GEK-45464D

INSTRUCTIONS

STATIC

BREAKER BACKUP

RELAYS

<u>TYPES</u>

SBC23A
SBC23B
SBC23C

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CONTENTS

STATIC BREAKER BACKUP RELAYS

TYPES SBC23A, SBC23B, SBC23C

INTRODUCTION

The type SBC23A, SBC23B, and SBC23C relays are static breaker-failure relays designed to provide system backup protection in the event of a circuit breaker failure. These relays meet 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, and over a wide range of fault-current conditions which may be encountered. One type SBC relay is required for each breaker.

DESCRIPTION

The SBC relays covered by these instructions are packaged in the M2D drawout case, the outline and mounting dimensions for which are shown in Figure 1. The relays include 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 ($3I_0$) currents.

3. An adjustable timer to provide time for the primary breaker to operate correctly.

4. Three electrically-separate contact output circuits (BFT) for tripping the backup breakers. Two of these circuits have electromechanical series targets.

5. An electrically-separate instantaneous (IT unit) contact, operated by the output of the level detector. If seal-in is used on the SBC23B and SBC23C models, the IT contact is **not** isolated.

6. A regulated power supply.

7. Surge suppression on all AC and DC input circuits.

Table I below lists the combined overall logic and external connections diagrams and additional features of each relay:

TABLE I

Relay Model	External Connections and Logic Diagram	Additional Features	
		Second, Non-Isolated Contact on IT Unit	Contact Converter
SBC23A	Figure 2	X	
SBC23B	Figure 3	Optional	X
SBC23C	Figure 4	Optional	X

Note that the SBC23A includes the additional non-isolated contact on the IT unit which is normally connected to provide a seal-in around the initiating contacts (BFI, 62X or 62Y). This seal-in contact is optional in the SBC23B and SBC23C models, and if used, the normally-isolated IT contact is no longer isolated.

Under normal conditions, the SBC relays do not have DC applied. Thus, the SBC is normally immune to any response to environmental electrical transients. DC is applied via BFI or 62X functions only when a fault occurs on a line associated with the breaker being protected.

The power suppy in these relays is so designed that the DC voltage must exceed 60% of the nominal voltage rating in order for the relay to operate. This feature prevents false trips from capacitance discharge or from the voltage-divider effect of the ground-fault lamps on the DC bus in the event that the DC input terminal of the SBC is accidentally grounded.

APPLICATION

The Type SBC 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 SBC relay must come from current transformers (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 SBC 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. They are the single-bus single-breaker, double-bus double-breaker, breaker-and-a-half, and ring bus arrangements, shown in Figures 5, 6, 7 and 8 respectively. Each listing in Table II indicates the assumed fault location, the breaker that is assumed to have failed, the contact initiation that activates the SBC, and which breakers or lock-out relays should be tripped by the BFT contacts. For example, in a single-bus single-breaker arrangement, (Figure 5), if breaker #2 is to be protected, the SBC relay receives the current 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 SBC 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 8. If breaker #1 is to be protected, the SBC relay receives the currents

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.	5	F1	2	2	Line B	Bus Lockout Relay	-	-
Double Bus-Double Bkr.	6	F1 or F2	3	3	Line B or North Bus	North Bus Lockout Relay	Brkr 4	Lock-out relay that transfer trips line B & blocks reclosing of Brkr. 4
Double Bus-Double Bkr.	6	F1 or F3	4	4	Line B or South Bus	South Bus Lockout Relay	Brkr 3	Lock-out relay that transfer trips line B & blocks reclosing of Brkr. 3
Breaker-&-a-Half	7	F1 or F3	4	4	Line A or North Bus	North Bus Lockout Relay	Brkr 5	Lock-out relay that transfer trips Brkr. 10 & blocks reclosing of Brkr. 5
Breaker-&-a-Half	7	F1 or F2	5	5	Line A or Line B	Brkr 4	Brkr 6	Lock-out relay that transfer trips Brkrs.10 & 11 & blocks re-closing of 4 & 6
Breaker-&-a-Half	7	F2 or F4	6	6	Line B or South Bus	South Bus Lockout Relay	Brkr 5	Lock-out relay that transfer trips Brkr. 11 & blocks reclosing of Brkr. 5
Ring Bus	8	F1 or F2	1	1	Line A or Line B	Brkr 2	Brkr 6	Lock-out relay that transfer trips Brkrs. 7 & 8 & blocks re-closing of 2 & 6

