
1	7-6-66	Made B. R. Brunner



PRINTS TO

MADE BY	APPROVALS	SWITCHGEAR	DIV OR DEPT.	0 1 7 8 A 7 0 2 9
March 17, 1964				
ISSUED March 26, 1964	Cam	PHILADELPHIA	LOCATION	CONT ON SHEET SH NO.

PF-803-WA (6-63)
PRINTED IN U.S.A.

LSP-R

CODE IDENT NO.

REV NO. 1-2-3

0178A7018

CONT ON SHEET SH NO.

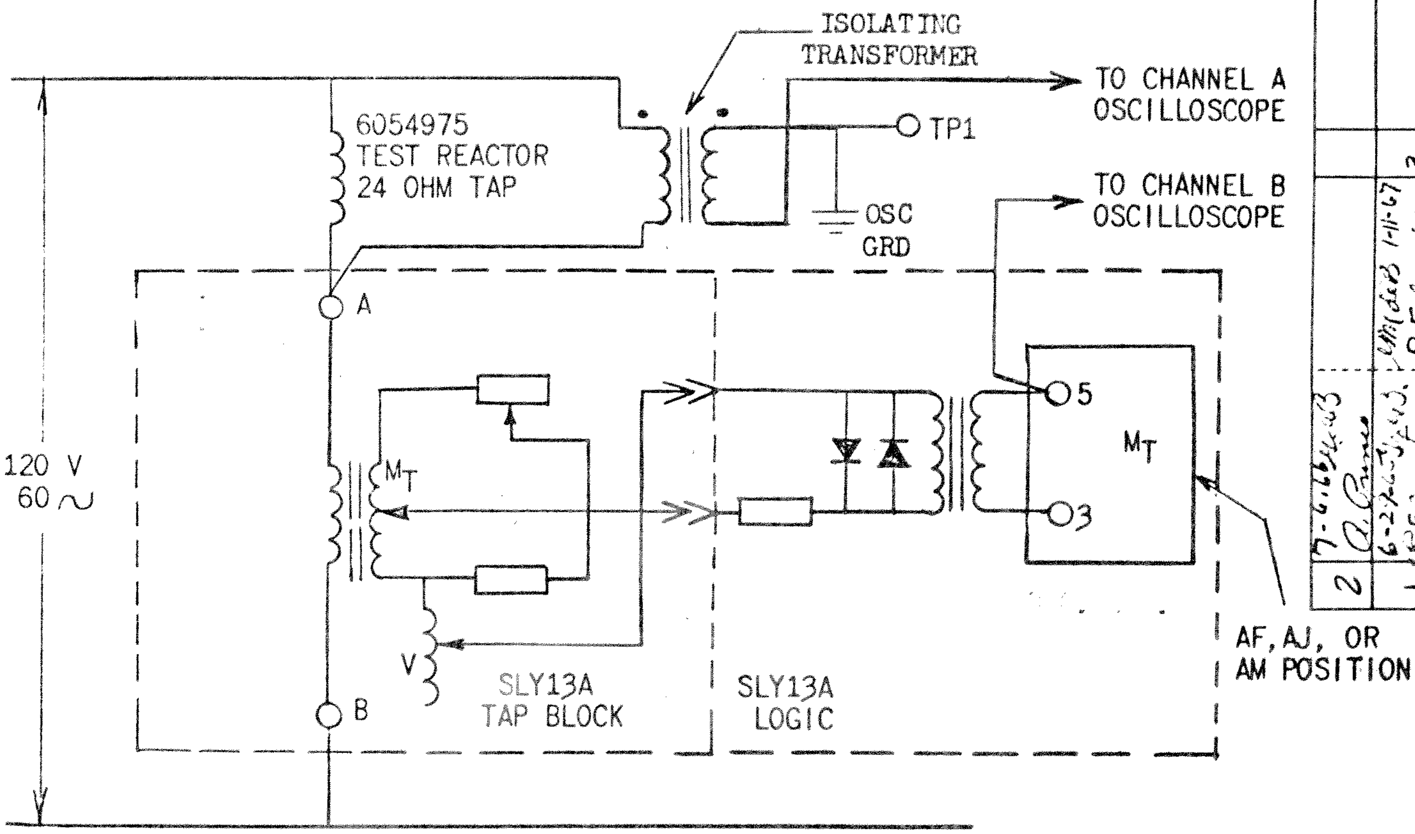
TITLE

TEST CIRCUIT FOR M_T ANGLE ADJUSTMENT

FIRST MADE FOR GEI-98309

FIG-18

REVISIONS



TEST CONNECTIONS			
	A	B	M_T CARD
PH 1-2	YA-5	YA-6	AF
PH 2-3	YA-7	YA-8	AJ
PH 3-1	YA-9	YA-10	AM

PRINTS TO

MADE BY A. Fuchs 1-13-1967 | APPROVALS Cam | SWITCHGEAR DIV OR DEPT. | PHILADELPHIA LOCATION

ISSUED 1-13-1967

FF 803 WA (6-63)

LSP P

CODE IDENT NO

CODE A

GENERAL ELECTRIC

0178A7020

CONT ON SHEET SH NO.

REV NO.

0178A7020

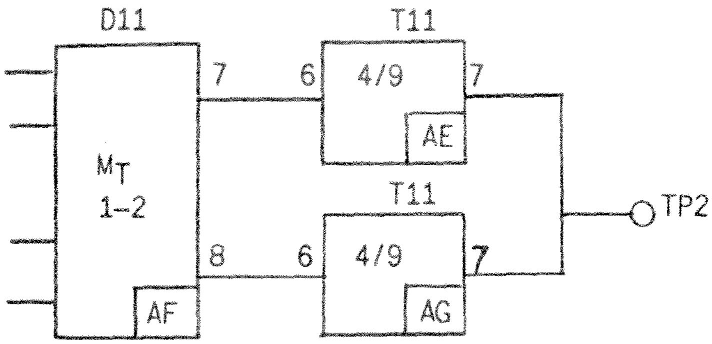
CONT ON SHEET SH NO.

TITLE
TEST CONDITIONS FOR 4/9 TIMERS IN M_T CIRCUITS

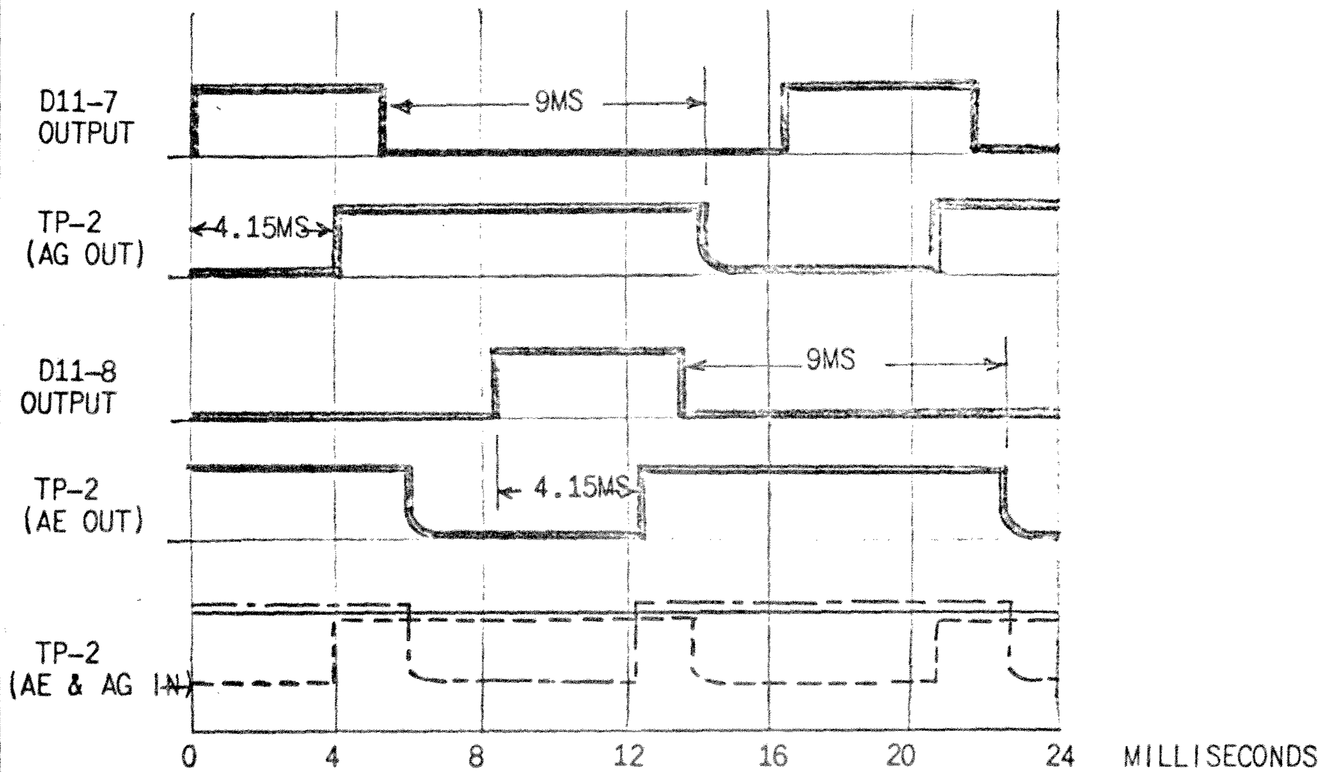
FIRST MADE FOR GEI-98309

FIG-19

REVISIONS



(CARD POSITIONS SHOWN FOR PHASES 1-2)



TEST CONNECTIONS & CONDITIONS

PHASES	TO TEST 419 CARD	REMOVE M_T CARDS	REMOVE 4/9 CARD	CHANNEL A OSC	CHANNEL B OSC.
1-2	AE	AJ, AM	AG	AE-6	TP-2
1-2	AG	AJ, AM	AE	AG-6	TP-2
2-3	AH	AF, AM	AK	AH-6	TP-2
2-3	AK	AF, AM	AH	AK-6	TP-2
3-1	AL	AF, AJ	AN	AL-6	TP-2
3-1	AN	AF, AJ	AL	AN-6	TP-2

PRINTS TO

MADE BY A. Fredrick March 10, 1964

ISSUED March 13, 1964

APPROVALS Cam

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7020

CONT ON SHEET SH NO.

FF-803-WA (6-63)
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LSP P

CODE A

GENERAL ELECTRIC

0178A7019

CONT ON SHEET | SH NO.

REV NO.

