INSTRUCTIONS

GEK-86108A

CARRIER AUXILIARY RELAY

TYPE SCA51A

FOR USE WITH STATIC RELAYS

GENERAL ELECTRIC

CONTENTS

CARRIER AUXILIARY RELAY
TYPE SCA51A

DESCRIPTION

The Type SCA51A relay is a carrier auxiliary relay for use in conjunction with power line carrier or microwave channels and static protective relaying equipment in directional comparison relaying schemes. The relay includes five separate relay functions which can be used singly or in combination. The desired mode of operation is selected by means of internal links and by making the appropriate external connections. The relay also includes a target.

The dc control voltage rating of the relay is switch selectable for 48, 110/125 or 220/250 volts dc. The relay is supplied in a medium size, double-ended (M2) drawout case.

The relay includes three static relay functions:

1. The RX (receiver auxiliary) function has an isolated input that is driven by the output of the power line carrier receiver. It can be driven by the closure of a contact in the carrier receiver or directly by a 300 milliampere dc output current from the receiver. The choice between these two modes of RX operation is made by a selector switch, accessible from the front of the relay. When the receiver output contact is used, the RX circuit rating can be set for 48, 110/125 or 220/250 volts dc by means of the selector switch; otherwise the selector switch is set in the 300 milliampere position.

2. The TTZ (coordination delay) function provides a delay of 3 to 40 milliseconds, adjustable by a front-of-panel potentiometer.

3. The RI (reclose initiate) function provides three normally open contacts, capable of making up to 30 amperes. The function has a fast pickup and a delayed dropout of 150 milliseconds.

In addition to the static functions, the relay includes two electromechanical auxiliary units:

1. The A auxiliary unit provides a single normally open contact capable of making up to 30 amperes for tripping duty. This unit can be connected internally in the pilot trip circuit when the current exceeds the capability of the RX contact. Pickup time of the A unit is four to five milliseconds.

2. The TB (blocking) auxiliary unit coil is connected to a case stud through a normally closed contact of the TTZ unit. Its operating time is less than three milliseconds.

APPLICATION

The Type SCA51A relay is designed for application as a carrier auxiliary relay in directional comparison blocking schemes employing SLY/SLYG 80 series static distance relays and power line carrier or microwave channels. Its most common usage is with the General Electric Type CS27C carrier equipment, but it can be used with channel equipment of other manufacture with proper allowance for channel time and if suitable interfacing with the RX receiver auxiliary unit is available.

Operation of the relay can best be explained by referring to the simplified diagram in Figure 1. This shows a directional comparison carrier blocking scheme, using SLY and SLYG relays and a CS27C carrier channel, protecting line C-D shown in Figure 2. The RX receiver auxiliary unit can be operated either: (a) by a 300 milliampere (maximum) dc current output from the carrier receiver, or (b) by the closure of a contact in the carrier receiver applying a 48, 125 or 250V dc signal onto the RX coil circuit. The choice between the two modes of operation, current or voltage, is made by a selector switch mounted on the front of the relay. Use of the contact output from the carrier receiver offers the advantage of dc isolation between the relay circuits and the carrier set.

Consider an external phase fault at point X in Figure 2. The mho tripping relay 21MT at breaker C will see the fault in the tripping direction and will pick up, energizing the TTZ unit and preventing any carrier transmission from that end of the line. The mho blocking relay 21MB at breaker D will also operate and initiate the transmission of blocking carrier from that end. Receipt of this carrier at end C will pick up the RX unit, opening its normally closed contact in the pilot trip circuit and preventing MT-TTZ operation from tripping the breaker.

During an internal fault, at point Y in Figure 2 for example, the mho trip relays at both ends will operate preventing transmission of carrier from either end. Thus the pilot trip circuit will be completed and the breakers at both ends will be tripped.

This describes the basic principles of a directional comparison scheme using the Type SCA51A carrier auxiliary relay. The following specific points must be considered in applying the SCA relay:

1. For the typical application described, using SLY/SLYG 80 series relays and the CS27C carrier channel, it is recommended that the link J3 be in its A to C position. This will place the TTZ function in series with the trip circuit. The pickup time of the TTZ should be set for five milliseconds. This will insure proper coordination between the opening of the RX contact upon receipt of carrier, and the closure of the TTZ contact as controlled by the 21MT closing. If the relay is applied with carrier sets of other manufacture, it is possible that longer TTZ times will be required to insure coordination. The user must determine channel time of the carrier equipment and select a safe TTZ time setting.

2. Link J2 provides a choice beween the normally closed or normally open contact of the RX function. On installations where RX is operated by a 300 milliampere output from the carrier receiver, or by the closure of a

normally open contact in the receiver, the J2 link should be in its A to C position which inserts the RX normally closed contact into the circuit.

On applications where carrier is transmitted continuously in standby, it is recommended that the polarity jumper on the RX board be in the "N On" position, which causes the RX unit to operate when carrier is not received. For this mode of operation the J2 link should be in its C-B position so that the normally open RX contact is in the pilot trip circuit.

3. Link J4 either bypasses or inserts the A unit. On applications where the SCA pilot trip circuit is connected directly to the breaker trip coil, as shown in Figure 1, the J4 link must be in its A to C position since the contacts of the TTZ and RX functions are not capable of making typical breaker trip coil currents. See Figure 3, simplified functional diagram, for link electrical functions.

   On applications where an auxiliary tripping relay is interposed between the SCA trip output and the breaker trip coil, it is possible that the RX contact can be connected directly to the auxiliary tripping relay. This is accomplished by connecting link J4 in the B to C position, bypassing the A unit. The user must determine that the current drawn by the auxiliary tripping unit is within the current rating of the TTZ and RX contacts, as listed in a following section on **CONTACT CURRENT RATINGS.**

4. The TB unit is included to provide a transient blocking function if required. This will provide additional security against a misoperation during a power reversal accompanying the sequential clearing of an external fault on a parallel line. The scheme is shown in simplified form in Figure 1.

Operation of the MB or MBG unit at the terminal closest to the external fault (refer to Figure 1) will pick up the TB unit. One contact of that unit opens the carrier stop circuit and a second contact changes the timing resistance in the TTZ circuit (with link J1 in position B to C) increasing the pickup time of the TTZ function by seven cycles. Thus, on a power reversal the TB unit will remain picked up for the 130 millisecond reset time of the MB or MBG unit thereby sustaining carrier at the local terminal for that period, even though MT or MTG operates on the reversal. The increased pickup time of the TTZ prevents the normally closed contact of that unit from opening the TB coil circuit on the reversal until after MB or MBG have reset.

The relay is shipped with jumper J1 in the C-B position, J2 in the C-A position, J3 in the C-A position, and J4 in the C-A position. The RX board jumpers are set as follows. A jumper is in the P-On position. The P Delay jumper is in the "out" position and the N Delay jumper is set to "in."

NOTE: POSITIVE DC VOLTAGE MUST ALWAYS BE CONNECTED TO RELAY STUD 11 AND NEGATIVE TO STUD 2.

RATINGS

TEMPERATURE RANGE

Operating - -20°C to +65°C

Storage - -40°C to +65°C

Humidity - 10-95 percent non-condensing

INSULATION

The insulation meets ANSI/IEEE C37.9 standards. Telephone relay contacts are rated at 1500 volts and reed relay contacts are surge protected.

CONTROL VOLTAGE RANGE

The range is switch selectable to 48, 110/125, and 220/250 volts dc. Receiver input is set by a separate switch to 300 milliamperes (input impedance is 25 to 30 ohms), or to 48, 110/125, 220/250 volts dc. The relay is designed to operate from 100 to 300 milliamperes or from 80 to 110 percent of 48, 125 and 250 volts dc. The maximum dc voltages are:

SWITCH SETTING	MAXIMUM VOLTAGE
48	56
125	140
250	280

This operating range covers the international 110 and 220 volt ranges.

CONTACT CURRENT RATINGS

A and RI contacts:

Carry continuous - 3 amps
Make for tripping duty - 30 amps

RX, TB and TTZ contacts:

50 watts resistive maximum load
300 volts dc maximum voltage
3 amps dc maximum make and carry current

BURDENS

BURDEN PER FUNCTION AT INPUT

Input	INPUT RANGE			
	300 ma dc	48 VDC	110/120 VDC	220/250 VDC
RX	27 ohms	10 ma	10 ma	10 ma
RI	N/A	0.5 ma	1.25 ma	2.5 ma
TTZ	N/A	10 ma	10 ma	10 ma
A	N/A	160 ma	160 ma	160 ma
TB	N/A	48 ma	48 ma	48 ma

N/A = not applicable

CURRENT REQUIRED AT STUD 11 FOR OPERATION

No functions operated (typical) - 23 milliamperes
Add when RI operates - 160 milliamperes
Add when RX or TTZ operate - 48 milliamperes each

SEISMIC

Tested to IEEE Std-501, 3g ZPA

TARGET

One 0.6/2.0 ampere target.

TARGET UNITS	0.6/2.0 UNIT	
	0.6 AMP TAP	2.0 AMP TAP
Maximum to insure operation (amperes)	0.6	2.0
Carry continuously (amperes)	1.5	3.5
Carry 30 amperes for (seconds)	0.5	4
Carry 10 amperes for (seconds	4	30
DC resistance (ohms)	0.6	0.13
60 cycle impedance (ohms)	6	0.53

CHARACTERISTICS

TYPICAL VARIATION OF CHARACTERISTICS WITH TEMPERATURE

Variation from -20°C to +65°C

TTZ delay pickup variation at 20 millisecond delay - less than one millisecond.

TTZ long delay pickup variation at 140 millisecond delay - less than ten milliseconds

TB pickup and dropout delay variation - less than two milliseconds

RX pickup and dropout delay variation at five millisecond delay - less than one millisecond

RI pickup delay variation at seven milliseconds - less than one millisecond

RI dropout delay variation at 140 milliseconds - less than 22 milliseconds

TYPICAL VARIATION OF CHARACTERISTICS WITH SUPPLY VOLTAGE

Variation from 80 percent to 110 percent of nominal voltage.

TTZ variable delay pickup variation at 20 milliseconds delay - less than one millisecond

TTZ long delay pickup variation at 140 milliseconds - less than five milliseconds

TB pickup and dropout delay variation - less than two milliseconds

RX pickup and dropout delay variation at five milliseconds - less than 0.5 millisecond

RI pickup delay variation at seven milliseconds - less than two milliseconds

RI dropout delay variation at 140 milliseconds - less than five milliseconds

OPERATE TIMES (Typical)

TTZ Relay:	variable 3-40 milliseconds less than three milliseconds dropout.
TB Relay : (b contact)	1-3 milliseconds (PU) 1-3 milliseconds (DO)
RX Relay:	1-2 milliseconds (PU) (or five milliseconds with jumper) 1-2 milliseconds (DO) (or five milliseconds with jumper)
A Relay:	3-5 milliseconds (PU) 25-50 milliseconds (DO)
RI Relay:	3-10 milliseconds (PU) 110-167 milliseconds (DO)

CONSTRUCTION

OPERATING PRINCIPLES

Major Functions

The SCA relay is an auxiliary relay for carrier equipment used with the SLY/SLYG 80 series distance relays. The SCA relay provides five functions which may be used singly or in combination. Insofar as is possible the functions are interconnected as normally required. However, some connections are application dependent and these connections are made either by internal link changes or by connection to case studs. The connections for various applications are described in the **APPLICATION** section.

The SCA relay has three front panel controls. One is a switch that selects the control voltage (dc supply voltage). This is a three position switch that can be set for operation on 48 Vdc, 110/125 Vdc, or 220/250 Vdc. This is done by using a multi-pole switch with diodes and resistors. The static (electronic) portions of the relay require 15 volts dc to operate. This is obtained from the dc control voltage by means of a dropping resistor and a zener diode. The value of the dropping resistor is controlled by the control voltage switch SW1. This switch, in conjunction with rectifier diodes, selects the dropping resistor or resistors used as shown in Figure 4. The diodes are required because each contact on the switch connects to several dropping resistor networks and the diodes isolate the networks from each other. A similar arrangement of isolation diodes and dropping resistors connected to other poles of switch SW1 provides the correct operating voltages for the other circuitry. POSITIVE DC MUST ALWAYS BE SUPPLIED TO STUD 11 AND NEGATIVE TO STUD 2.

The SCA relay is designed for tripping service, not continuous operation. Continuous operation will damage the relay. Only the RX relay will stand continuous energization and this is not recommended in normal operation.

Refer to Figure 3 for the following discussion. This simplified functional diagram omits some components, such as varistors and surge capacitors, for clarity. The diagram shows the major relay functions with the static functions (RX, TTZ and RI) shown by blocks and the two electromechanical relay functions (A and TB) shown by the normal relay symbols. The jumpers can connect jumper terminal "C" to either "A" or "B."

In normal operation this relay is used to connect a signal from stud 12 or 13 to stud 1 (trip bus) and stud 15 (trip bus with trip diode) with the circuit completion and/or timing dependent on one or more inputs, TTZ, RX and TB. If TTZ (coordination delay) is to be used, the signal must be applied to stud 13 and jumper J3 must connect "A" to "C." The signal at stud 13 will initiate the TTZ timing and after a preset delay the TTZ relay will be energized to close the TTZ contact between J3-A and stud 12 completing the circuit to this point. If the TTZ function is not desired the signal can be applied to stud 12 to bypass TTZ.

From stud 12 the signal is fed via jumper J2 to either the normally closed (form b) or normally open (form a) contact of the RX relay. The RX (receiver auxiliary relay) is operated by a carrier set signal applied to studs 7 and 8 of the

SCA relay. Studs 7 and 8 are electrically isolated from the remainder of the relay except for the RX input signal being coupled through an optical coupler to operate the RX relay.