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 SBC relay operates and the BFT contact trips 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 SBC relays, probably the most important consideration is the setting of the main timer. Figure 9 illustrates all the times involved, from the instant the fault occurs until the backup 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 must be long enough to permit the primary relaying and primary breaker to operate and clear the fault, with margin. In general, it is a good practice to set the SBC 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 9 that for any given total operating time of the SBC, 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 10.)

The pickup of the current detector should be set for 67% or less of the minimum fault current for which the breaker-failure protection must 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 that applied DC to the relay could result in an undesired trip. This subject is discussed in a later paragraph describing the uses of the isolated contact operated from the output of the level detector.

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 into the circuit when clearing a fault. This resistor current is maintained for a significant time, and may have a substantial magnitude. The value of this resistor current and its duration must be considered when determining the settings of the level detector and main timer in the SBC. If the level detector is set below the resistor current, it will remain picked up until the resistor current is interrupted, and hence the main SBC timer setting must be set proportionately longer. If, on the other hand, the level detector setting is above the resistor current, it will reset when the main breaker contacts open, thereby permitting a shorter time setting on the main SBC timer.

The non-isolated IT_2 contact output of the IT unit in the SBC23A, which connects to stud 9, is intended for use as a seal-in function, as shown on the external connection diagram in Figure 2. 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 could result in resetting of the initiating protective relays before the SBC can time out. This seal-in should be used advisedly, inasmuch 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 static line relay logic diagrams will provide a continuous input.

The electrically-separate (IT_1) contact provides an output as soon as the SBC receives an input from the initiating contacts (BFI, 62X, 62Y) and the level detector operates. This output contact can be used to apply a separate, independent trip signal to the breaker with which the SBC is associated, thereby increasing the overall security of the scheme. Under usual operating conditions of the SBC, the associated breaker would already have received a trip signal from the protective relaying. Thus the separate trip signal provides an alternate chance to trip the breaker correctly, in the event of some failure in the protective relay tripping circuits, thereby avoiding unnecessary tripping of the backup breakers.

Furthermore, this feature increases security during testing, since a mistake in test procedures that results in initiating the SBC operation will cause the tripping of only the one breaker associated with the SBC. This is so because when the associated breaker is tripped by this additional contact output, the current detectors will reset, thus preventing the SBC from timing out.

In the SBC23B and SBC23C relays, the non-isolated IT_2 contact is connected internally to stud 11A, instead of stud 9 as in the SBC23A. If the seal-in function is required, stud 11A must be internally jumpered to stud 11, and stud 11 externally connected to (+)DC. The IT_1 contact between studs 11 and 12 can still be used for instantaneous tripping, with the restriction that stud 11 is connected to (+)DC.

OPERATION - GENERAL

There are four current inputs to the SBC23 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.

When the power supply is activated, the current-level detector will produce an output if the current in the associated breaker is above the level-detector setting. The output of the level detector energizes the A/O timer and the IT unit, if selected by placing the logic tap in "LD" (Level Detector) position. The operating time (A) of the A/O timer, as previously described, would be set long enough to give the primary breaker a chance to trip correctly, but short enough to ensure system stability in the event that the primary breaker should fail to trip.

When timer A/O times out, it energizes transistor switch (TS), which in turn picks up the BFT unit, the contacts of which initiate tripping of the necessary backup breakers. If the primary breaker clears the fault correctly, either the initiating contact (BFI, 62X or 62Y) or the level detector will have reset before the A/O timer times out, and no tripping of the backup breaker will occur.