0178A7019

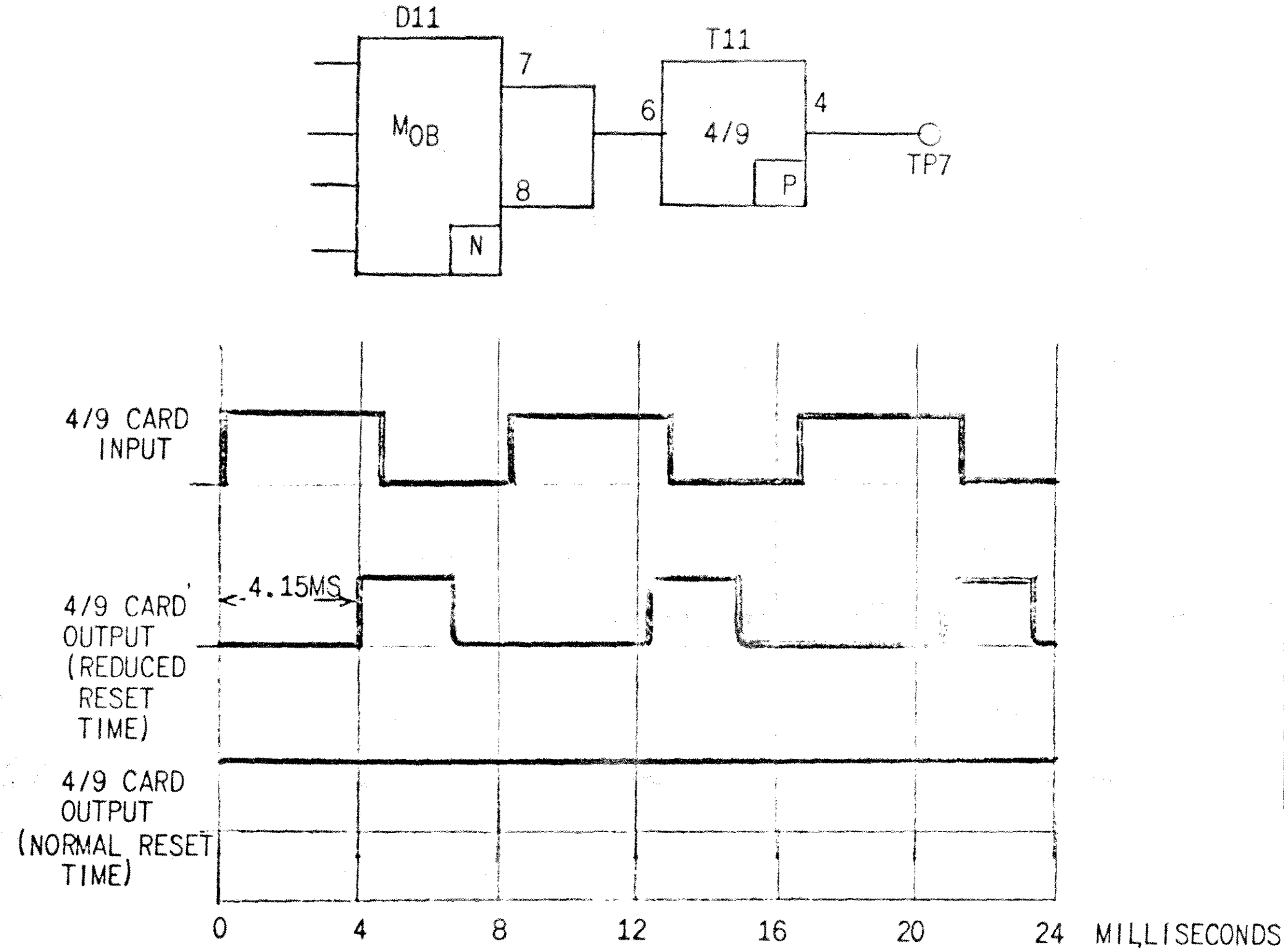
CONT ON SHEET | SH NO.

TITLE
TEST CONDITIONS FOR 4/9 TIMER
IN M_{OB} CIRCUIT

FIRST MADE FOR GEI-98309

FIG-20

REVISION



PRINTS TO

MADE BY: March 10, 1964

ISSUED: March 13, 1964

APPROVALS

SWITCHGEAR — DIV OR DEPT.

PHILADELPHIA — LOCATION

0178A7019

CONT ON SHEET | SH NO.

FF-803-WA (6-63)
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A

GENERAL ELECTRIC

0178A7014

CONT ON SHEET SH NO.

REV NO. -1-

0178A7014

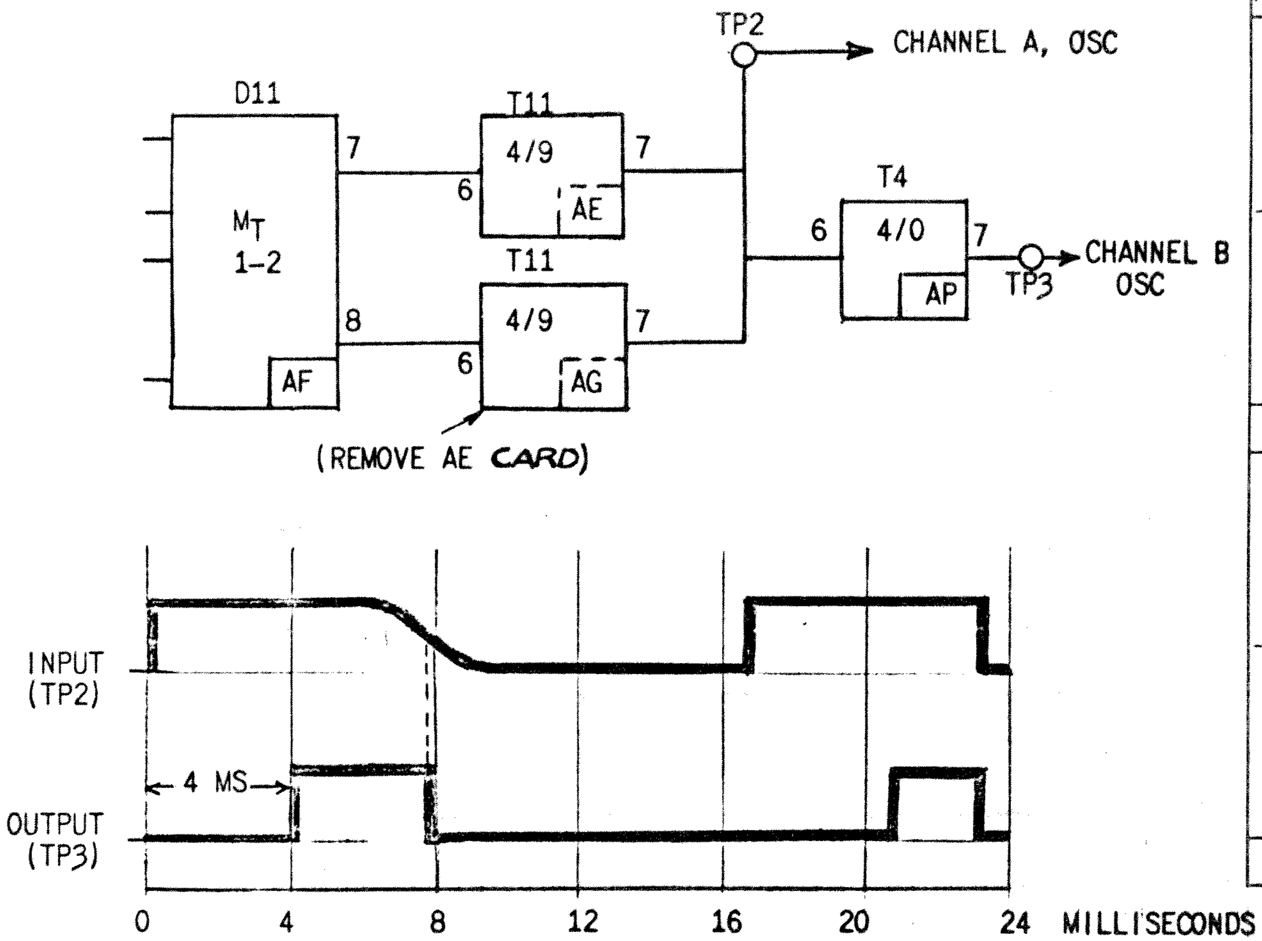
CONT ON SHEET SH NO.

TITLE TEST CONDITIONS FOR 4/0 TIMER - SLY13A

FIRST MADE FOR GEI-98309

FIG-21

REVISIONS



1 July 6, 1965

PRINTS TO

MADE BY G. Fedrick March 10, 1964

ISSUED March 13, 1964

APPROVALS

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7014

CONT ON SHEET SH NO.

CODE A

GENERAL ELECTRIC

0178A7009

CONT ON SHEET SH NO.

REV NO. 1-2

0178A7009

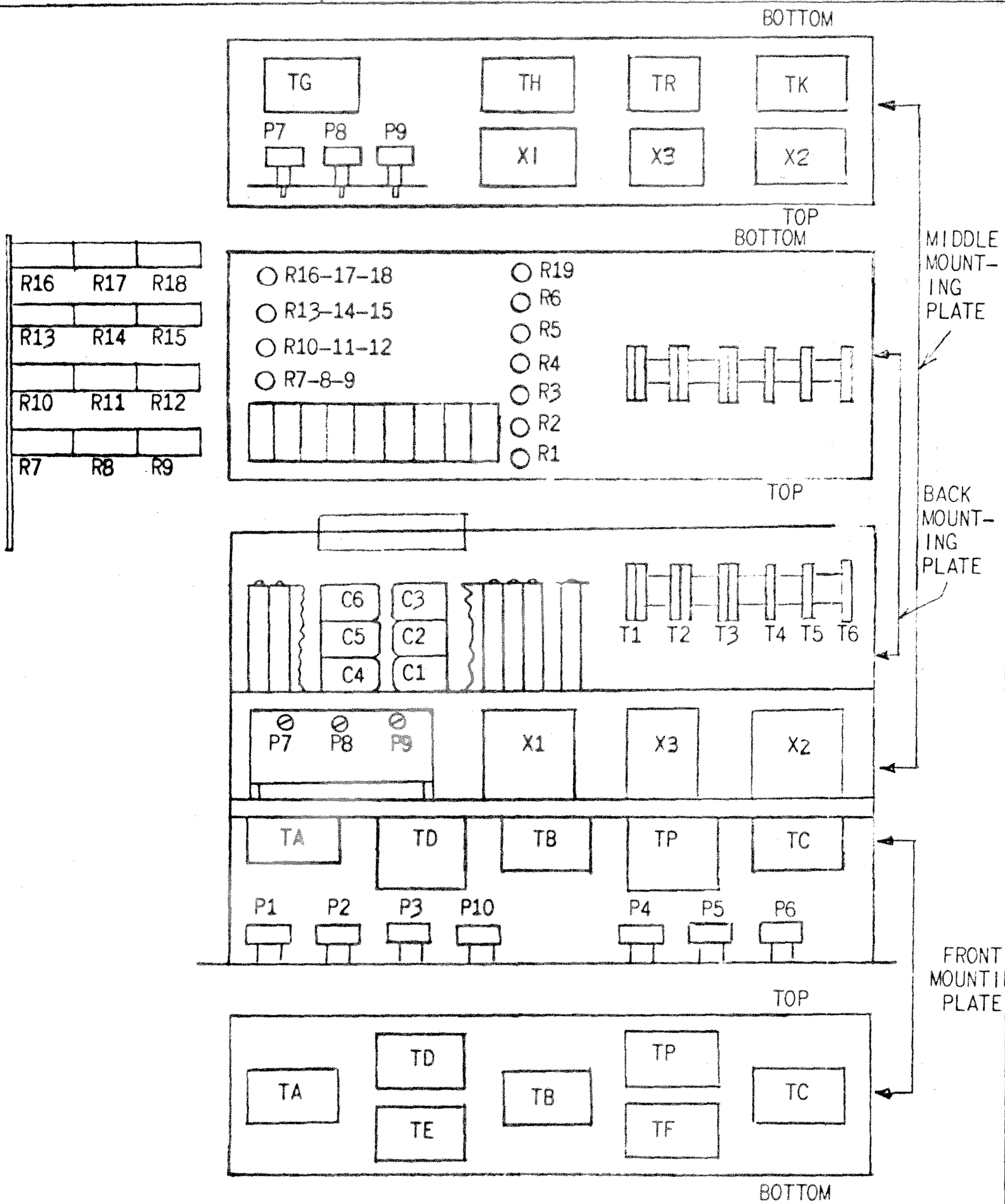
CONT ON SHEET SH NO.