The signal then goes to jumper J4 terminal C. It can be routed to terminal B to go directly to the trip bus or to terminal A to operate the A relay coil. The A relay is a telephone relay capable of carrying trip current which TTZ, RX and TB contacts cannot do. Therefore, if the circuit from stud 13 to stud 1 must carry trip current (make 30A), then jumper J4 must be set so jumper terminals A and C are connected. The TTZ and RX contacts only have to supply the A relay coil current. When the A relay coil is energized, the A relay contact will complete the circuit to the trip bus via the target coil.

The current to the trip bus must pass through the target coil. The coil is tapped to operate on either a 0.6 or two ampere current. When the coil is energized, a visible flag is set.

The current through the target coil flows to stud 1 or alternately to stud 15 through a trip diode D3. The presence of an output voltage at stud 1 initiates operation of the RI delay circuit. The RI relay closes within a few milliseconds of an output appearing at stud 1. The RI relay remains closed for approximately 150 milliseconds after the output at stud 1 drops to zero. Three sets of RI contacts are available at the studs.

The TB relay can be energized only if TTZ is not energized. A set of normally closed (form b) TB contacts are brought to studs 3 and 4. If jumper J1 is set to connect jumper terminals B and C then energizing TB (TTZ not energized) changes the pickup time of TTZ to a fixed 130 milliseconds instead of the normal 3-40 milliseconds set by a front panel control. Change in state of TB after the 130 millisecond delay changes the TTZ pickup time but this has no effect since TTZ is already picked up.

The remainder of this section describes the operation of the printed circuit cards that provide the three static relay functions.

RI BOARD (RECLOSE INITIATE BOARD)

Refer to Figure 5. The RI board is driven from the trip bus. It energizes the RI relay immediately when the trip bus is energized. The RI relay remains energized approximately 150 milliseconds after the trip bus is de-energized.

The input signal from the trip bus is applied to card pin 10. It goes through a divider consisting of resistors R24, R25, and R26 and is applied to the base of transistor Q5. Capacitor C2 is connected to the divider network to provide low pass filtering to reject noise. The emitter of transistor Q5 is connected to a 6.8 volt zener diode CR14 so the base of transistor Q5 must go at least 7.5 volts positive with respect to card common, pin 7, before the transistor turns on. This requires 20 volts or more at the card input. Card input pin 10 must be positive with respect to card common, pin 7.

When transistor Q5 conducts, its collector current is coupled through resistor network R28 and R27 to the base of transistor Q12. This turns on transistor Q12 which quickly charges capacitor C3 to about plus 15 volts. The voltage across C3 goes to the base of transistor Q6. When the base goes above six volts transistor Q6 turns on. This six volt threshold is obtained from the 15 volt supply. The 15 volt supply consists of dropping resistors R56, R57, R58 and zener diode CR13. The six volt threshold is obtained from divider R34 and R35 feeding the base of Q7. Transistors Q6 and Q7 are a differential pair. So long as the base of Q7 is more positive than the base of Q6, then Q7 will conduct and Q6 will be off. However, when the base of Q6 becomes more positive than that of Q7 then Q6 will conduct. There is a narrow range where both conduct but that is not significant in this application. When Q6 conducts, it turns on transistor Q13 which turns on the Darlington pair Q8 and Q9. The collectors of these transistors are connected via card pin 6 to the coil of the RI relay. The other side of the RI coil goes to a positive dc voltage through appropriate dropping resistors. When the Darlington pair Q8 and Q9 are on, the RI relay is energized. VR5 suppresses any relay spikes.

The RI relay is energized as long as the input to the RI card is high. When the input goes low transistors Q5 and Q12 go off immediately. The voltage across C3 does not drop immediately. Instead it discharges slowly through R32. It will require about 130 milliseconds for the voltage across C3 to drop to six volts. Until this voltage drops to six volts Q6 will be on and keep relay RI energized. When this voltage goes below six volts Q6 goes off as do Q13, Q8 and Q9. This turns off the coil of relay RI. The mechanical design of RI is such that it drops out slowly, 30 to 40 milliseconds. Therefore the total drop-out time is 160 to 170 milliseconds with some additional variation due to manufacturing tolerances.

The RI board contains diodes CR1, CR2, CR15 and CR16 as well as resistors R56 , R57, and resistors R38 and R39. These components are switched in and out of the circuit by the control voltage switch SW1 on the SW board. The operation of these components was described earlier.

<u>TTZ CIRCUIT</u> (TRIP COORDINATION DELAY)

Refer to Figure 6. The input signal is applied between card pins 8 and 7 (common). The signal to pin 8 has already been through dropping resistors selected by the switch on the SW1 board on the 125 and 250 V setting. A small disk capacitor C13 is provided across the input to bypass high frequency noise. The signal then goes through resistor R3 to a divider consisting of resistors R4, R5 and R6. The signal also continues through resistor R7. The divider R4, R5 and R6 provides two voltages. The voltage at the junction of R4 and R5 is 595 divided by 952 or 62 percent of the voltage at the input to the divider (top of R4). This reduced voltage is applied to the base of Q2. The other divider output is at the junction of R5 and R6 and goes to the base of Q15. This base voltage is 221/4850 or 0.045 times the input at card pin 8. Since approximately 0.7 volts is required to turn on the base of Q15, this transistor will only be on when the input to the card, at card pin 8, exceeds 15 volts. Since the normal inputs are either zero volts or greater than 30 volts this transistor is normally either off or on. The circuit associated with transistor Q15 is provided so that the voltage at card pin 8 must be greater than or equal to 15 volts in order for the TTZ circuit to be operable.

Leaving the operation of the divider and considering a suddenly applied signal entering R7, the signal passes through R7 and goes to card pin 1. It goes through a variable external resistor (TTZ delay control) and returns to the TTZ card via card pin 9. In another mode the signal goes to pin 3 out to relay contacts and back to pin 9. The signal, or actually the current resulting from the application of the signal, charges capacitor C1. Capacitors C8 and C9 are merely noise-bypass capacitors. The voltage across C1 rises and approaches the voltage across the divider R4, R5 and R6. This voltage across capacitor C1 is also applied to the base of Q1. Q1 and Q2 are a differential pair that are turned on by Q15 whenever the normal positive input signal is applied to card pin 8. As already described, the base of Q2 is connected to the voltage divider R4, R5, and R6 so the base voltage is 62 percent of the voltage across the full divider. The base of Q1 is connected to capacitor C1 which will start at zero volts before a signal is applied and charge to the full divider voltage after a positive signal is applied. At some time after a positive signal is applied, the base of Q1 goes more positive than the base of Q2. When this happens Q2, which has been conducting, stops conductng and Q1 starts conducting. This turns on Q14, Q3 and Q4, which energizes the coil of relay TTZ. The time required for C1 to charge to this point is determined by the value of the TTZ delay control potentiometer connected between card pins 1 and 9. There is a fixed delay of about 130 milliseconds when the signal goes out by pin 3.

When the TTZ relay coil is energized, the TTZ relay contacts connected to card pins 11 and 17, pins 10 and 18, as well as those connected to card pins 12 and 15, operate in one to two milliseconds.

When the positive input signal is removed and the input voltage goes to zero, the divider (R4, R5 and R6) voltage drops to zero. In the process diode CR3 quickly discharges capacitor C1 through the divider and through any other external circuitry connected to card pin 8. As already described the drop in divider voltage turns off transistor Q15 to insure the TTZ relay is de-energized.

Diode CR13 is used externally to prevent damage to the relay if the supply voltage is reversed.

RX BOARD (RECEIVER BOARD)

The RX board contains the receiver (RX) circuit. Refer to Figure 7. The input signal is applied to this board on pins 1 and 2. Pin 1 must be positive with respect to pin 2. The signal goes from pin 1 to the RX input switch SW2. Switch SW2 is used to select the RX input voltage. This is done by SW2 setting the input resistance so the input current on each input range is about ten milliamperes depending on the exact input voltage. This is accomplished by switching in more resistance with increasing voltage. This is done by switch section SW2B. The lowest input range is the 300 milliampere range. This range differs from the voltage ranges (48, 125, and 250 Vdc) in that a low resistance (R43 of 27 ohms) is switched across card pins 1 and 2 by switch section SW2A. This provides a low impedance RX input. At the same time switch section SW2B has dropped the series resistance to 820 ohms. On this range an input current to the receiver of 300 milliamperes will give approximately a nine volt drop across card pins 1 and 2. At the same time ten milliamperes will flow through R44 to optical coupler OC1.

The input circuit operates OC1 which optically couples a signal from the input to the remainder of the RX circuit. Optical coupling is employed so there is no direct electrical connection between the input and the rest of the SCA relay. On the input side, the optical coupler OC1 consists of a light emitting diode (LED).

The input circuit supplies a current of ten milliamperes to OC1 when an input voltage or current is applied. The current applied to the LED must have the right polarity. Reverse polarity may damage OC1 so diode CR17 is provided to bypass any reverse current. Resistor R47 is provided to shunt low level extraneous signals around the LED in OC1 if the input is left open.

When an input signal is applied to card pins 1 and 2 the LED in OC1 emits light that illuminates a photo-Darlington transistor within OC1. When illuminated this phototransistor conducts current. This current drives the remainder of the RX circuit. The photo-Darlington transistor requires a bias voltage across it to work. This voltage is obtained from the control voltage (DC supply voltage) by means of a dropping resistor and a zener diode. The dropping resistor is external to the RX board and its value is set by the control voltage switch SW1. The current from the dropping resistor enters the card on pin 3. The 15 volt zener diode CR20 sets the maximum voltage across the photo-Darlington in OC1. In operation the voltage across the photo-Darlington may be less.

The signal from OC1 is taken off the photo-Darlington emitter. A voltage divider, R53 and R54, off the emitter feeds transistors Q16 and Q17, which can be used to introduce pickup and dropout delays. If the delays are desired, the emitter divider signal goes through R51 to charge capacitor C14 and drive the base of Q16. The base of Q17 is held at plus five volts by divider R64 and R62. When a signal is applied to the RX input and the emitter of OC1 goes high, capacitor C14 starts charging. When its voltage exceeds plus five volts, transistor Q16 will turn on. Similarly when the input to the RX circuit goes low, capacitor C14 will discharge through R51. Transistor Q16 will turn off when the voltage across C14 drops below plus five volts. When transistor Q16 is on, Q17 is off, and vice versa. If the pickup and/or the dropout delay is not desired then the appropriate delay jumper P Delay (positive input edge delay) or N Delay (negative going input edge delay) is put in the "out" position. This puts a diode, either CR24 or CR25, across R51 to eliminate the charging delay for a particular input transition. For example, if CR25 is connected by putting the P Delay jumper in the "out" position, then when the emitter of OC1 goes positive (positive going input signal), capacitor C14 will charge via diode CR25 with negligible delay. Similarly, if CR24 is connected, the capacitor will discharge with negligible delay when the RX input goes low.

As mentioned earlier the operation of Q16 and Q17 is such that when one is on the other is off. This is used to provide a choice of the RX relay being either on or off with a positive input signal. This is done by providing jumpers, P On (relay "on" on positive input) and N On (relay "on" on low input). This is done as follows. Resistors R52 and R63 are in the collector circuits of Q16 and Q17 respectively and complete the collector circuit to plus 15 volts. If an application requires that the RX relay be "on" when the input is high (positive) then the P On jumper is installed to connect the Q16 collector signal to the base of Q18. As already described, a positive input to the RX circuit turns on Q16 which will turn on Q18, Q10 and Q11 to energize the RX relay. Conversely, if it is necessary that RX be energized when the input to the RX circuit is zero, then the jumper is moved from P On to N On.

Reed relay RX is operated by the dc supply voltage through dropping resistors selected by the control voltage switch on the SW1 card. The coil of the RX relay is shunted by VR7 to absorb turn-off transients.

SW1 BOARD

Refer to Figure 8. The SW1 board is not a single function board. Primarily it is associated with the control voltage switching. This board includes control voltage switch SW1 and many of the diodes and resistors associated with changing the control voltage. Switch section SW1A is used to control the dropping resistors in series with the "A" and "TB" relay coils. These dropping resistors are in series with the common end of the relay coils. The TB relay is on the SW board and its connection to SW1A can be seen. When a positive voltage is applied to card pin 20, current flows through the TB relay coil to common card pin 2. The lowest resistance path to common is determined by switch section SW1A. In the 48 volt switch position the coil current will flow through diode CR11 through SW1A to common. In the 125 volt position current will flow through CR12 and SW1A to common. In the 250 volt position the coil current for the "TB" relay flows through resistors R22 and R23 to common.

Switch section SW1B switches the dropping resistors in the positive supply leads for some of the circuits. The switch section SW1C switches dropping resistors in the TTZ input circuit.

RELAY INTERNAL CONNECTIONS

The internal connections are shown in Figure 9.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as part of a control panel will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If damage as a result of rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are damaged or the adjustments disturbed.

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

ACCEPTANCE TESTS

GENERAL

The relay should be examined and tested upon delivery to ensure that no damage has been sustained in shipment and that the relay functions properly. If the examination or acceptance tests indicate that readjustment is necessary, refer to the section on **SERVICING.**

The following tests may be performed as part of the installation of the relay. This section includes all tests that may be performed on the relay.

The relay is shipped with jumper J1 in the C-B position, J2 in the C-A position, J3 in the C-A position, and J4 in the C-A position. The RX board jumpers are set as follows: a jumper is in the "P On" position; the "P Delay" jumper is in the "out" position and the "N Delay" jumper is set to "in."

VISUAL INSPECTION

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

2. Check that all links are properly set.

3. Check that the jumpers on the RX card are properly set.

4. Check that the knob pointers are properly positioned. In its extreme positions, the TTZ delay pointer should fall equal distances on either side of a vertical line through the knob. The switch knobs should point to the extreme voltage or current setting when turned to that extreme.