SBC23A

The IT unit in the SBC23A has two output contacts. One contact has a common point with the power supply and is used as a seal-in function, as previously noted. The other contact is electrically separate, and can be used to provide an instantaneous output from the level detector. This latter contact, as previously described, can be used to apply an additional trip signal to the associated primary breaker.

SBC23B

The SBC23B relay is similar to the SBC23A except that the IT unit has only a single, electrically separate, output contact, and a contact converter (CC1) has been included. The function of the contact converter is to convert a contact operation into a signal that is compatible with the logic circuit of the SBC 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 tap that precedes the A/O timer. If the tap 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 $\overline{CC1}$ 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.

The IT unit can be operated directly from either the level detector or the contact converter, depending on the link setting.

The IT_1 contacts are normally completely isolated. The IT_2 contacts are connected from the (BFI, 62X, 62Y) input terminal to an internal lug (11A). By connecting (11A) to terminal (11) internally, and connecting (11) to +DC externally, a seal-in feature can be obtained. However, IT_1 will no longer by isolated.

SBC23C

The SBC23C relay is similar to the SBC23A except that one more timer (B/O) and a contact converter have been added. The B/O timer is independently adjustable over the same range as the (A/O) timer. With the IN/OUT link in the IN position, the B/O timer requires (1) the BFI contacts must be closed, (2) input current must be above pickup level, and (3) the contact converter CC1 must be energized.

With the IN/OUT relay in the OUT position, the B/O timer only requires (1) the BFI contacts must be closed and (2) the contact Converter CC1 must be energized.

The output BFT relay will be operated by either the (A/O) or the (B/O) timer, depending on the time settings of the respective timers and whether the (B/O) timer is energized by the contact converter (CC1).

The IT unit has an isolated normally-open contact (IT_1) and another non-isolated normally-open contact (IT_2) connected from the input (BFI 62X, 62Y) terminal to an internal lug (11A). By internally connecting (11A) to terminal (11) and externally connecting terminal (11) to +DC, a seal-in feature can be obtained. However, IT_1 will no longer be isolated.

RANGES

PHASE CURRENTS

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

Tap Ranges: 1A - 2A
2A - 4A See Figures 11, 12 and 13 for tap selections
4A - 10A

GROUND CURRENT

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

Tap Ranges: 0.5A - 1.0A
1.0A - 2.0A See Figures 11, 12 and 13 for tap selection
2.0A - 5.0A

TIMERS

A/O and B/O timers 50-500 milliseconds. See Figures 14, 15 and 16 for rheostat location.

RATINGS

The SBC current circuits are rated at 10 amps continuously, and have 1 second thermal ratings of 210 amps.

CAUTION

When hipotting the SBC, remove all external wiring from terminal 10. Do not hipot terminal 10. The reason is that capacitors C1-C12 are rated for 600 VDC 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

RATING	CONTINUOUS CURRENT AMPS	TRIP DUTY AMPS	INTERRUPTION CURRENT (AMPS) INDUCTIVE**	NON-INDUCTIVE
125 VDC	3	30	0.50	1.5
250 VDC	3	30	0.25	1.0
115V 60 Hz	3	30	0.75	2.0
230V 60 Hz	3	30	0.50	1.5

** The inductive rating is based on the inductance of an average trip coil.

Table IV lists the ratings of the electromechanical targets (T_1 and T2) on both the 0.2 and 2.0 amp taps that are available.

TABLE IV

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 SBC relay will withstand the test voltage waveform described below 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 MHz. The source has an internal impedance of 150 ohms. 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 often have capacitors placed in parallel with the contacts. The purpose of these capacitors is to protect the static relays from surges that 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 SBC relay, however, is designed such that the seal-in circuit, and thus the SBC output contacts, will not operate if two fully-discharged capacitors of equal value are charged into 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 point 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 instantaneous trip unit of the SBC 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 in Table V.

TABLE V

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

BURDENS

The AC burden for each of the current transformer circuits is tabulated in Table VI for 5 amperes of 50 and 60 Hz current through each basic current setting range, minimum and maximum respectively.