TITLE
LOCATION OF COMPONENTS
TAP BLOCK UNIT-SLY13A RELAY

FIRST MADE FOR

FIG-22

REVISIONS



PRINTS TO

MADE BY A. Fredrick March 10, 1964

ISSUED M... 13, 1...

APPROVALS

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0178A7009

CONT ON SHEET SH NO.

FF-803-WA (6-63)
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A

GENERAL ELECTRIC

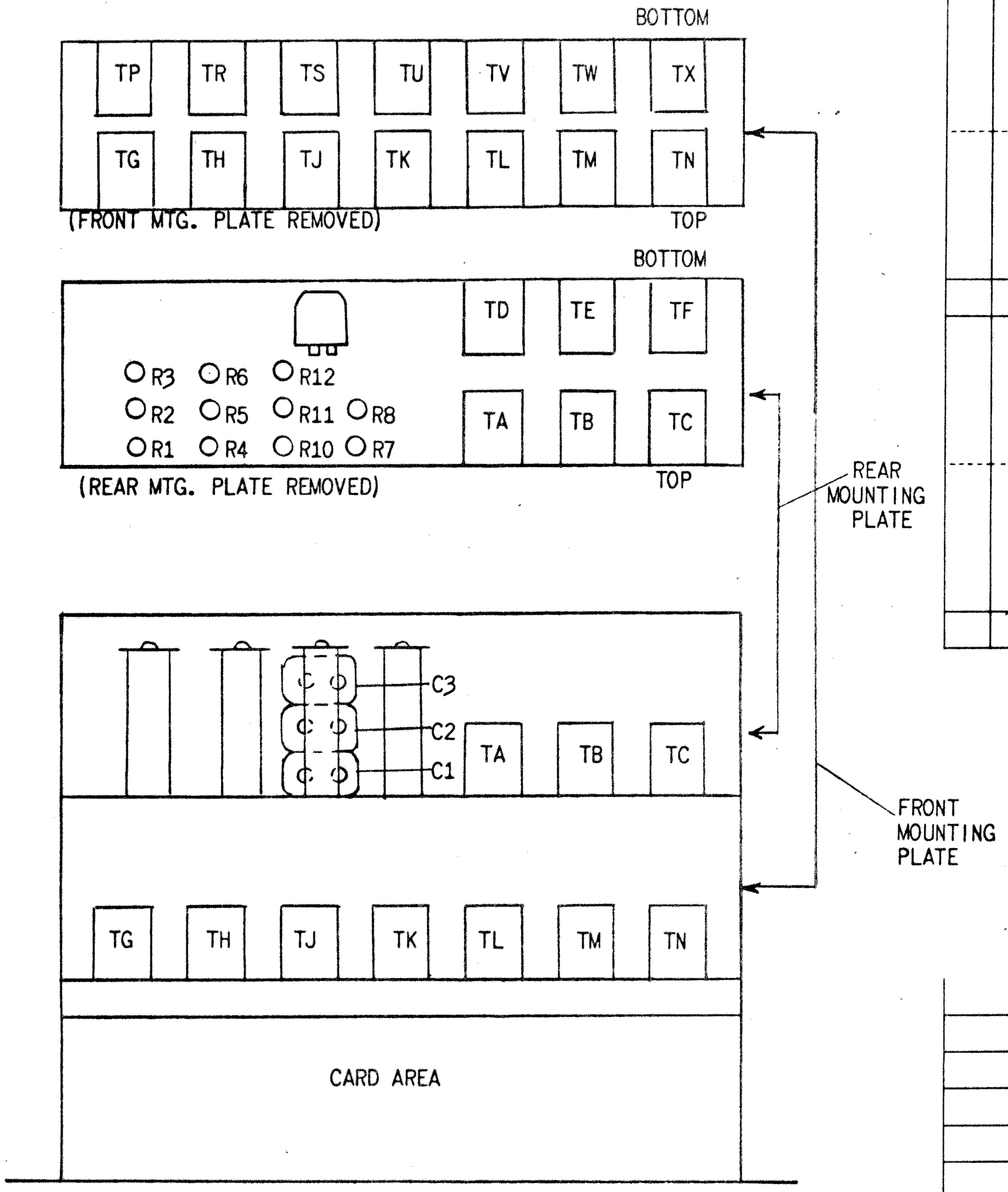
0178A7015

TITLE LOCATION OF COMPONENTS–LOGIC UNIT TYPE SLY13A RELAY

FIRST MADE FOR

FIG-23

REVISIONS



PRINTS TO

MADE BY A. Frederick March 10, 1964	APPROVALS	SWITCHGEAR	DIV OR DEPT.
ISSUED March 13, 1964	Cam	PHILADELPHIA	LOCATION

0178A7015

CONT ON SHEET SH NO.

A

GENERAL ELECTRIC

0148A3917AK

CONT ON SHEET | SH NO.

REV NO. 1-

0148A3917AK

CONT ON SHEET | SH NO.

TITLE MB BLOCK SPIKE

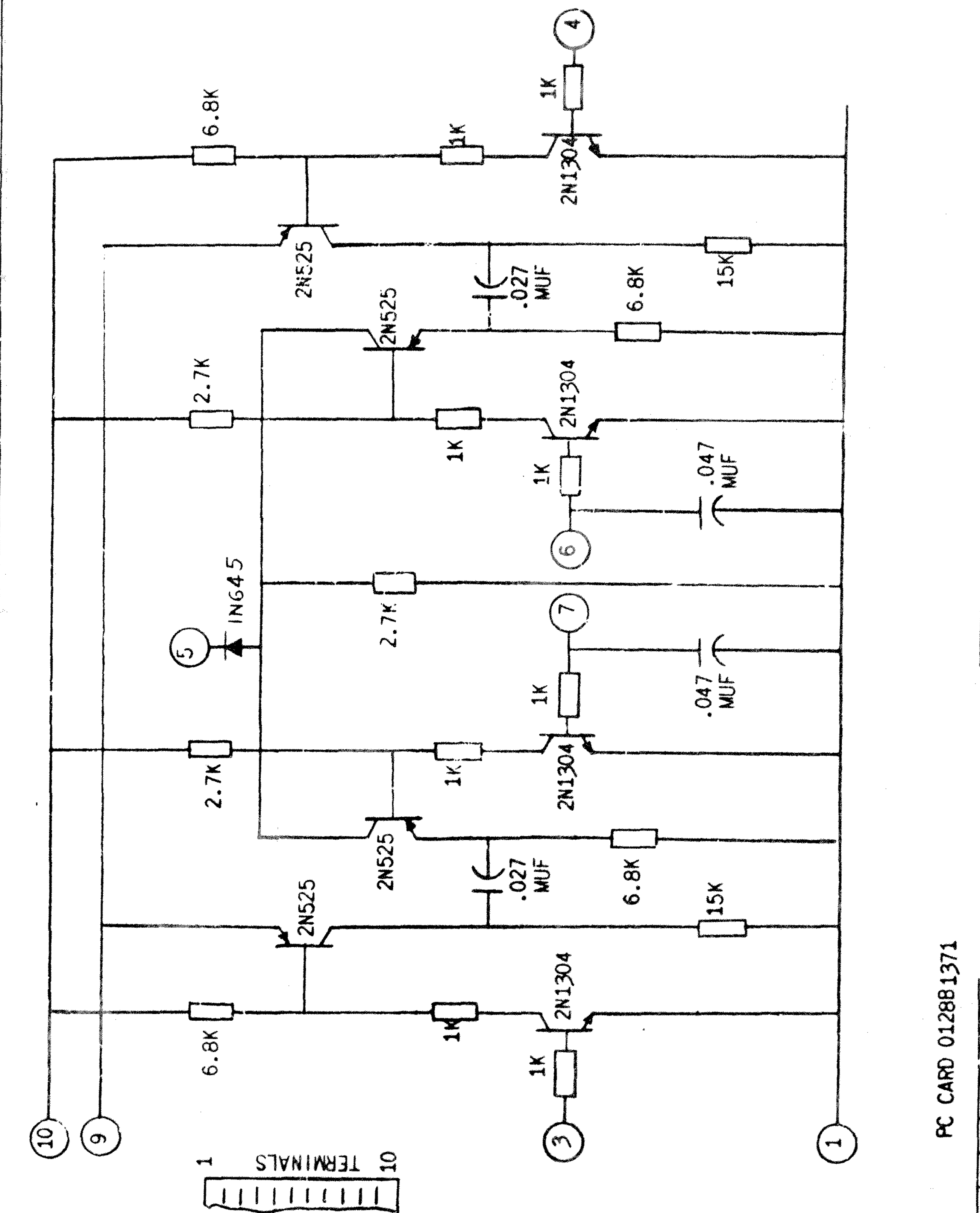
FIG-24A

FIRST MADE FOR SLY13A

D18

REVISIONS

1 Jan 13 1965 [illegible]



PRINTS TO

MADE BY R Bechtold JUNE 19, 1964

ISSUED June 23, 1964

APPROVALS RCl

SWITCHGEAR | DIV OR DEPT.

PHILADELPHIA | LOCATION

0148A3917AK

CONT ON SHEET | SH NO.

LSP-R

CODE IDENT NO.

FF-803-WA (9-63) PRINTED IN U.S.A.

A

GENERAL ELECTRIC

0 1 4 8 A 3 9 1 7 A H

CONT ON SHEET SH NO.

REV NO.

C 1 4 8 A 3 9 1 7 A H

CONT ON SHEET SH NO.

