INSTRUCTIONS

GEK-34182B

SUPERSEDES GEK-34182A

STATIC BREAKER BACKUP RELAY

TYPES

SBC21A
SBC21B
SBC21C
SBC21D
SBC21E
SBC21F

POWER SYSTEMS MANAGEMENT DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA PA

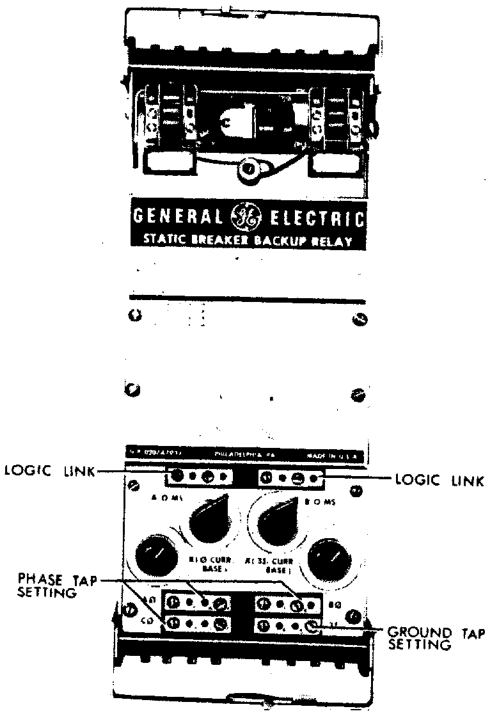

FIG. 1 (8040951) Type SBC21F Relay Removed From Case (Front View)

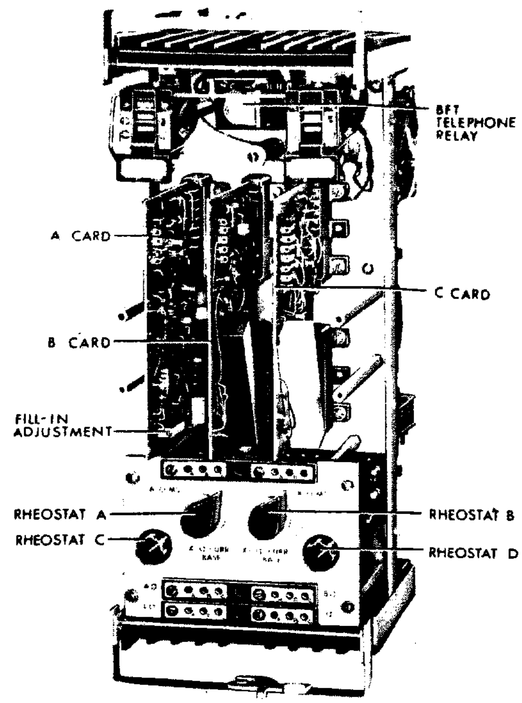

FIG. 2 (8040950) Type SBC21F Relay Removed From Case (3/4 Front View)

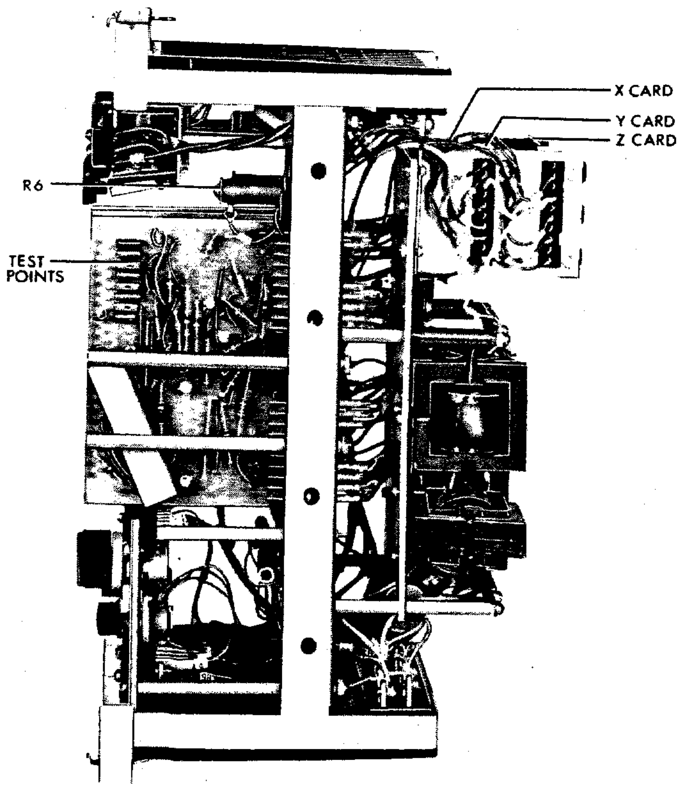

FIG. 3 (8040954) Type SBC21F Relay Removed From Case (Side View)

LIST OF FIGURES

NOTE: This instruction book has had a major revision.
Please check your previous copy to compare material.

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STATIC BREAKER BACKUP RELAY
TYPES SBC21A,B,C,D,E,F

INTRODUCTION

The Type SBC21 relays are static breaker failure relays designed to provide system backup protection in the event of a circuit breaker failure. These relays incorporate the major requirements of a breaker failure backup scheme -- high security and capability for fast clearing times. These relays are applicable with any of the several bus/breaker arrangements in general use today; and over a wide range of fault current conditions which may be encountered. One Type SBC21 relay is required for each breaker in a bus array.

DESCRIPTION

All Type SBC21 relays are packaged in an M2D (See Fig. 41) drawout case and contain the following basic components and features.

1. Input provisions for a contact initiation (BFI, 62X, 62Y) that activates the power supply and the relay.
2. A fast reset current detector with two independently adjustable pickup settings for phase (I_A, I_B, I_C) and ground ($3I_O$) currents.
3. An adjustable timer to provide time for the primary breaker to operate correctly.
4. Three elctrically separate contact output circuits (BFT) with two circuits having electromechanical series targets for tripping the back-up breakers.
5. A regulated power supply.
6. Surge suppression on all AC and DC input circuits.

There are six models available, identified as SBC21A, B, C, D, E or F. The SBC21A is the simplest model and it contains only the basic components and features listed above. The other five models contain the basic components and features plus some combination of the optional features that are noted below.

1. Seal-in of the contact initiation. The seal-in has an inherent time delay pickup. This enhances the security of the relay by minimizing the possibility of surges or transients operating the seal-in.
2. Contact converter input to supervise the breaker failure timer.
3. A second timer which in conjunction with the other timer allows different time settings depending on the input conditions.

The figures for the combined overall logic and external connection diagrams and the features contained in each relay model are shown in Table I.

TABLE I

RELAY MODEL	EXTERNAL CONNECTIONS & LOGIC DIAGRAM	OPTIONAL FEATURES		
		SEAL-IN	CONTACT CONVERTER	SECOND TIMER
SBC21A	FIGURE 4			
SBC21B	FIGURE 5	X		
SBC21C	FIGURE 6		X	
SBC21D	FIGURE 7	X	X	
SBC21E	FIGURE 8		X	X
SBC21F	FIGURE 9	X	X	X

APPLICATION

As noted previously there are several different relays in the SBC21 line. Each one has its own features to meet the needs of particular schemes. Since users generally have their own ideas regarding the specific approach they desire,we leave it up to the user to select the device that includes the features that he deems to be required or desirable. The following discussion applies to all the SBC21 relays covered by this book.

The Type SBC21 static breaker failure relays are intended for application on a per breaker basis. That is, there is one breaker failure relay associated with each breaker in a bus array. On this basis the current inputs to a particular SBC21 relay must come from CT's that measure the current in the associated breaker. The trip outputs must be routed to initiate the tripping (or transferred tripping) of all breakers necessary to clear the fault upon failure of the breaker associated with the SBC21 relay. This routing will depend upon the bus and breaker arrangement. The listing in Table II covers the bus arrangements that are in common use today. They are the single bus-single breaker, double bus-double breaker, breaker-and-a-half, and ring bus arrangements; and they are shown in Figures 10, 11, 12 and 13 respectively. Each listing in Table II indicates the assumed fault location, the breaker which is assumed to have failed, the contact initiation that activates the SBC21, and which breakers or lockout relays should be tripped by the BFT contacts. For example, in a single-bus-single breaker arrangement (Figure 10), if breaker #2 is to be protected, the SBC21 relay receives the currents associated with breaker #2. The contact initiation is from the protective relays of line B. If breaker #2 fails for a fault at F1, the SBC21 relay operates and the BFT contact #1 trips the bus lockout relay. For another example consider the ring bus arrangement that is shown in Figure 13. If breaker 1 is to be protected, the SBC21 relay receives the currents associated with breaker 1. The contact initiation is from the protective relays of line A for a fault at F1. For a fault at F2 the protective relays of line B provide the contact initiation. Assuming breaker 1 fails for a fault at F1, the SBC21 relay operates and the BFT contacts trip the following: BFT #1 trips breaker 2 and BFT #2 trips breaker 6. BFT #3 trips the lockout relay that transfer trips breakers 7 and 8 and blocks reclosing of 2 and 6.

In the application of the SBC21 relays probably the most important consideration is the setting of the main timer. Figure 14 illustrates all the times involved from the instant the fault occurs until the back-up circuit breakers operate to clear the fault. This total time must be short enough to enable the system to maintain stability and to limit as much as possible the damage to the faulted equipment. On the other hand,it should be long enough to permit a long enough setting on the breaker failure timer to insure the security of the scheme for normal conditions where the primary circuit breaker clears the fault.

In general, it is a good practice to set the SBC21 timer so that the overall time of operation (including the pickup time of the current detector and the operating time of the BFT output relay) provides for ample margin without infringing on stability limit in the event of a breaker failure. The IEEE Relay Committee recommends at least three cycles of MARGIN.

It is apparent from Figure 14 that for any given total operating time of the SBC21, reducing the dropout time of the current detector will increase the margin. Thus, it is recommended for applications where margins of less than three cycles are contemplated that dropout times be reduced by reducing the setting of the fill-in timer of the current detector. The reduction in dropout time must be compatible with the acceptable minimum pickup of the current detector. (See Figure 15.)

The settings of the current detector should be such that they will operate at a level of at least 1.5 times pickup for any fault for which breaker failure back-up is intended to operate. It should be recognized that the function of the current detector is to establish whether or not current is flowing in the associated circuit breaker. In this sense the most sensitive setting is desirable. However, if the settings are such that the current detector is picked up on load, the security of the scheme is reduced since any error in testing etc. that applies DC to the relay could result in an undesired trip out.

Another factor in the selection of a pickup setting for the current detector is the type of circuit breaker involved. Some circuit breakers insert resistors in the circuit when clearing a fault. This resistor current is maintained for a significant time and may have a substantial magnitude. For such applications the pickup setting of the current detector should be coordinated with the main timer setting to insure that this resistor current does not result in a false trip. Note that the dropout to pick up ratio of the current detector in all these relays is higher than 95 percent.

A seal-in unit is provided in some of the SBC21 models for those who wish to use such a function. This seal-in has a slight time delay to provide additional security against seal-in operations resulting from such causes as surges, etc. The purpose of such a function is to ride over contact bounce in the 62X contacts (if such bounce exists) and to maintain the DC input to the SBC in the event of a zero voltage fault that results in resetting of the initiating protective relays before the SBC can time out.

This seal-in should be used advisedly in as much as it can reduce the security of the scheme during testing if the current detectors are set to pick up below load current magnitudes. Note that most if not all static line relaying systems include their own seal-in functions. Thus, the BFI function illustrated on the logic diagrams will provide a continuous input.

Under normal conditions all the SBC21 relays do not have DC applied. Thus, during these periods they are free of all surge problems. DC is applied via BFI or 62X functions only when a fault occurs on a line associated with the breaker being protected.

TABLE II

BUS AND BREAKER ARRANGEMENT	FIG. #	FAULT LOC.	FAILED BREAKER	CURRENT FROM ASSOC. BREAKER	CONTACT INITIATION FROM	BFT CONTACT #1 TRIPS	BFT CONTACT #2 TRIPS	BFT CONTACT #3 TRIPS
Single Bus-Single Bkr.	10	F1	2	2	Line B	Bus Lockout Relay	-	-
Double Bus-Double Bkr.	11	F1 or F2	3	3	Line B or North Bus	North Bus Lockout Relay	Brkr 4	Lockout relay that transfer trip line B & blocks reclosing of 4
Double Bus-Double Bkr.	11	F1 or F3	4	4	Line B or South Bus	South Bus Lockout Relay	Brkr 3	Lockout relay that transfer trips line B & blocks reclosing of 3
Breaker-and-a-half	12	F1 or F3	4	4	Line A or North Bus	North Bus Lockout Relay	Brkr 5	Lockout relay that transfer trips 10 & blocks reclosing of 5
Breaker-and-a-half	12	F1 or F2	5	5	Line A or Line B	Breaker 4	Brkr 6	Lockout Relay that transfer trips brkrs. 10 & 11 & blocks reclosing of 4 & 6.
Breaker-and-a-half	12	F2 or F4	6	6	Line A or Line B	South Bus Lockout Relay	Brkr 5	Lockout relay that transfer trips 11 & blocks reclosing of 5
Ring Bus	13	F1 or F2	1	1	Line A or Line B	Breaker 2	Brkr 6	Lockout relay that transfer trips brkrs. 7 & 8 & blocks reclosing of 2 & 6

OPERATION OF THE SCHEMES

There are four current inputs to the SBC21 relays. They are the three phase currents (I_A, I_B, I_C) and ground current ($3I_0$). The contact initiation and the application of the BFT contacts depend upon the bus and breaker arrangement as previously explained. The operation begins when the contact initiation (BFI, 62X, 62Y) activates the power supply. The BFI contacts would come from the static relays on the associated line. These contacts will close when the static relays see a fault and are producing a trip output. The BFI contacts will stay closed until the fault disappears and the relays reset. The 62X and 62Y contacts come from electromechanical line relays and these contacts will close whenever the electromechanical relays produce a trip signal to trip the associated breaker. Once the power supply is activated the operation of the scheme depends on the features contained in the relay model. This is explained below for each of the six relay models. It will be assumed that a fault has occured and that the input current to the SBC is greater than the pickup setting so that the level detector produces an output once the power supply is activated.

SBC21A (FIGURE 4)

This relay model contains only the basic components. When the power supply is activated the level detector produces an output that energizes the A/O timer. If the timer is energized longer than its setting, it indicates that the primary breaker has failed to clear the fault. The pickup (A) of the timer should be set long enough to give the breaker a chance to trip but short enough to ensure system stability and maximum continuity of service by operating faster than remote second zone relays. Once the A/O timer operates it energizes a transistor switch (TS) that in turn picks up BFT. If the primary breaker had cleared the fault then either the contact initiation (BFI, 62X, 62Y) or the level detector would have dropped out before the timer could have timed out and no back up tripping would take place.

SBC21B (FIGURE 5)

The operation of the SBC21B relay is the same as the SBC21A relay except for the seal-in circuit which seals in around BFI. With this arrangement, complete dependance is placed on the current detectors to reset the timer when the primary breaker(s) clear the fault.

SBC21C (FIGURE 6)

The SBC21C relay contains the basic components plus a contact converter CC1. The function of the contact converter is to convert a contact operation into a signal that is compatible with the logic circuit of the SBC21C relay. By closing an external contact DC is supplied to the contact converter and an output signal is produced from CC1 once the power supply is activated by the contact initiation (BFI, 62X, 62Y). The signal from CC1 supervises the A/O timer in one of two ways. The choice depends on the position of the link that precedes the A/O timer. If the link is placed in the OR position, the A/O timer is controlled by an output from the level detector OR an output from CC1. The timer will reset only if both the level detector and CC1 reset or the contact initiation resets. If the link is placed in the AND position, the A/O timer is controlled by an output from the level detector AND an output from CC1 via the AND2 logic function. For this case the A/O timer will reset if either the level detector or CC1 resets or the contact initiation resets.

SBC21D (FIGURE 7)

The operation of the SBC21D relay is the same as the SBC21C relay except for the seal-in circuit. Depending upon the position of the link that precedes AND1, the seal-in will be energized from either the level detector or from CC1.

SBC21E (FIGURE 8)

The SBC21E relay contains two timers (A/O and B/O) and a contact converter CC1. Assuming that the power supply has been activated, the A/O timer is energized by an output from the level detector and it is generally set for relatively long times. The B/O timer is energized by an output from AND2 and it is generally set for short times. With the link in the IN position, AND2 will produce an output whenever there is an output from the level detector and CC1. With the link in the OUT position, AND2 will produce an output whenever CC1 produces an output. The purpose of having two timers is to provide for two different tripping times depending on the input conditions. For example, it may be desired to provide a short tripping time if the circuit breaker mechanism failed to operate, since this would imply that all three poles of the circuit breaker failed to open. However, if the circuit breaker mechanism has operated but the breaker failed to interrupt the circuit, longer tripping times can be allowed, since it is highly probable that only one of the poles failed to interrupt the circuit. The above can be accomplished with the SBC21E relay by using the breaker auxiliary switch to energize CC1. If the breaker mechanism fails to operate, CC1 would produce an output that energizes the B/O timer via AND2. With the link in the IN position the SBC21E relay is more secure, since AND2 is supervised by an output from the level detector. If the output from AND2 persists for the pickup setting of the B/O timer, the BFT contacts operate. However, if the breaker mechanism has operated but one of the breaker poles has failed to interrupt the circuit, there would be no output from the B/O timer because the auxiliary switch would deenergize CC1. For this case the A/O timer will operate the BFT.

SBC21F (FIGURE 9)

The operation of the SBC21F relay is the same as the SBC21E relay except for the seal-in circuit. Depending upon the position of the link that precedes AND1, the seal-in will be energized from either the level detector or from CC1.

RANGES

I Phase Currents

A. Pickup current is continuously adjustable from 1 to 10 amperes on any phase by means of tap adjustments and a rheostat.

B. Tap Ranges:

1A - 2A
2A - 4A } See Figure 1 for tap selections
4A - 10A

II Ground Current

A. Pickup current is continuously adjustable from 0.5 to 5 amperes by means of a tap adjustment and a rheostat.

B. Tap Ranges:

0.5A - 1.0A
1.0A - 2.0A } See Figure 1 for tap selections
2.0A - 5.0A

III Timers

A. A/O timer 50-500 msec.
B. B/O timer 50-500 msec. } See Figure 1 for rheostat location.

RATINGS

The SBC21 current circuits are rated at 10 amps continuously, and have one second thermal rating of 210 amps.

CAUTION: WHEN HIPOTTING THE SBC21 REMOVE ALL EXTERNAL WIRING FROM TERMINAL 10. DO NOT HIPOT TERMINAL 10. THE REASON IS THAT CAPACITORS C1-213 ARE RATED FOR 600VDC AND THE HIPOT VOLTAGE MAY DAMAGE THE CAPACITORS.

The breaker failure tripping telephone relay (BFT) is continuously rated at nameplate rated DC supply voltage. Table III lists the ratings of the three electrically separate BFT contacts.

TABLE III

BFT CONTACT RATINGS

RATING	CONTINUOUS CURRENT AMPS	TRIP DUTY AMPS	INTERRUPTION CURRENT (AMPS) INDUCTIVE	NON-INDUCTIVE
125V DC	3	30	0.5	0.75
250V DC	3	30	0.25	0.2
115V 60 HZ	3	30	2.0	4.0
230V 60 HZ	3	30	1.0	2.0

Table IV lists the ratings of the electromechanical targets (T1 and T2) on both the 0.2 and 2.0 taps that are available.

TABLE IV

TARGET RATINGS

TAP SETTING	OPERATING RANGE (AMPS)	TRIP DUTY (AMPS)	DC RESISTANCE (OHMS)
2.0	2-30	30	0.13
0.2	0.2-3	3	7.0

SURGE WITHSTAND CAPABILITY

The SBC21 relay will withstand the following test voltage waveform without incorrect operation or damage to any component.

The test voltage waveform consists of a high frequency damped oscillation with a frequency of 1.5 megahertz. The source has an internal impedance of 150Ω. The initial value (zero to peak) is 2500 volts and the damping is such that the envelope of the waveform decays to half the initial value (1250 volts) in 6.0 microseconds. The test voltage is applied between relay surge ground and each of the other relay terminals.

CAPACITANCE CHARGING CAPABILITY

Static relays with contact outputs generally have capacitors placed in parallel with the contacts. The purpose of these capacitors is to protect the static relays from surges which may be coupled to the wires connected on the contact outputs. The BFI contacts associated with static line relays may have these capacitors. If any switches are placed in series with the BFI contacts (DC power switches as an example) the closing of these switches will cause previously uncharged capacitors to charge through the breaker failure relay input circuit. This could result in an incorrect operation in some breaker failure schemes if a seal-in circuit is employed and the current detectors are set below full load current. The SBC21 relay however is designed such that the seal-in circuit will not operate if two fully discharged capacitors of equal value are charged by the contact initiation input at stud 17. That is, with minus battery connected to stud 18 and two capacitors connected in series with their center points grounded to relay surge ground and with one end of the capacitors connected to stud 17 and the other end of the capacitors connected through a switch to plus battery, the seal-in of the SBC21 relay will not operate when the switch is closed. The limiting values of the capacitors depend on the voltage rating of the power supply and are listed below.

POWER SUPPLY VOLTAGE RATING	CAPACITOR
48V	32 μf
125V	12 μf
250V	6 μf

BURDENS

The AC burden for each of the current transformer circuits is tabulated in Table V for 5 amperes of 60 hertz current through each basic current setting range, minimum and maximum respectively.

TABLE V

5 AMP, 60 HERTZ BURDEN

BASIC RANGE	P.U. SETTING (AMPS)	VOLT-AMPS I^2Z (I=5 AMPS)	IMPEDANCE (OHMS)	POWER-FACTOR (LAGGING DEGREES)
Phase (1-2A)	1	0.54	0.021	21
Ground (0.5-1A)	0.5	1.12	0.045	14
Phase (1-2A)	2.0	0.51	0.021	23
Ground (0.5-1A)	1.0	1.1	0.044	34
Phase (2-4A)	2.0	0.34	0.014	15
Ground (1-2A)	1.0	0.57	0.023	19
Phase (2-4A)	4.0	0.33	0.014	18
Ground (1-2A)	2.0	0.54	0.022	27
Phase (4-10A)	4.0	0.27	0.011	19
Ground (2-5A)	2.0	0.38	0.016	18
Phase (4-10A)	10.0	0.27	0.011	20
Ground (2-5A)	5.0	0.38	0.015	26

The overall battery drain at relay terminals #17 and #18 is itemized in TABLE VI for the three possible relay DC ratings under three possible operating conditions.

TABLE VI
BATTERY DRAIN

RATED D.C.	CONDITION	DC DRAIN (AMPS)
125 VDC	DROPPED OUT (NO FAULT) TIMING TRIPPING	0 A 105 ma 167 ma
48 VDC	DROPPED OUT (NO FAULT) TIMING TRIPPING	0 A 110 ma 174 ma
250 VDC	DROPPED OUT (NO FAULT) TIMING TRIPPING	0 A 92 ma 155 ma

CHARACTERISTICS

Aside from the logic functions there are four (4) basic units the characteristics of which are important to the application of all the SBC21 relays. These are noted below.

POWER SUPPLY

All the SBC21 relays covered by this book contain a regulated power supply. This power supply regulates the voltage to the logic functions so that they perform properly over a range of applied DC voltage from 80 percent to 110 percent of rated voltage.

OUTPUT RELAY (BFT)

The trip output of all the SBC21 relays consist of a high speed telephone relay with several contacts. The contacts of this telephone relay will close within 1/4 cycle of the instant that the coil circuit is energized from the logic. However, a shorter pulse of energization may also cause the output relay to close its contacts. This is in effect "overtravel". The overtravel of the output relay is less than two milliseconds. The dropout time of the output relay is somewhat longer than two cycles.

TIMER

The timers in all the SBC21 relays are extremely accurate and repeatable in performance. The resolution of the setting mechanism is such that these timers may be set as shown on the calibration plate. At any given temperature and setting the timer will repeat its timing operation to within ± 2 percent of its setting. Over the entire range of applied DC voltage from 80 to 110 percent of rated or temperature from -20 to +60 degrees centigrade the timer will hold its setting to within ± 5 percent of setting.

The timers in all the SBC21 relays have a very quick reset. If the input to the timer is removed for a time in the order of 0.2 milliseconds or longer it will reset completely. Thus, in order for the timer to time out it requires a continuous unbroken input for the complete timing cycle.

CURRENT DETECTOR

The current detector in all the SBC21 relays is comprised of magnetic input circuits for each phase current and $3I_0$, pickup setting potentiometers, one level sensing circuit, and a fill-in timer. See Figure 16. The level sensing circuit produces an output when the instantaneous magnitude of the input exceeds its fixed pickup sensitivity. The output will go away as soon as the instantaneous magnitude of the input gets below its fixed dropout level which is greater than 95 percent of the pickup level. The fill-in timer will produce an output as soon as a signal appears at its input. This output will persist until the input from the level sensing circuit goes away and the adjustable time-delay dropout setting on the fill-in timer expires.