TABLE VI
BURDENS FOR 5 AMP 50 Hz RELAYS

TRANSACTOR	TAP SETTING (AMPS)	IMPEDANCE (OHMS)	POWER FACTOR (DEG. LAG)
Phase	1 - 2	0.0123	28.5
Phase	2 - 4	0.0052	16.5
Phase	4 -10	0.0024	8.9
Residual	0.5- 1	0.0347	43.0
Residual	1 - 2	0.0123	28.5
Residual	2 - 5	0.0052	16.5

BURDENS FOR 5 AMP 60 Hz RELAYS

TRANSACTOR	TAP SETTING (AMPS)	IMPEDANCE (OHMS)	POWER FACTOR (DEG. LAG)
Phase	1 - 2	0.0127	24.0
Phase	2 - 4	0.0053	14.0
Phase	4 -10	0.0024	7.7
Residual	0.5- 1	0.0351	36.0
Residual	1 - 2	0.0127	24.0
Residual	2 - 5	0.0053	14.0

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

TABLE VII

RATED DC	CONDITION	NOMINAL MILLIAMPERE DC DRAIN
125	Dropped out (No Fault)	No Drain
	Timing: Electronics	131
	IT Unit	63
	Tripping: BFT Unit	63
	Total. All Circuits	257
48	Dropped out (No Fault)	No Drain
	Timing: Electronics	138
	IT Unit	48
	Tripping: BFT Unit	48
	Total. All Circuits	234
250	Dropped out (No Fault)	No Drain
	Timing: Electronics	115
	IT Unit	63
	Tripping: BFT Unit	63
	Total, All Circuits	241

NOTE: The use of the optional contact converter circuit adds an additional 15 milliampere drain.

CHARACTERISTICS

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

POWER SUPPLY

All the SBC 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% to 110% of rated voltage.

The power supply card also provides defense against operation for grounding of relay terminal 17. The power supply card must see greater than 60% of battery voltage before the power supply will be switched on.

OUTPUT RELAYS (BFT AND IT)

The trip output of all the SBC relays consists 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 2 milliseconds. The dropout time of the output relay is somewhat longer than 2 cycles.

TIMER

The timers in all the SBC relays are extremely accurate and repeatable in performance. The resulution 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 $\pm$ 2% of its setting. Over the entire range of applied DC voltage from 80% to 110% of rated, or temperature from -20 to +60^{o}C, the timer will hold its setting to within $\pm$ 5% of setting.

The timers in all the SBC 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 SBC 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 18.) 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% 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 18, the input to the level-sensing circuit is provided with four transactor circuits. The voltage outputs from each transactor are 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 outputs 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 a 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 output 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 in the section on **RATINGS**, is based on the assumption that the fill-in timer will be set for 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 18.) 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 require <u>continuous</u> input for the duration of their settings in order to time out. Thus, a continuous output is required from 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 into the current detector circuits will be required in order to produce a continuous output from the fill-in timer. (See Figure 10.) <u>It is important to note</u> that <u>pickup</u> 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 21).

In summation, the normal factory setting on the fill-in timer is for approximately 9 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 10. Pickup current is defined as the RMS sine-wave current required to produce a <u>continuous output</u> from the current detector.

Since all the SBC relays have no DC voltage applied until after the associated line relays operate (see Figures 2, 3 and 4), there will be some slight operating delay in the pickup of the current detector. Figure 22 indicates the maximum and minimum operating times as a function of current as a multiple of 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 three-phase faults or three-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 SBC 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 (A/O)
3. Secondary time-delay setting (B/O)
4. Phase current pickup setting
5. Ground current pickup setting
6. Link position settings

The section under **APPLICATION** itemizes the considerations involved in the selection of settings for items 1-5 above. The positions of the links depend on the particular model and the user's preference. These have been described in the sections under OPERATION - GENERAL.

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 TESTS** 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 SBC 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 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 at 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 pickup 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 TESTS.**

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.