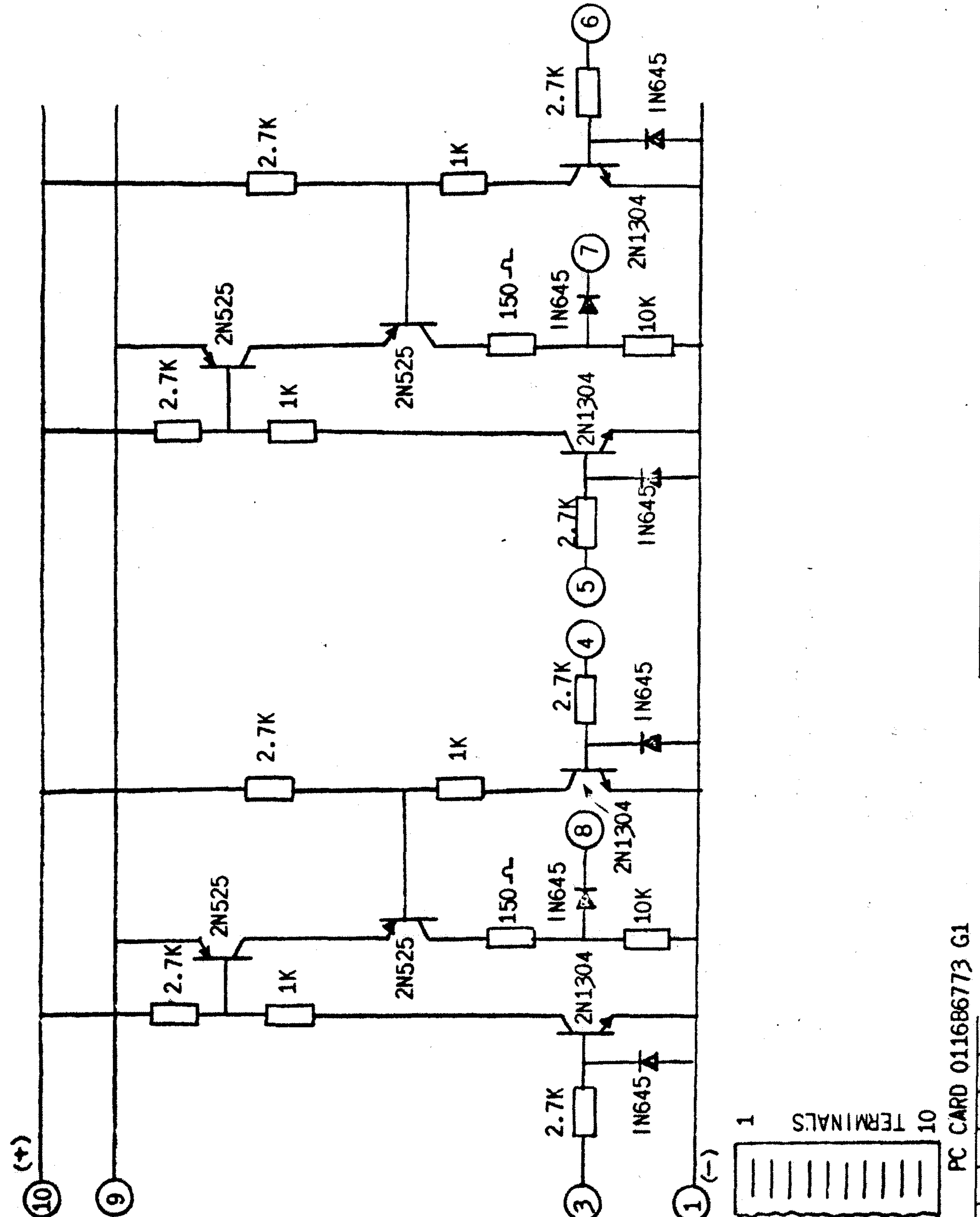
TITLE

MHO UNIT - 2 POLARITIES- "BLOCK-BLOCK"

FIRST MADE FOR

FIG-24B D11

REVISIONS



PRINTS TO

MADE BY Feb. 7, 1964

ISSUED

APPROVALS

SWITCHGEAR DIV OR DEPT.

PHILADELPHIA LOCATION

0 1 4 8 A 3 9 1 7 A H

CONT ON SHEET SH NO.

CODE A

GENERAL ELECTRIC

0148A3902AJ

CONT ON SHEET | SH NO.

REV NO. -2-

C148A3902AJ

CONT ON SHEET | SH NO.

TITLE

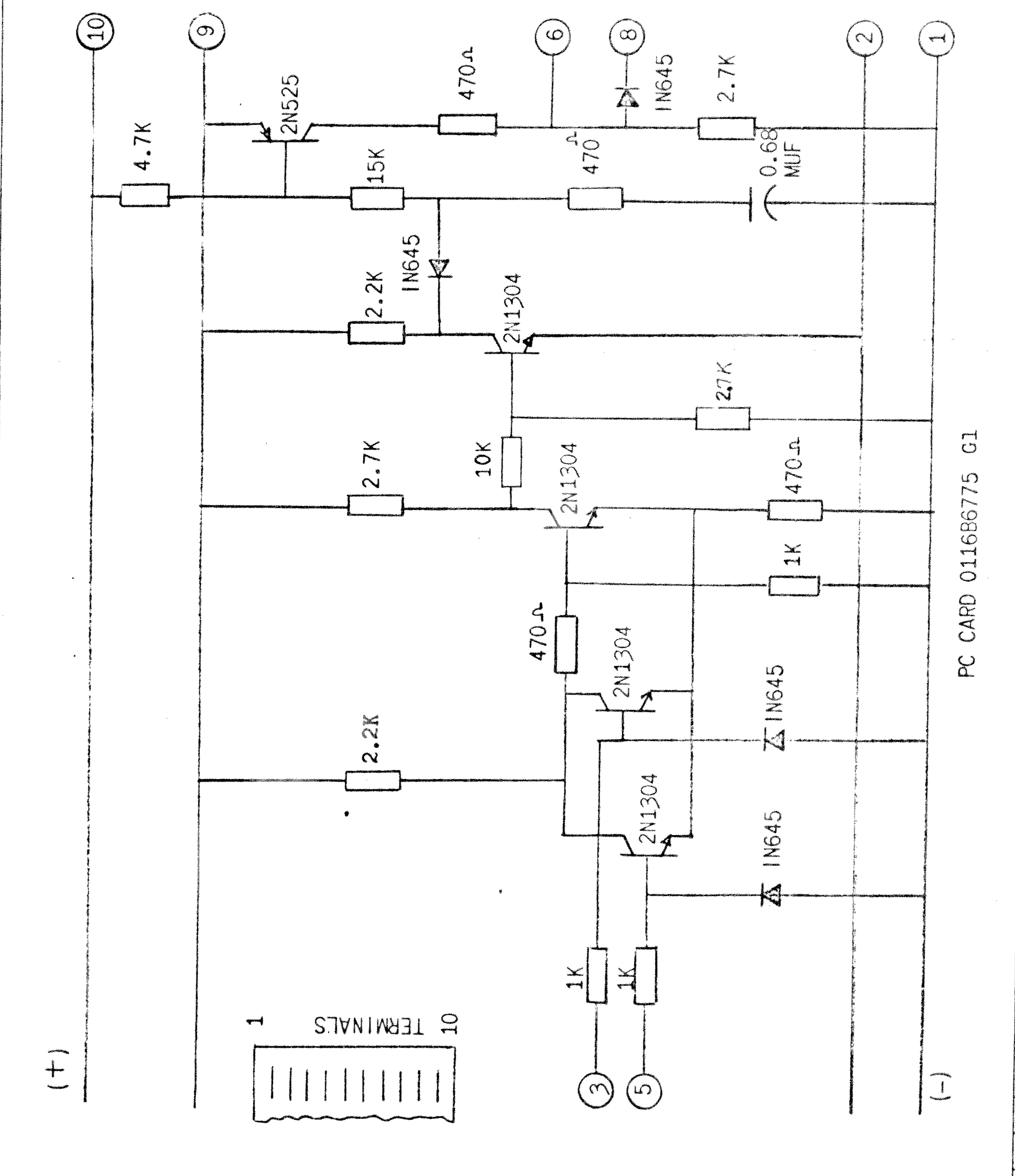
D-13 OVERCURRENT LEVEL DETECTOR

FIG-24C

FIRST MADE FOR

D13

REVISIONS



PRINTS TO

MADE BY [handwritten signature] Feb 2, 1964

ISSUED February [illegible]

APPROVALS [handwritten initials]

SWITCHGEAR | DIV OR DEPT.

PHILADELPHIA | LOCATION

0148A3902AJ

CONT ON SHEET | SH NO.

FF-803-WA (6-63)

CODE A | GENERAL ELECTRIC | 0 1 4 8 A 3 9 0 1 AM

CONT ON SHEET | SH NO.

REV NO. -1-

0 1 4 8 A 3 9 0 1 A M

CONT ON SHEET | SH NO.

TITLE

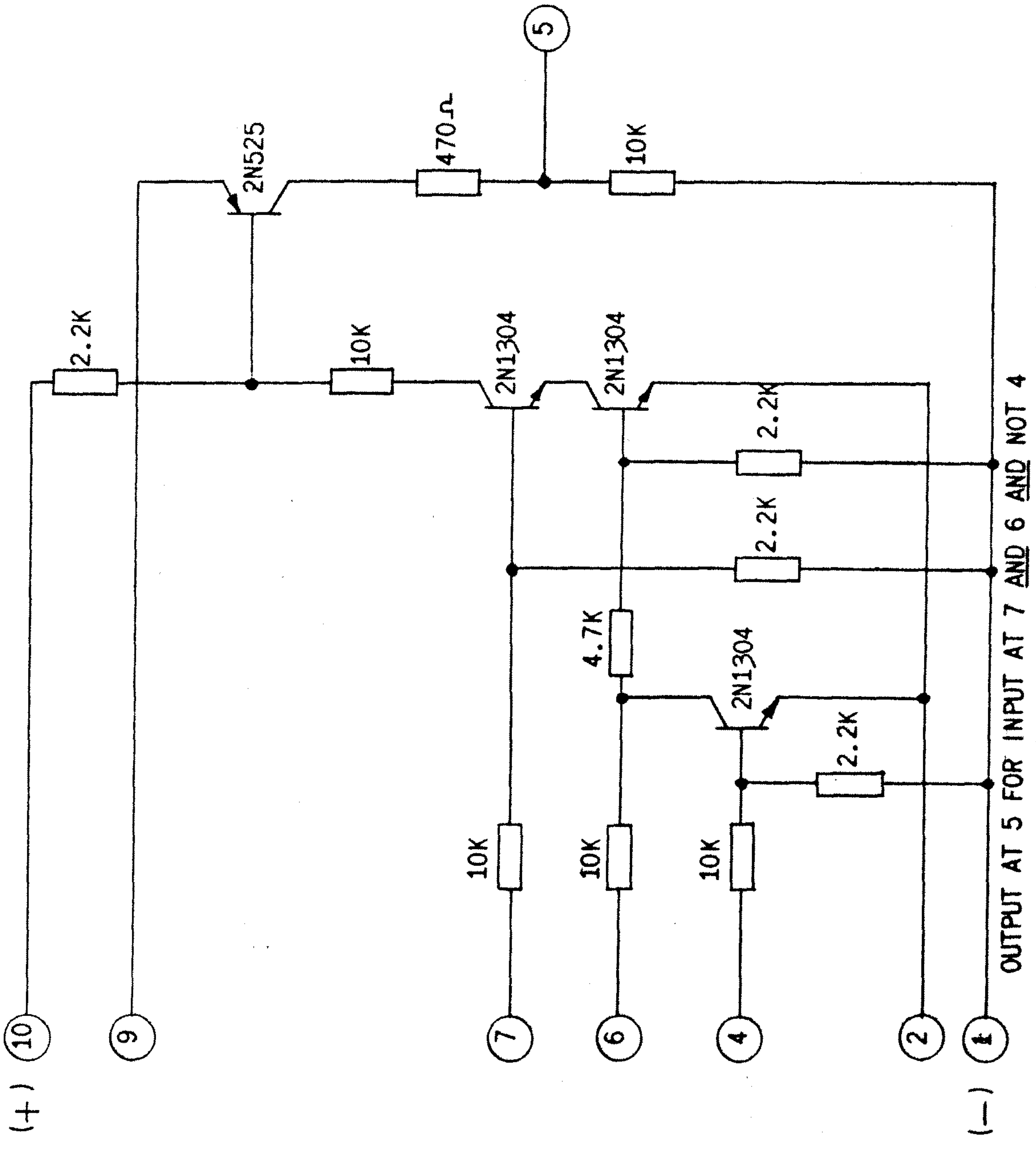
AND WITH NOT

FIRST MADE FOR SLZ -COMPARER

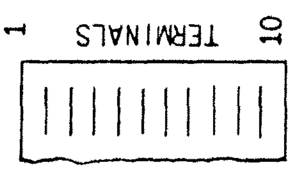
FIG - 24D

L3

REVISIONS



PC CARD 0116B4989 G1



PRINTS TO

MADE BY R Bechtold FEB.5,1963	APPROVALS	L.V. SWITCHGEAR — DIV OR DEPT.	0 1 4 8 A 3 9 0 1 A M
ISSUED June 6, 1963		PHILADELPHIA — LOCATION	CONT ON SHEET / SH NO.

FF.803-WA (5-62) REV
PRINTED IN U.S.A.