As will be noted from Figure 16 the input to the level sensing circuit is provided with four transactor circuits. The voltage outputs from each transactor is proportional to the respective current inputs. The outputs of the transactors are individually rectified and the phase circuits are separated from the ground ($3I_0$) circuit. A portion of each of the two circuits is supplied to the level sensing circuit via potentiometers. Since the sensitivity of the level sensing circuit is fixed by design, the pickup settings for phase and ground currents are made independently by means of the two potentiometers in conjunction with the current tap selection. Note, that since the output of all three phase bridge rectifier circuits are in parallel, the level detector responds to the highest of the three phase currents.

For a phase-to-phase or phase-to-ground fault or single-phase test simulation, the voltage applied to the input of the level sensing circuit will be a full wave rectified signal. This signal starts at zero magnitude, builds up to a maximum on a sine wave curve, and then drops off on a sine wave curve to zero magnitude. This is repeated as long as the current input conditions exist. It is obvious that the output of the level sensing circuit cannot be continuous under these conditions since it will, regardless of the magnitude of the input, drop out twice each cycle every time the rectified input approaches and passes through zero. It is for this reason that the fill-in timer is employed to "ride over" these gaps in output from the level sensing circuit. The amount of fill-in time required will depend on the magnitude of the input to the level sensing circuit. The range of pickup adjustment as given under the section on RATINGS is based on the assumption that the fill-in timer will be set for (8.7 milliseconds) something longer than a half cycle dropout so that a continuous output from this timer will be obtained when the peak value of the input signal to the level sensing circuit is just equal to the sensitivity of that circuit. This is the normal factory setting of the fill-in timer and it results in a "dropout" time of the current detector that is about 10 milliseconds. (See Figure 17). The dropout time is somewhat longer than the fill-in time because of the stored energy in the magnetic circuits after the current disappears.

As was noted above, the main timers required <u>continuous</u> input for the duration of their settings in order to time out. Thus, a continuous output is <u>required from</u> the fill-in timer. If faster overall dropout time of the current detector is required, it is necessary to reduce the fill-in timer setting. With this reduced fill-in timer setting and no other change, a higher input current will be required into the current detector circuits in order to produce a continuous output from the fill-in timer. (See Figure 18). <u>It is important to note</u> that pickup of the current detector is defined as the RMS sine wave current applied at the input of the relay that produces a <u>continuous</u> output from this detector for the given fill-in timer setting. It should be recognized that in making the pickup setting only single phase current inputs should be used. Three phase current inputs tend to fill in the gaps so that the input to the level sensing circuit never goes to zero (see Figure 19).

In summation, the normal factory setting on the fill-in timer is set for approximately nine milliseconds. With this setting the dropout time of the current detector will be about 10 milliseconds. The range of pickup adjustment will be as given under the section on RATINGS. If faster dropout times are desired, the fill-in timer must be set for a shorter time and this in effect raises the pickup of the relay. This relationship is illustrated in Figure 18. Pickup current is defined as the RMS sine wave current required to produce a continuous output from the current detector.

Since the application of all the SBC21 relays no DC voltage is applied until after the associated line relays operate, (see Figures 4-9) there will be some slight operating delay in the pickup of the current detector. Figure 20 indicates the maximum and minimum operating times as a function of current as a multiple pickup setting. The variation in time is a result of the instant in the current cycle at which the DC is applied. Note that these curves apply for single-phase fault or single phase test currents. For 3-phase faults or 3-phase test currents the minimum time curve will apply regardless of the incident angle of the current at the instant the DC is applied.

SETTINGS

The following settings must be made in all the SBC21 relays covered by this book. The settings should be made in the order in which they are listed below.

1. Current detector fill-in timer setting
2. Main time-delay setting
3. Phase current pickup setting
4. Ground current pickup setting
5. Link position settings

The section under APPLICATION itemized the considerations involved in the selection of settings for

Items 1-4 above. The positions of the links depends on the particular model and the users preference. These have been described in the sections under "Operation of the Schemes."

There are reasons for the order listed above in which the settings should be made. These reasons and other considerations are noted below.

It is important that the fill-in timer setting be made first because, as explained in the section under CHARACTERISTICS, the pickup range of the current detector will vary depending on this setting. The section under "ACCEPTANCE TEST" describes exactly how this setting should be made or checked.

The next setting to be made is the time delay of the main timer. Since in the field the SBC21 relays do not normally have DC voltage applied, the current detectors are not operating regardless of magnitude of current until BFI or 62X contacts close to apply DC. This means that before the timer can start timing it is necessary for the fault detectors to pick-up. For this reason it is necessary to set the main timer so that the overall time from the instant the DC voltage is applied to the relay until an output is obtained from the BFT contacts is equal to the desired time delay. This test must be performed with current into the relay prior to applying the DC.

The magnitude of this current is an important consideration in this setting. Since the current detector cannot pick up until the instantaneous magnitude of the input current exceeds its sensitivity, there can be some variation in timing on a statistical basis depending on what instant in the current cycle the dc voltage is applied. In order to limit this variation it is recommended that the input current to the relay be selected in the range of 5 to 10 times the pickup setting. Thus, for setting this timer it is suggested that single phase current be fed into the ground circuit with the ground pick-up setting on the minimum possible setting. This input current should then be selected to be about 5 to 10 times the RMS value required to get a continuous output from the current detector. This arrangement will limit the statistical variation to some fraction of a millisecond. The circuit and the instructions to make these settings are given in the section under "ACCEPTANCE TEST."

It should be noted that with the above settings the relay will, for severe faults, operate in the set time. For low current faults it may get a few milliseconds slower which is in the direction to provide slightly more margin for these faults where stability and damage considerations are considerably less onerous.

After setting the main time delay the pickup settings on phase and ground currents should be made as indicated in the section under "ACCEPTANCE TEST." The considerations related to the actual settings to select have been discussed in the section under APPLICATION.

OPERATING PRINCIPLES

INTRODUCTION

The operating sequence of logic signals for each of the SBC's can be followed with the aid of the proper internal connections diagram as shown below:

RELAY TYPE	FIGURE
SBC21A	21
SBC21B	22
SBC21C	23
SBC21D	24
SBC21E	25
SBC21F	26

PRINTED CIRCUIT CARDS

The following sections describe the operation of the printed circuit cards. Table VII shows the printed circuit card internal included in each SBC model.

TABLE VII

PRINTED CIRCUIT CARD FIGURES						SBC MODEL
A	B	C	X	Y	Z	
27	28	--	35	36	37	12SBC21A(-)D
27	28	30	35	36	37	12SBC21B(-)D
27	28	31	35	36	37	12SBC21C(-)D
27	28	32	35	36	37	12SBC21D(-)D
27	29	33	35	36	37	12SBC21E(-)D
27	29	34	35	36	37	12SBC21F(-)D

"A" CARD (Level Detector with Adjustable "FILL-IN")

The operational amplifier's invert input (4) is biased at approximately +2.4 volts DC. While the input at TP2 is below this level, TP3 has a negative voltage level present. As TP2 (Non-invert input) signal becomes more positive than the 2.4 VDC, the Op-Amp swings positive (TP3) and drives Q1 on.

In a quiescent dropped out state then, TP3 is a negative signal; Q1 is off, Q2 is off, the unijunction oscillator P1, C3 and Q3 is oscillating; Q5 is off; Q6 is on and the signal at TP4 is "0". When TP3 comes high, Q1 goes on, the unijunction oscillator stops oscillating and the capacitor C3 is fully discharged, Q2 comes on, Q4 stays non conducting, Q5 comes on, Q6 goes off, and the output at TP4 comes high.

Now as the TP3 signal goes negative again, Q1 goes off, Q2 remains conducting by virtue of the previously conducting Q5 and feed back loop D3, D4, and R14. The C3 capacitor begins to charge with the (R10+P1) X (C) time constant, and the output signal remains ON.

When the C3 capacitor voltage reaches the firing level of the unijunction, a pulse is generated thus turning on the SCR Q4, which turns off Q5, resets the feed back circuit, drives Q6 on and yields a "0" output voltage. In effect, the circuitry after the Op-Amp provides the adjustable "Fill-In" time (time-delay dropout) described elsewhere in this text.

In practice, the RC time constant is factory set such that the time delay on the card (P1 adjustment) is slightly greater than 1/2 cycle on a 60 hertz basis (i.e. approximately 8.7 milliseconds).

Since the A/O timer resets in less than 1/4 milliseconds, this "Fill-in" time plug energy decay time in the magnetics both contribute to the total dropout time shown in Figure 20.

"B" CARD (A/O Timer and BFT Driver)

Two types of printed circuit cards are used.

Each card has its reed relay (RD) output at Pins 12 and 14; +10.2VDC Pin 10 (Red test point); Ref. Pins 1 and 20 (Black test point); and -10.2VDC Pin 11.

The 0165B4687 G5 consists of an A/O timer with input at Pins 2 and 5.

The 0165B4687 G6 consists of two (2) parallel timers: A/O and B/O with inputs at Pins 2 and 6 respectively. Both timers drive the same output driver.

A/O TIMER

In the quiescent off state (not timing) Q1 is off, Q2 is on, C3 is fully discharged, Q3 is off, Q4 is off, Q5 is off, and the reed relay remains de-energized, therefore, the contact between Pins 12 and 14 stays open.

In the timing state, Q1 is turned on by the presence of an input signal. Q2 is off and C3 is charging thru R7 and the external rheostat. At pickup, C3 is charged to approximately 6.5 volts and Q3 is on providing base current to Q4 turning on. With Q4 on, Q5 turns on which in turn provides current for the reed relay and the contact between Pins 12 and 14 closes. This contact output will remain closed until Q1 switches off, Q2 turns on and C3 discharges. When C3 discharges Q3 turns off, Q4 turns off, Q5 turns off, and the reed relay is de-energized.

The timing range for the A/O timer is from 50 to 500 milliseconds and is adjusted by a 0.75 meg ohm rheostat external of the printed circuit card.

B/O TIMING

The mechanics of the B/O timing is identical to that for the A/O timing described above. B/O input is Pin 6 and the rheostat input pins are pins 7 and 8 respectively. The timing range for the B/O timer is the same as that for the A/O timer (50-500 milliseconds).

"C" CARD (Miscellaneous Function Card)

0165B4686 G1 (SBC21B): SEAL-IN (Fig. 30)

The input for the seal-in function is at Pin 2. The output is a reed relay normally open contact across Pins 12 and 13.

With no signal at TP5, Q3 is off, Q5 is off, and Q6 is off thus keeping "SI" de-energized.

When TP5 comes high, Q3 goes on, Q5 goes on, Q6 goes on, and SI begins to conduct current. Within 1.0 millisecond "SI" will be fully energized and the associated contacts will be closed.

0165B4686 G2 (SBC21C): AND, OR Contact Converter (Fig. 31)

The inputs for the AND circuit are pins 5 and 6. The output is Pin 15. For no signal at either pin 5 or 6 Q1 and Q2 are off thus holding Q4 on with TP3 or pin 15 low. If one or the other transistors (Q1 or Q2) is driven on, Q4 remains on. Only if both Q1 and Q2 are driven on, will Q4 drop out of saturation allowing TP3 or Pin 15 signal to appear, through R8.

The OR circuit inputs are pins 3 and 4. Pin 14 or TP4 is the associated output. Signal presence at Pins 3 or 4 are transmitted through D1 or D2 respectively to yield output at TP4.

The contact converter inputs are across pins 7 and 8. When the CC1 contact is open (CC1 is a reed contact on the "Z" card), TP7 and the output pins 16 and 17 are tied to reference by resistor R16. When the CC1 contact is closed, TP7 and the output points yield output voltage in accordance with the resistor divider R15, R16, and load resistance.

0165B4686 G3 (SBC21D): AND, OR Contact Converter, Seal-in (Fig. 32)

The AND and the OR circuits operate as described above.

The contact converter is similar to the G2 card except that the output pins are 16, 17, and 18.

The seal-in element operates as the G1 card described above.

0165B4686 G4 (SCB21E): AND, Contact Converter (Fig. 33)

The AND circuit operates as explained for the G2 card except the input pin numbers are 6 and 9 and the output pin is 19.

The contact converter functions as explained for the G2 card except that the output pin number is 17.

0165B4686 G5 (SBC21F): AND, Seal-in, Contact Converter (Fig. 34)

The AND circuit operates as explained for the G2 card except that the input numbers are 6 and 9 and the output is 19.

The seal-in element functions as explained for the G1 card described above.

The contact converter functions as explained for the G2 card except that the output pin numbers are 17 and 18.

"X" CARD (Quad. Full Wave Bridge)

0165B4796 G1 (FIG. 35)

The card functions as a full wave bridge for the three phase and residual transactor secondary circuits.

The inputs and outputs are noted below:

PHASE	INPUT PIN	OUTPUT PIN
AØ	1, 2	9
BØ	3, 4	9
CØ	5, 6	9
$3I_0$	7, 8	10

Reference is Pin 11

Note that the three (3) phase outputs are logically "ORed" on this board at output Pin 9. In short, this means that the phase voltage of greatest magnitude in time will prevail at the output Pin 9.

"Y" CARD (Zener Regulated Power Supply) (0183B2302G1 Fig. 36)

The Y card provides a regulated source of $\pm$10.2VDC to the relay logic. Three test points are provided to monitor the zener regulators mounted on this card. The red test jack is connected to the +10.2 volt bus, the green test jack is connected to the -10.2 volt bus, the black test jack is connected to relay reference (OV).

"Z" CARD (Contact Converter Card)

GE ASSEMBLY	FIGURE	DC RATING
0183B2304 G4	43	48VDC 125VDC 250VDC

This card functions as a triple rated contact converter card. In practice, closure of the contact external to the SBC provides for closure of the electrically isolated CC1 contact within the relay. CC1 contact state is subsequently translated to a voltage level for compatible logic state.

II. Current Detectors

A. General Description

The following discussion applies to all models of the SBC21 series of relays.

The three phase elements (AØ, BØ, CØ... the outputs of which are combined in logical "OR") and the residual element ($3I_0$) are independently adjustable from the front of the relay in continuous increments as follows:

PHASE	RESIDUAL
1-2A	0.5-1A
2-4A	1-2A
4-10A	2-5A

The four (4) links at the bottom of the relay provide for the above listed discrete ranges of adjustment, while the two (2) lower rheostats provide for the continuous adjustment within a range. The four tap blocks are identified as AØ, BØ, CØ, and $3I_0$ respectively; the range selection for the three position tap blocks increases from left to right. The seven (7) lines scribed on the nameplate associated with each rheostat indicates an approximate current detector pickup level calibration (factory) in multiples of the base pickup as follows reading clockwise: 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.5 X (base pickup)

Note that these pickup calibration marks apply to the factory convention of setting the current detector with 8.7 millisecond "fill-in" time.

The following two examples demonstrate the current detector setting calculation using the calibration marks. The assumption is, of course, that the current detector has an undisturbed factory calibration.

1. The AØ tap block screw is in the middle position (range 2-4A). The phase rheostat knob is pointing at the fourth mark from the left (1.6X range base). Since the relay is in the range 2-4 amps the range base equals 2 amps. Multiplying the range base by the calibration mark multiple, we have: Pickup: 1.6 X 2 = 3.2 amps. Therefore, approximately 3.2 amps RMS, through the AØ current circuit, is necessary to pick up the current detector. Similarly, the above applies for B and C phase current.

2. The residual ($3I_0$) tap block screw is in the right position (range 2-5 amps). The $3I_0$ rheostat knob is pointing at the second calibration mark from the left (1.2X base range). Since the relay is in the range 2-5 amps, the $3I_0$ range base equals 2 amps. Multiplying the range base by the calibration mark multiple, we have: Pickup: 1.2 X 2 = 2.4 amps. Therefore, approximately 2.4 amps RMS through the $3I_0$ current circuit is necessary to pick up the current detector.

ACCEPTANCE TESTS

Immediately upon receipt of the relay an INSPECTION AND ACCEPTANCE TEST should be made to insure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed. If the examination or test indicates that readjustment is necessary, refer to the section on SERVICING.

CAUTION: WHEN HIPOTTING THE SBC21 REMOVE ALL EXTERNAL WIRING FROM TERMINAL 10. DO NOT HIPOT TERMINAL 10. THE REASON IS THAT CAPACITORS C1-C3 ARE RATED FOR 600 VDC AND THE HIPOT VOLTAGE MAY DAMAGE THE CAPACITORS.

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

Setting or checking all SBC relays consist of the following tests and these tests must be performed in the following order.

A. FILL-IN TIMER SETTING

The fill-in timer is essentially an adjustable dropout timer which is factory set to 8.7 milliseconds. Other fill-in times less than 8.7 milliseconds are obtainable, but lowering the fill-in time raises the pickup level as shown on the graph of Figure 15. As an example, if the fill-in time of 5 milliseconds is required and set, then the 5 millisecond fill-in pickup level is approximately 1.24 times the 8.7 millisecond setting. (See Figure 15 and the CHARACTERISTICS section for other parameters.)

The timer and its associated adjustment potentiometer are located on the "A" card (left card see Figure 2). Set up the test circuit shown on Figure 38 and perform the following instructions:

1. Apply rated DC to relay terminals 17 (+) and 18 (-).

2. Insure that the relay circuit currents are zero by removing the lower connection block.

3. Make the oscilloscope and contact circuits described on Figure 38 being certain to observe the caution that the scope power cord is ungrounded.

Opening the normally open contact in the circuit removes signal from the timer input and thereby allows for fill-in timer measurement.

Place the scope in an external triggering mode with negative slope and note that upon opening the depressed normally open contact, a positive signal goes to about "0" volts in about 8.5 - 9.0 milliseconds. If the measurement is less than or greater than this range, correctly set the time to precisely 8.7 milliseconds by adjusting the potentiometer located in the lower corner of the "A" card.

B. CURRENT DETECTOR PICKUP TEST

Having checked or adjusted the fill-in time setting per section A, set up the test current circuit of Figure 39.

Connect an oscilloscope such that the vertical input is connected to TP4 of the "A" card and reference is connected to TP1 of the "A" card. The oscilloscope power cord should be ungrounded.

The following test is for a fill-in time setting of 8.7 milliseconds:

1. Set all current tap blocks as follows:

AØ	1-2A
BØ	1-2A
CØ	1-2A
$3I_0$	0.5-1

2. Set both current rheostat pointers to the 1X range base (first calibration line going clockwise).
3. Apply current to the AØ terminals per Figure 39 until the oscilloscope indicates a continuous DC output. The input current shall be approximately one (1) ampere.
4. Repeat three (3) above for phase B and C.
5. Apply current to the $3I_0$ terminals per Figure 39 until the oscilloscope indicates a continuous DC output. The input current shall be approximately 0.5 amps.
6. Using the procedure above, check the other taps and multiples of current settings.

To test the current detector pickup for fill-in times less than 8.7 milliseconds use the above procedure except that the pickup currents will be higher and have approximate values per Figure 15. Also, see CHARACTERISTICS section for other parameters.

C. CURRENT DETECTOR PICK UP SETTING

1. Use the procedure of the previous section (B) except set the current rheostats to the desired current pickup and secure the rheostats.

D. TRIPPING TIMERS

The rheostat(s) on the front of the relay associated with the trip timer(s) are identified as the A/0 (all relays) and B/0 (SBC21E, F). The seven (7) calibration marks which are scribed represent the following overall trip times reading clockwise: 50, 75, 100, 200, 300, 400, 500 (milliseconds).

The "A" and "B" signify a continuously adjustable pickup time delay in the range of 50 to 500 milliseconds. The "0" signifies that the timer resets "instantaneously" (in reality, in less than 200 microseconds).

Set up the AC, DC and oscilloscope connections shown in Figure 40. Apply the current to the ground circuit on the 0.5 tap at X1 base pickup. Observe the following two CAUTIONS:

CAUTION

1. THE SYSTEM SIDE CIRCUITS OF THE BFT CONTACTS MUST BE REMOVED BEFORE THE TEST CONNECTIONS ARE MADE (USE OF AN XLA TEST PLUG IS RECOMMENDED).
2. THE OSCILLOSCOPE MUST NOT BE GROUNDED...USE A THREE-TO-TWO PRONG POWER CORD ADAPTER. THE REASON FOR THIS LATTER CAUTION IS THAT RELAY REFERENCE IS NEAR (-) DC POTENTIAL AND GROUND POTENTIAL IS GENERALLY ABOUT 1/2 DC POTENTIAL.

To check or set the timer, use the following procedure:

Set the test current into the relay at 5X pickup. Upon closing the BFI contact of Figure 40, the scope trace is initiated. Note that since rated DC voltage is triggering the scope, the trigger feature should be operated in the attenuated mode. After the timer under test (A/0 or B/0 timer) has timed out and the BFT relay has operated, the BFT contacts close and the scope trace goes to "0" volts. The time from trace initiation until the signal goes to zero is the breaker failure tripping time.

For specific relay timer settings follow the subsequent instruction.

Note that the A/0 timer and B/0 timer (when used) rheostats are identified as such and clockwise rotation of each increases the tripping time.

1. SBC21A (A/0) Initiate timing of the relay as explained above by closing the BFI contact. Set the length of tripping time by adjusting the A/0 rheostat. Lock the rheostat position and check several times that the tripping time is consistent.

Apply test current to each of the four current circuits per Figure 37 and adjust the current level until the "A" card TP4 indicates that the current detector has just picked up. The current levels should be as follows for the four circuits: 1.9-2.1A RMS phase circuits --- 0.95-1.05A RMS residual circuit.

Having selected the phase and residual current detector settings to be used on the system (1-10A for phase and 0.5-5A for residual) set the tap plugs to the appropriate range selection: as an example a 6A phase setting should use the third tap block range (4-10A). Set up the AØ current circuit of Figure 39, and set the RMS value of current to the desired current detector pickup level exactly. Slowly adjust the phase rheostat until the current detector just picks up. Check that the current detector pickup level on the remaining two phases is +5 percent of the original setting. Lock the phase rheostat and be sure that the current detector setting has not drifted in the interim. Arrange the $3I_0$ current circuit of Figure 39 and calibrate the residual current detector by setting the test current to the desired $3I_0$ operate level while adjusting the residual rheostat until the current detector just picks up. Lock the residual rheostat, and check that the operate level has not changed.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

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

CONTACT CLEANING

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

SERVICING

Should servicing of the relay become necessary, follow the test procedures as explained in the section titled ACCEPTANCE TEST, for calibration and test of the relay. Telephone relay contact cleaning is located in the section titled PERIODIC CHECKS AND ROUTINE MAINTENANCE. Also, see section on RENEWAL PARTS for servicing printed circuit cards.

RECEIVING, HANDLING AND STORAGE

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

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

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

RENEWAL PARTS

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

Should a printed circuit card become inoperative, it is recommended that this card be replaced with a spare. In most instances, the user will be anxious to return the equipment to service as soon as possible and the insertion of a spare card represents the most expeditious means of accomplishing this. The faulty card can then be returned to the factory for repair or replacement.

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

CAUTION: GREAT CARE MUST BE TAKEN IN REPLACING COMPONENTS ON THE CARDS. SPECIAL SOLDERING EQUIPMENT SUITABLE FOR USE ON THE DELICATE SOLID-STATE COMPONENTS MUST BE USED AND, EVEN THEN, CARE MUST BE TAKEN NOT TO CAUSE THERMAL DAMAGE TO THE COMPONENTS, AND NOT TO DAMAGE OR BRIDGE OVER THE PRINTED CIRCUIT BUSSES. THE REPAIRED AREA MUST BE RECOVERED WITH A SUITABLE HIGH-DIELECTRIC PLASTIC COATING TO PREVENT POSSIBLE BREAKDOWNS ACROSS THE PRINTED CIRCUIT BUSSES DUE TO MOISTURE OR DUST.

ADDITIONAL CAUTION: DUAL IN LINE INTEGRATED CIRCUITS ARE ESPECIALLY DIFFICULT TO REMOVE AND REPLACE WITHOUT SPECIALIZED EQUIPMENT. FURTHERMORE, MANY OF THESE COMPONENTS ARE USED ON PRINTED CIRCUIT CARDS WHICH HAVE BUS RUNS ON BOTH SIDES. THESE ADDITIONAL COMPLICATIONS REQUIRE VERY SPECIAL SOLDERING EQUIPMENT AND REMOVAL TOOLS AS WELL AS ADDITIONAL SKILLS AND TRAINING WHICH MUST BE CONSIDERED BEFORE FIELD REPAIRS ARE ATTEMPTED.