5. Check that the control voltage switch is set to the correct voltage.

6. Check that the RX input level switch is correctly set for the application.

MECHANICAL INSPECTION

1. The armature of the target unit should move freely when operated by hand. The target must come into view and latch when the armature is operated by hand and should unlatch when the target release lever is operated.

2. Make sure that the fingers and shorting bars in the relay cradle and case blocks agree with the internal connections diagram. The internal connections diagram is included here as Figure 9.

3. Telephone Relays

    a. Check that each normally open contact has a gap of 0.015 plus or minus 0.005 inch.

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

    c. Check that each normally closed contact has a gap of 0.015 plus or minus 0.005 inch when actuated.

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

ELECTRICAL TESTS

Electrical tests for each relay function are described in the sections that follow. The tests are described for 48 volt operation but can be run at other rated voltages by setting the relay properly and using a test pulse equal to the dc supply voltage.

Install all boards. Set the relay for 48 volt operation including the RX input. Use a step function for the test pulse. Use the positive going leading edge of the step function for pickup time determination. The negative going trailing edge is used for dropout time tests.

After the electrical tests to be performed are complete, the relay should receive a visual inspection. Make sure all settings and jumpers are properly set.

RI Operate and Dropout Times - Refer to Figure 10.

1. Set jumpers J1 to A, J2 to A, J3 to A and J4 to B.
2. Apply 48 volt timer test pulse to stud 12 (stud 2 is common).
3. Measure pickup and dropout times of contacts between studs 17 and 18, 9 and 19, 10 and 20 (all contacts are normally open).
4. Operate times should be less than 20 milliseconds, dropout time 100 to 175 milliseconds.

TTZ Operate and Dropout Times - Refer to Figure 11

1. Use same jumper connections as RI Operate and Dropout Times test.
2. Apply 48 volt timer test signal to stud 13.
3. Measure operate and dropout times between studs 3 and 4 and at stud 1 to common with the delay adjust pot (TTZ delay) at each extreme calibration mark. Dropout should be close to zero at stud 1 and two-to-four milliseconds at stud 4.
4. The pickup delay at the minimum setting should be two to three milliseconds at stud 1 (four to seven milliseconds at stud 4).
5. The pickup delay at the maximum setting should be 34 to 46 milliseconds at stud 1 (35-48 milliseconds at stud 4).
6. The TTZ contact between stud 12 and jumper J3-A is normally open. TB contact (studs 3 and 4) is nor-mally closed.
7. Turn off power. Change J1 to C-B. Apply 48 Vdc to stud 16.

8. Measure TTZ pickup and dropout times at stud 1. Pickup should be fixed (no control from front panel) at 110-160 milliseconds. Dropout should be close to zero.

9. RI may operate during these tests.

RX Operate and Dropout Times

Refer to Figure 12. Set jumpers J1C-A, J2C-A, J3C-A, J4C-B. Set jumpers on RX board P Delay and N Delay to "out." Set other jumper to P On (see Figure 18). Set relay and RX input voltage switches to 48 volts.

1. Apply 48 volt timer test pulse between stud 7 (positive) and stud 8 (negative).

2. Apply 48 volts to stud 12.

3. Measure operate and dropout times to stud 1 (normally closed RX contact).

4. Measure operate and dropout times between studs 5 and 6 (normally open contact).

5. Operate and dropout times should be less than four milliseconds. Refer to Figure 13.

6. Change jumper J2 to C-B.

7. Apply 48 volts to studs 11 and 13.

8. Measure operate and dropout times to stud 1 (normally open RX contact).

9. Operate and dropout times should be less than three milliseconds.

10. Turn off power. Remove board. Put on board jumpers P Delay and N Delay in "in" position. Leave other jumper in P On.

11. Repeat steps 1-5 above. Pickup and dropout times should be three to seven milliseconds.

12. Turn off power. Remove board.

13. Set on board jumpers to the desired configuration.

TB Operate and Dropout Times - Refer to Figure 14.

1. Set relay for 48 volt operation.

2. Set jumpers J1 to C-A, J2 to C-A, J3 to C-A and J4 to C-B.

3. Apply timer test pulse to stud 16 (stud 2 is common).

4. Measure pickup and dropout times between studs 3 and 4 (normally closed). Pickup time should be less than four milliseconds, dropout time should be less than four milliseconds.

A Operate and Dropout Times - Refer to Figure 15

1. Set jumper J1 to C-A, set J2 to C-A, remove J3 and set jumper J4 to C-A.
2. Apply 48 volts to stud 13.
3. Apply timer test pulse to stud 12.
4. Measure pickup and dropout times at stud 1 and stud 15. Stud 2 is common.
5. Pickup time should be no more than six milliseconds.
6. Dropout time should be no more than 60 milliseconds.
7. Replace jumper J3.

Target Unit Tests - Refer to Figure 16.

1. Set jumper J2 to C-A and jumper J4 to C-B.
2. Connect relay per test connections shown in Figure 16.
3. With the target reset, 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
0.6	Less than 0.6 ampere
2.0	Less than 2 amperes

4. When the power is removed, check that the armature drops out and the target indicator remains latched. Also check that the dropout on the 2.0 ampere tap is 0.5 ampere or more.
5. The target indicator should disappear from view when the target reset rod is pushed.

INSTALLATION PROCEDURE

RELAY SET-UP PROCEDURE

When setting up the relay for test or operation, the following five items should be checked:

1. Control Voltage Switch: This must be set to match the dc supply voltage supplied to the relay. Refer to Figure 17.

2. RX Input Switch: This switch is set to match the input signal provided by the carrier set. Refer to Figure 17.

3. Links J1, J2, J3 and J4: Refer to Figure 17. The setting of these links is determined by the application. Refer to the **APPLICATION** section.

4. RX Board Jumpers: Refer to Figure 18. A jumper must be in either the "P On" or "N On" position to determine whether an input signal (voltage applied to studs 7 and 8) energizes or de-energizes the RX relay. There are two other jumpers that insert or remove five millisecond delays on RX pickup and dropout. These RX board jumpers are set to match the application. Refer to the **APPLICATION** section.

5. TTZ Delay Potentiometer: Refer to Figure 17. This adjustment controls the coordination delay. The delay setting is application dependent. Consult the **APPLICATION** section to select the delay. The calibrated dial is accurate to plus or minus one millisecond or plus or minus ten percent at rated dc supply voltage. At low dc voltages (80 percent of rating) the delays may increase by one or two milliseconds. Improved accuracy in setting the TTZ delay can be achieved by using an oscilloscope or an accurate timer.

An operational test of the relay may be performed before installation. The nature of the test would depend on the configuration of the relay. Suitable tests can be set up using the test procedures described in the **ACCEPTANCE TESTS** section.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

Relays in operation should 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

*** 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.

TROUBLESHOOTING

In the event the relay fails to function properly, it should be removed from service and tested. It must be supplied with rated dc voltage and the appropriate input signals.

Test the relay to see if it operates on the bench. If it does, the relay is probably OK, and the problem most likely is in the case or the wiring to the case.

If the relay does not work on the bench, use the Troubleshooting Chart to help isolate the problem. Complex problems may require conventional electronic trouble-shooting techniques.

The control knobs are collet knobs. To remove the knobs, pry off the cap with a knife. Use a screwdriver or hex driver to loosen the collet nut and remove the knob. To reinstall, make sure the insulated washer is placed between the knob and panel. Align the knob pointer before final tightening.

* Indicates Revision

TROUBLESHOOTING CHART

TROUBLE AFFECTS	REPLACE
RX	RX board
TTZ	TTZ board, TTZ delay pot
TB	SW1 board
RI	RI board, RI telephone relay
A	A telephone relay

A defective SW1 board can affect any function. If replacing the board suggested in the troubleshooting chart does not solve the problem, try a new SW1 board.

RENEWAL PARTS

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

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

The following spares are recommended:

	PART NUMBER
RX board	0184B5621
TTZ board	0184B5622
RI board	0184B5620
SW1 board	0184B5623
Telephone relay	006418025P445
Target	006293203P518
Diode	0246A9410P2158
Potentiometer	0246A9131P202
Capacitor	0246A9021P0100A1
Capacitor	0246A9013P503

LIST OF FIGURES

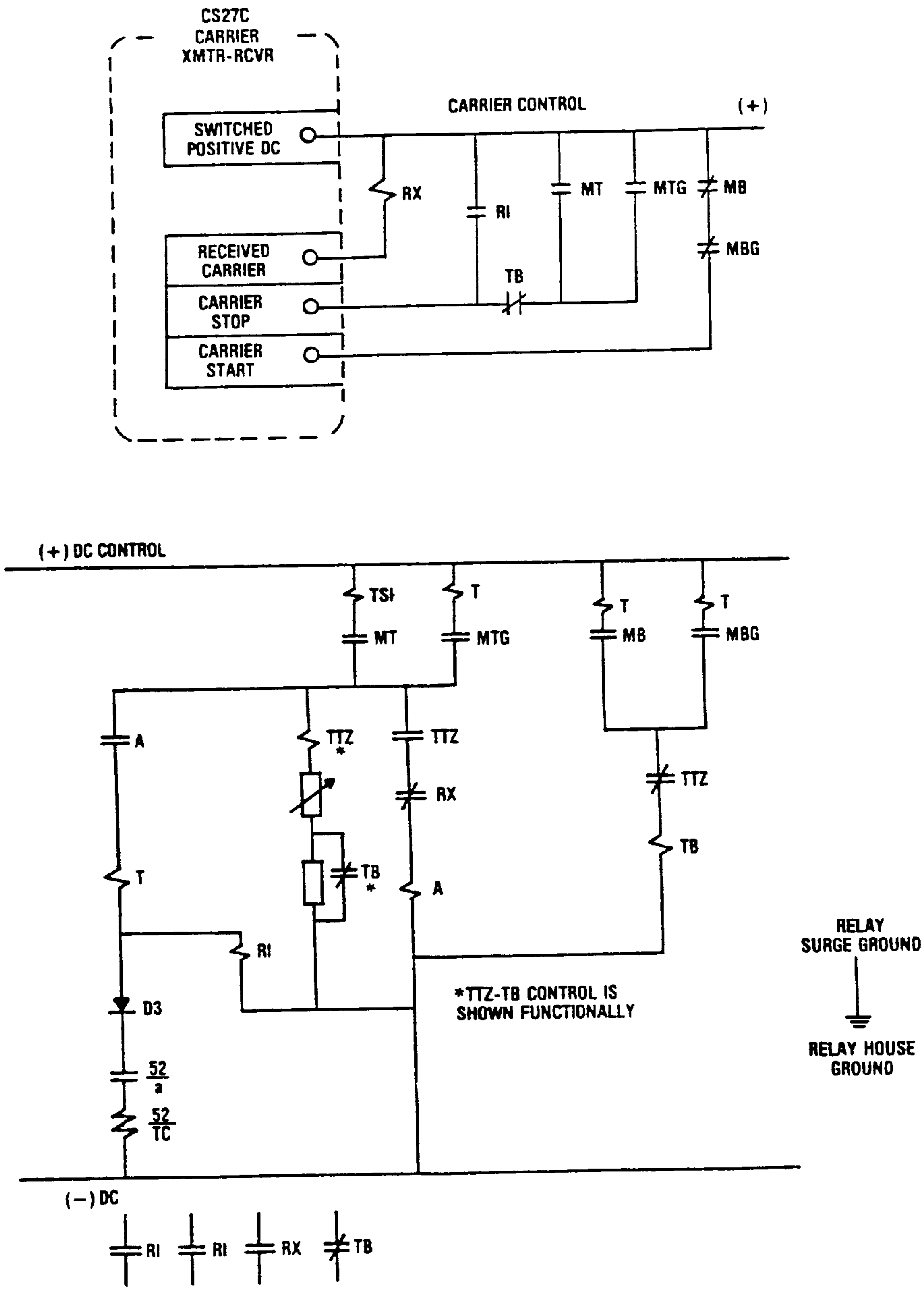
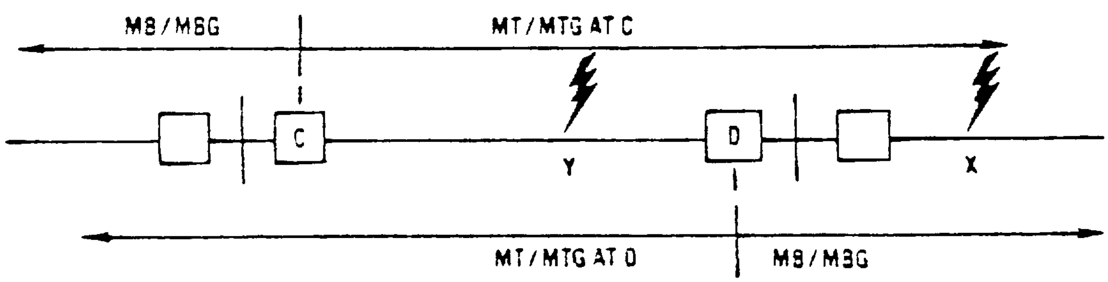