LSP-R

C... A GENERAL ELECTRIC 0148A3901AN

CONT ON SHEET SH NO.

REV NO. /-

0148A3901AN

CONT ON SHEET SH NO.

TITLE 3 AND

FIRST MADE FOR SLZ

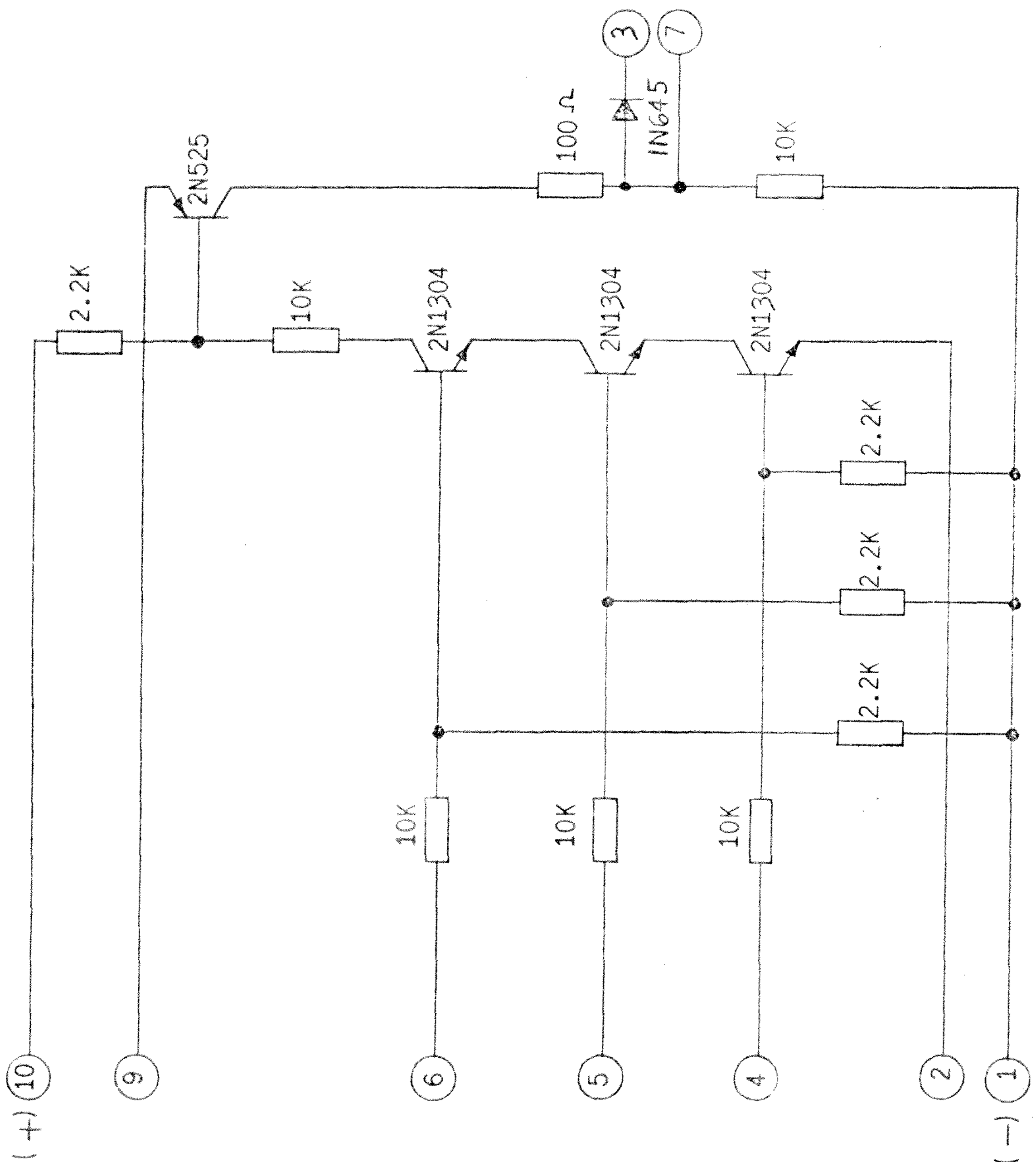
FIG-24E

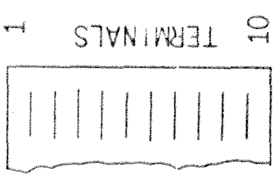
L4

REVISIONS

JAN ... 64

1





PC CARD 0116B4939 G1

PRINTS TO

MADE BY E Bechtold FEB 5, 1962	APPROVALS	L.V. SWITCHGEAR DIV OR DEPT.
ISSUED June 6, 1963		PHILADELPHIA LOCATION

0148A3901AN

CONT ON SHEET SH NO.

FF-803-WA (8-62)
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LSP-R

CODE IDENT NO.

CODE A GENERAL ELECTRIC

0148A3901AR

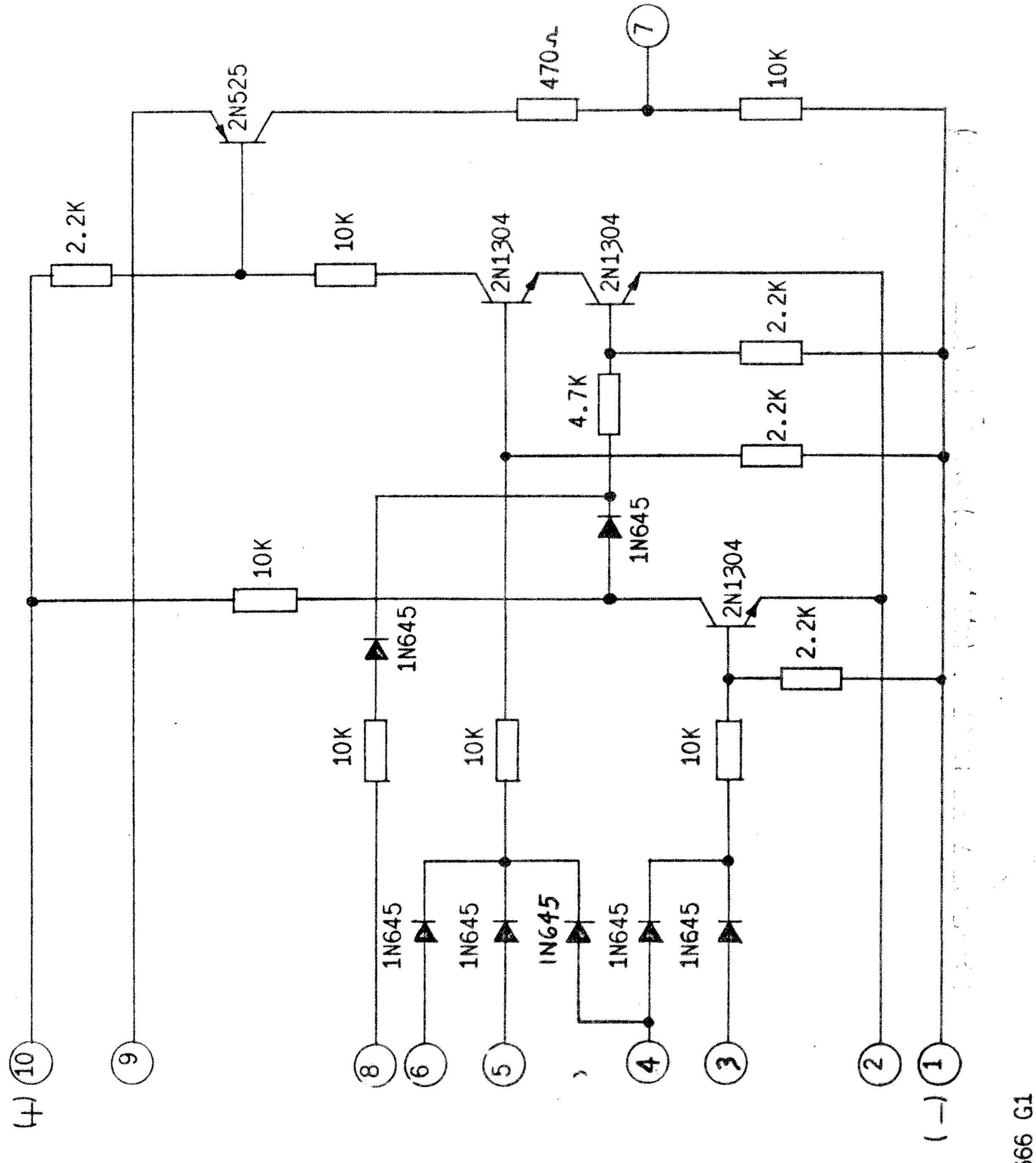
REV NO. 1-X-3	TITLE AND WITH NOT
0148A3901AR	
CONT ON SHEET SH NO.	FIRST MADE FOR SLZ-RB LOGIC

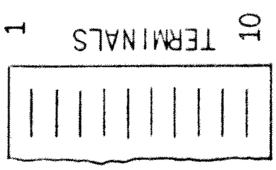
CONT ON SHEET SH NO.

FIG-24F

L6

REVISIONS





PC CARD 0116B6666 G1

PRINTS TO

MADE BY	APPROVALS			
R Bechtold FEB. 5, 1963		L.V. SWITCHGEAR	DIV OR DEPT.	0148A3901AR
ISSUED Jan 6, 1963		PHILADELPHIA	LOCATION	CONT ON SHEET SH NO.

FF-803-WA (8-62)

CODE IDENT NO.

CODE A

GENERAL ELECTRIC

0148A3906 BD

CONT ON SHEET SH NO.

REV NO. 1-

0148A3906 BD

CONT ON SHEET SH NO.