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

2. SBC21B (A/O) Use the same test applied to the SBC21A.
3. SBC21C (A/O) Place the "timer link" in the "OR" mode and use the same test applied to the SBC21A.
4. SBC21D (A/O) Place the "timer link" in the "OR" mode and use the same test applied to the SBC21A.
5. SBC21E
   (B/O) Timer
   Adjust the B/O timer prior to adjusting the A/O timer. Place the AND2 link in the IN position. Keep the external auxiliary contact (see Figure 5) closed. Turn the A/O rheostat fully clockwise so that it does not time out before the B/O timer times out. Use the same test procedure as that used for the SBC21A except adjust the B/O rheostat instead of the A/O rheostat. Lock the B/O rheostat position and recheck the overall tripping time.
   (A/O) Timer
   Hold the external auxiliary contact open in order to inhibit the previously adjusted B/O timer function from operating. Adjust the A/O rheostat from the full clockwise position to the approximate expected time setting. Check and readjust the A/O setting with the identical procedure used to set the A/O timer in the SBC21A.
6. SBC21F (B/O and A/O)
   Check both timer functions in the same sequence and with the same procedure which applies for the SBC21E.

E. LOGIC FUNCTIONS, SETTINGS AND TESTS

Having set the current detectors and the A/O and B/O (if used) timers, perform the following tests using the Fig. 39 test circuit for the A/∅ configuration. Let the test current be 1.5X current detector pickup.

SBC21A (No auxiliary tests required)
SBC21B (Figure 5)

Place the seal-in link in the "OUT" position and apply test current to the relay. With an ohmmeter across relay terminals #9 and #17, close and open switch (s_1) and check that the ohmmeter continued to read ∞ ohms.

Place the seal-in link in the "LEV DET" position and apply test current to the relay. Upon momentarily closing the switch (s1), check that the ohmmeter measures "0" ohms while the switch is closed and ∞ ohms while the switch is open.

Place the seal-in link in the mode of operation which is required in the system operation.

SBC21C (Figure 6)

Keep switch (s_1) closed.

Place the timer link in the OR position. Check that by either applying test current alone or closing the auxiliary contact alone or by doing both, the BFT relay operates.

Place the timer link in the AND position. Check that the BFT relay operates only when the test current is applied and the auxiliary contact is closed simultaneously.

Place the timer link in the required mode of operation.

SBC21D (Figure 7)

1. With an ohmmeter across relay terminal 9 to 17, hold the switch (s1) closed. Place the seal-in link in the LEV DET position; check that the ohmmeter goes to "zero" when the test current is applied and goes to ∞ when the test current is removed.

Place the seal-in link in the CCI position. Check that the ohmmeter goes to 0 ohms when the auxiliary contact is closed and goes to infinity when the auxiliary contact is opened.

Place the seal-in link in the OUT position and check that the ohmmeter stays at ∞ ohms whether the test current is applied or the auxiliary contact is closed.

Place the seal-in link in the mode which the system scheme requires.

2. Timer link: perform all of the tests indicated for the SBC21C.

SBC21E (Figure 8)

In setting the B/O and A/O timers, the contact converter and the IN position of the AND2 link were checked. Place the AND2 link in the OUT position. Close the auxiliary contact and check that the BFT relay operates. Place the AND2 link in the required position.

SBC21F (Figure 9)

1. Perform all of the instructions for part 1 of the SBC21D logic function tests since the seal-in functions are identical.

2. Having placed the seal-in link in the mode to be applied, perform the AND2 test described above in the SBC21E section in its entirety.

INSTALLATION PROCEDURE

I. INTRODUCTION

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

The relay should be mounted on a vertical surface. The outline and panel diagram is shown in Fig. 41.

The internal connection diagrams for the various relay types are shown in Figs. 21 to 26 inclusive. Typical wiring diagrams are given in Figs. 4 to 9 inclusive.

One of the mounting studs or screws should be permanently connected to surge ground by a conductor not less than No. 12 AWG gage copper wire or its equivalent. (See Figs. 21 to 26 inclusive.)

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

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

CAUTION: WHEN HIPOTTING THE SBC21 REMOVE ALL EXTERNAL WIRING FROM TERMINAL 10. DO NOT HIPOT TERMINAL 10. THE REASON IS THAT CAPACITORS C1-213 ARE RATED FOR 600VDC AND THE HIPOT VOLTAGE MAY DAMAGE THE CAPACITORS.

Since most operating companies use different procedures for installation tests, the section under ACCEPTANCE contains all necessary tests which may be performed as part of the installation procedure at the discretion of the user.

The minimum suggested tests are as follows:

II. TIMER TEST

Test per timing test as explained in section titled ACCEPTANCE.

III. CURRENT DETECTOR PICKUP SETTING

Set up the test current circuit of Figure 39.

Place an oscilloscope on the A card TP4 as an indication of current detector pickup. Note that a "0" volt signal denotes dropout and a positive DC signal represents current detector pickup.

As a quick check on each of the relay calibration marks, perform the following:

Place all current tap block screws in the middle position.

AØ	2-4A
BØ	2-4A
CØ	2-4A
$3I_0$	1-2A

Place both current rheostat pointers to the first calibration line (i.e. 1X range base).