Figure 1 (0285A8181-0, Sh. 1) Simplified Directional Comparison Blocking Scheme



TYPICAL PROTECTED LINE AND FAULT LOCATIONS

Figure 2 (0285A8181-0, Sh. 2) Typical Protected Line and Fault Locations

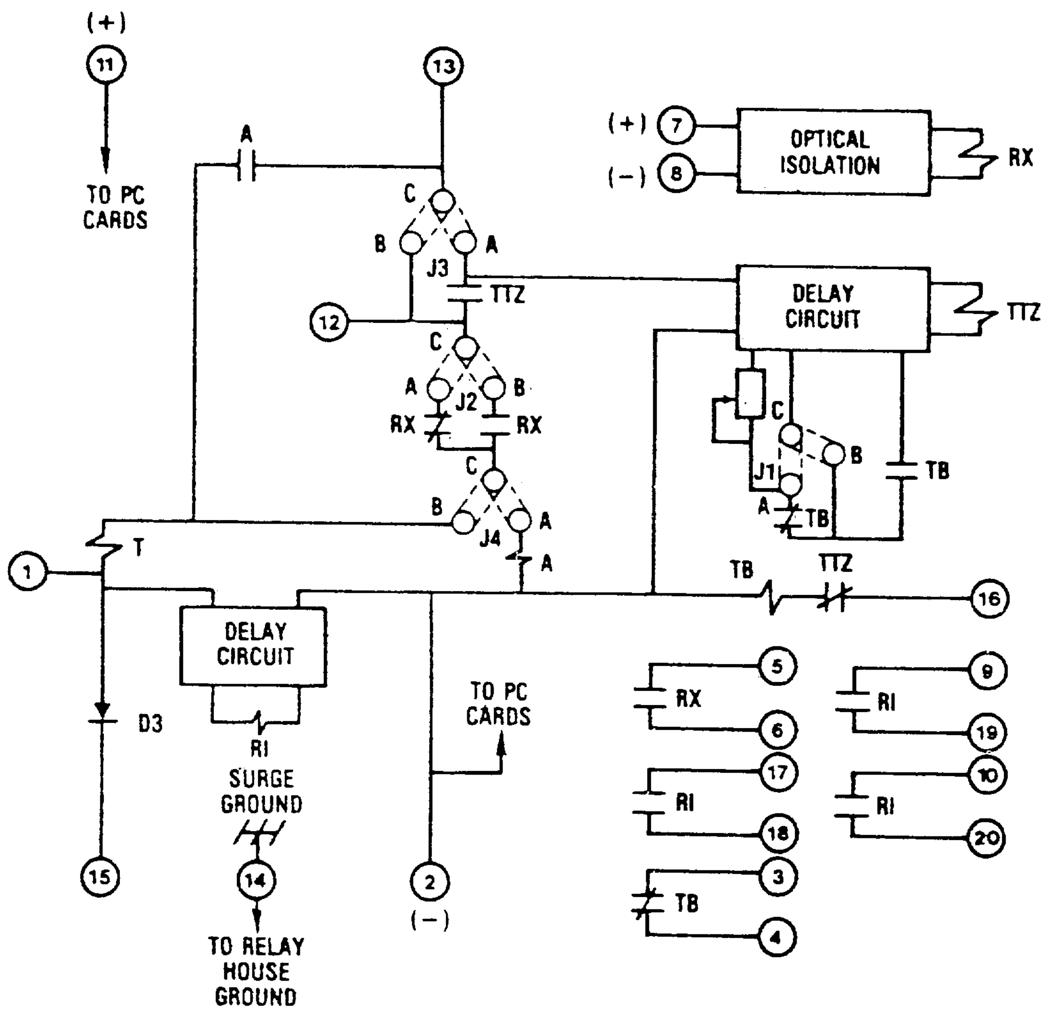


Figure 3 (0285A8180-0) Simplified Functional Diagram

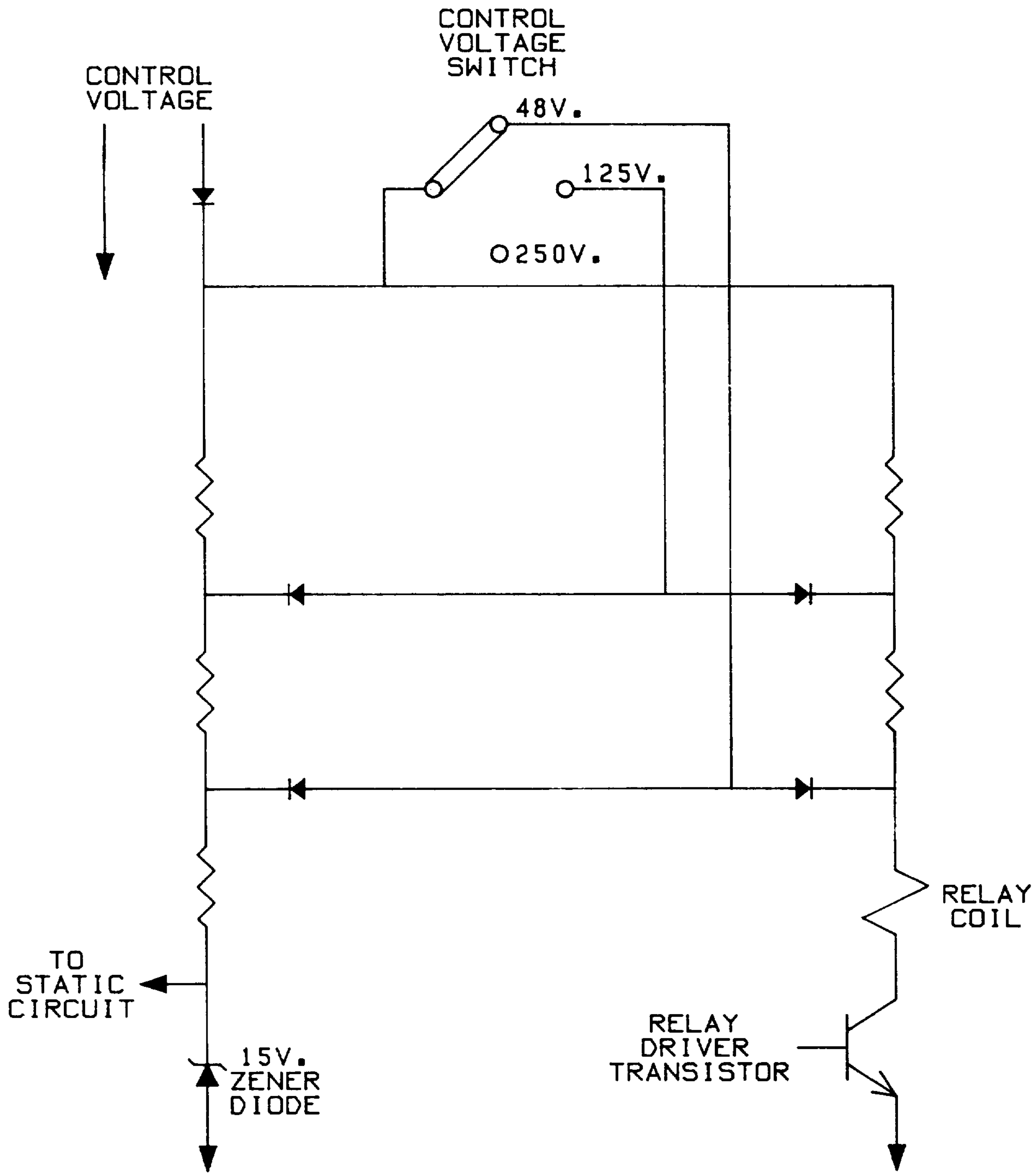
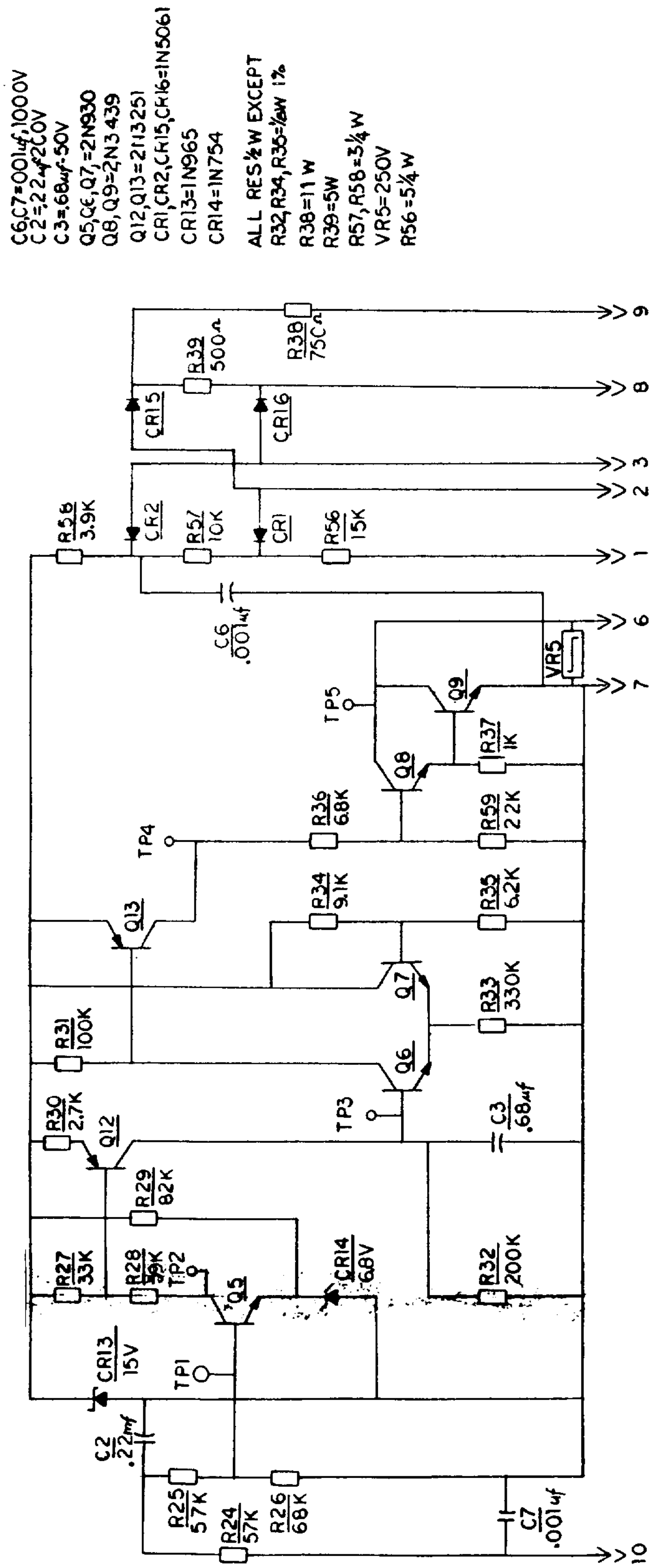
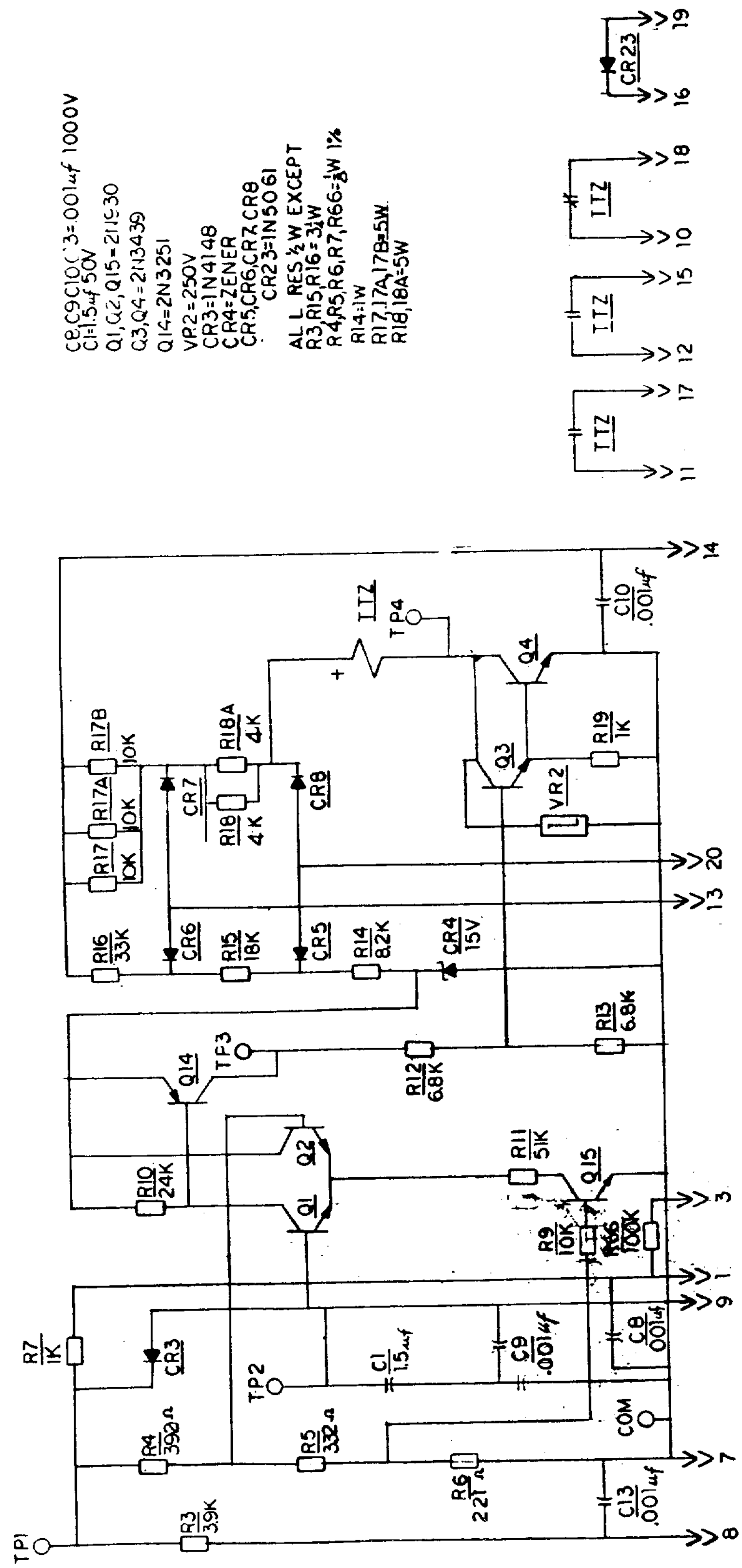