TITLE 2-8/0

FIG-24G

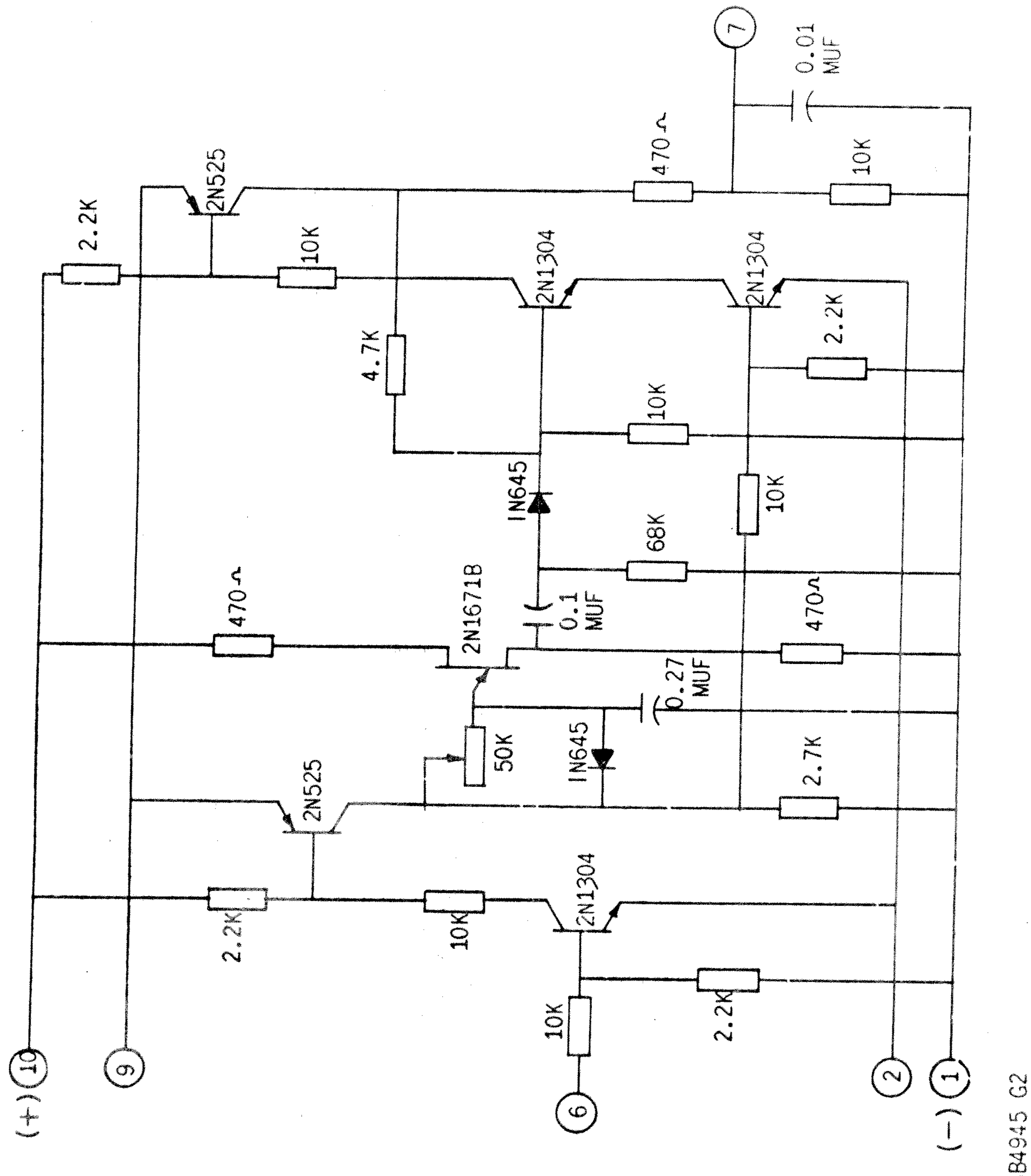
FIRST MADE FOR SLA

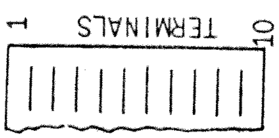
T4

REVISIONS

1

11.23.66 B. [illegible]





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MADE BY R. Bechtold OCT 11, 1966

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SWGR. DIV OR DEPT.

PHILA. LOCATION

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CODE A GENERAL ELECTRIC 0148A3906AD

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REV NO. 2

0148A3906AD

CONT ON SHEET | SH NO.

TITLE 32-64/0

FIRST MADE FOR SLZ

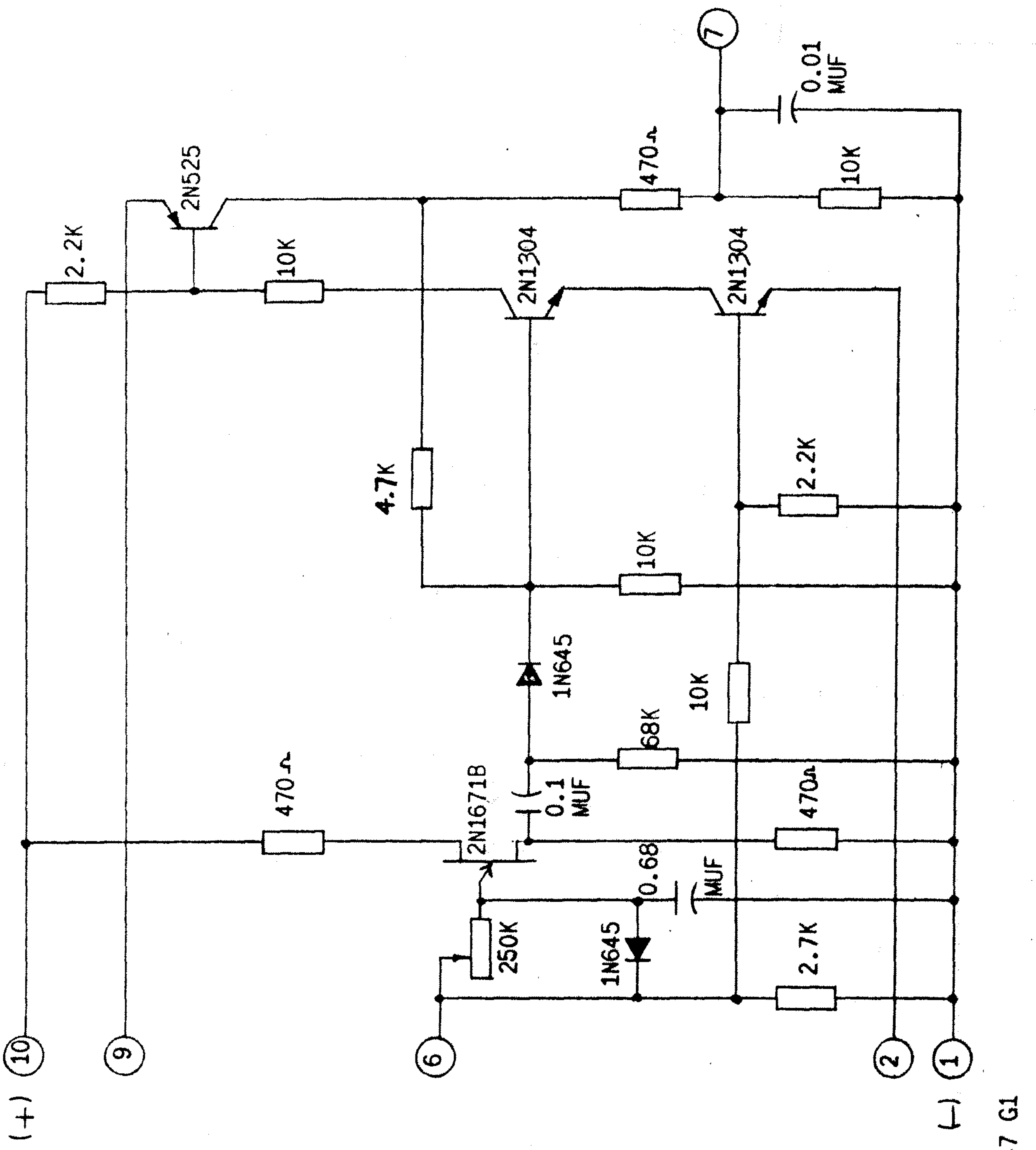
FIG-24H

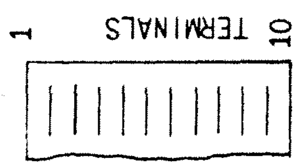
T7

REVISIONS

2 | Nov 4, 1963 | R. Ratner

1 | May 7, 1964





PC CARD 0116B4947 G1

PRINTS TO

MADE BY R Bechtold FEB. 7, 1963

ISSUED June 6, 1963

APPROVALS

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0148A3906AD

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CODE A GENERAL ELECTRIC 0148A3906AG

CONT ON SHEET SH NO.

REV NO. 1-2

0148A3906AG

CONT ON SHEET SH NO.

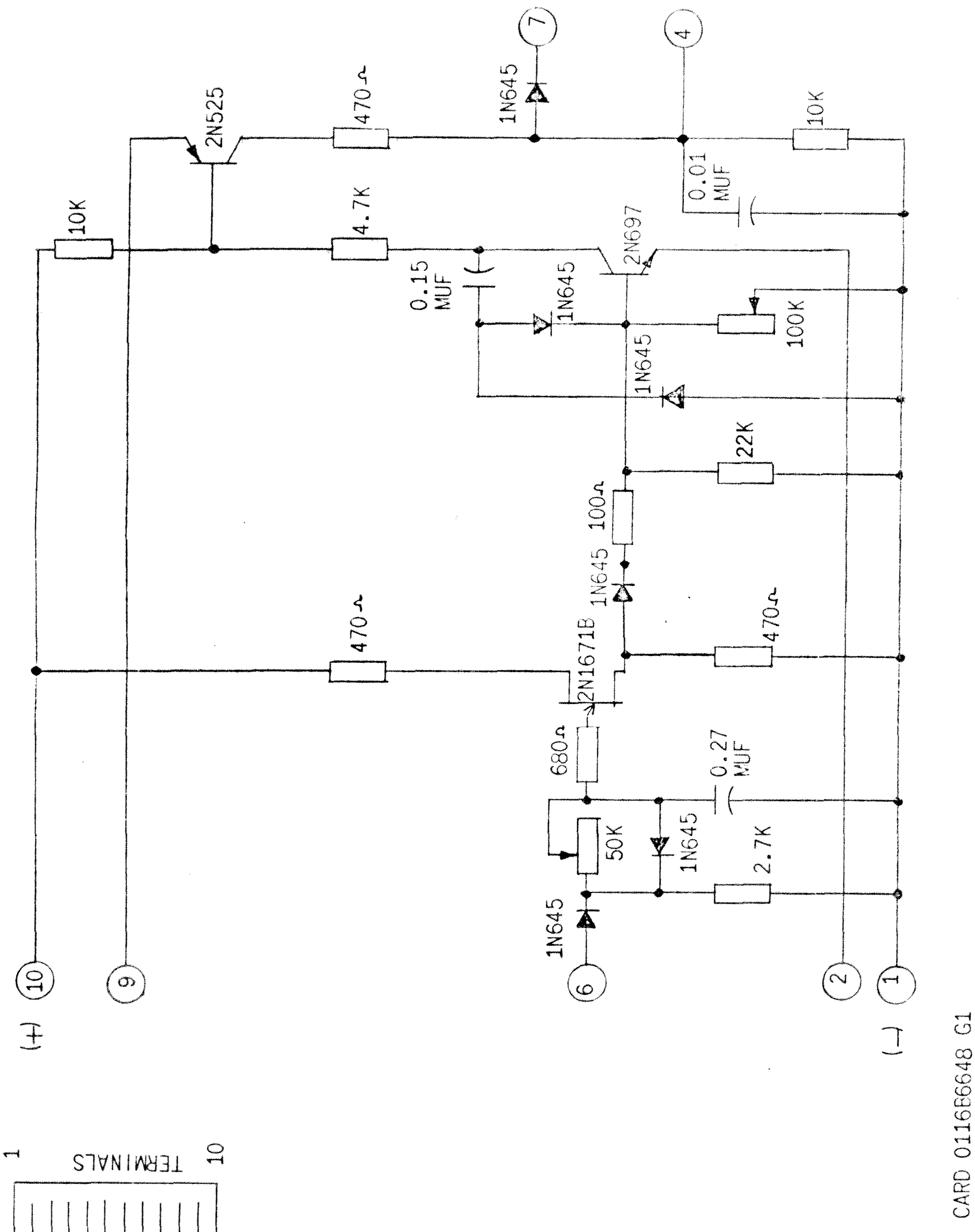
TITLE 4/9

FIRST MADE FOR SLZ

FIG-24J

T11

REVISIONS



PC CARD 0116B6648 G1

PRINTS TO

MADE BY R Bechtold FEB 7, 1963

ISSUED June 6, 1963

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PHILADELPHIA LOCATION

0148A3906AG

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CODE IDENT NO.

CODE A | GENERAL ELECTRIC | 0148A3913AA

REV NO. 0148A3913AA

CONT ON SHEET — SH NO.