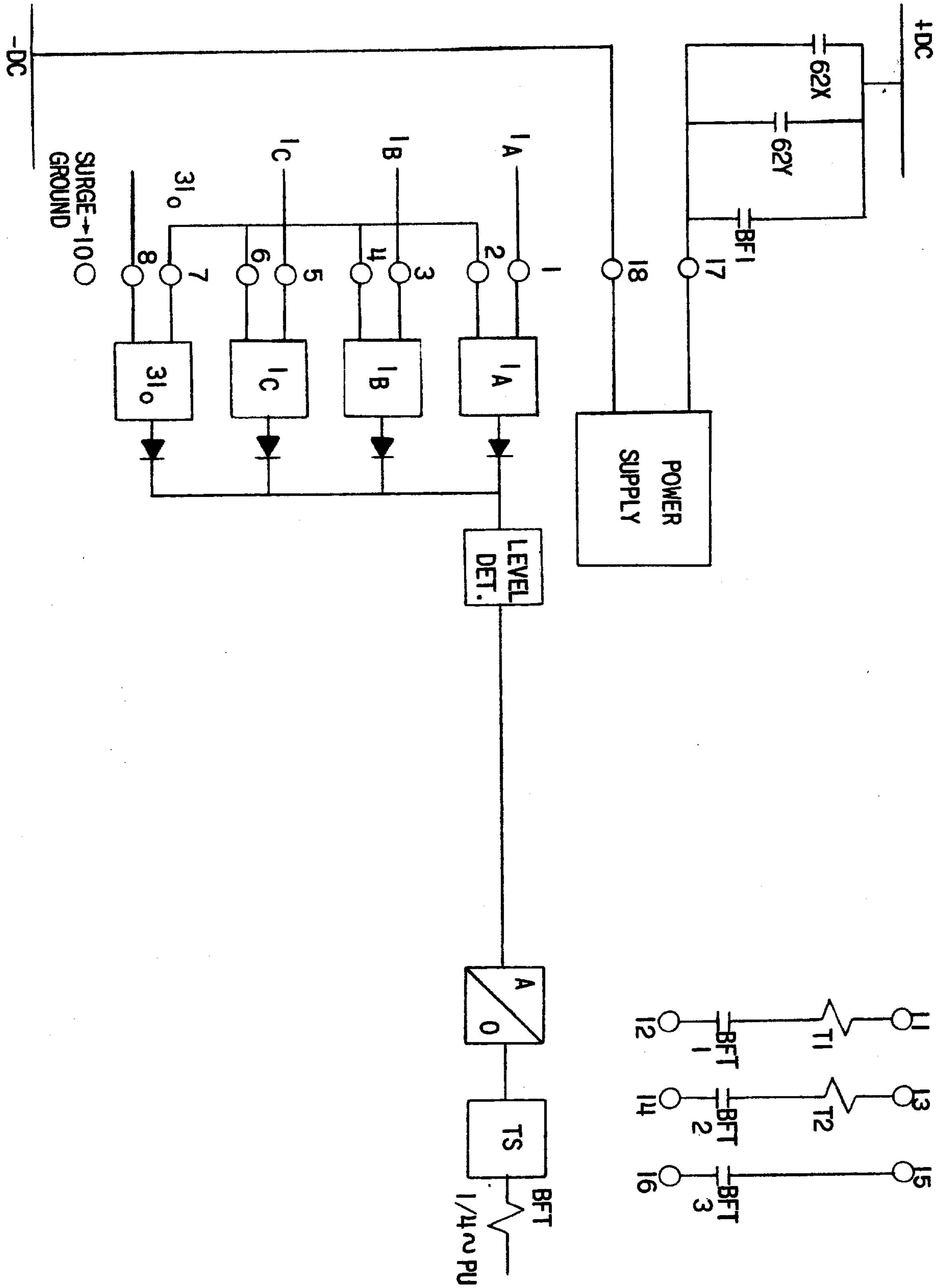


FIG. 4 (0227A7121-1) External Connection Diagram for the SBC21A Relay

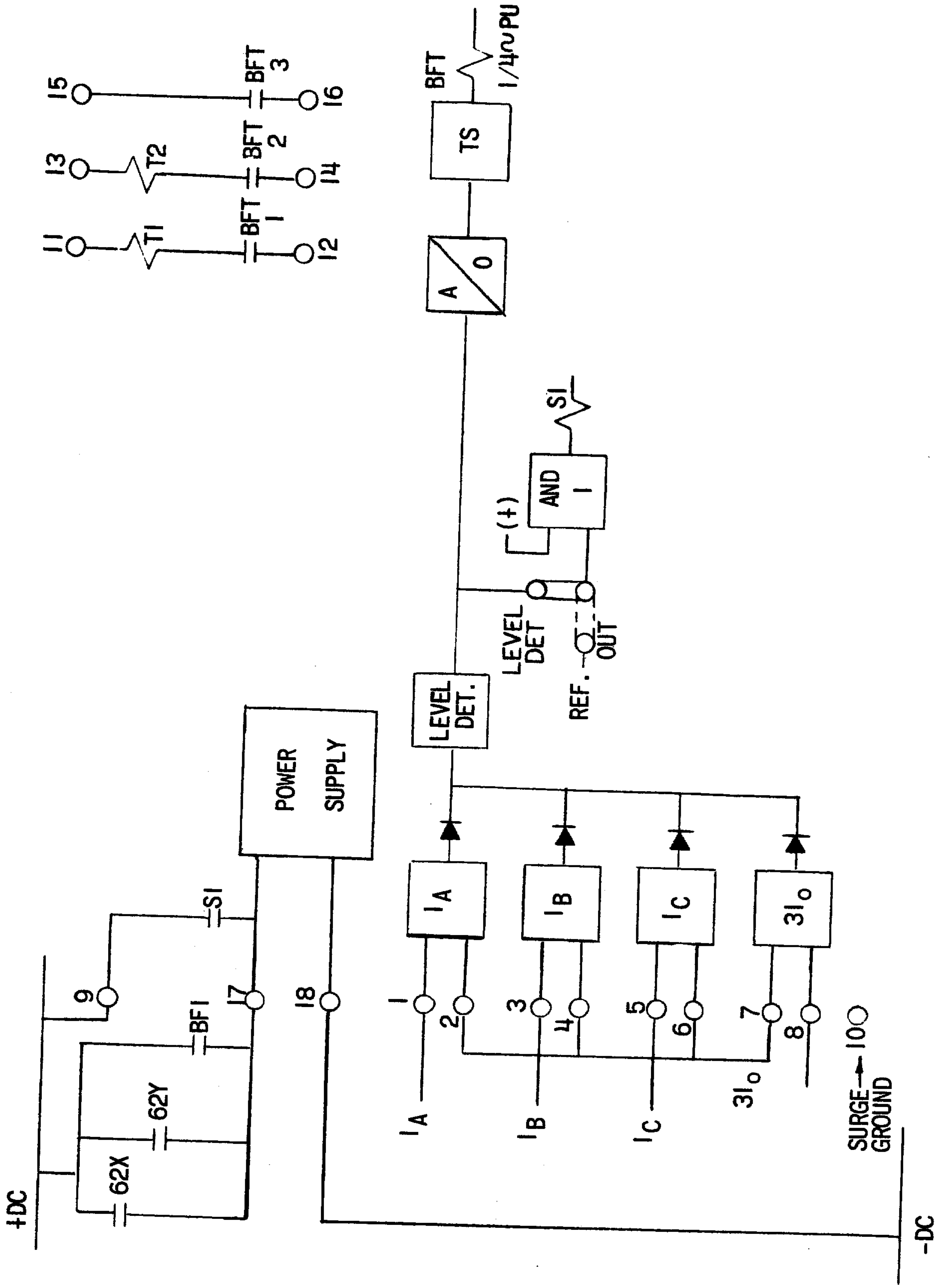


FIG. 5 (0227A7122-2) External Connection Diagram for the SBC21B Relay

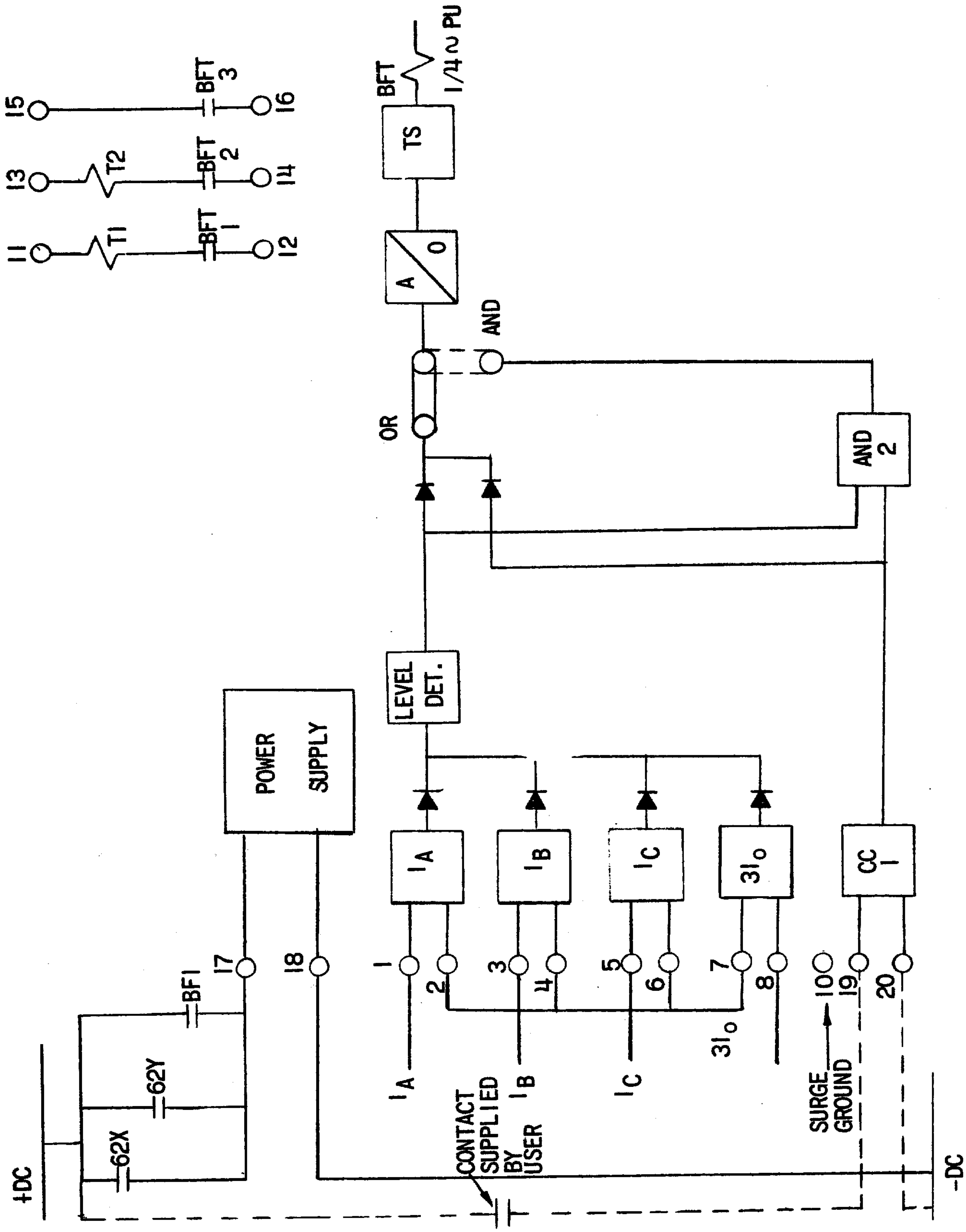


FIG. 6 (0227A7123-1) External Connections Diagram for the SBC21C Relay

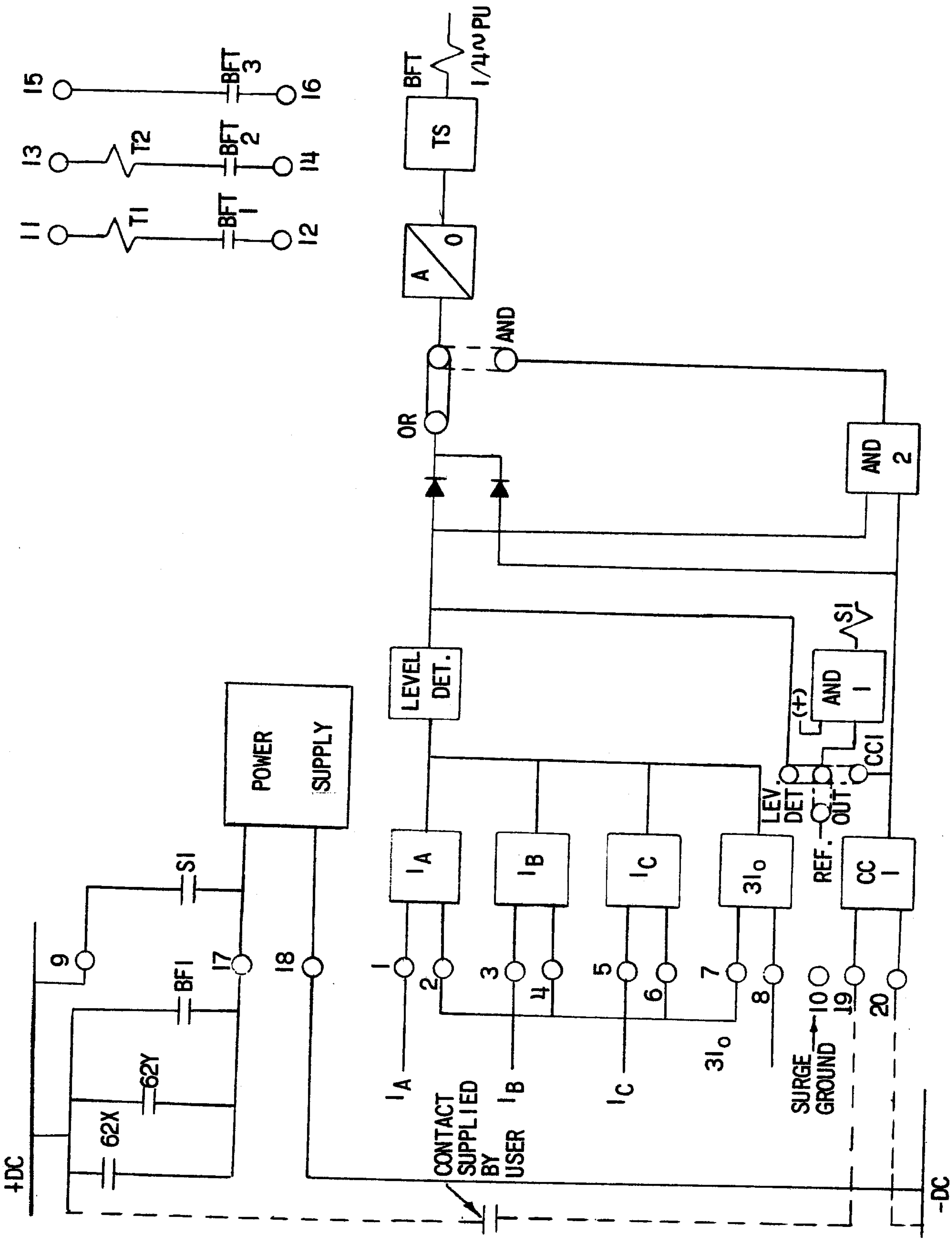


FIG. 7 (0227A7124-1) External Connection Diagram for the SBC21D Relay

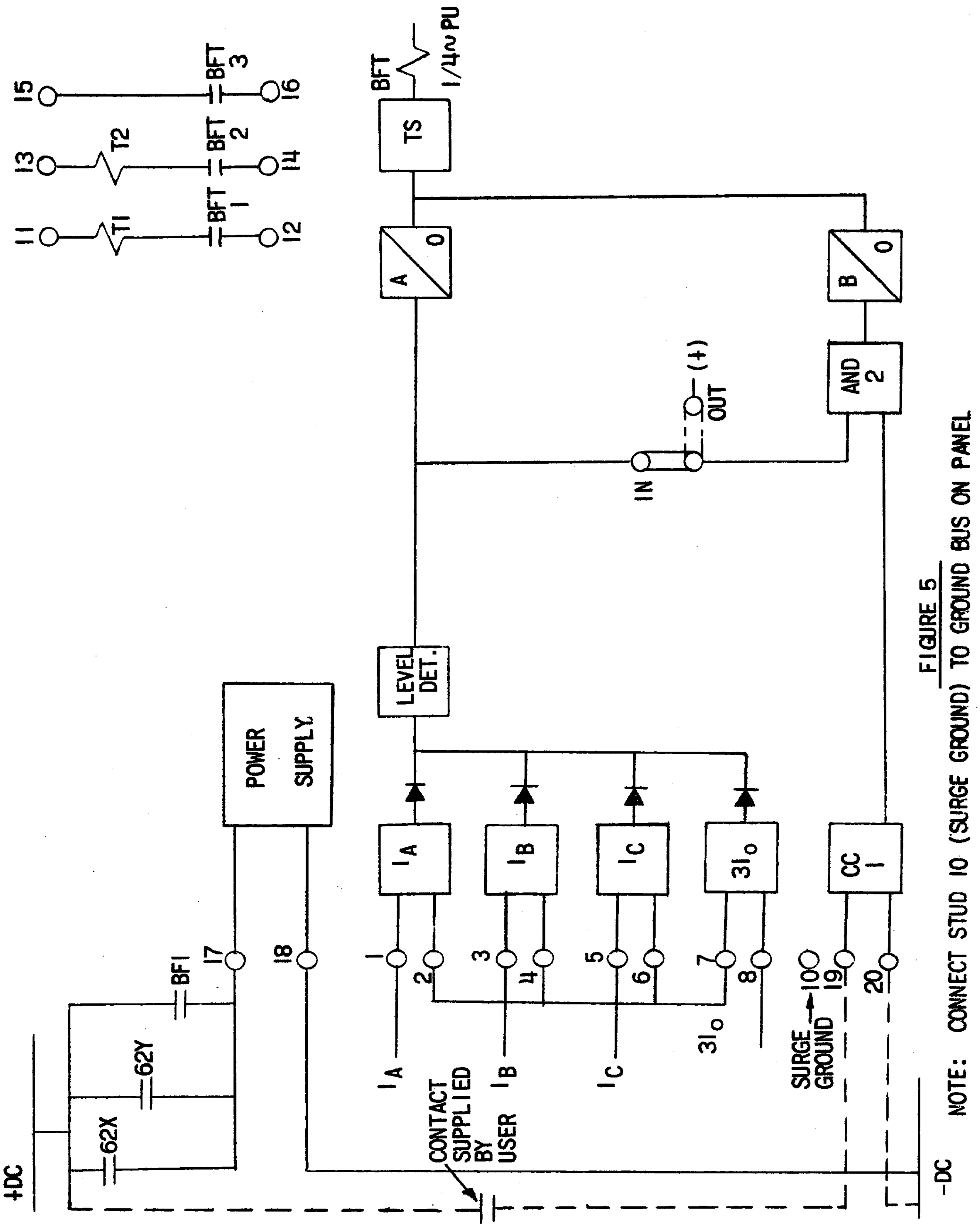


FIG. 8 (0227A7125-1) External Connection Diagram for the SBC21E Relay

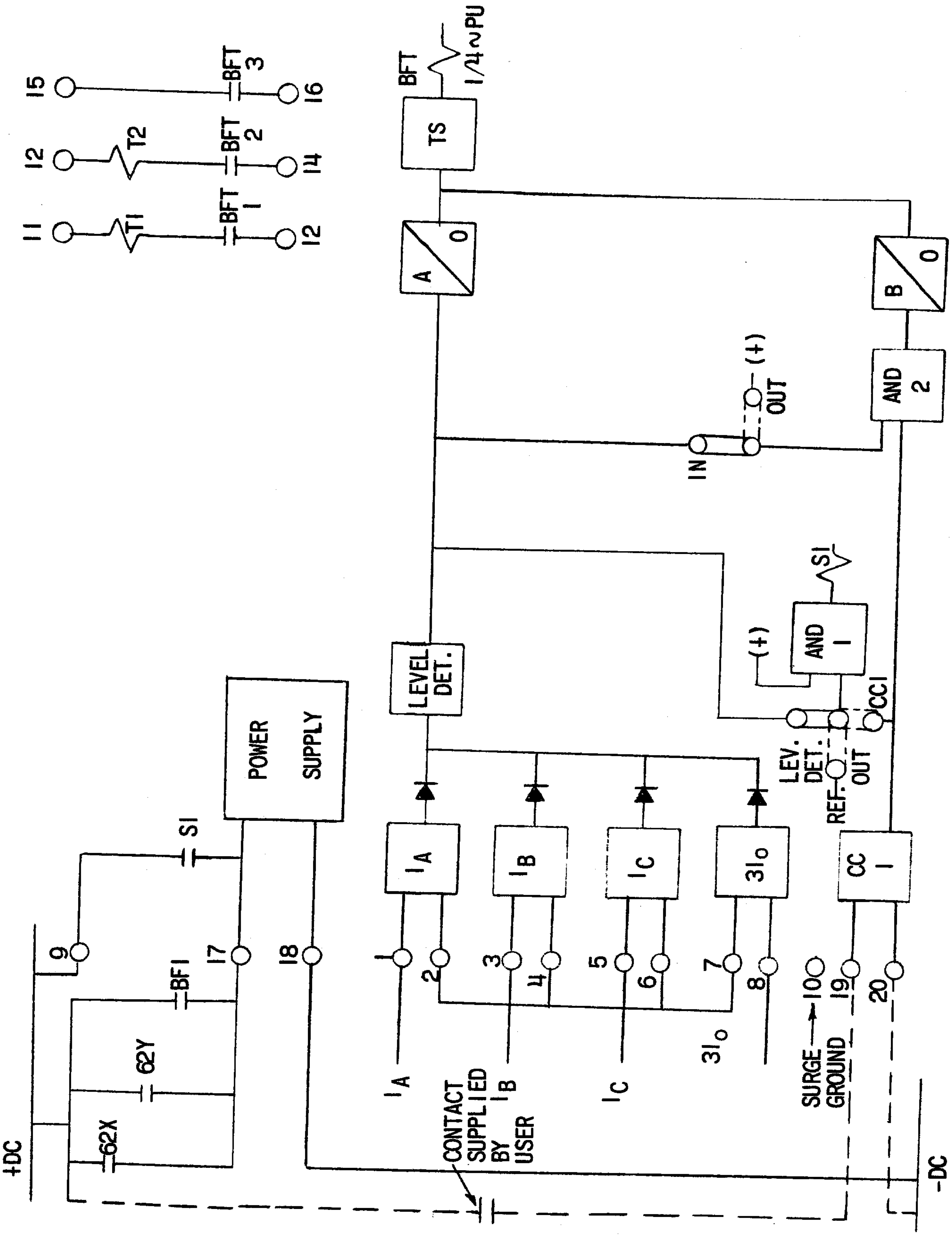


FIG. 9 (0227A7126-1) External Connection Diagram for the SBC21F Relay

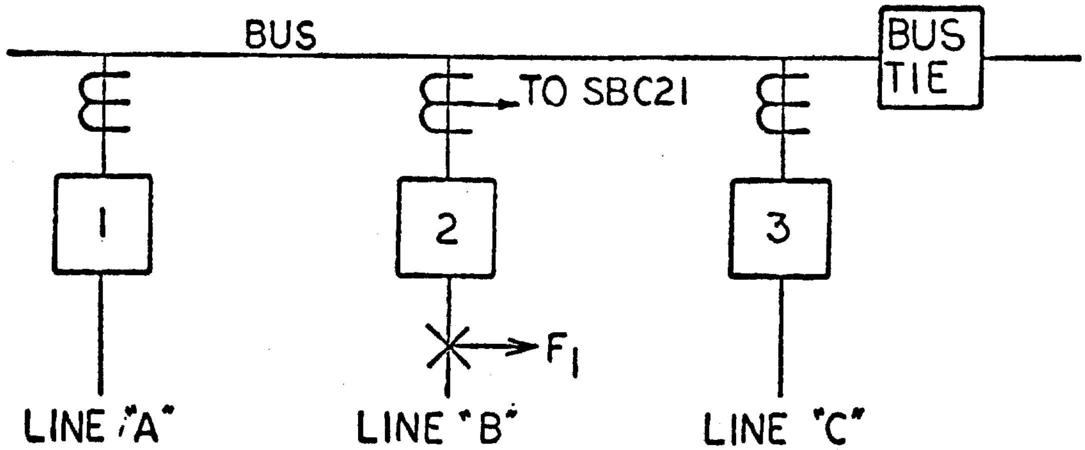


FIG. 10 (0246A2279-0) Relay Application Single Bus, Single Breaker

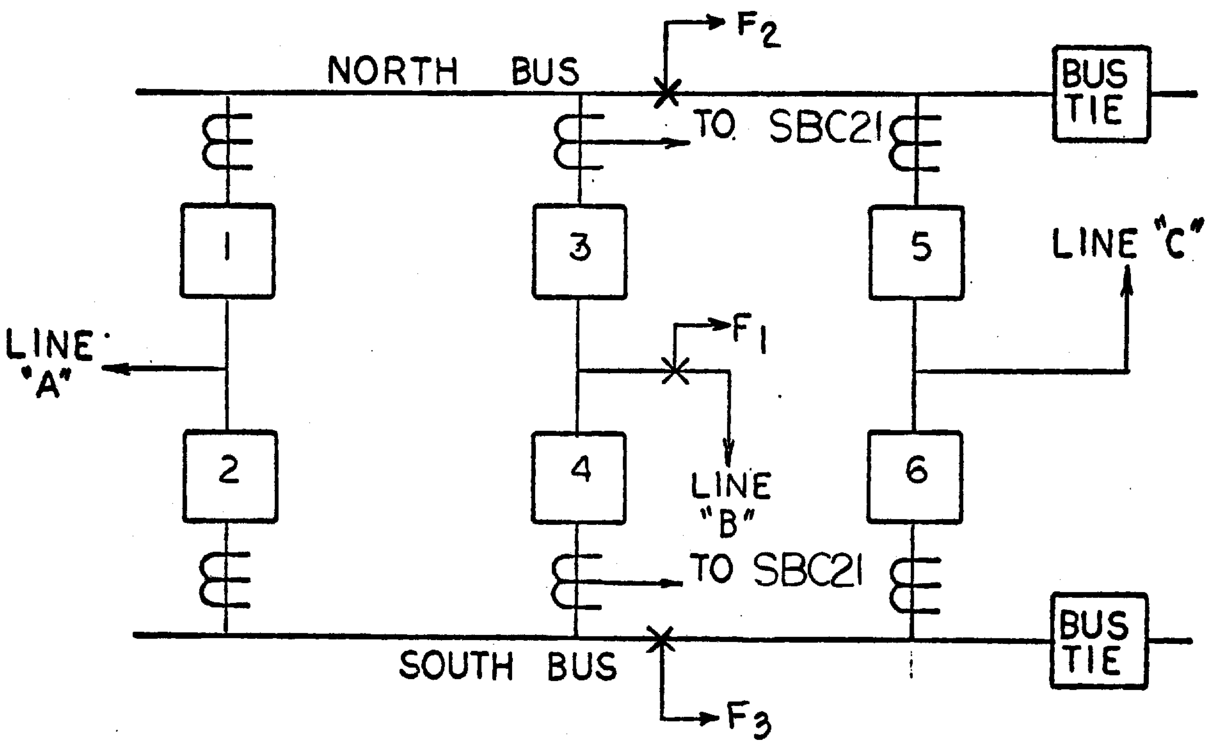


FIG. 11 (0246A2277-1) Relay Application Double Bus, Double Breaker

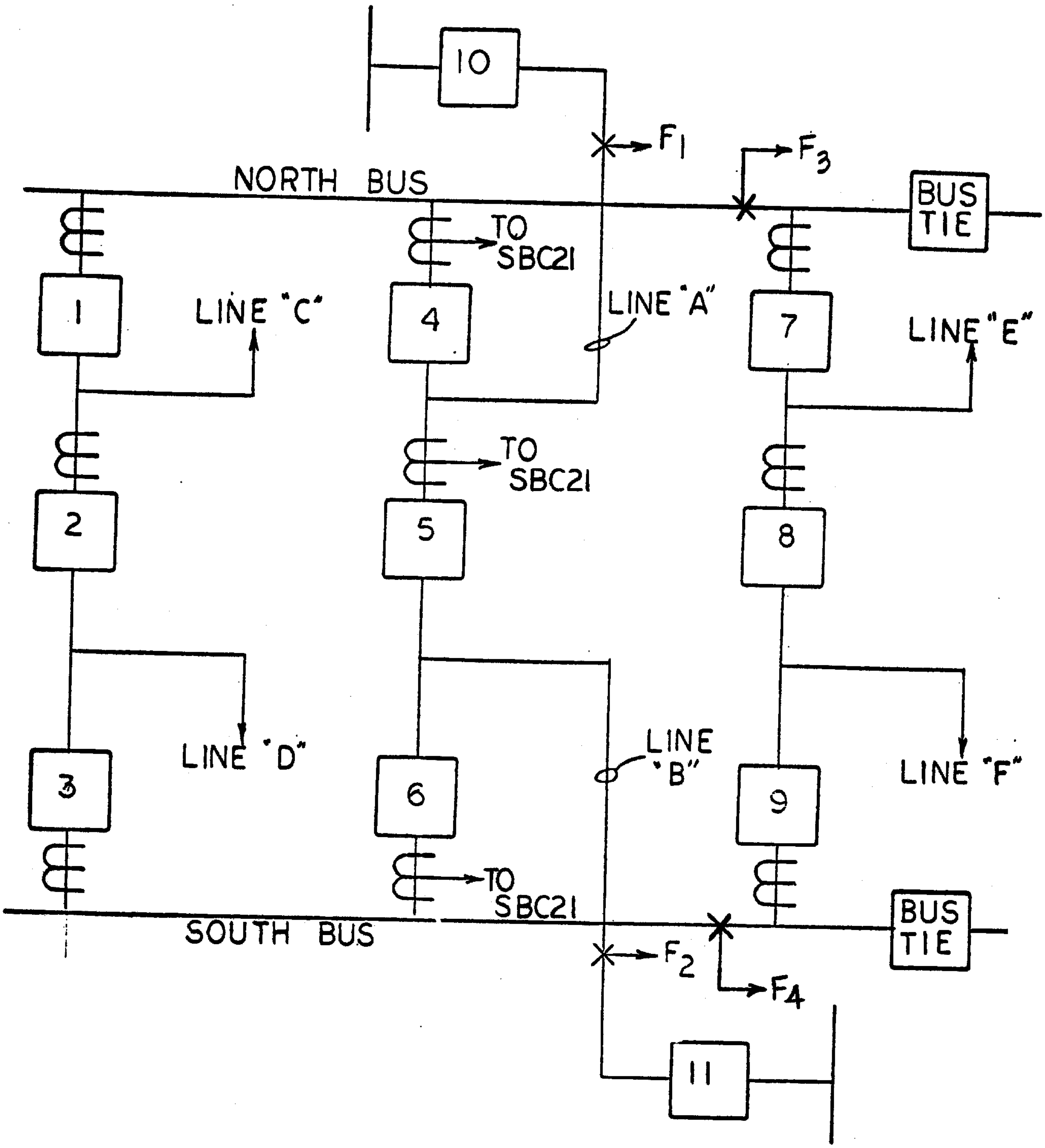


FIG. 12 (0246A2280-1) Relay Application Breaker-and-a-Half

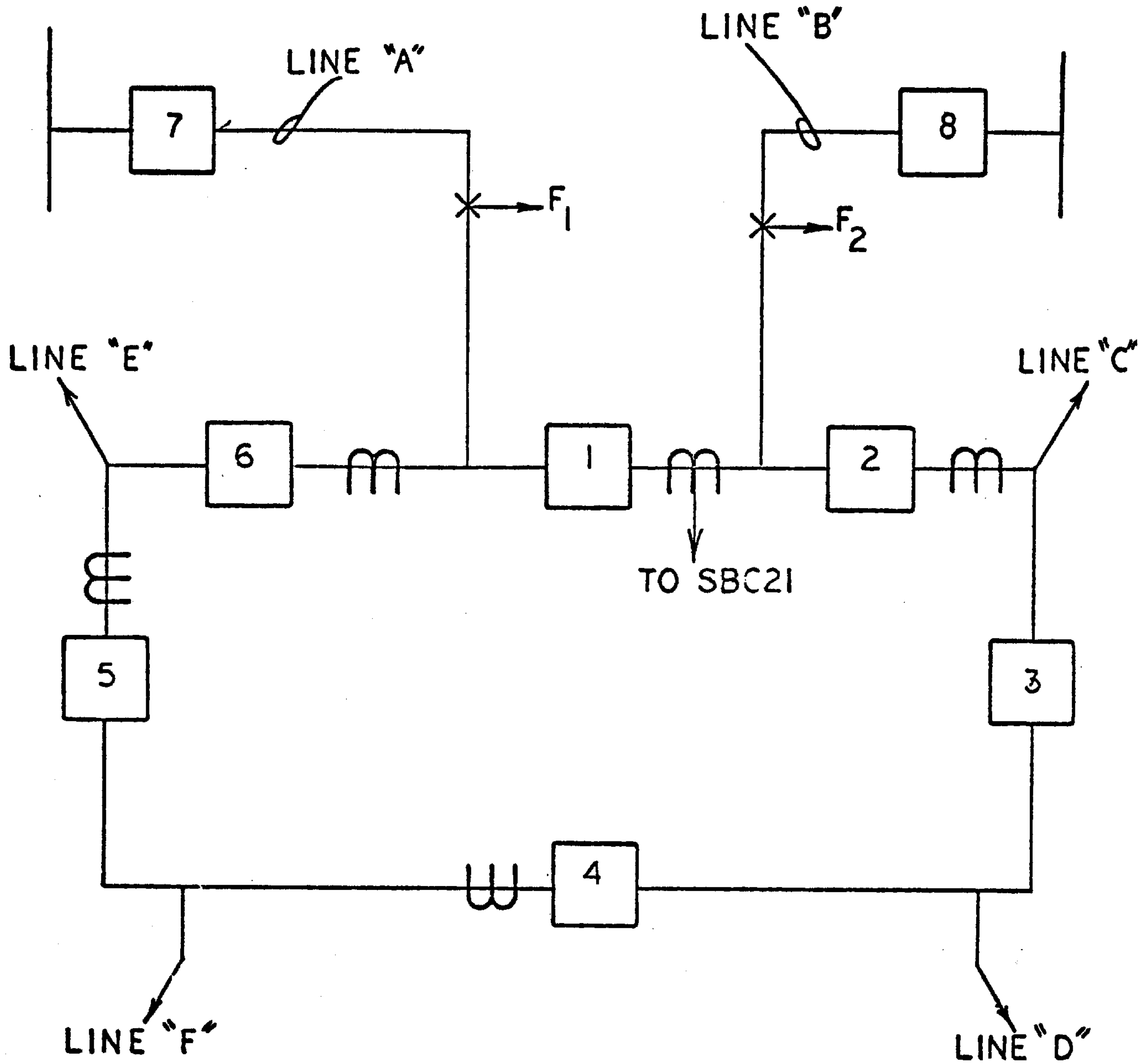


FIG. 13 (0246A2278-0) Relay Application Ring Bus

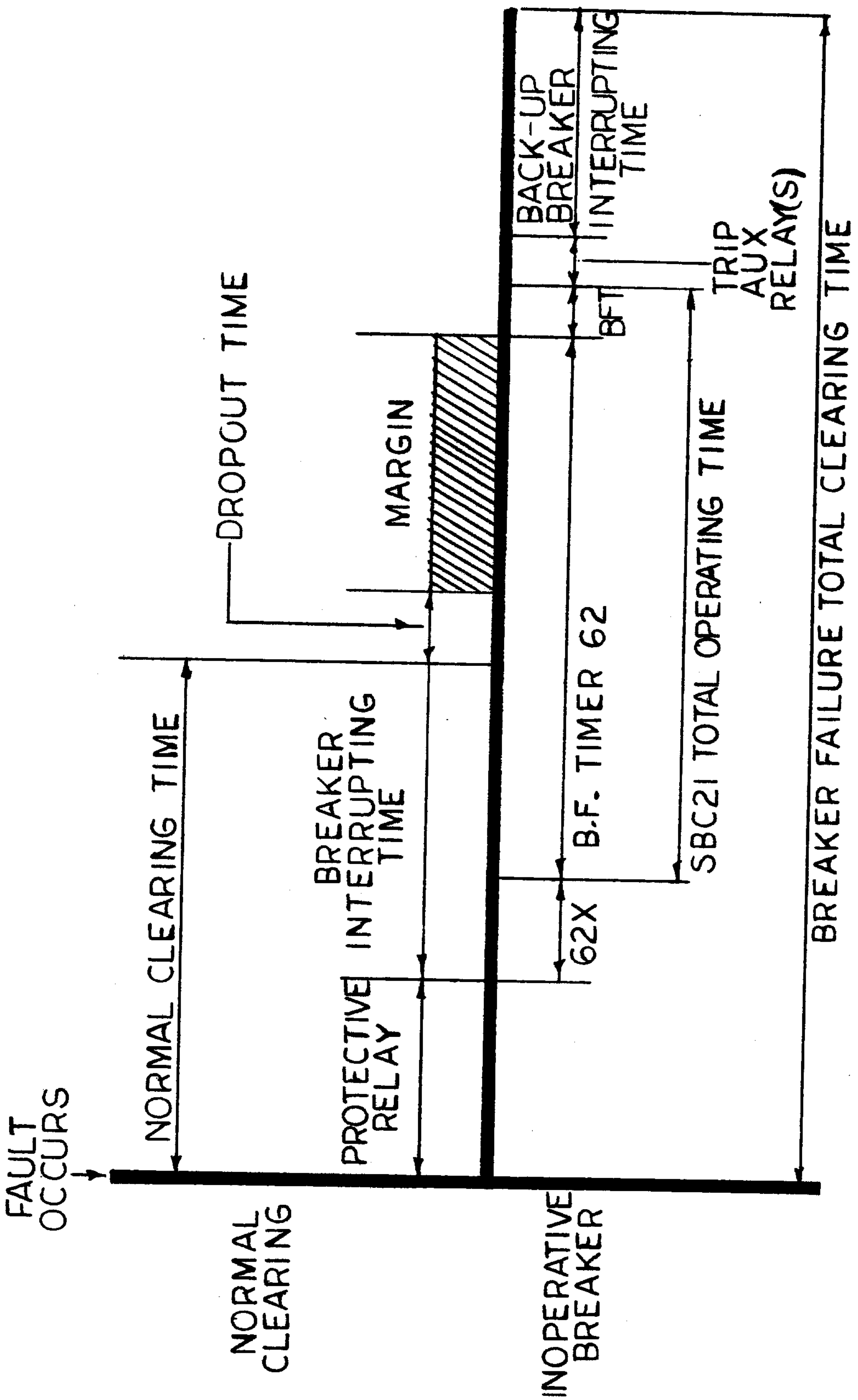


FIG. 14 (0227A7128-1) Breaker Failure Time Chart for the SBC21 Relay

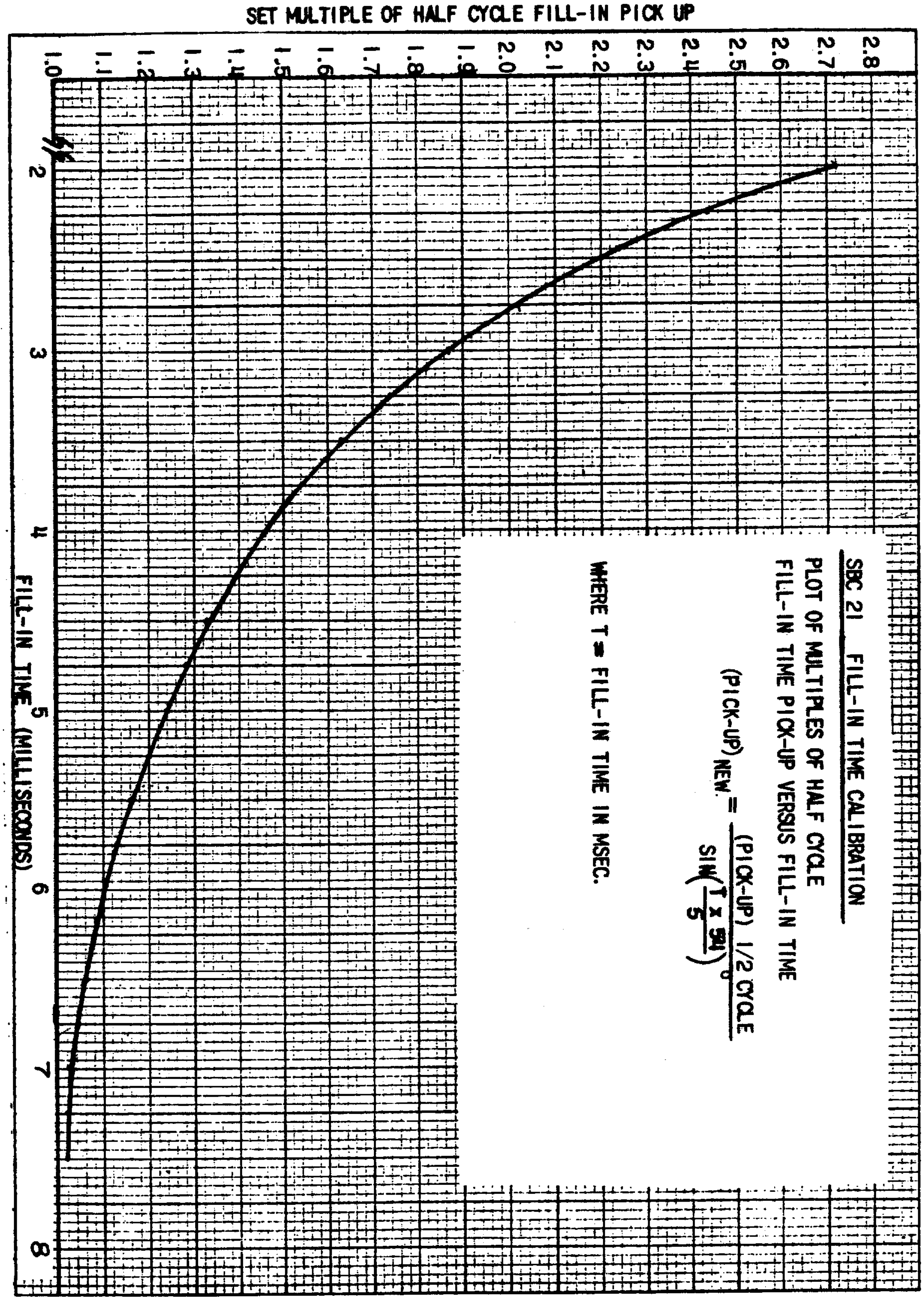


FIG. 15 (0246A2206 Sh. #1) Fill-In Time Calibration Graph for the SBC21 Relay