Figure 4 (0285A6201-0) Voltage Switching Arrangement



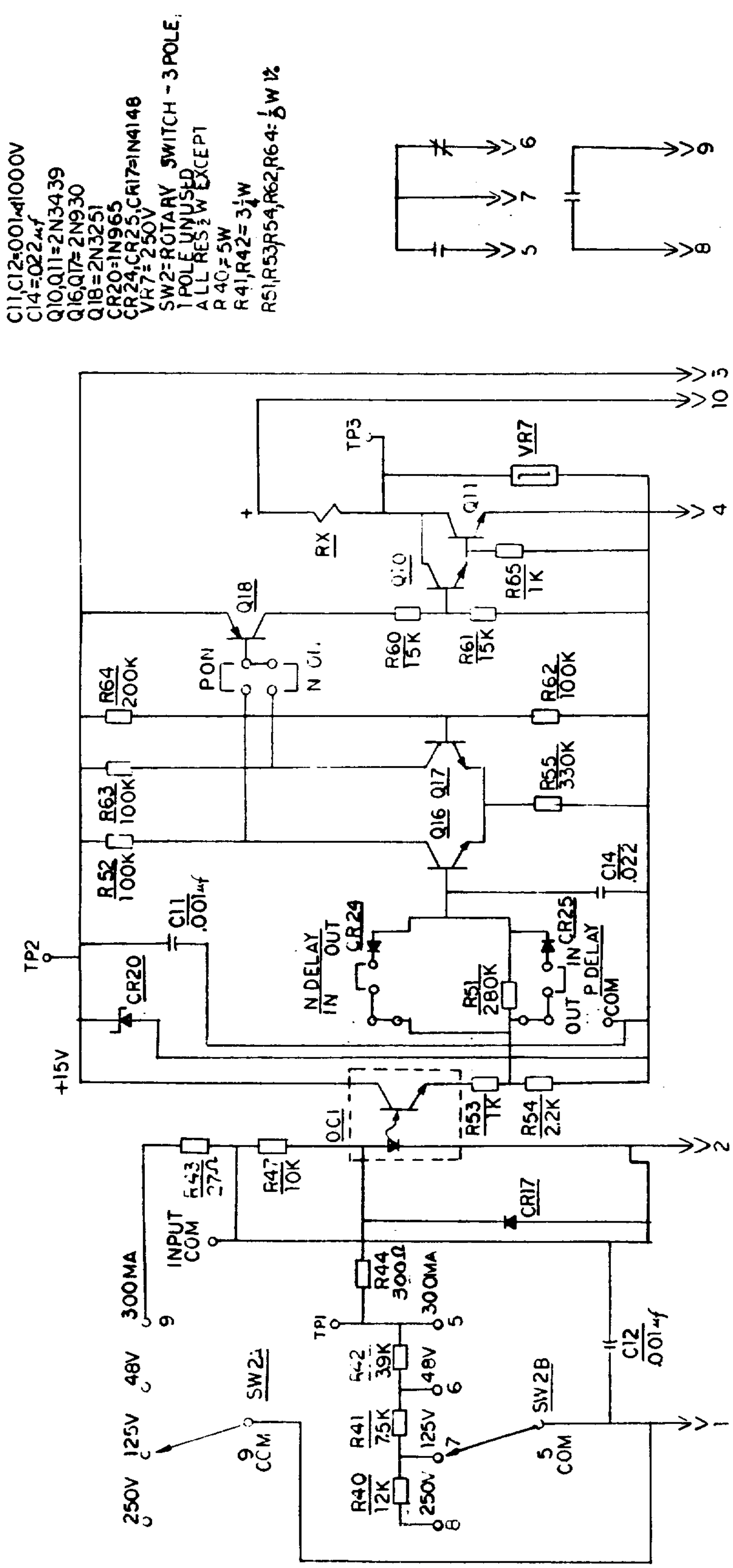
* Figure 5 (0184B5720 [1]) Internal RI Board

* Indicates Revision



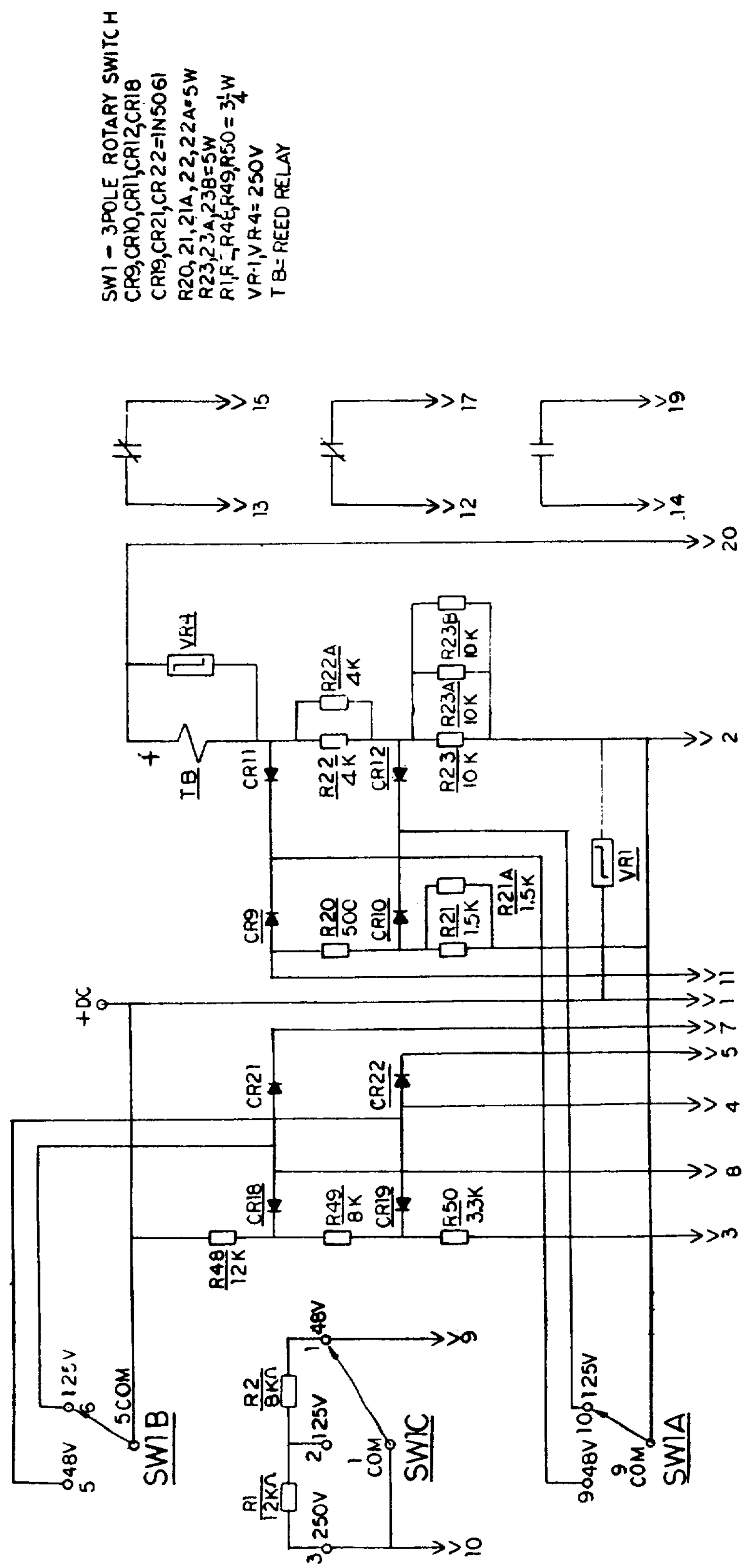
* Figure 6 (0184B5722 [2]) Internal TTZ Circuit

* Indicates Revision



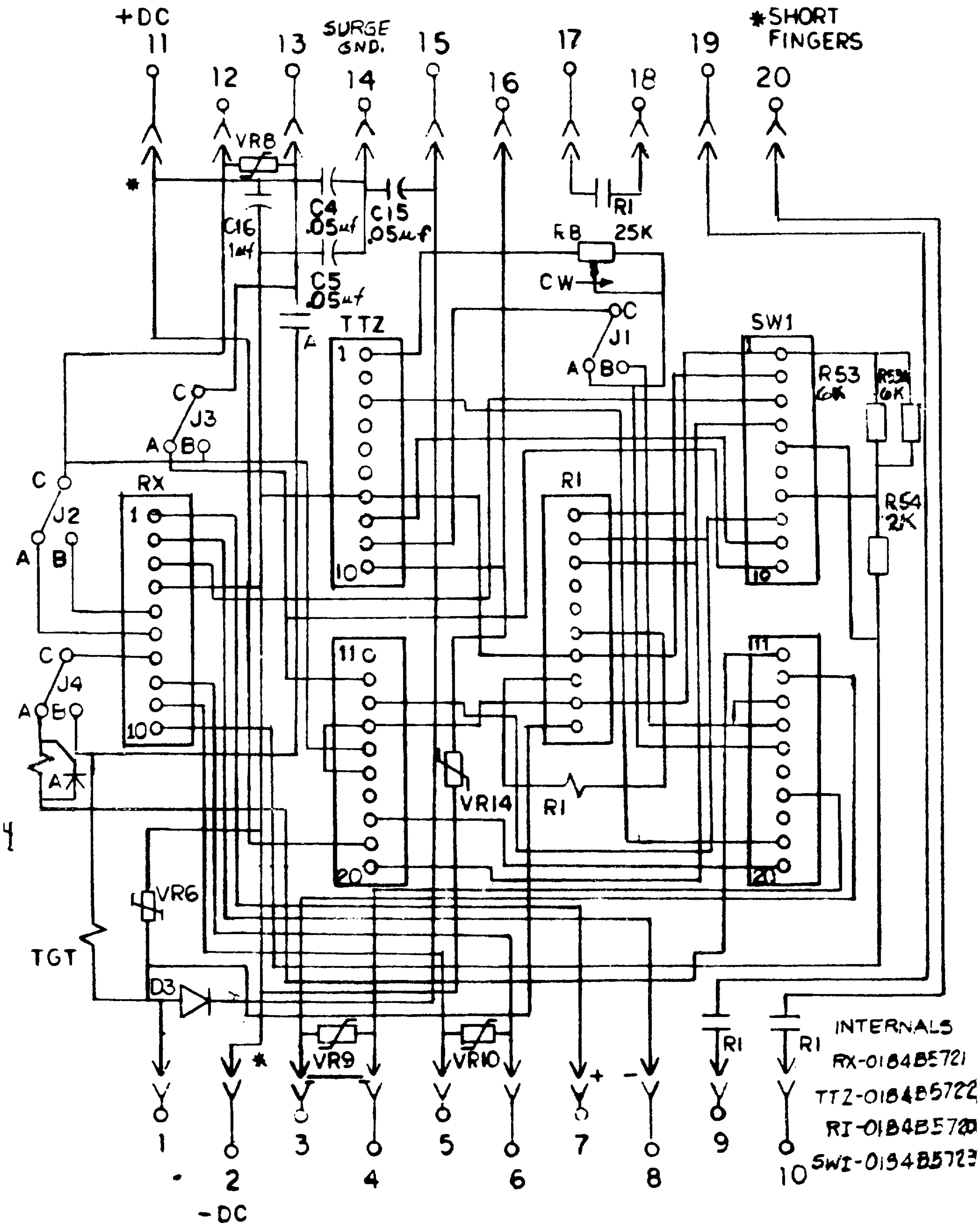
* Figure 7 (0184B5721 [1]) Internal RX Board