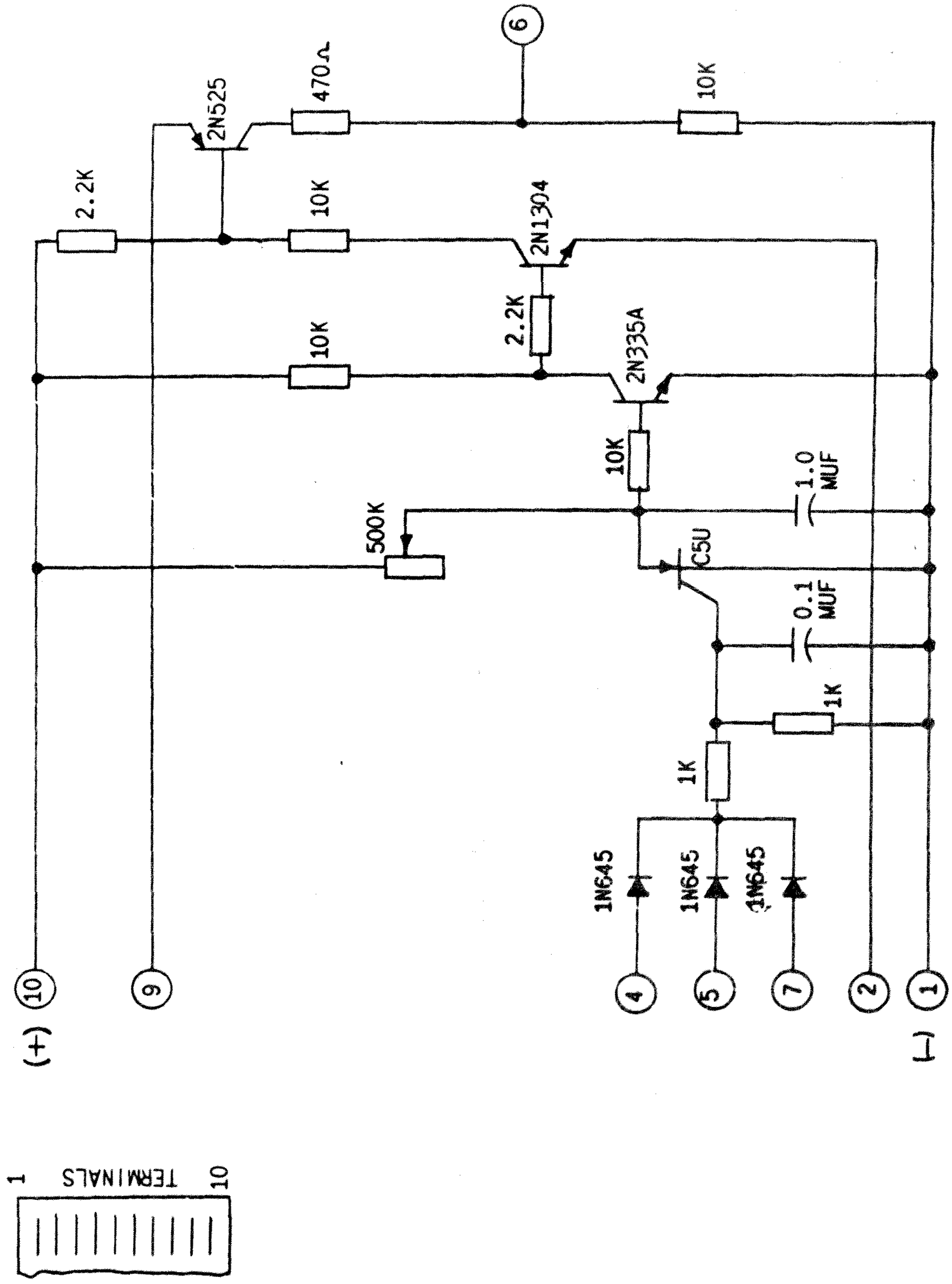
TITLE P/9

FIG-24K

FIRST MADE FOR SLZ

T2

REVISIONS



PC CARD 0116B6642 G1

PRINTS TO

MADE BY R. Bechtold FEB. 7, 1963	APPROVALS	L.V. SWITCHGEAR — DIV OR DEPT.	0148A3913AA
ISSUED June 6, 1963		PHILADELPHIA — LOCATION	CONT ON SHEET — SH NO.

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CODE IDENT NO.

CODE D

GENERAL ELECTRIC

0165A7661

CONT ON SHEET SH NO.

REV NO. ~~1-2-3-4~~-5

0165A7661

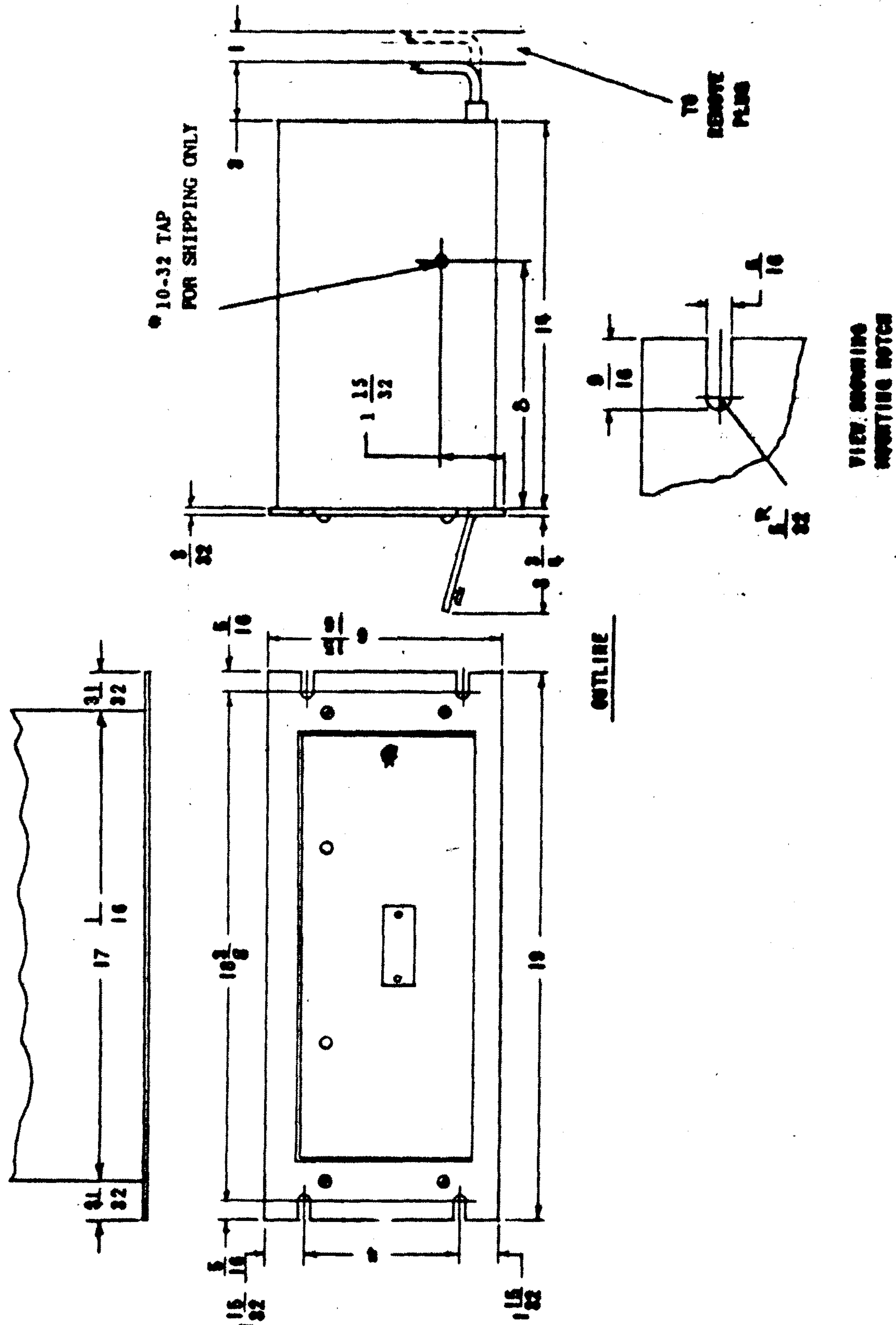
CONT ON SHEET SH NO.

TITLE

OUTLINE & MOUNTING DIMENSIONS

FIRST MADE FOR & RACK UNIT (TAP BLOCK)

FIG-25



REVISIONS

1	Nov 14, 1963 R Bechtold	
2	JAN 9 64 R Bechtold	
3	JAN 30 64 R Bechtold	
4	June 29, 1965 R Bechtold	
5	Jul 29, 1966 R Bechtold	

PRINTS TO

MADE BY R Bechtold JUNE 27, 1963

ISSUED July 12, 1963

APPROVALS

L.V. SWITCHGEAR — DIV OR DEPT.

PHILADELPHIA — LOCATION

0165A7661

CONT ON SHEET SH NO.

CODE D

GENERAL ELECTRIC

0165A7662

CONT ON SHEET | SH NO.

REV NO. 1-2-3-

0165A7662

CONT ON SHEET | SH NO.

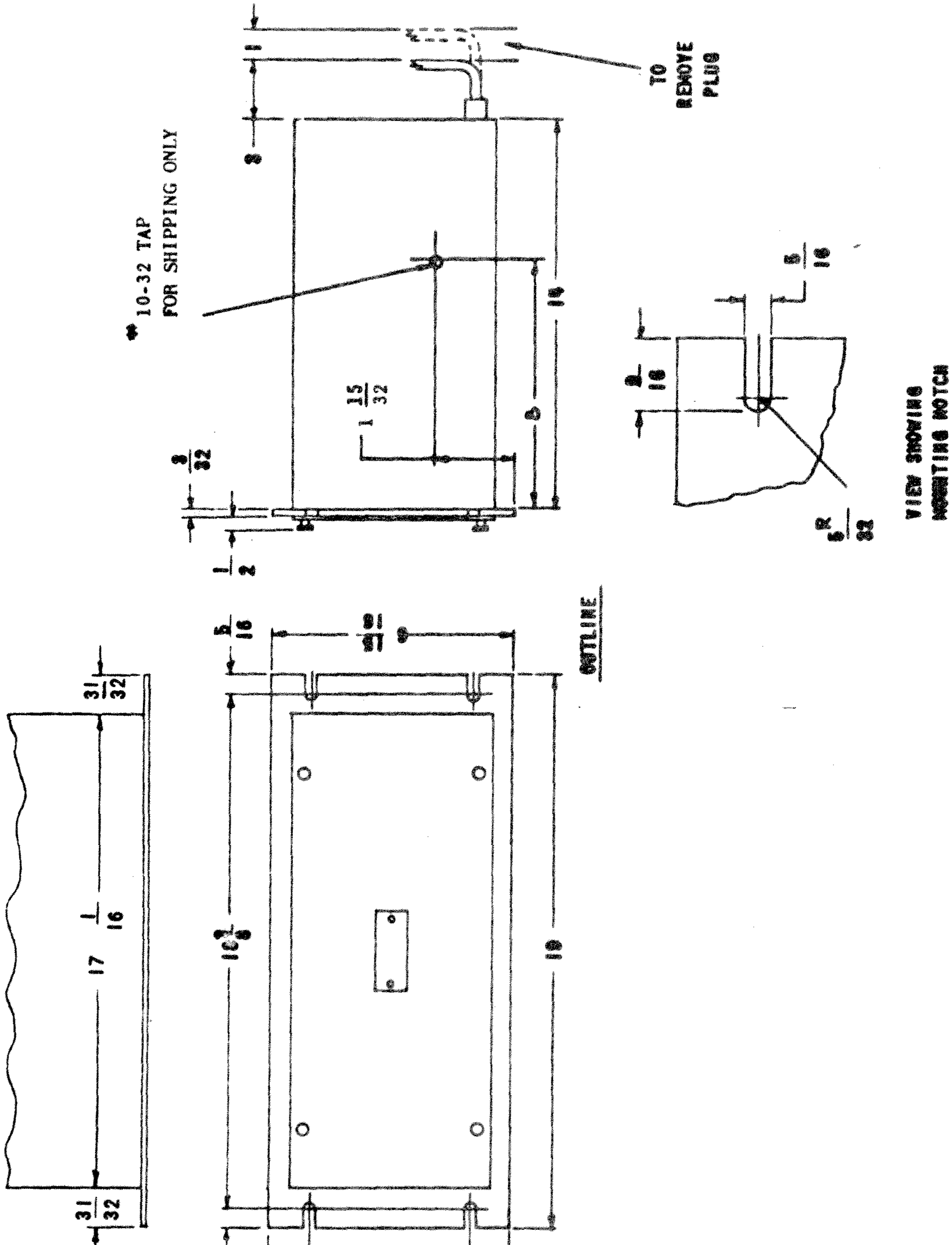
TITLE

OUTLINE & MOUNTING DIMENSIONS

FIG-26

FIRST MADE FOR 4 RACK UNIT (LOGIC)

REVISIONS



PRINTS TO

MADE BY R Bechtold JUNE 27, 1963

ISSUED July 12, 1963

APPROVALS

L.V. SWITCHGEAR — DIV OR DEPT.