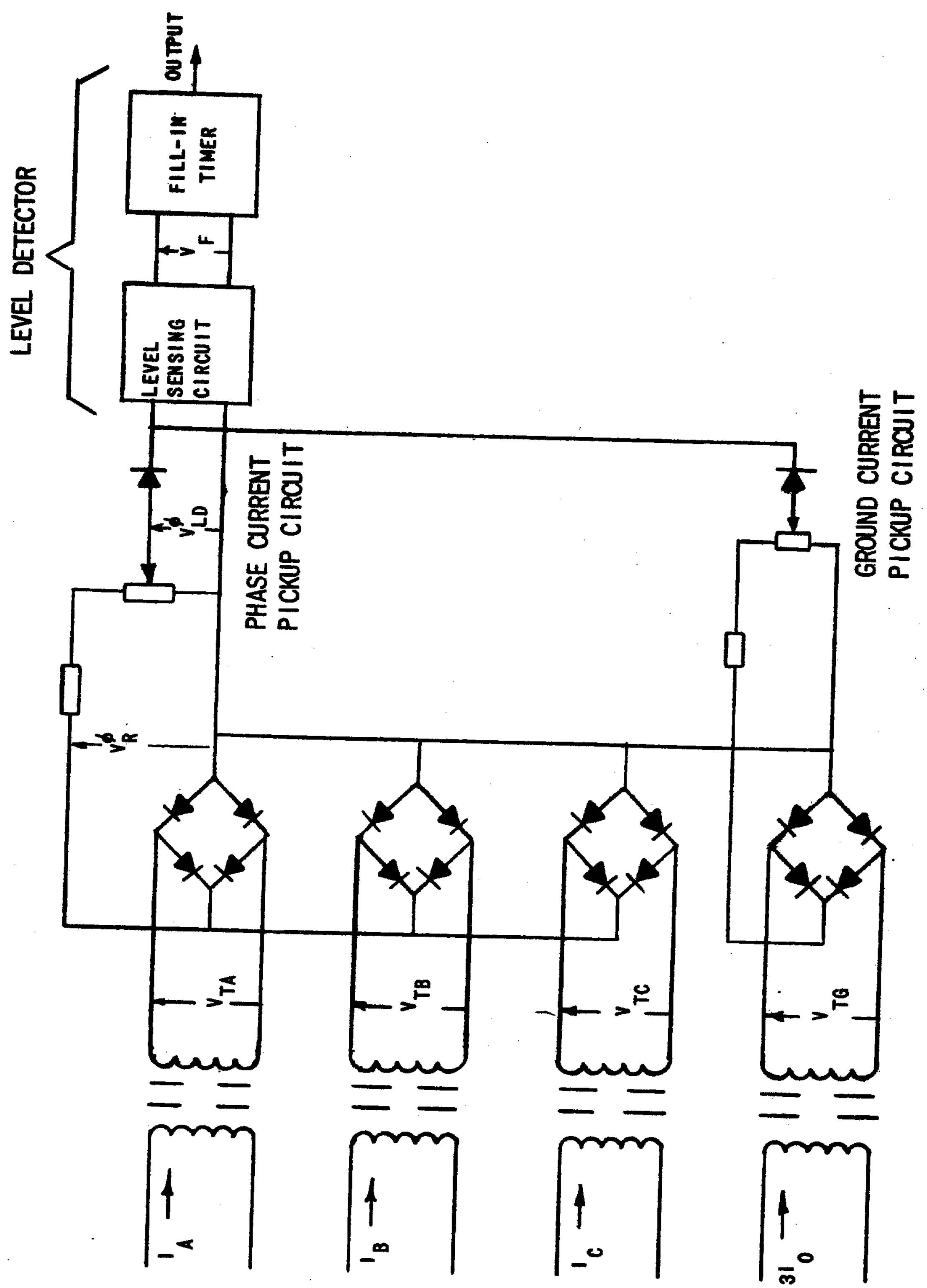


FIG. 16 (0246A2272-0) Current Detector Circuit Illustration for the SBC21 Relay

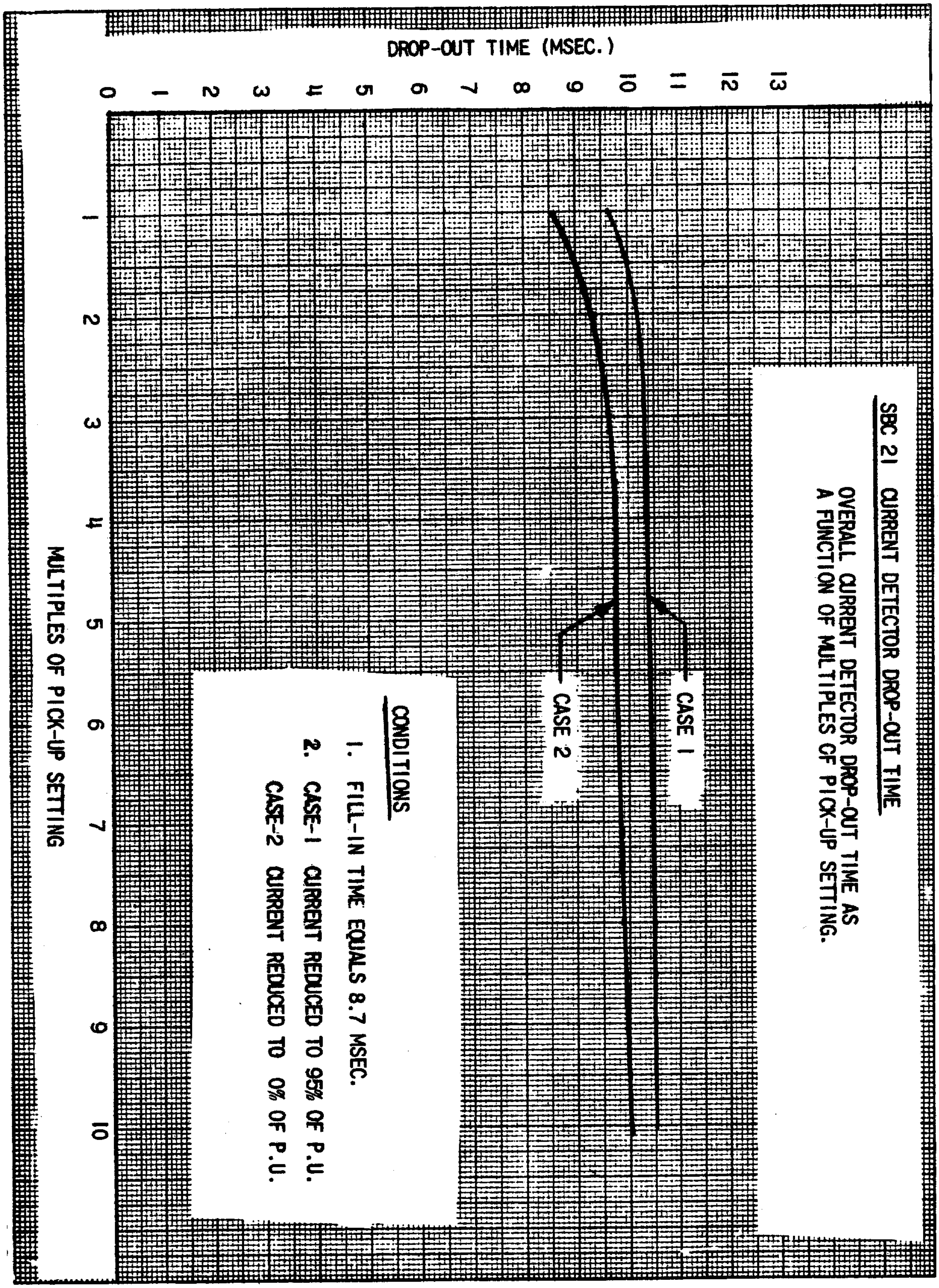
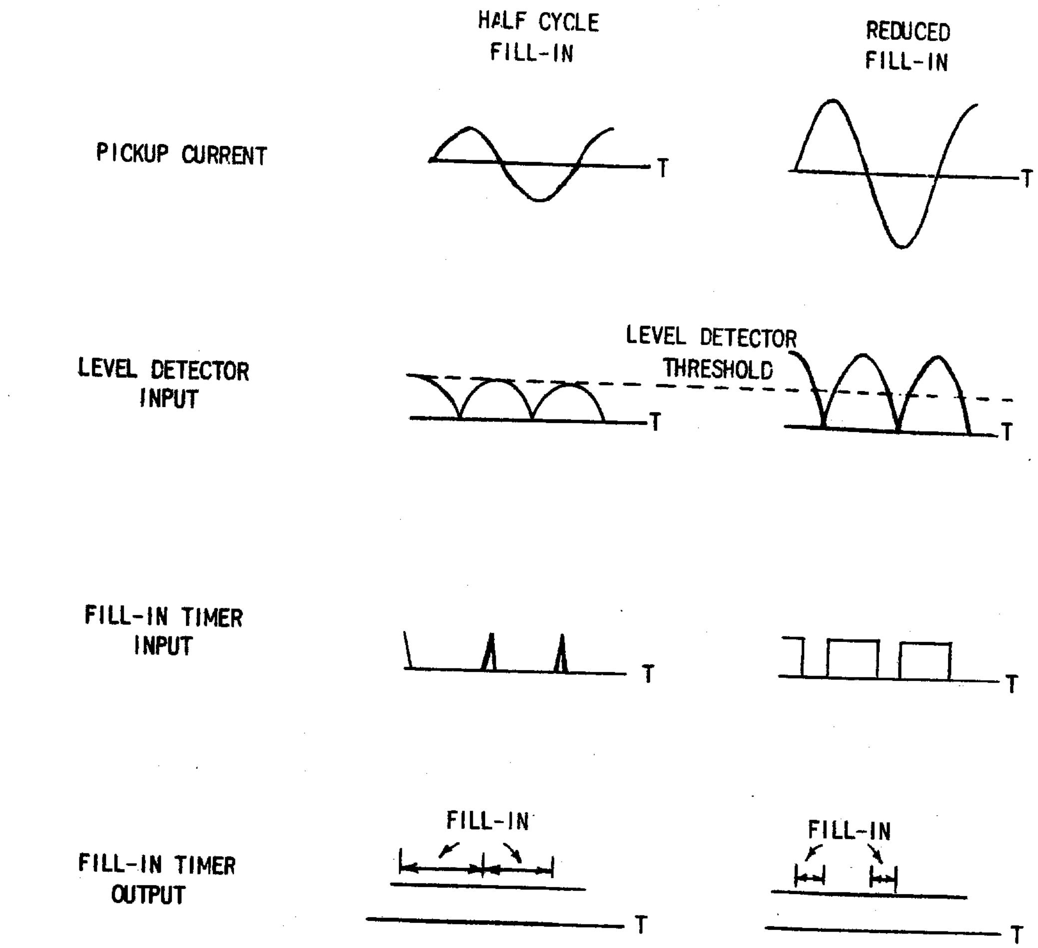


FIG. 17 (0246A2206 Sh. #4) Current Detector Drop-out Time Graph for the SBC21 Relay



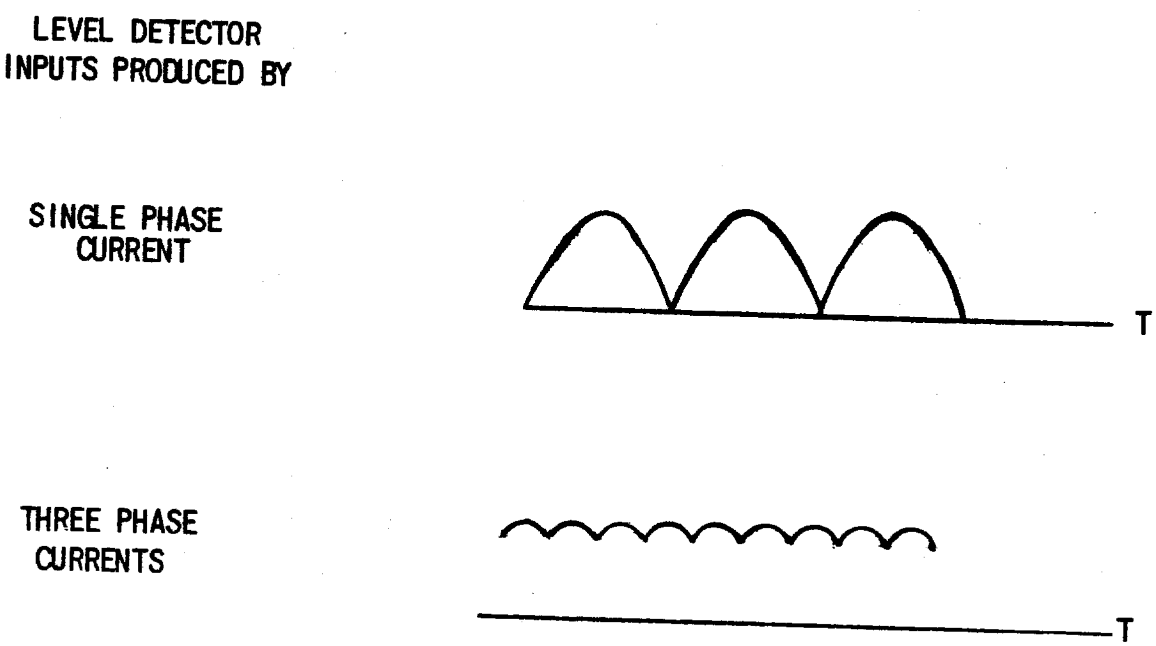


FIG. 18 (0246A2273-0) Current Detector Pickup Current for Reduced Fill-in Times for the SBC21 Relay

FIG. 19 (0246A2274-0) Current Detector Level Detector Inputs Produced by Single Phase and Three Phase Currents for the SBC21 Relay

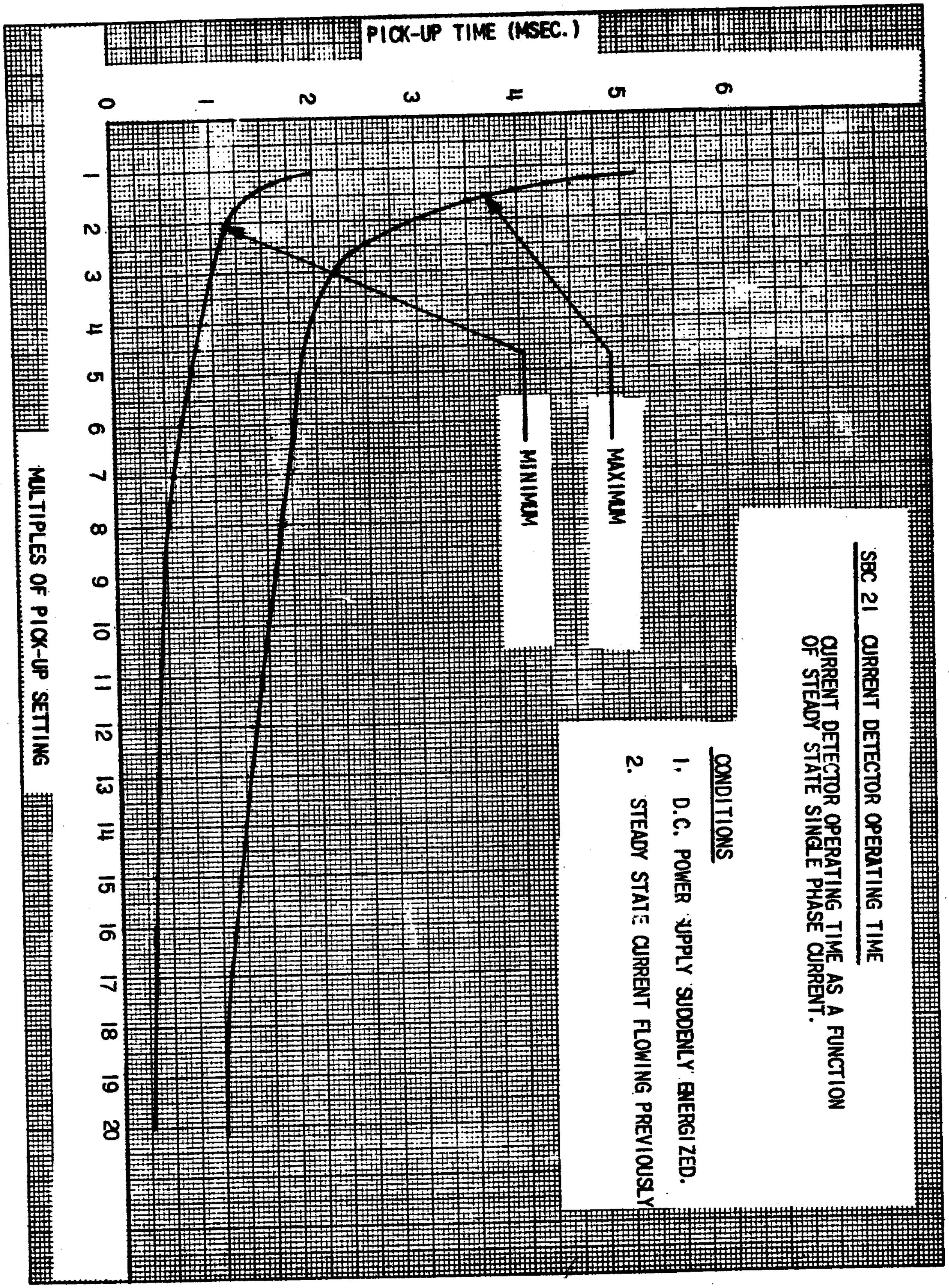
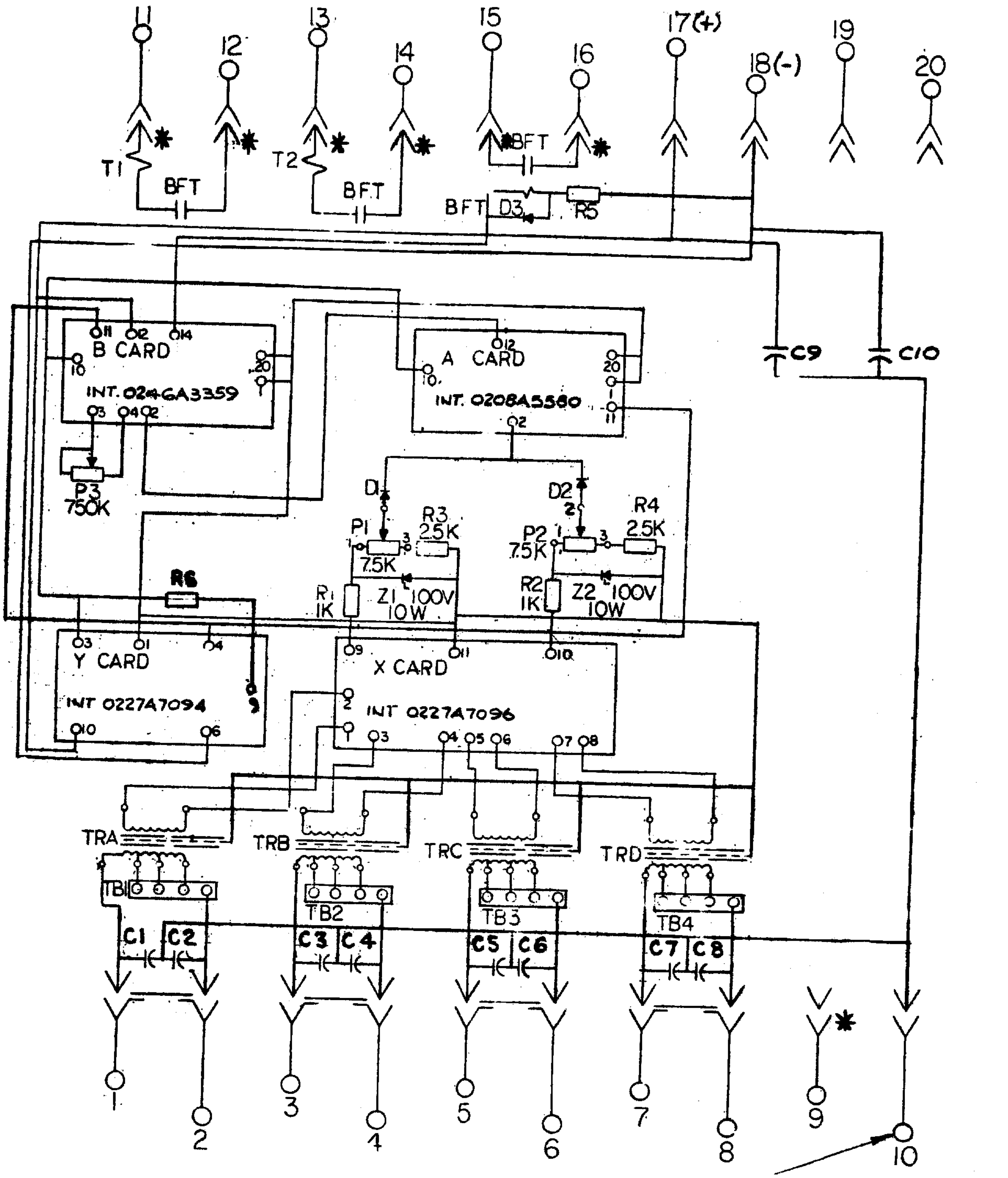


FIG. 20 (0246A2206 Sh. #3) Current Detector Operating Time for the SBC21 Relay



THIS TERMINAL AND RELAY CASE MUST BE CONNECTED TO SURGE GROUND

R5

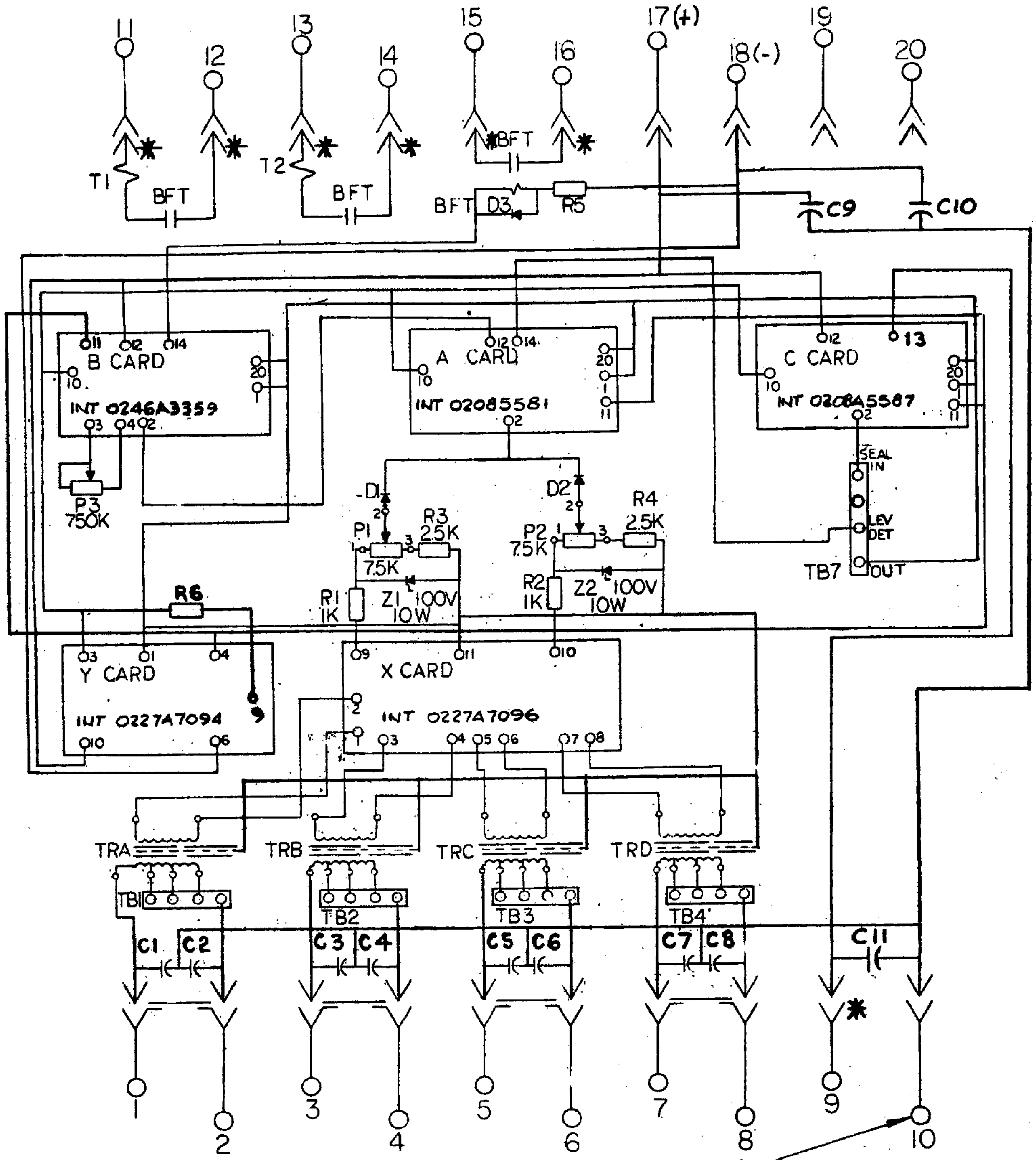
DCV	VALUE
48	500Ω 10W
125	1500Ω 10W
250	3500Ω 10W

T1=LEFT HAND TARGET
T2=RIGHT HAND TARGET
BFT=BREAKER FAILURE TRIP
* = SHORT FINGER
TB=TAP BLOCK
TR=TRANSACTOR

R6

DCV	VALUE
48	250Ω 20W
125	1000Ω 20W
250	2500Ω 33W

FIG. 21 (0227A2578-4) Internal Connection Diagram for the SBC21A Relay



THIS TERMINAL AND RELAY CASE MUST BE CONNECTED TO SURGE GROUND

T1=LEFT HAND TARGET
T2=RIGHT HAND TARGET
BFT=BREAKER FAILURE TRIP
✱ = SHORT FINGER
TB=TAP BLOCK
TR=TRANSACTOR
CCI=CONTACT CONVERTER