* Indicates Revision



* Figure 8 (0184B5723 [1]) Internal SW1 Board

* Indicates Revision



* Figure 9 (0285A8189 [2]) Internal Connections

* Indicates Revision

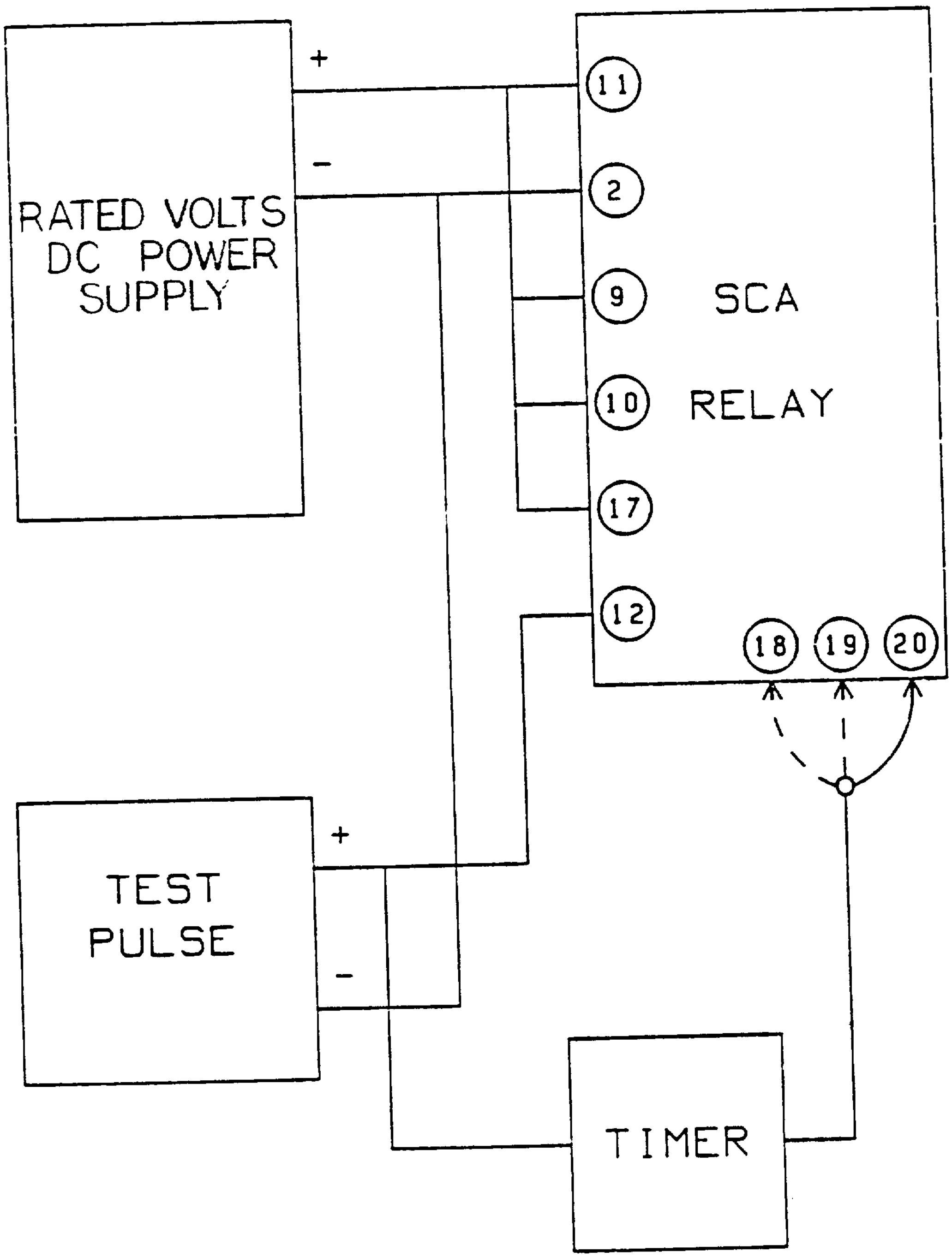


Figure 10 (0285A5156-1) RI Operate and Dropout Times

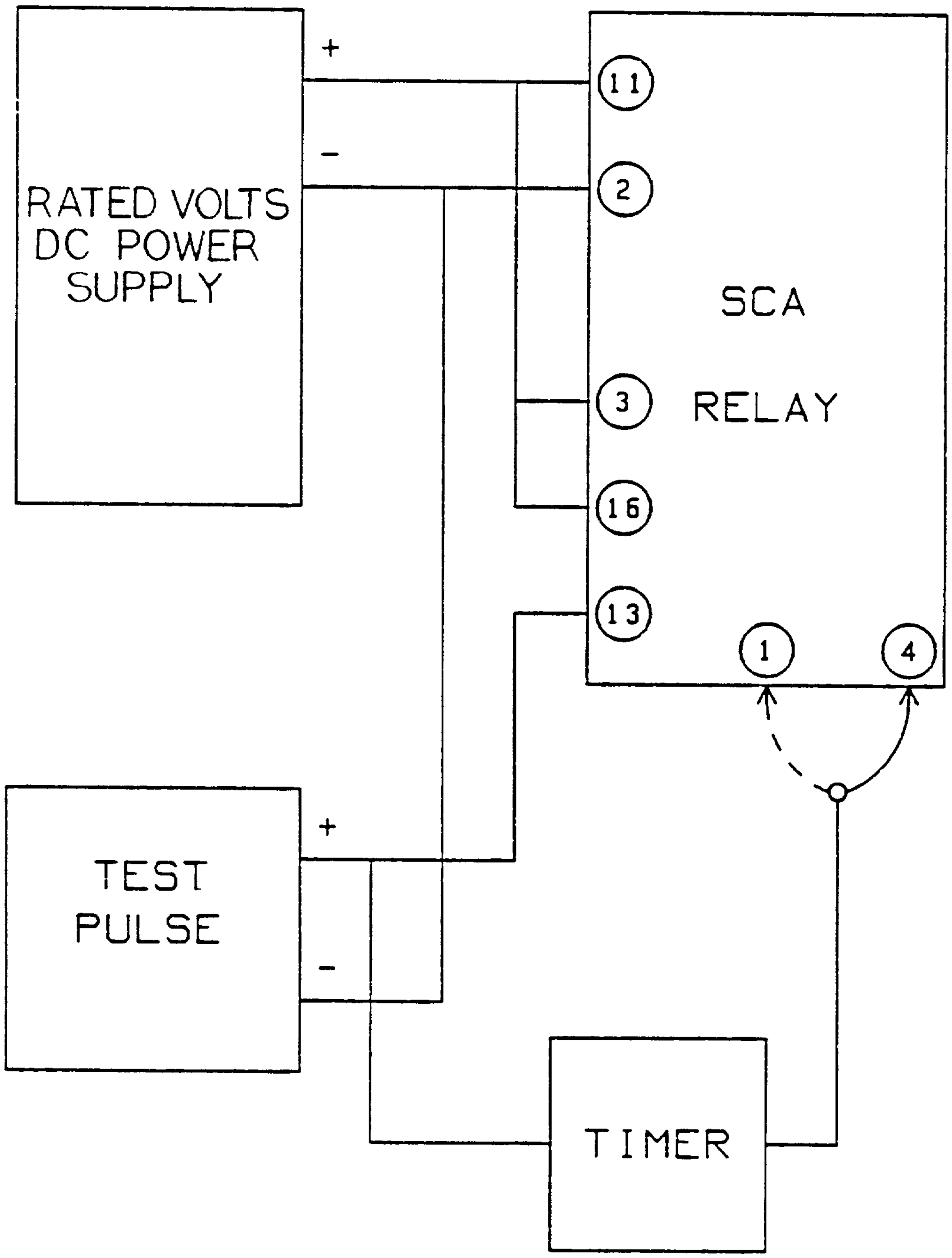


Figure 11 (0285A5157-1) TTZ Operate and Dropout Times

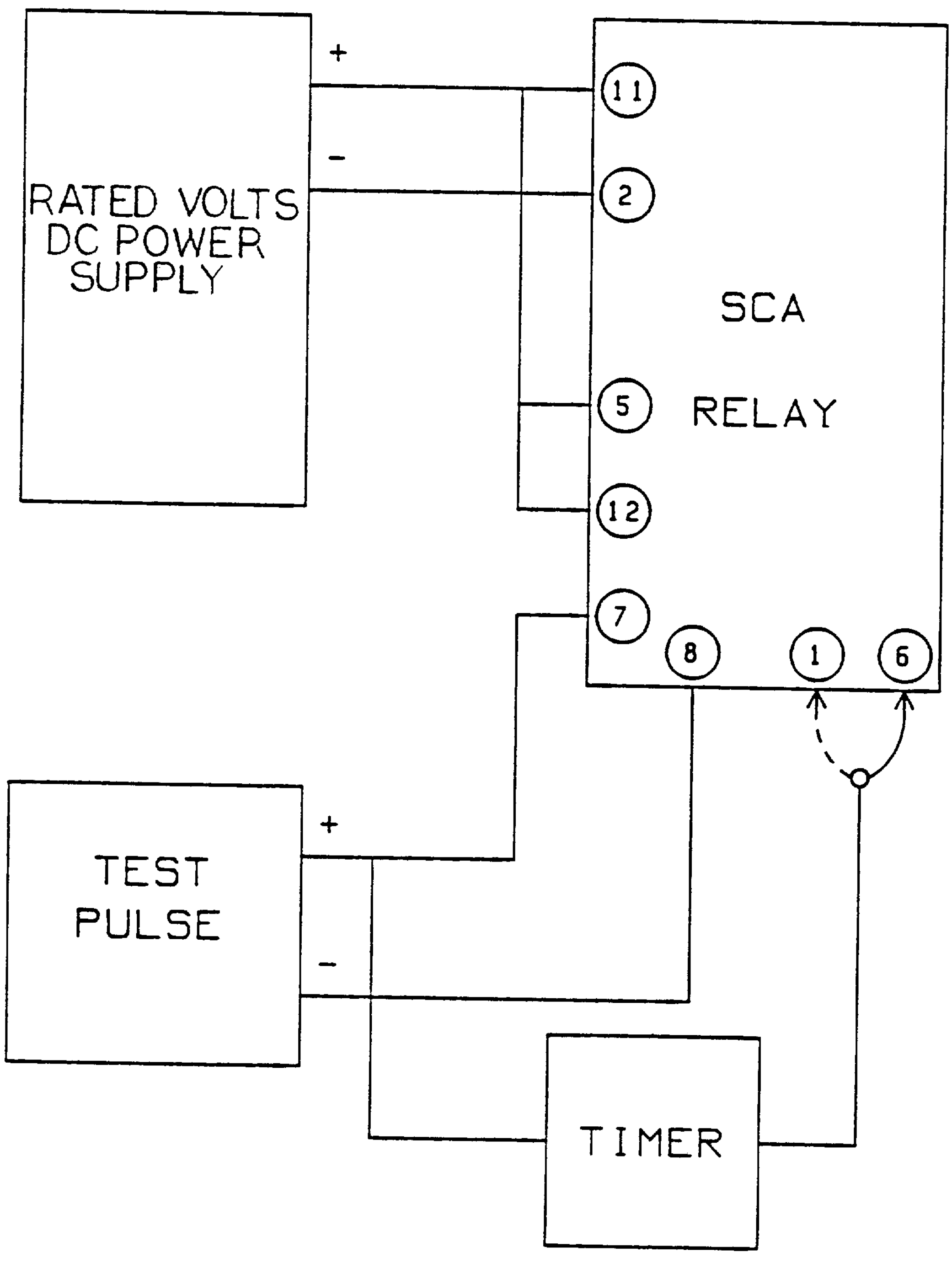


Figure 12 (0285A5158-1) RX Operate and Dropout Times

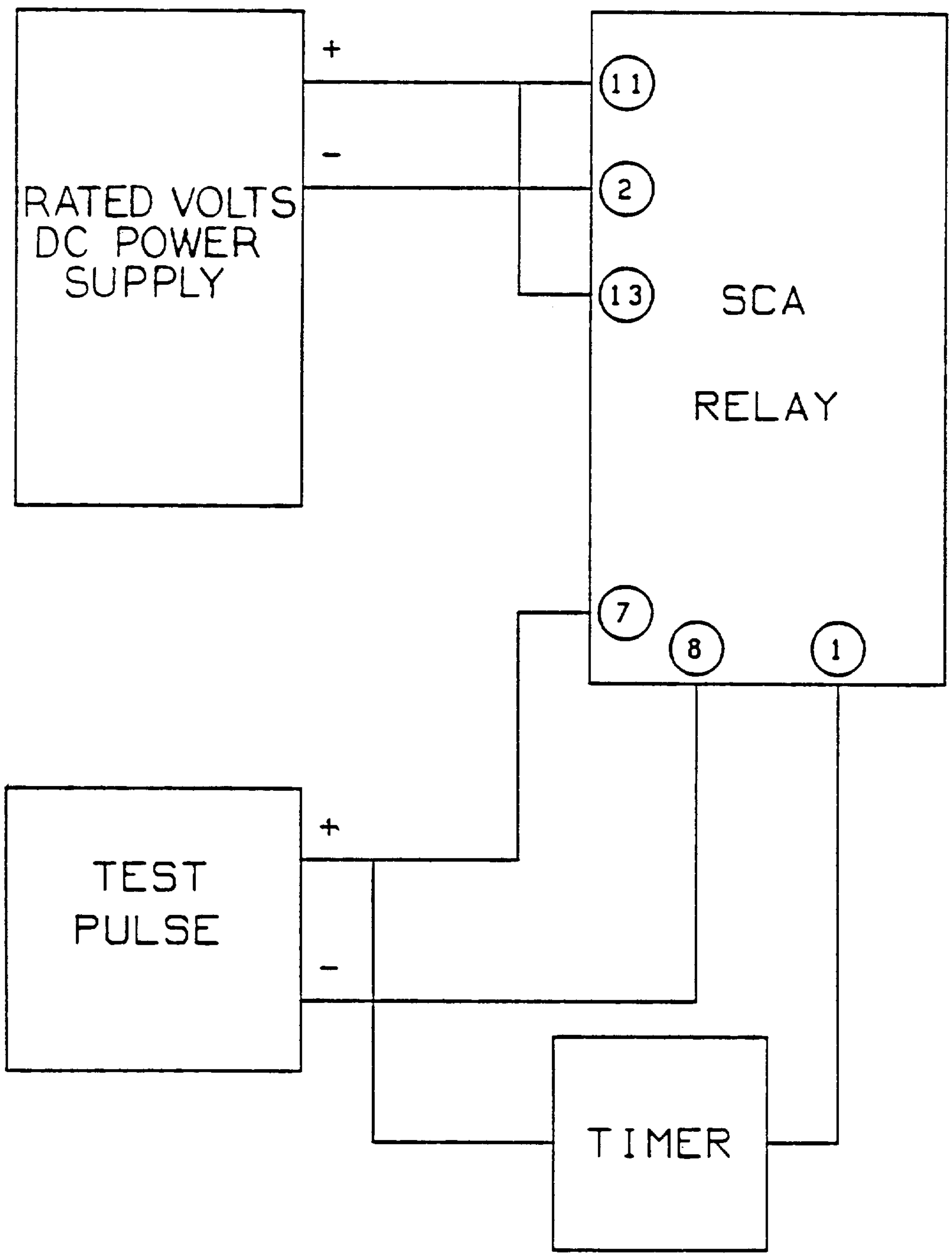