PHILADELPHIA — LOCATION

0165A7662

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FF-803-WA (1-62)

GENERAL ELECTRIC

0178A5813

CONT ON SHEET SH NO.

REV NO. -1

0178A5813

CONT ON SHEET SH NO.

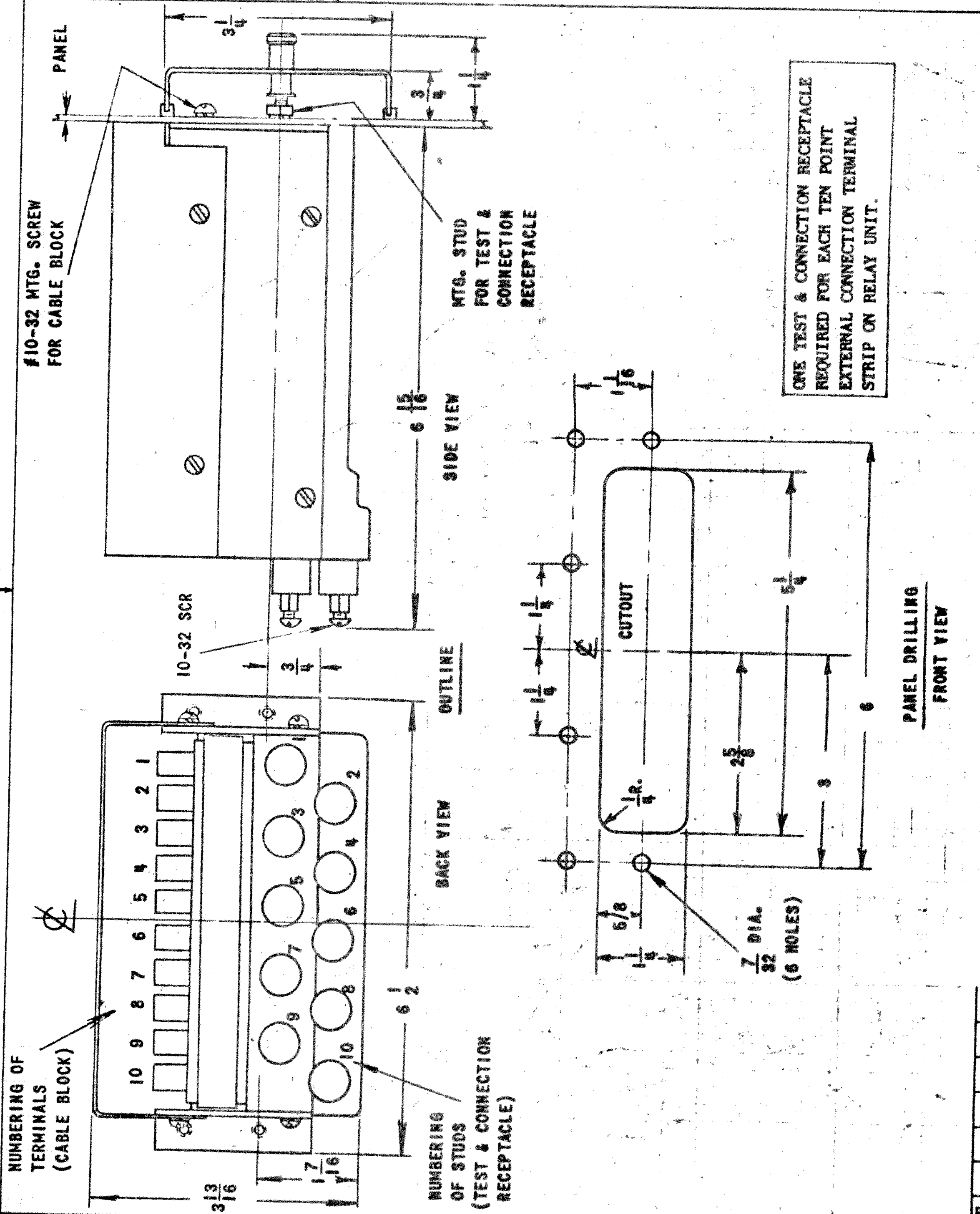
TITLE

OUTLINE & PANEL DRILLING
FOR TEST & CONNECTION RECEPTACLE

FIRST MADE FOR STATIC RELAYS

FIG- 27

REVISION



ONE TEST & CONNECTION RECEPTACLE REQUIRED FOR EACH TEN POINT EXTERNAL CONNECTION TERMINAL STRIP ON RELAY UNIT.

PRINTS TO

MADE BY J. Connor Feb. 7, 1964

ISSUED February 24, 1964

APPROVALS

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PHILADELPHIA — LOCATION

0178A5813

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GENERAL ELECTRIC

0178A7030

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REV NO.

0178A7030

CONT ON SHEET | SH NO.

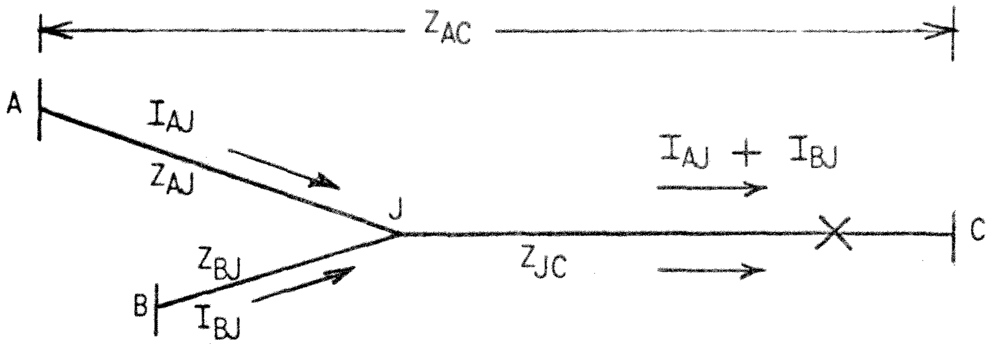
TITLE

3-TERMINAL APPLICATIONS

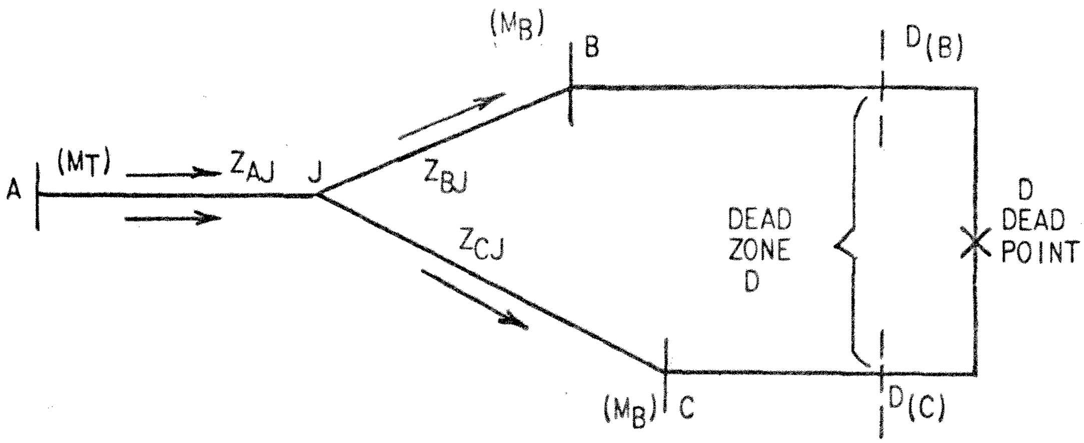
FIRST MADE FOR GEI-98309 (SLY13A)

FIG-28

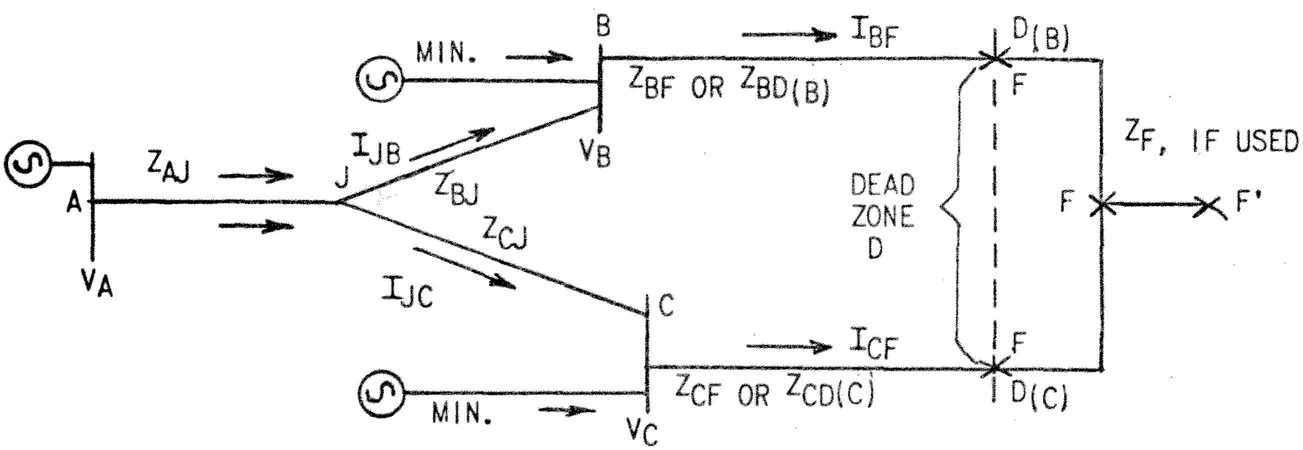
REVISIONS



A – INTERNAL FAULT WITH INFEED, 3-TERMINAL LINE



B – EXTERNAL FAULT WITHOUT INFEED, 3 TERMINAL LINE



C – EXTERNAL FAULT WITH INFEED, 3 TERMINAL LINE

PRINTS TO

MADE BY April 17, 1964

ISSUED March 30, 1964

APPROVALS

SWITCHGEAR — DIV OR DEPT.

PHILADELPHIA — LOCATION

0178A7030

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FF-803-WA (6-63)

CODE IDENT NO.