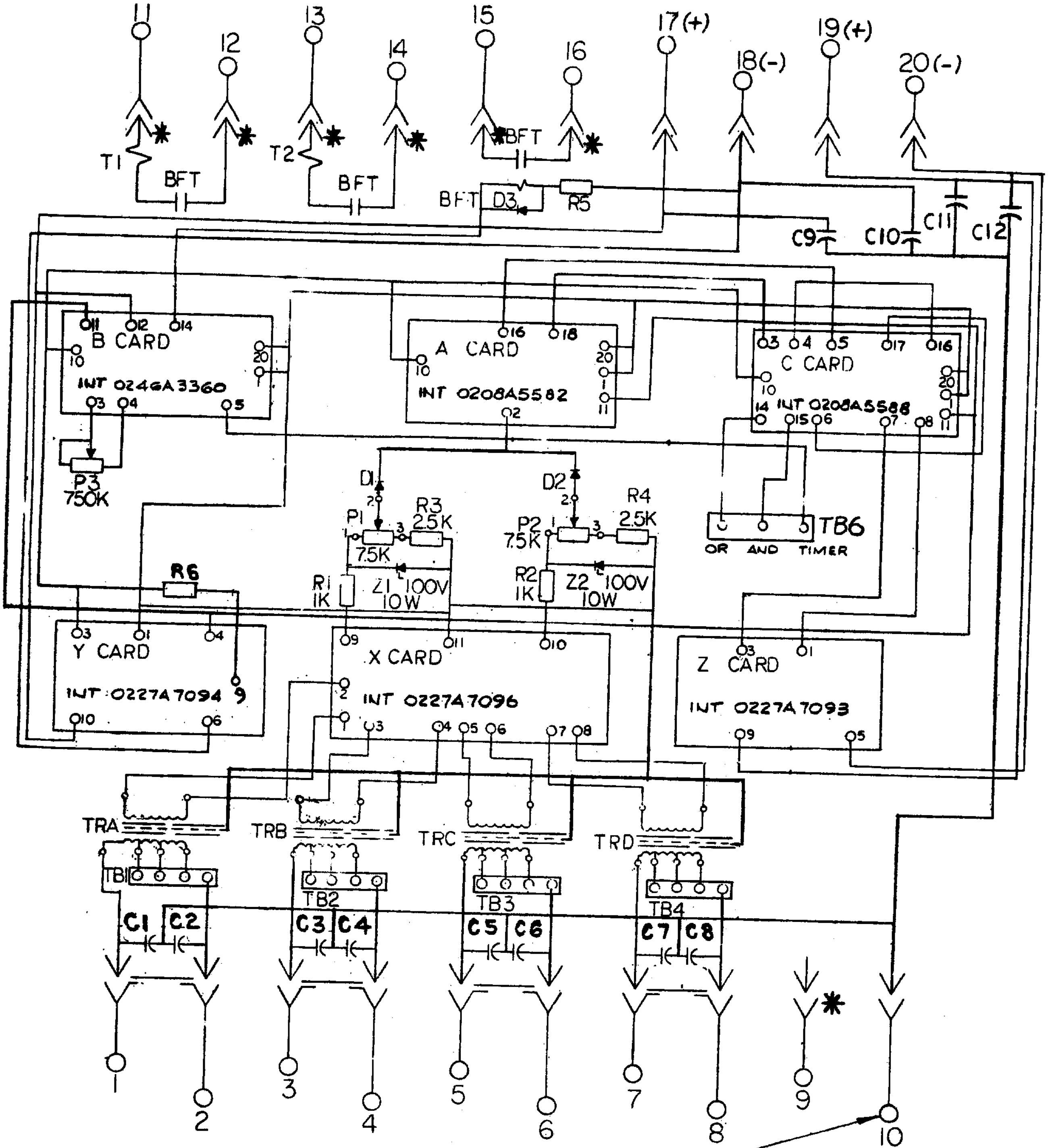
R5

DCV	VALUE
48	500Ω 10W
125	1500Ω 10W
250	3500Ω 10W

R6

DCV	VALUE
48	250Ω 20W
125	1000Ω 20W
250	2500Ω 33W

FIG. 22 (0227A2579-4) Internal Connection Diagram for the SBC21B Relay



THIS TERMINAL AND RELAY CASE MUST BE CONNECTED TO SURGE GROUND.

R5

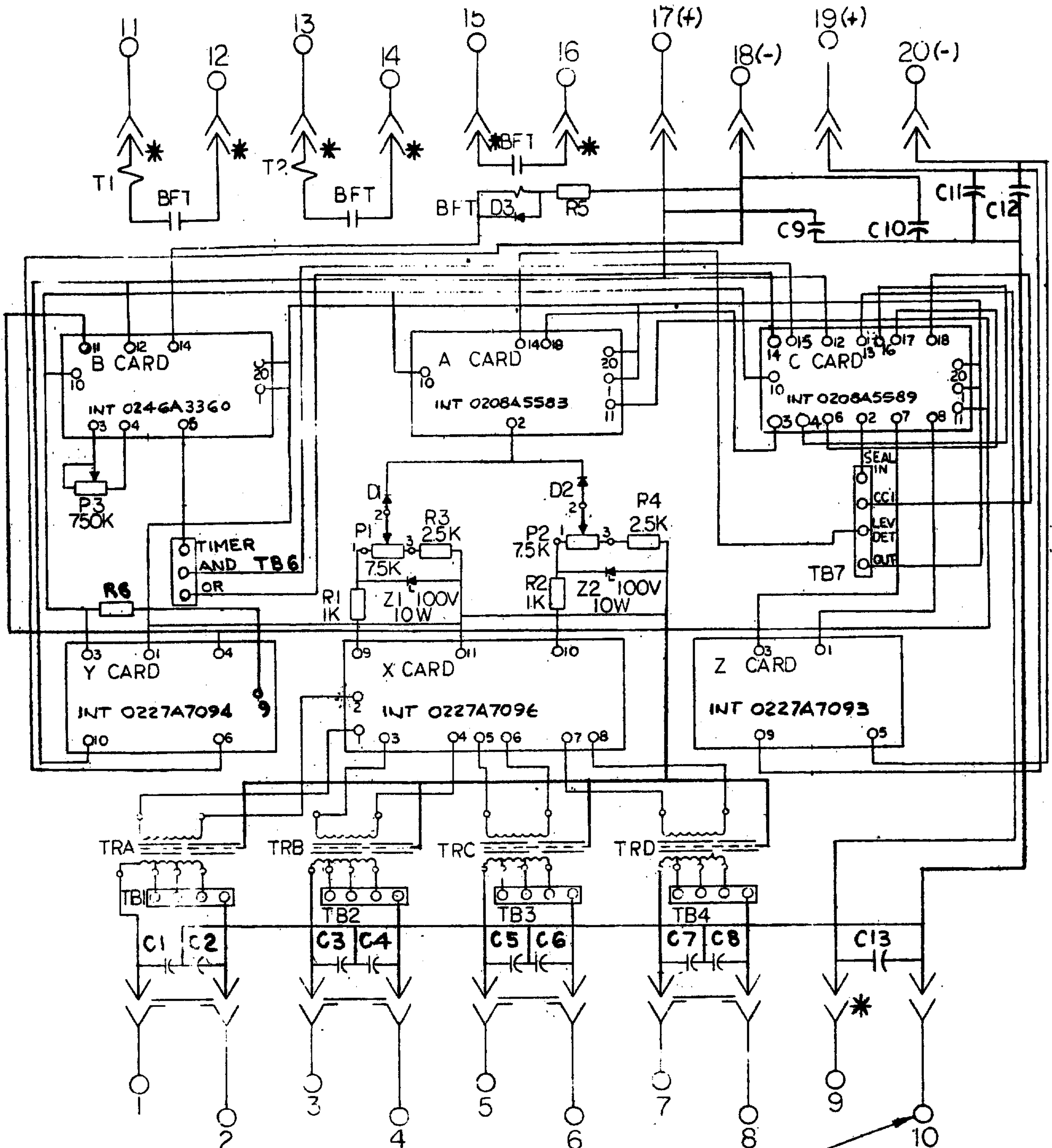
DCV	VALUE
48	500Ω 10W
125	1500Ω 10W
250	3500Ω10W

T1=LEFT HAND TARGET
T2=RIGHT HAND TARGET
BFT=BREAKER FAILURE TRIP
✱ = SHORT FINGER
TB=TAP BLOCK
TR=TRANSACTOR

R6

DCV	VALUE
48	250Ω 20W
125	1000Ω 20W
250	2500Ω 33W

FIG. 23 (0227A2577-4) Internal Connection Diagram for the SBC21C Relay



THIS TERMINAL AND RELAY CASE MUST BE CONNECTED TO SURGE GROUND.

T1=LEFT HAND TARGET
T2=RIGHT HAND TARGET
BFT=BREAKER FAILURE TRIP
✱ = SHORT FINGER
TB=TAP BLOCK
TR=TRANSACTOR
CCI=CONTACT CONVERTER

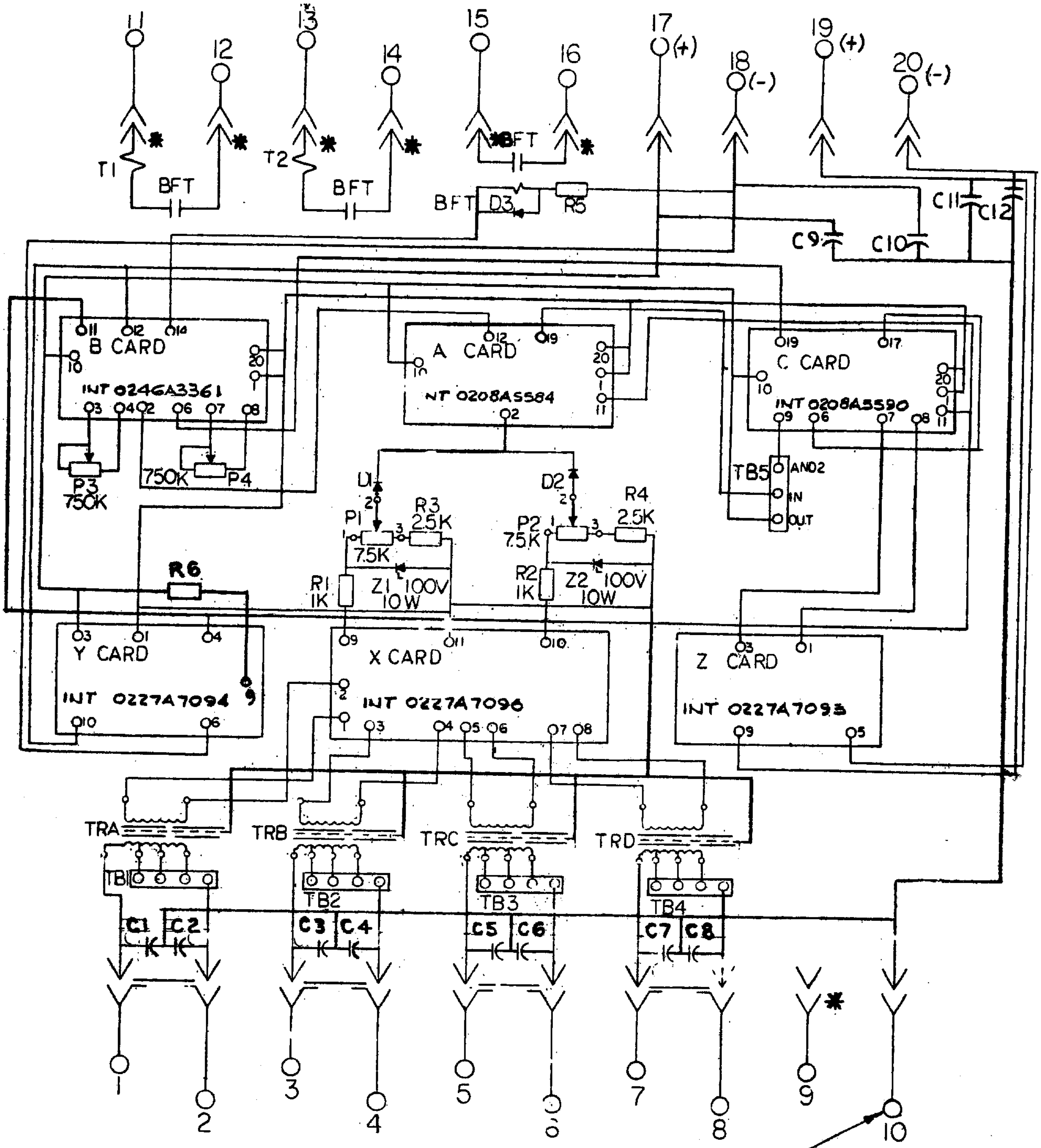
R5

DC.V	VALUE
48	500Ω 10W
125	1500Ω 10W
250	3500Ω10W

R6

DCV	VALUE
48	250Ω 20W
125	1000Ω 20W
250	2500Ω 33W

FIG. 24 (0227A2580-4) Internal Connection Diagram for the SBC21D Relay



THIS TERMINAL AND RELAY CASE MUST BE CONNECTED TO SURGE GRD.

R5

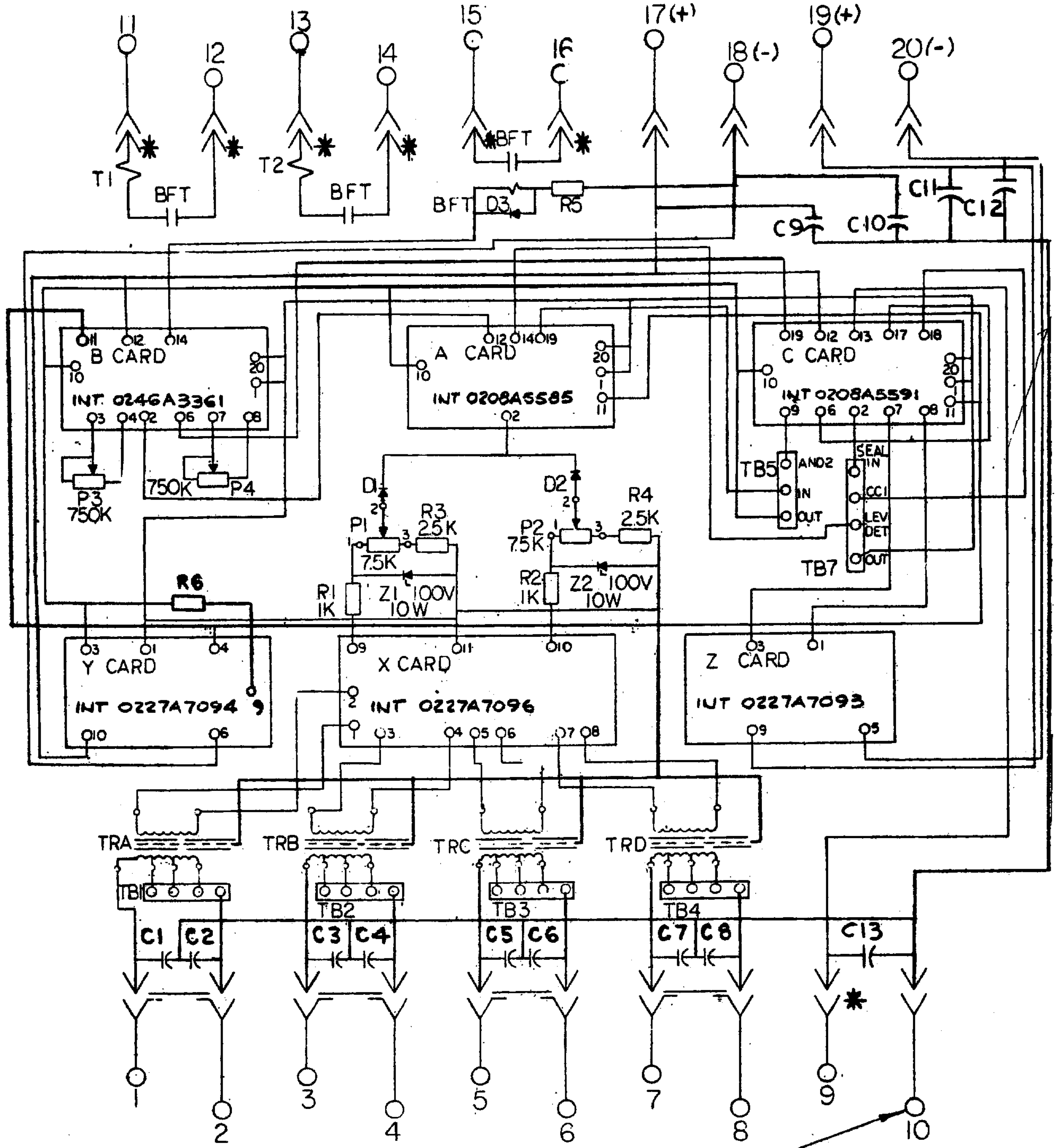
DCV	VALUE
48	500Ω 10W
125	1500Ω 10W
250	3500Ω10W

T1=LEFT HAND TARGET
T2=RIGHT HAND TARGET
BFT=BREAKER FAILURE TRIP
✱ = SHORT FINGER
TB=TAP BLOCK
TR=TRANSACTOR

R6

DCV	VALUE
48	250Ω 20W
125	1000Ω20W
250	2500Ω 33W

FIG. 25 (0227A2576-4) Internal Connection Diagram for the SBC21E Relay



THIS TERMINAL AND RELAY CASE MUST BE CONNECTED TO SURGE GROUND

T1=LEFT HAND TARGET
T2=RIGHT HAND TARGET
BFT=BREAKER FAILURE TRIP
✱ = SHORT FINGER
TB=TAP BLOCK
TR=TRANSACTOR
CC1=CONTACT CONVERTER

R5

DCV	VALUE
48	500Ω 10W
125	1500Ω 10W
250	3500Ω10W

R6

DCV	VALUE
48	250Ω 20W
125	1000Ω 20W
250	2500Ω 20W

FIG. 26 (0227A2581-5) Internal Connection Diagram for the SBC21F Relay

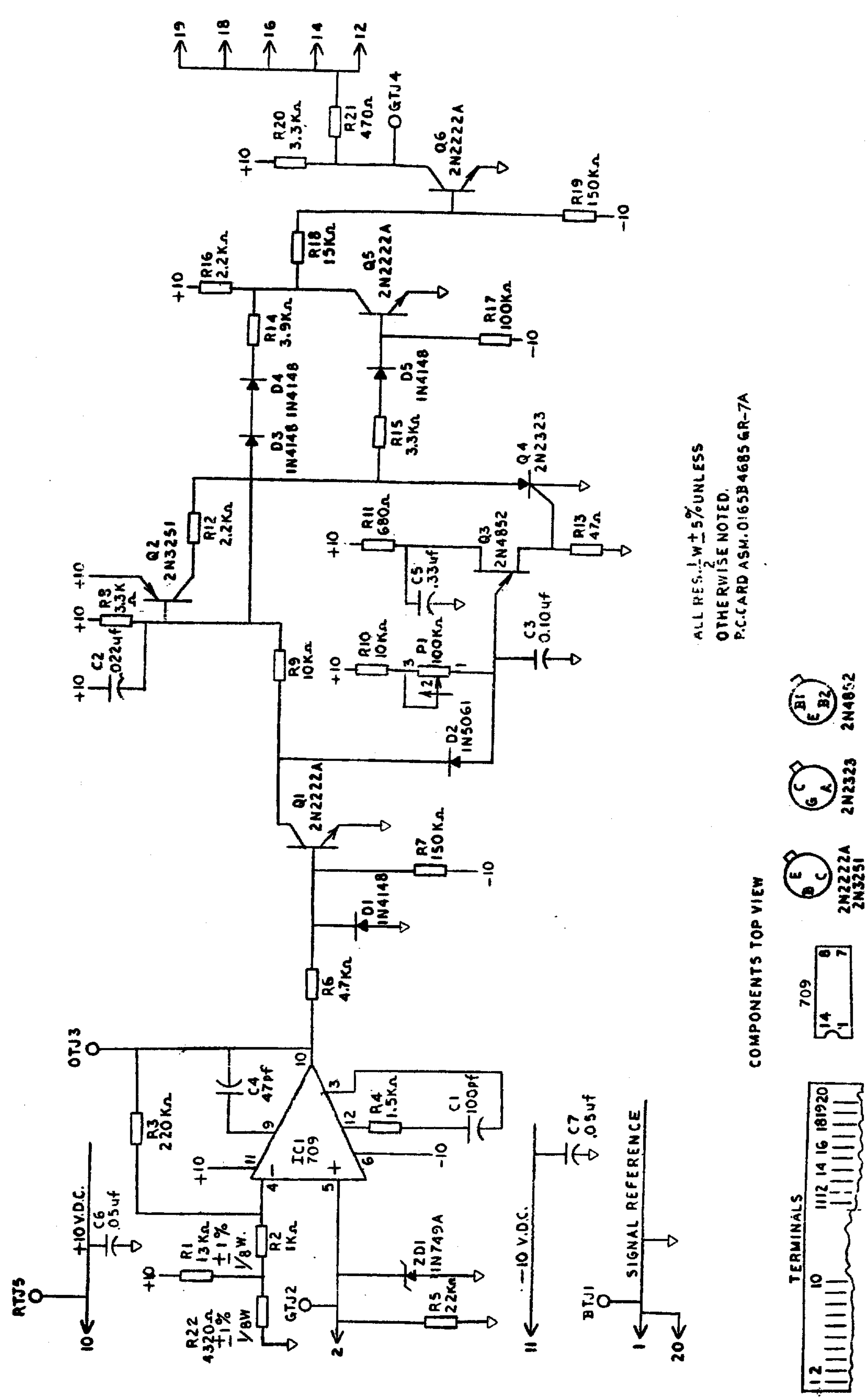


FIG. 27 (0108B8933-1) Level Detector With Adjustable Millisecond Fill-In Time ("A" Card)

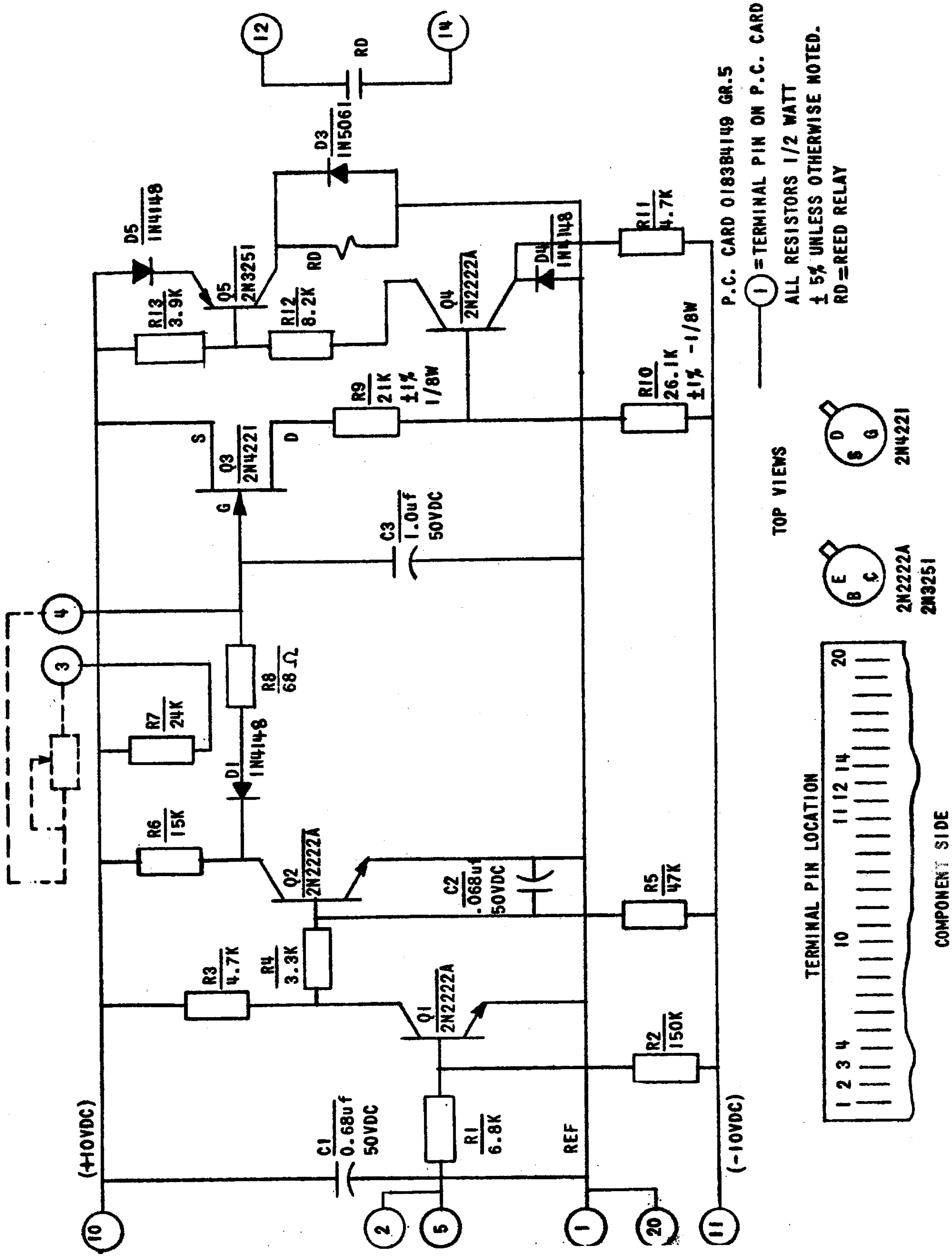


FIG. 28 (0257A8350-1) A/O Timer and Reed Driver For the SBC21 A, B, C and D Relays ("B" Card)