Figure 13 (0285A5159-1) RX Operate and Dropout Times

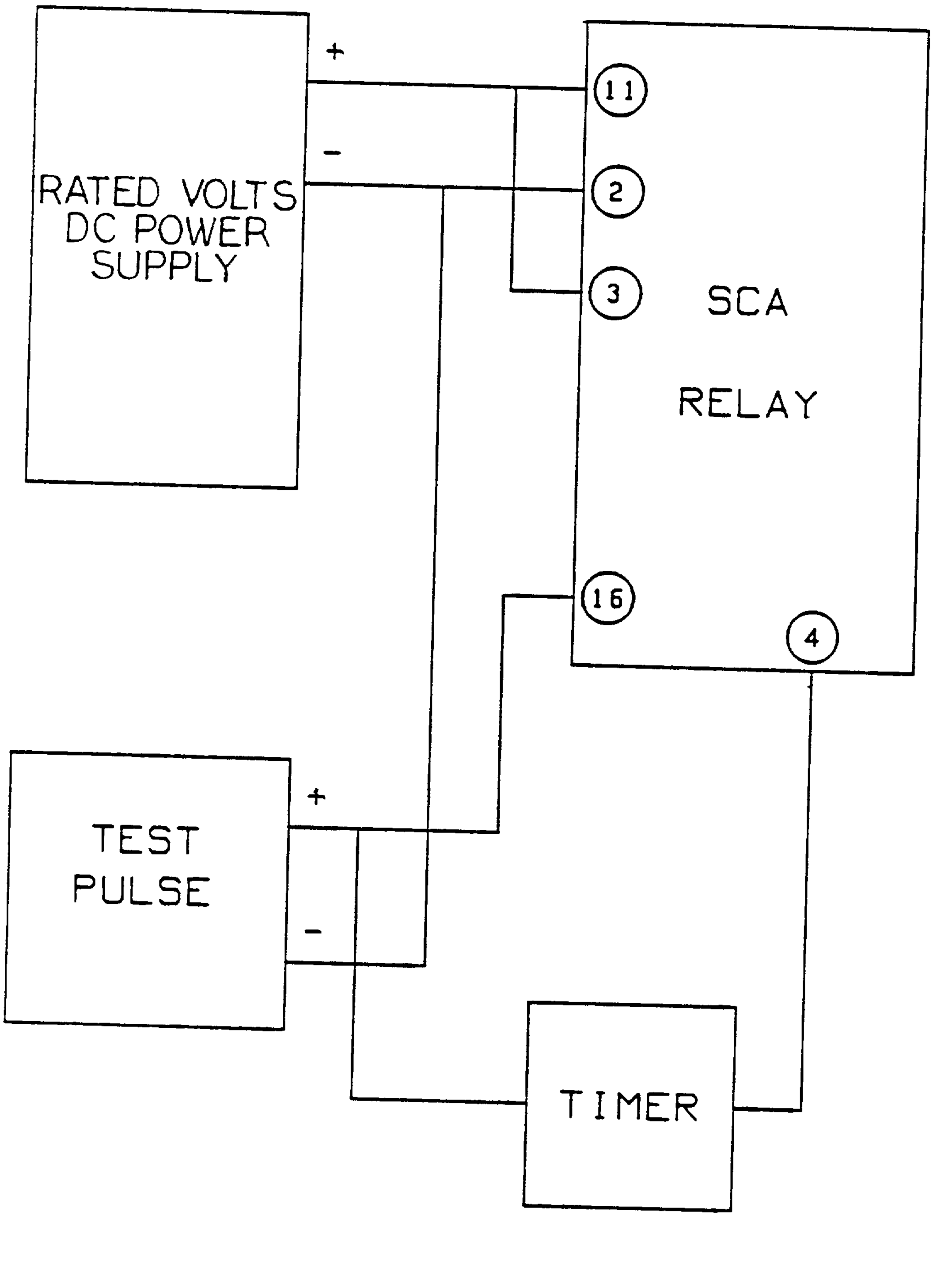


Figure 14 (0285A5160-1) TB Operate and Dropout Times

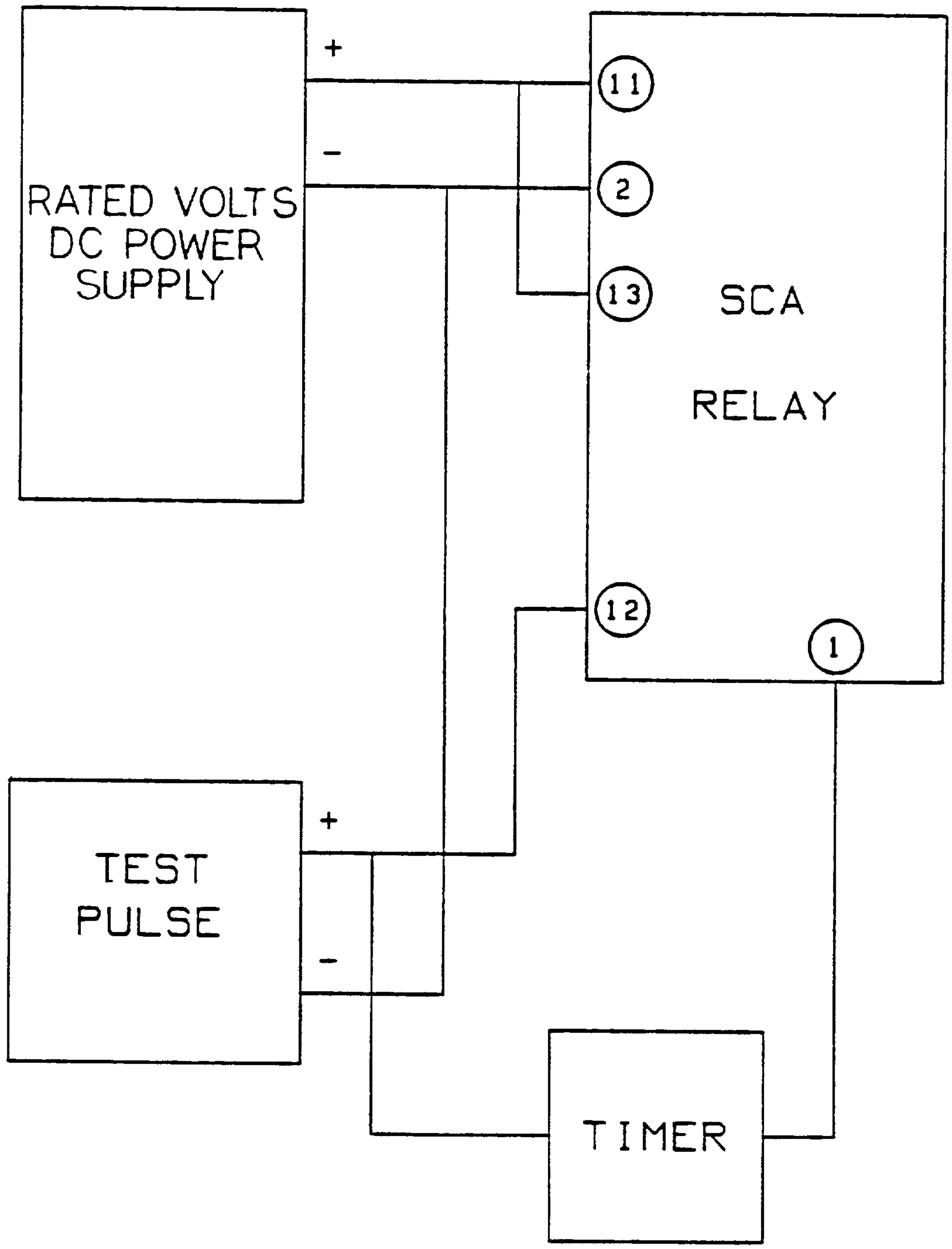


Figure 15 (0285A5161-1) A Function Operate and Dropout Times

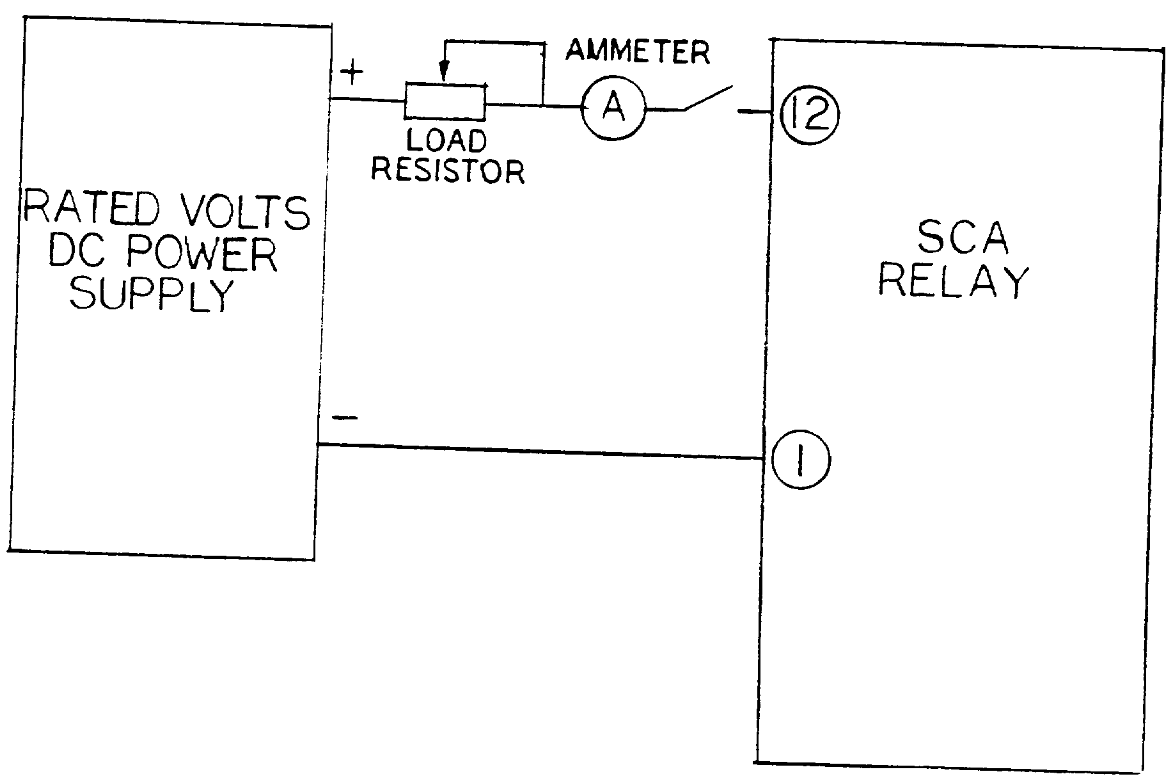


Figure 16 (0285A5162-0, Sh. 2) Target Unit Tests

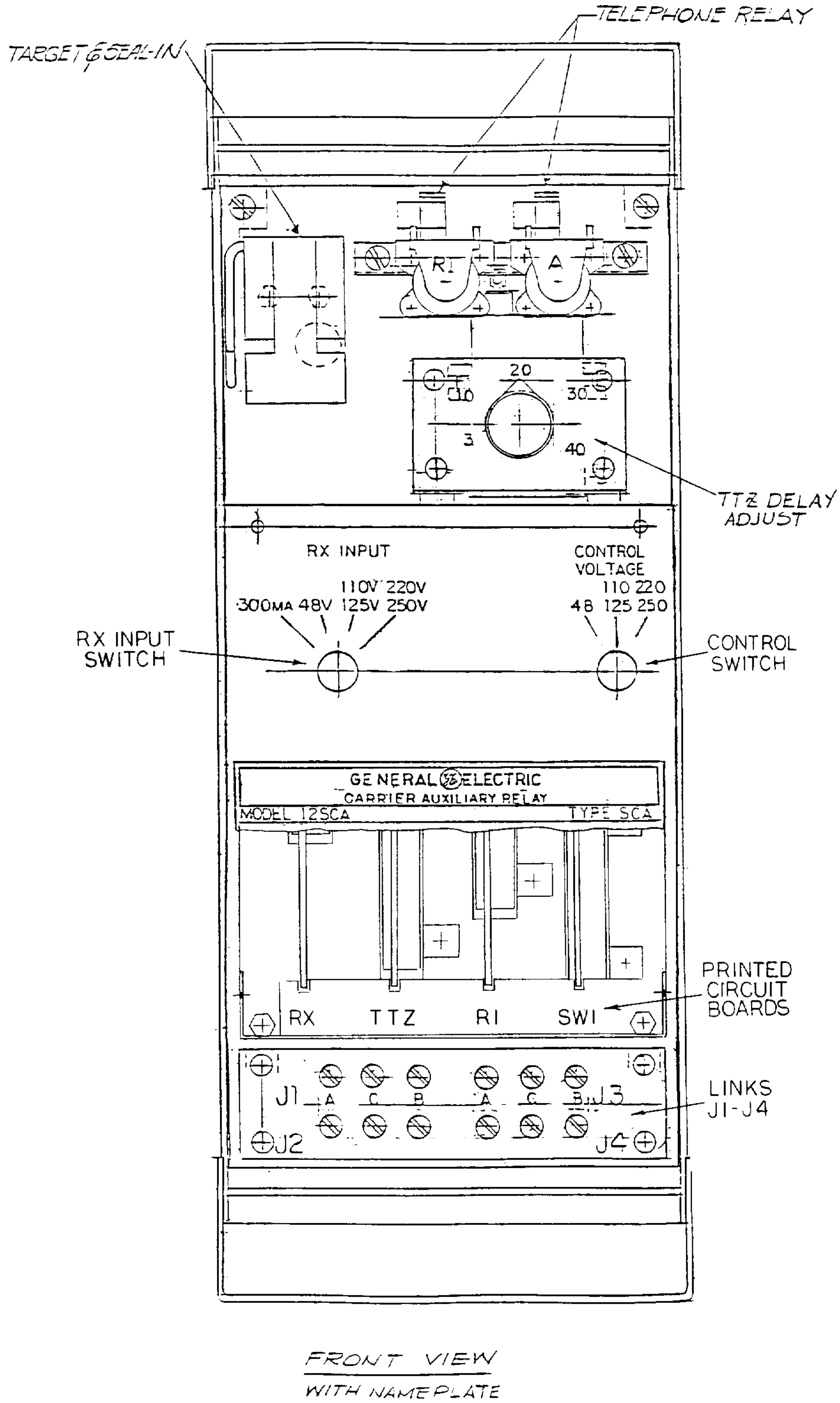
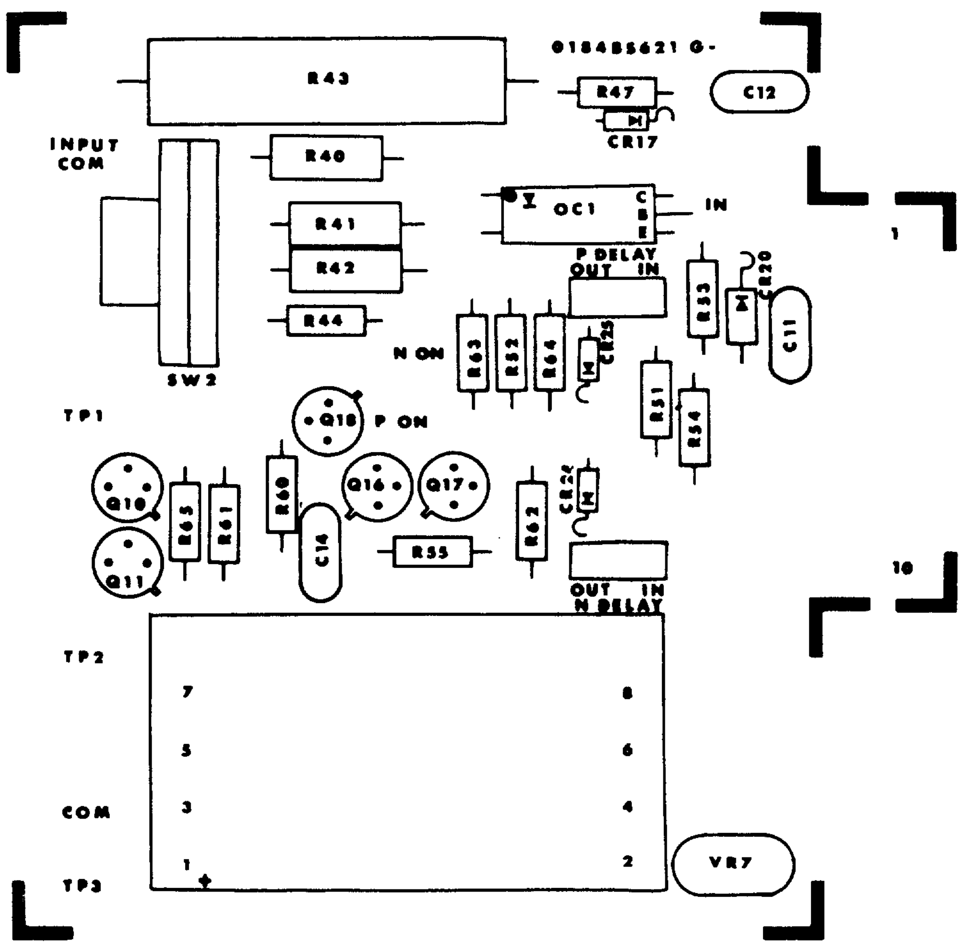
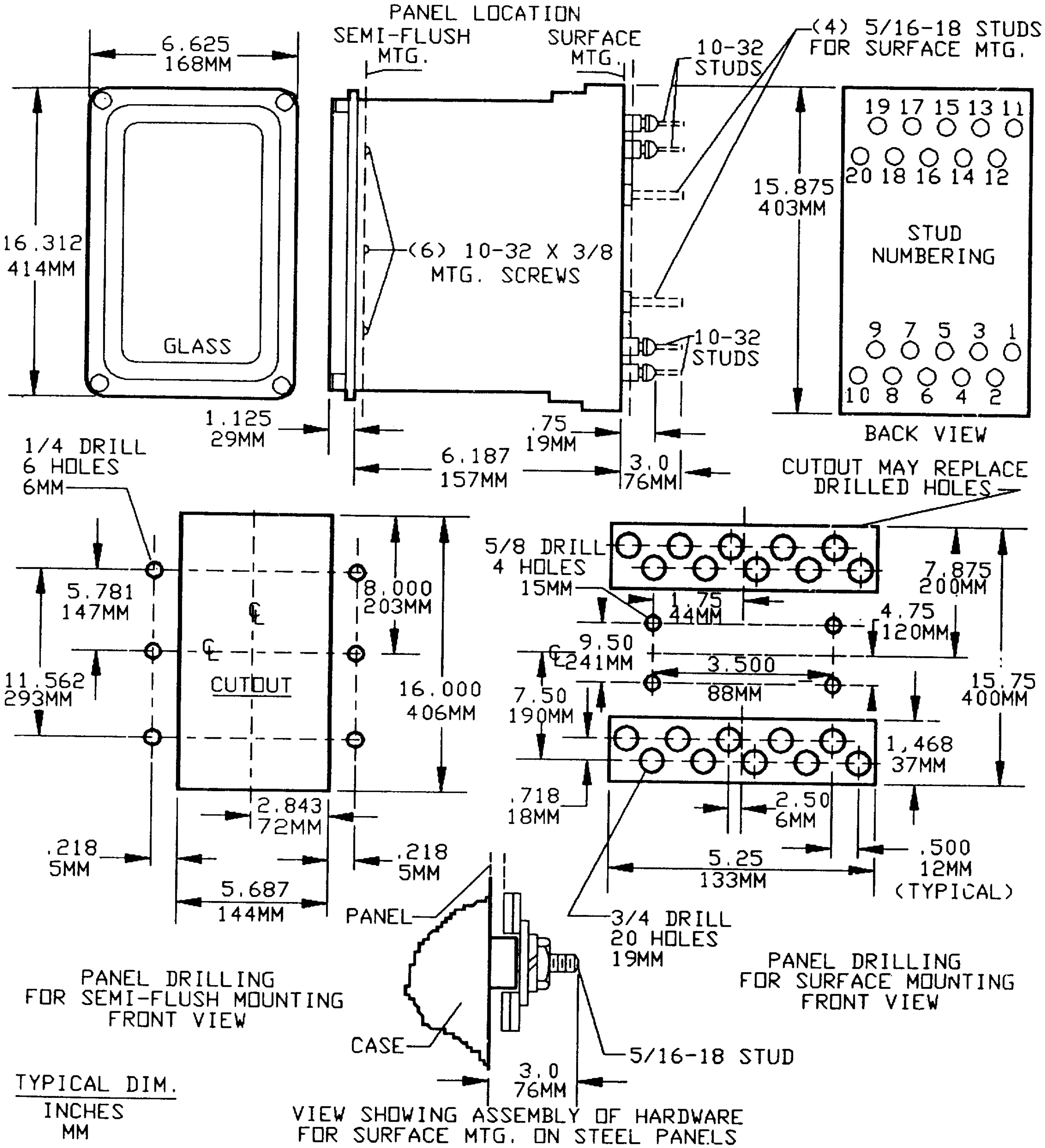


Figure 17 (0138B7595-1) Front View of SCA51A Relay



* Figure 18 (0184B5621 Sh.1) RX Board Jumpers