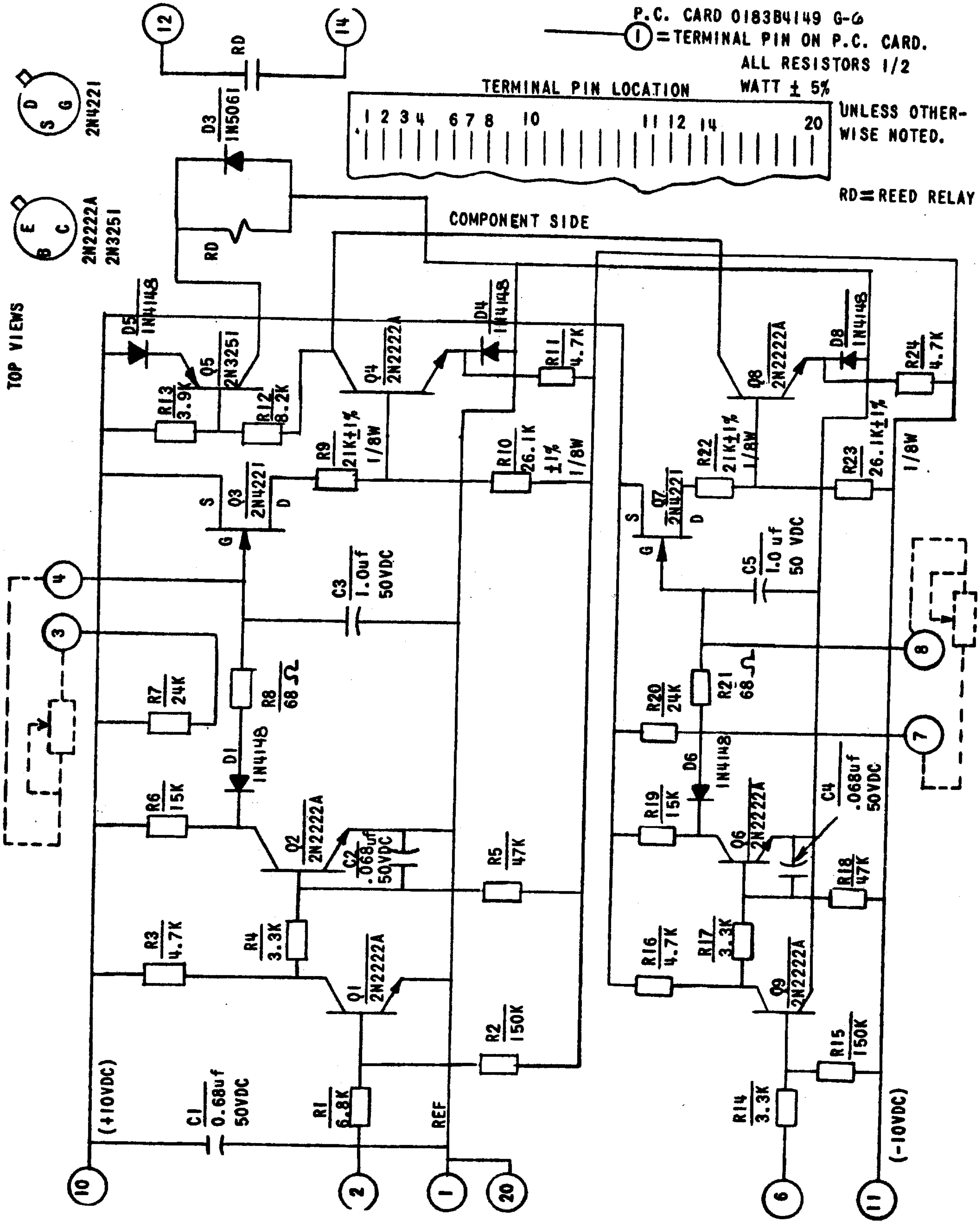


FIG. 29 (0269A3010-0) A/O Timer, B/O Timer, and Reed Driver for the SBC21E and F Relays ("B" Card)

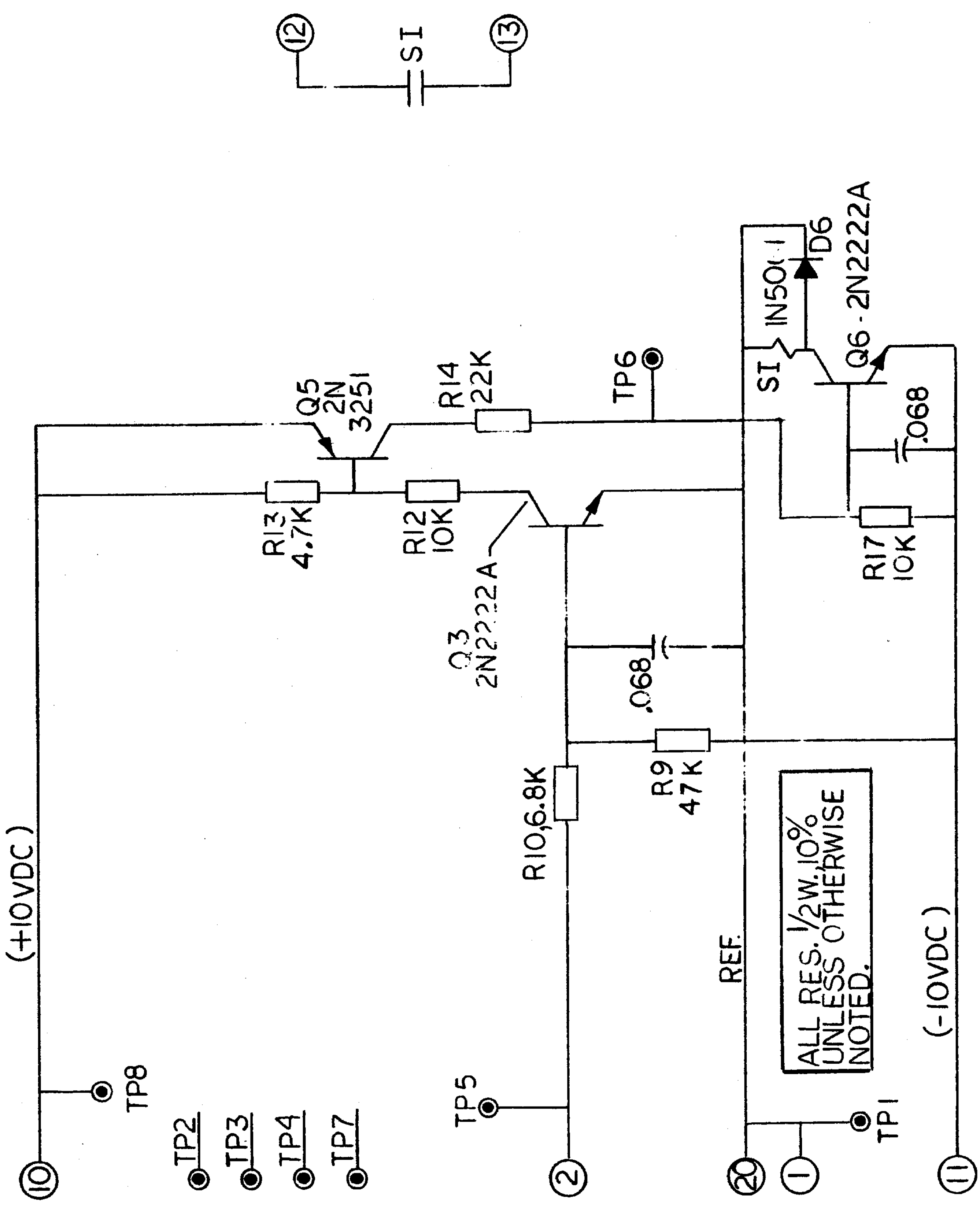


FIG. 30 (0208A5587-0) Seal-in For The SBC21B Relay ("C" Card)

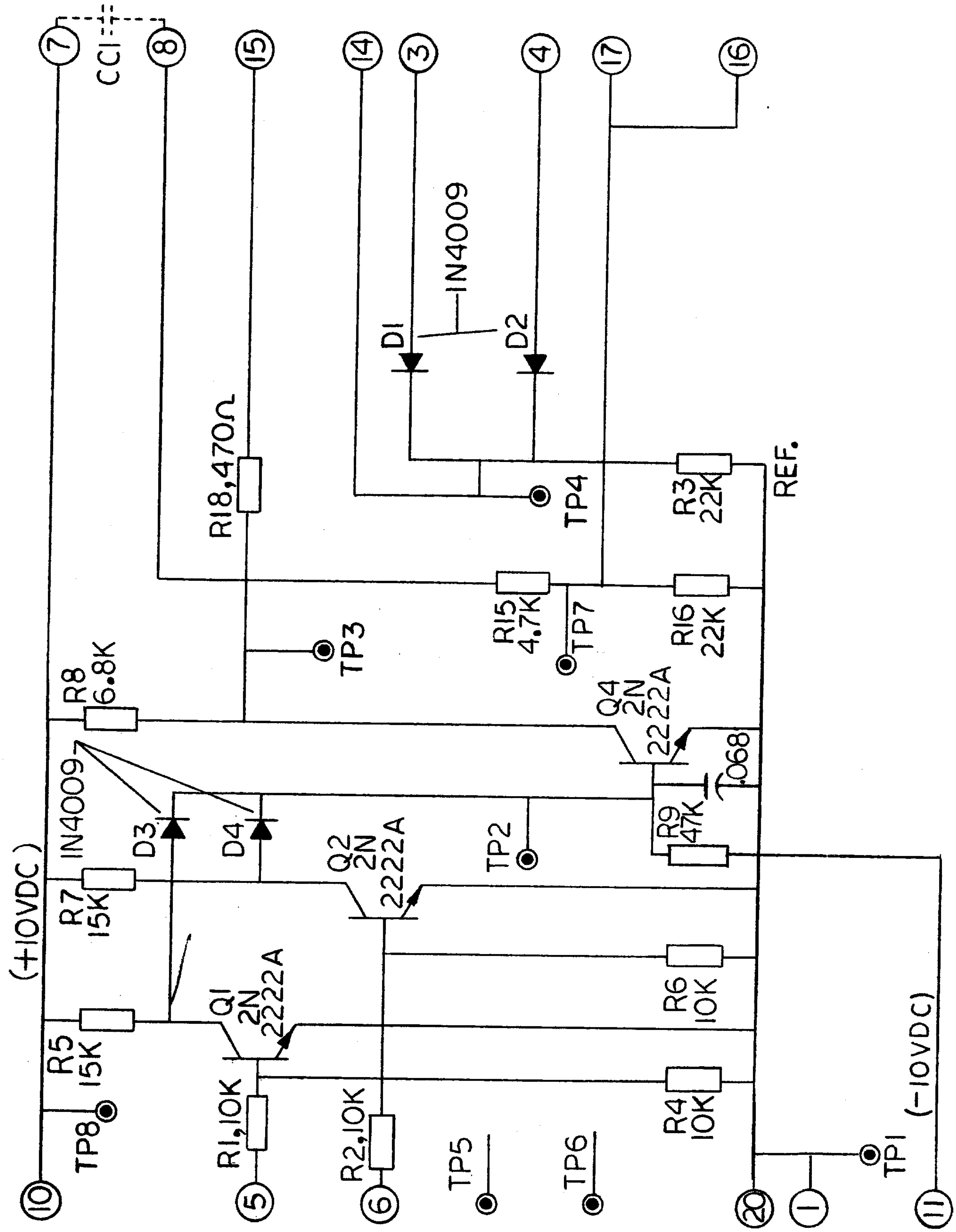


FIG. 31 (0208A5588-3) AND, OR, AND Contact Converter For The SBC21C Relay ("C" Card)

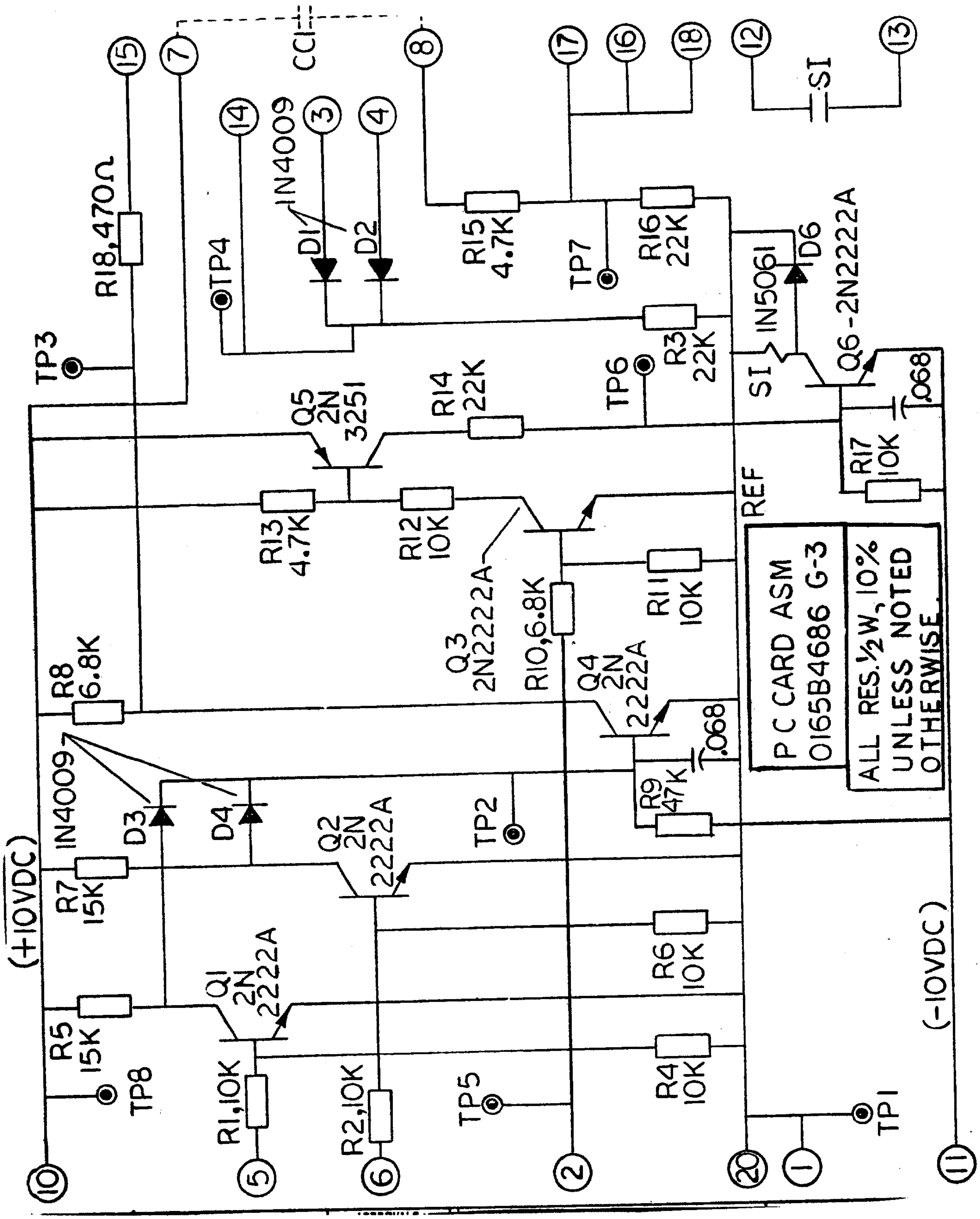


FIG. 32 (0208A5589-3) AND, OR, Contact Converter And Seal-in For The SBC21D Relay ("C" Card)

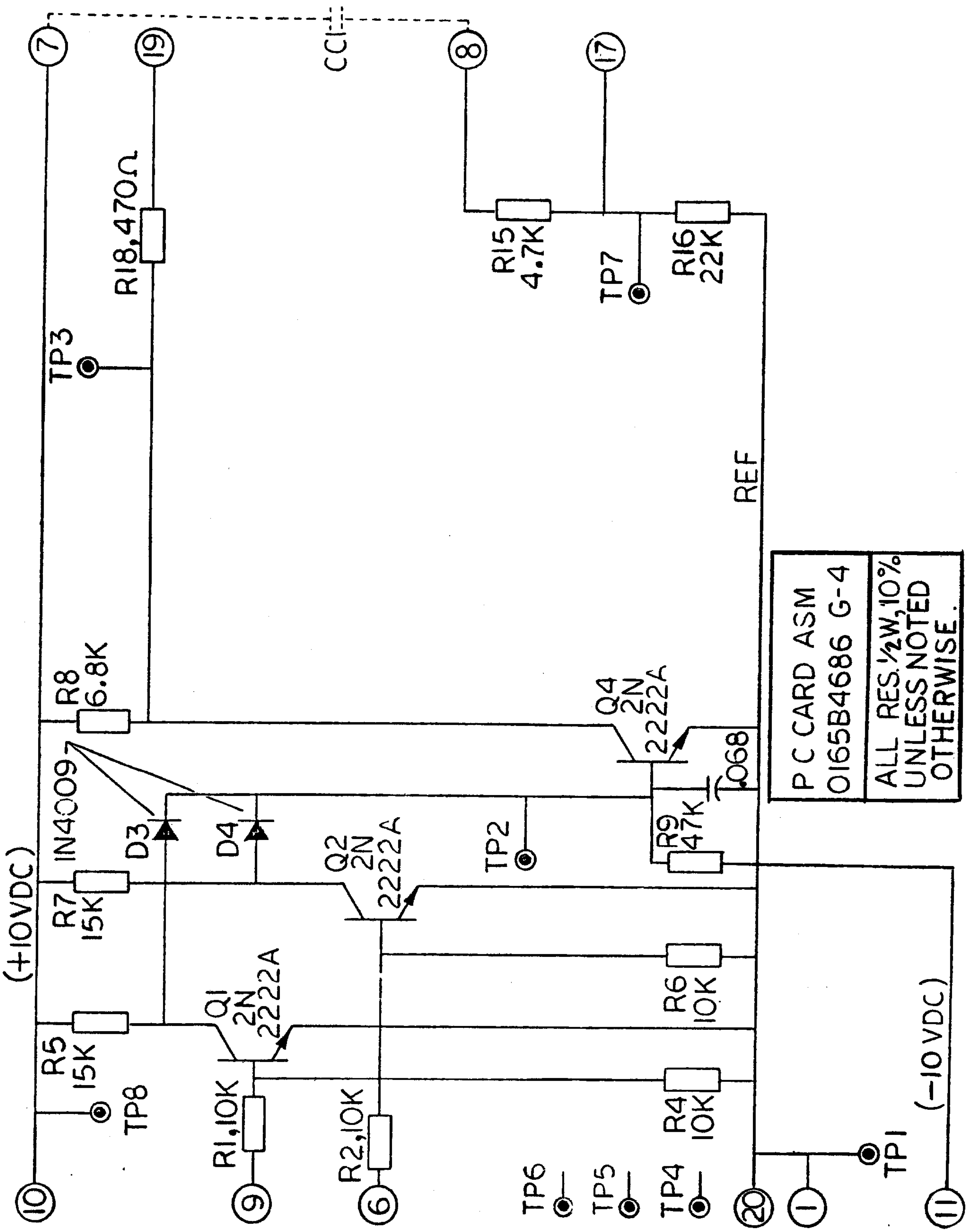


FIG. 33 (0208A5590-3) AND, And Contact Converter For The SBC21E Relay ("C" Card)

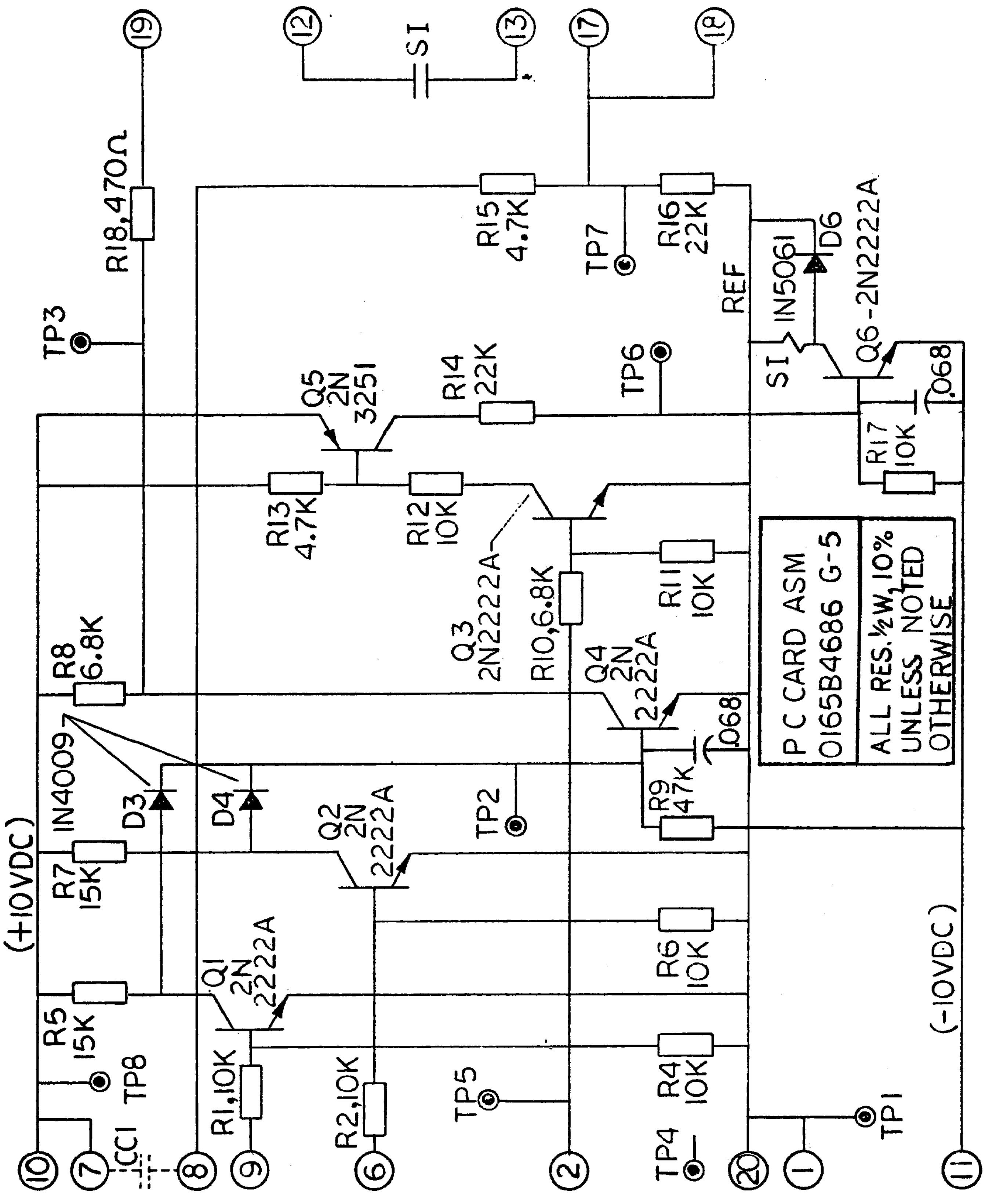


FIG. 34 (0208A5591-3) AND, And Seal-in For The SBC21F Relay ("C" Card)

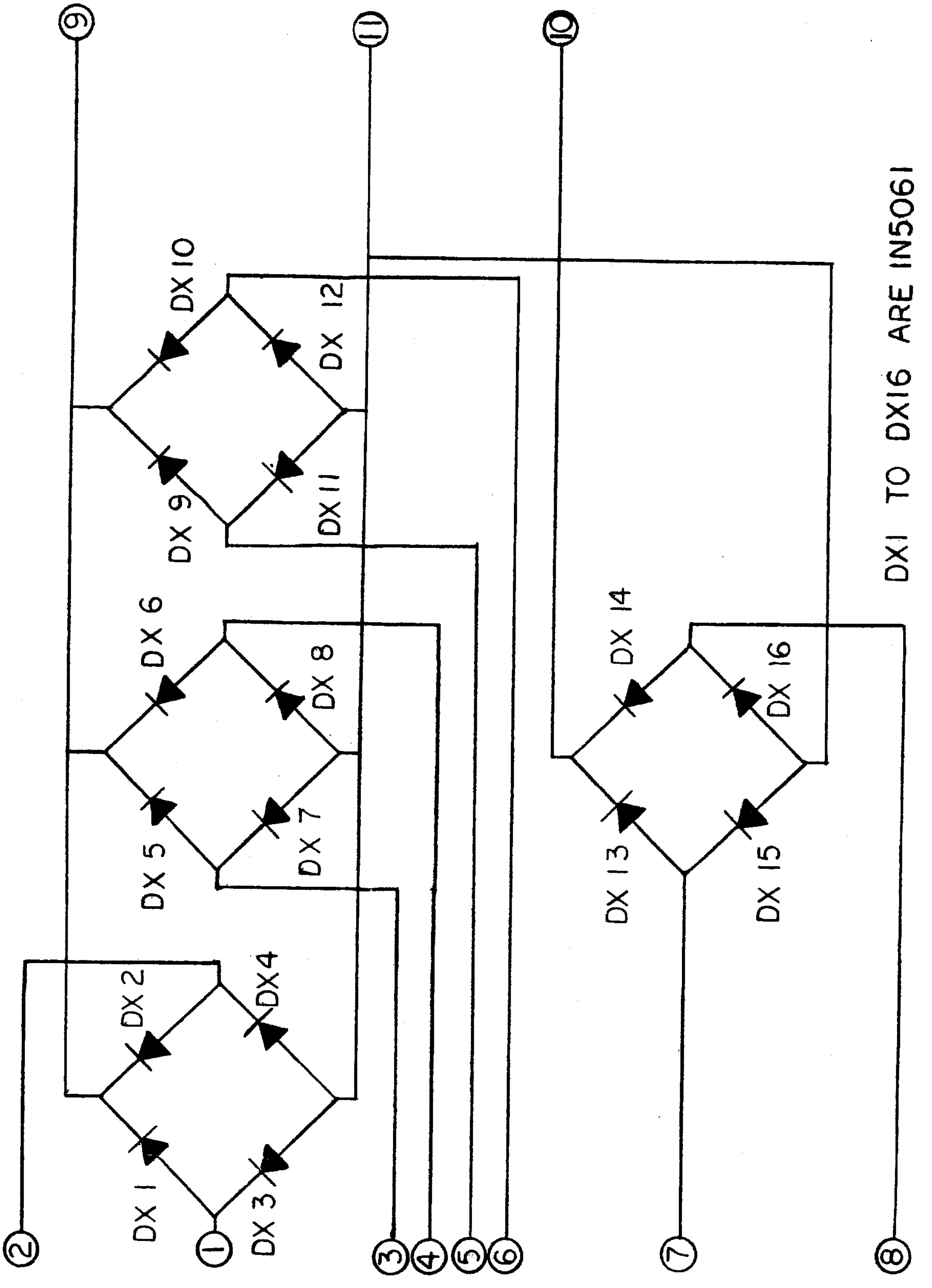


FIG. 35 (0227A7096-0) Full Wave Bridges For The SBC21 Relay ("X" Card)

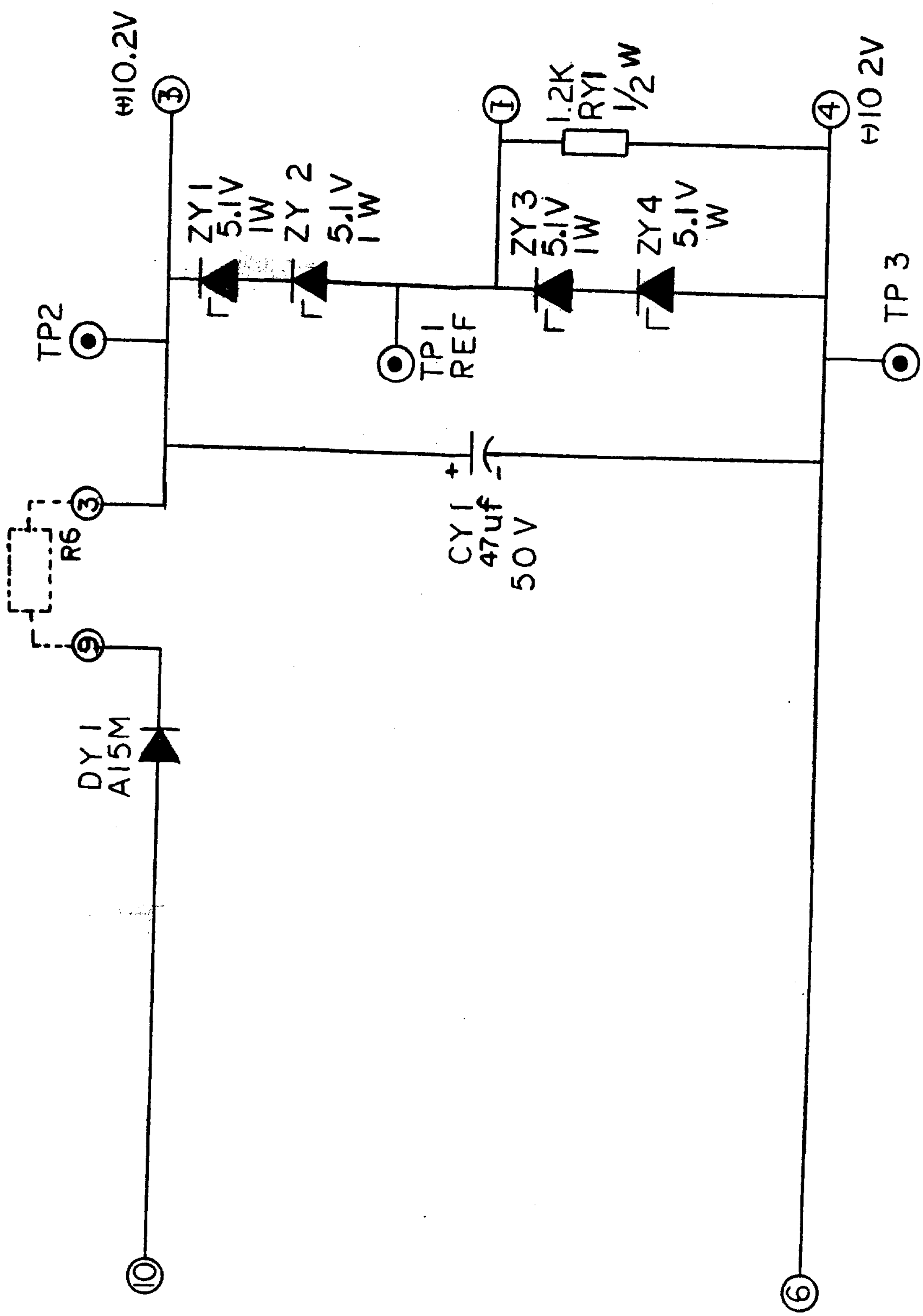


FIG. 36 (0227A7094-6) Power Supply For The SBC21 Relay ("Y" Card)

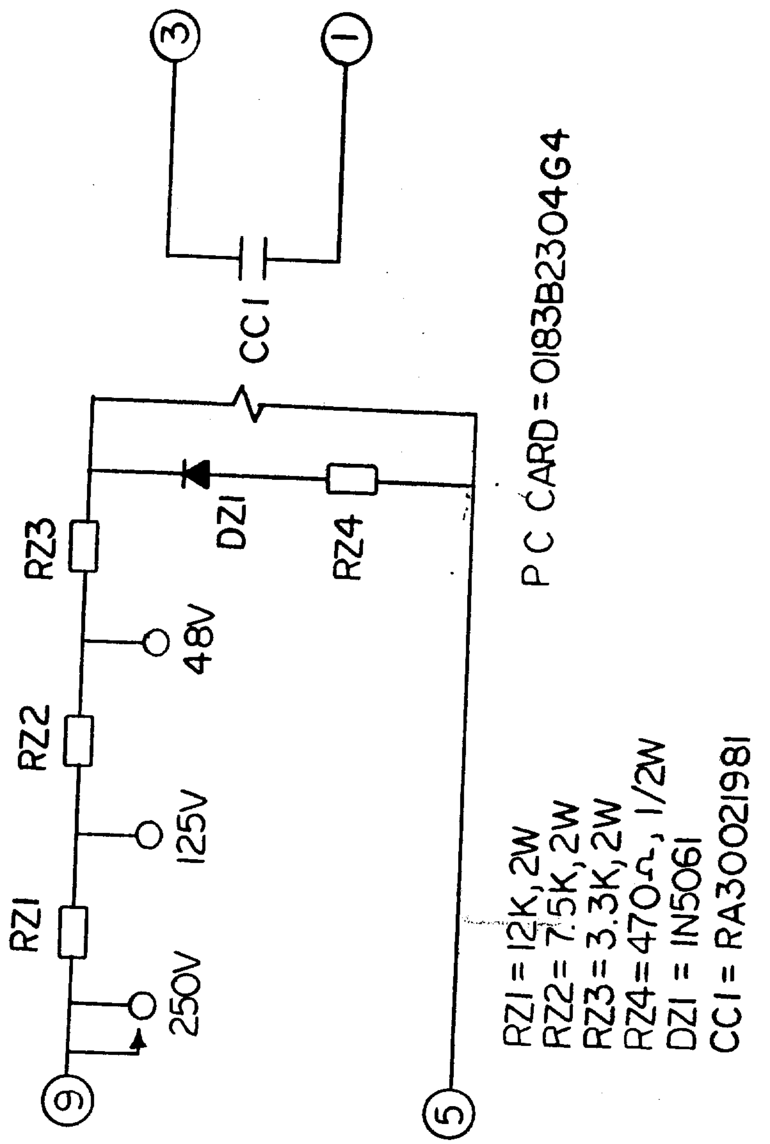
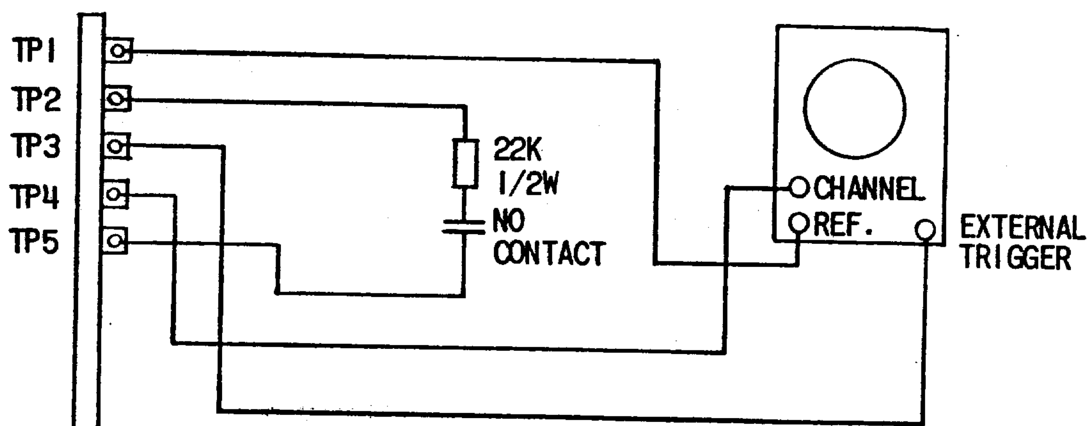


FIG. 37 (0269A3076-0) Contact Converter For The SBC21 Relay ("Z" Card)

INSTRUCTIONS:

1. APPLY RATED DC TO RELAY TERMINALS 17 (+) AND 18 (-).
2. CHECK THAT THE CT CURRENTS INTO THE RELAY CIRCUITS EQUAL ZERO. (PULL LOWER CONNECTION PLUG).
3. SET UP OSCILLOSCOPE AND CONTACT CIRCUITS AS SHOWN BELOW.
4. BE SURE THAT THE OSCILLOSCOPE POWER CHORD IS UNGROUNDED.



"A" CARD

TIMING PROCEDURE

PLACE THE SCOPE IN A NEGATIVE SLOPE EXTERNAL TRIGGERING MODE.

DEPRESS THE N.O. CONTACT AND NOTE THAT UPON RELEASING THE CONTACT THE SCOPE TRACE INITIATES.

FROM FACTORY CALIBRATION, A POSITIVE SIGNAL AT TP4 SHOULD GO NEGATIVE IN 8.5 - 9 MILLISECONDS AFTER TRACE INITIATION

TO ALTER OR READJUST THIS SETTING TURN THE POT. AT THE BOTTOM OF THE "A" CARD CW TO INCREASE FILL-IN TIME OR CCW TO DECREASE THE TIME.

FIG. 38 (0246A2203-0) Fill-In Time Setting Test Circuit For The SBC21 Relay

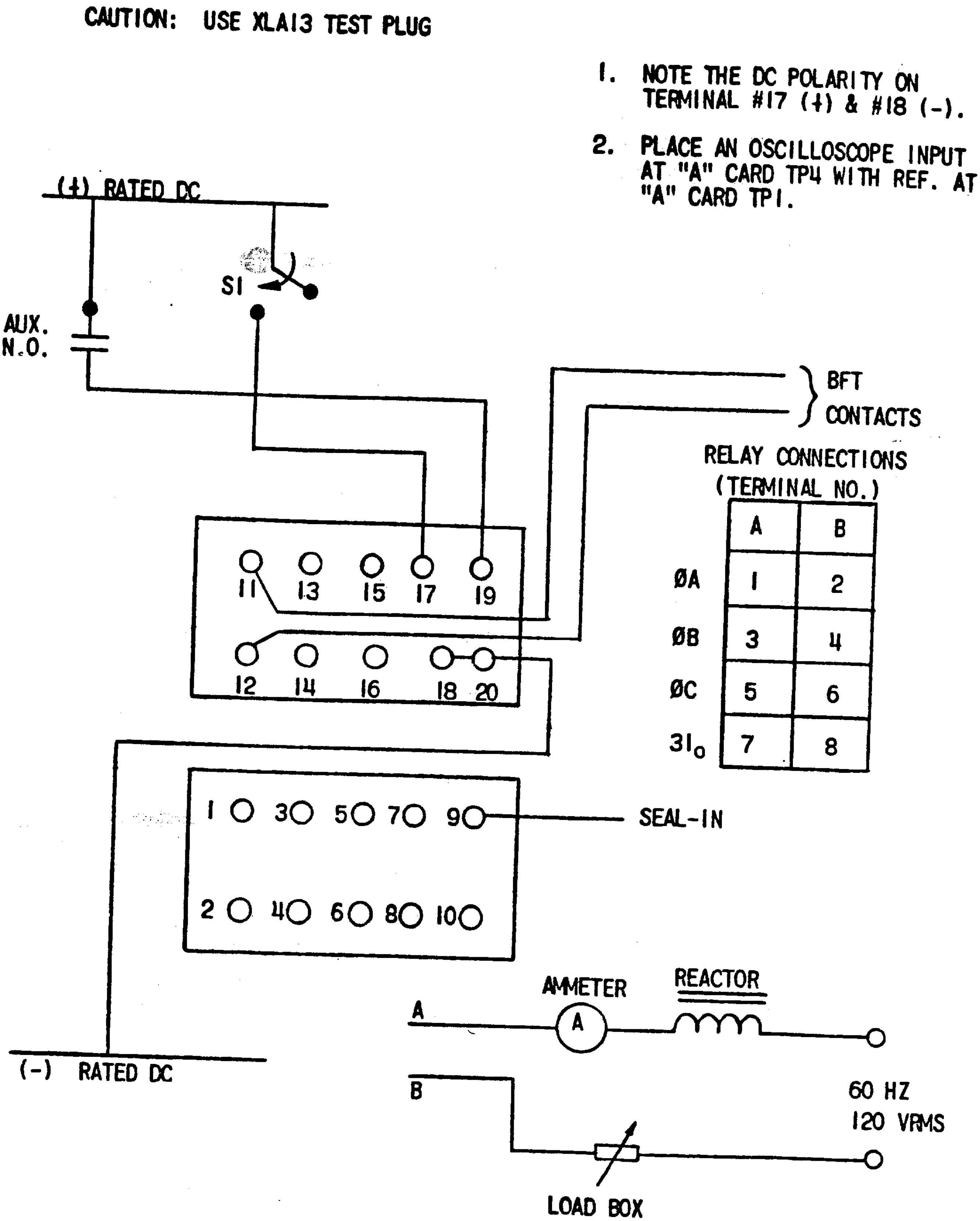


FIG. 39 (0246A2204-0) Current Detector Test Circuit For The SBC21 Relay

CAUTION : SYSTEM CIRCUITS AT CONTACT TERMINALS #11 AND #12 **MUST** BE REMOVED FOR TEST (USE AN XLA13 TEST PLUG)

a. SET AMMETER CURRENT (A) TO 5 TIMES THE PICK-UP CURRENT LEVEL.

b. INITIATE TIMING SEQUENCE BY CLOSING THE BFI CONTACT.

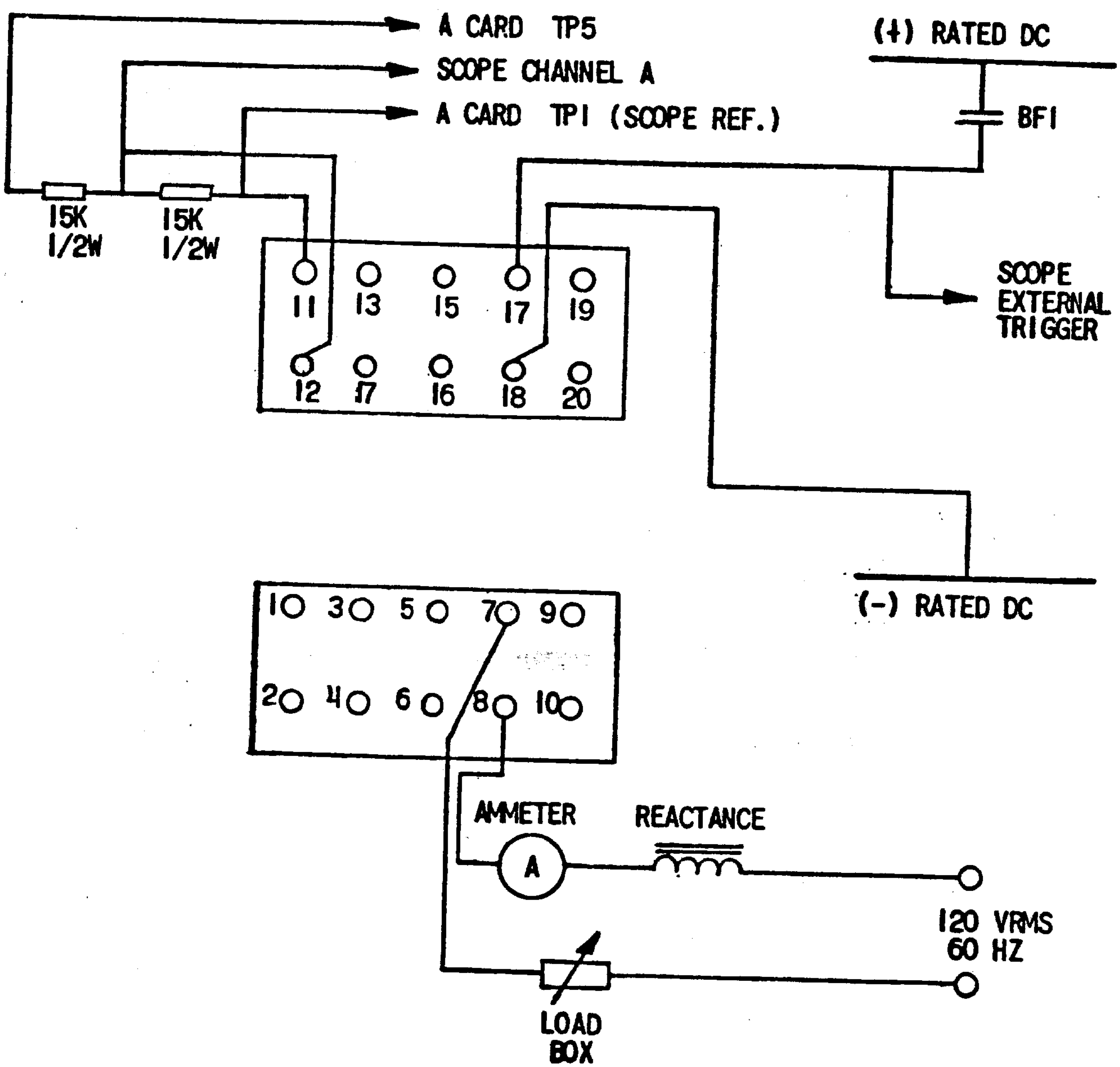


FIG. 40 (0246A2202-0) Overall Timing Test Circuit For The SBC21 Relay

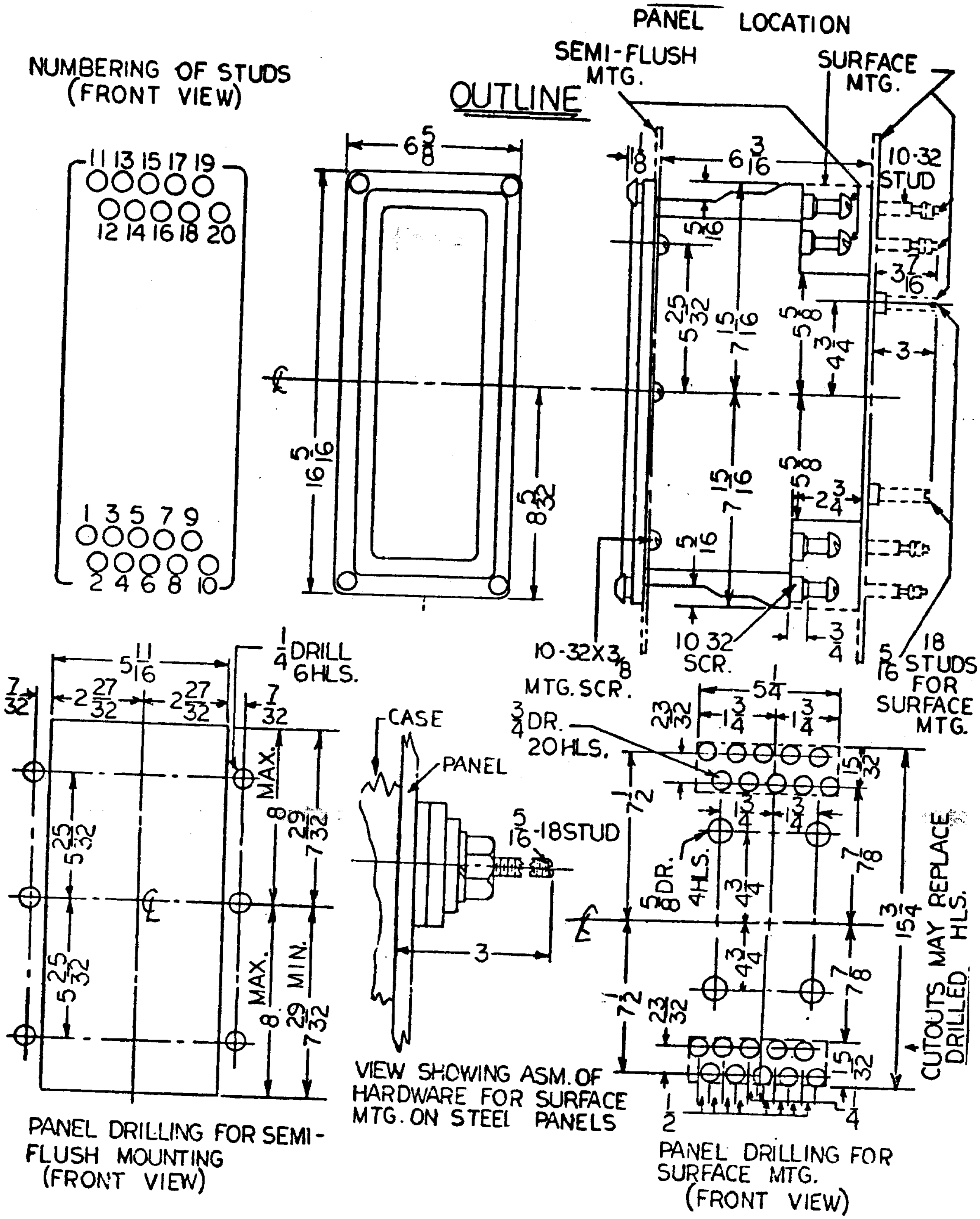


FIG. 41 (0227A2485-0) Outline And Panel Drilling Dimensions For The SBC21 Relay