* Indicates Revision



* Figure 19 (K-6209274 [6]) Outline and Panel Drilling for SCA51A Relays

* Indicates Revision

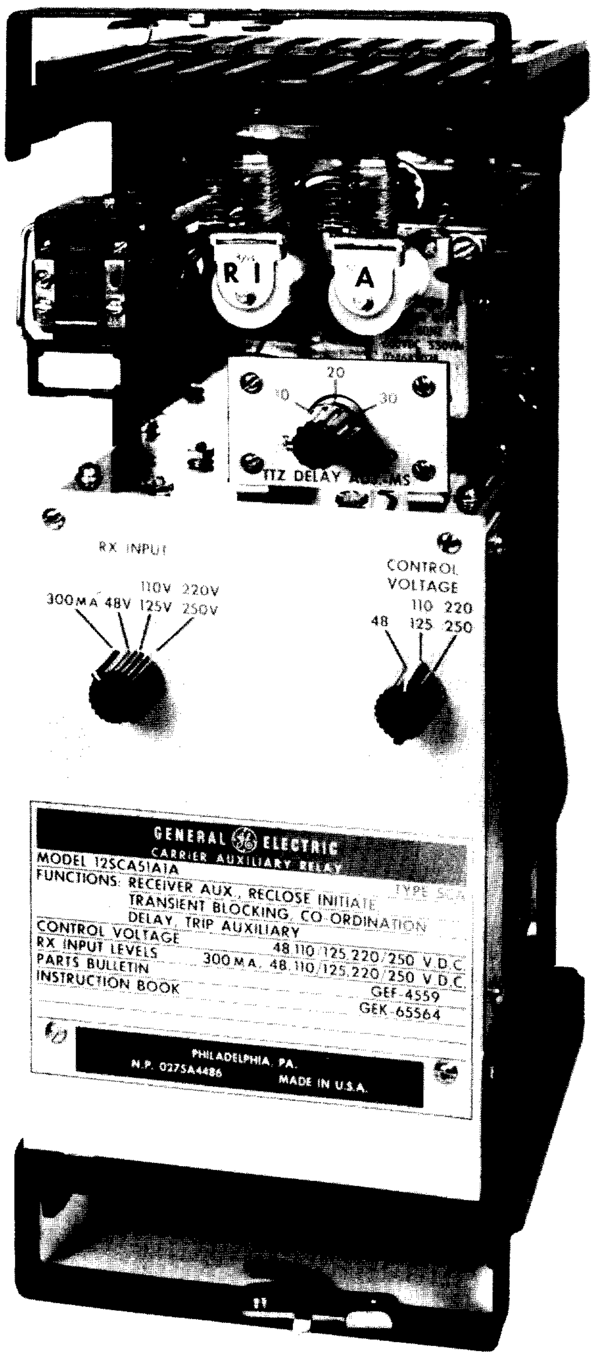


Figure 20 (8043691) Front View of SCA51A Relay Removed from Case

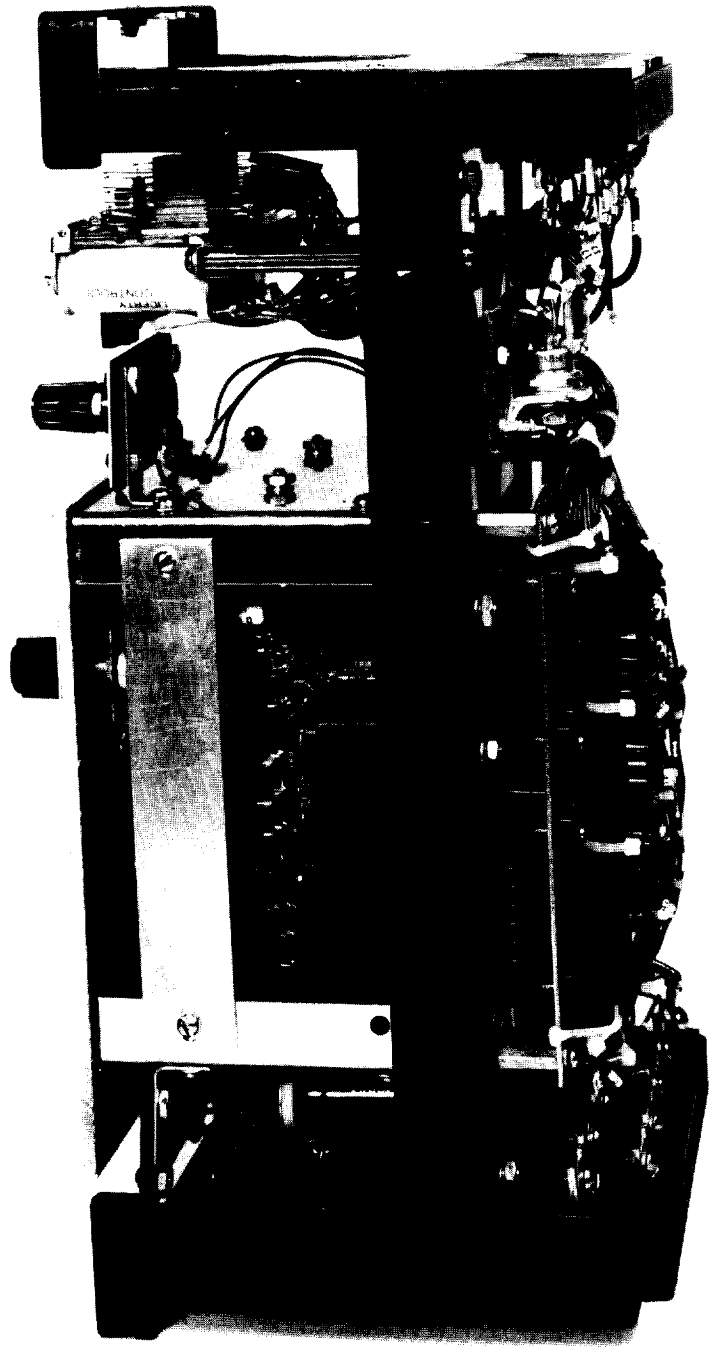


Figure 21 (8043692) Left Side View of SCA51A Relay

Figure 22 (8043694) Rear View of SCA51A Relay

GE Power Management

215 Anderson Avenue
Markham, Ontario
Canada L6E 1B3
Tel: (905) 294-6222
Fax: (905) 201-2098
www.ge.com/indsys/pm