The secondary (B/O) time delay is set with the AND2 link in the OUT position and with no input current. The contact converter (CC1) must be energized at the same time as the power supply. Terminals 9 and 17 can be connected together and then switched to +DC for initiation of the B/O timer.

After setting the time delay, the pickup settings on phase and ground currents should be made, as indicated in the section under **ACCEPTANCE TESTS.** 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 SBCs can be followed with the aid of the proper internal connections diagram, as shown below:

RELAY TYPE	FIGURE
SBC23A	23
SBC23B	24
SBC23C	25

All the SBCs contain functional elements as described below:

A) +10.2V, -10.2V DC zener-regulated power supply with RF surge suppression (Printed Circuit Card identified as "Y")

B) Power supply level-sensing circuit, to prevent pickup if terminal #17 is grounded

C) AC circuit surge suppression (C1 through C8)

D) Triple range primary tapped transactors and tap blocks for $Phase_A$, $Phase_B$, $Phase_C$, $3I_0$ current circuits (TRA, TRB, TRC, TRD; TB1, TB2, TB3, TB4)

E) Quad full-wave bridge for full-wave rectification of ØA, ØB, ØC, and $3I_0$ transactor outputs (Printed Circuit Card identified as "X")

F) Relay-mounted components necessary for vernier transactor voltage control, overvoltage protection and signal "OR" (R1, R3, P1; R2, R4, P2; Z1, Z2; D1, D2)

G) Level-detector cir7 can be connected together and then switched to +DC for initiation of the B/O timer.cuitry necessary to detect AC level and convert "FILL-IN" to DC logic levels (Printed Circuit Card identified as "A")

H) Breaker-failure timer with continuous adjustment from 50 to 500 milliseconds with reed relay drive (Printed Circuit Card identified as "B" and externally-mounted rheostat P3, A/O; P4, B/O)

I. Breaker-failure tripping relay (BFT) is a type-J telephone relay with surge suppression (D3) and current limit (R5) having three (3) normally-open contacts and two (2) electromechanical targets (T1, T2).

PRINTED CIRCUIT CARDS

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

TABLE VIII

PRINTED CIRCUIT CARD FIGURES						SBC MODEL
A	B	C	X	Y	Z	
26	27	29	31	32	--	12SBC23A(-)D
26	27	30	31	32	33	12SBC23B(-)D
26	28	30	31	32	33	12SBC23C(-)D

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

The power supply voltages are connected to the following pins:

+10.2 VDC	Pin #10	(Red Test Point)
Reference	Pins #1 and #20	(Black Test Point)
-10.2 VDC	Pin #11	

For the "A" card, the input information is supplied to Pin #12. The output information (logic level) is obtained at the respective card pins 12, 14, 16, 18 and 19.

The MC1709L operational amplifier's inverting input (4) is biased at approximately +2.4 VDC, by R1 and R24. While the input at TP2 is below this level, TP3 has a negative voltage level present. As the TP2 (Non-inverting 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 uni-junction oscillator (P1, C3 and Q3) is oscillating; Q6 is On and the signal at TP4 is "0". When TP3 comes high, Q1 goes On, the unijunction oscillator stops oscillating and 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 CR3, CR4 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 Hz basis (i.e. approximately 8.7 milliseconds).

Since the A/O timer resets in less than 1/4 millisecond, this "Fill-in" time, plus energy decay time in the magnetics, both contribute to the total dropout time shown in Figure 19.

"B" CARD (Adjustable Timer and Reed Driver)

The card has its reed relay (RD) output connected to Pins #12 and #14, and the power supply voltages are at the following pins:

+10.2 VDC	Pin #10	(Red Test Point)
Reference	Pins #1 and #20	(Black Test Point)
-10.2 VDC	Pin #11	

The 0183B4149 G5 consists of an A/O timer with input at Pins #2 and #5 and its timer rheostat (external) across Pins #3 and #4. Poth the SBC23A and the SBC23B use this card.

The 0183B4149 G6 card contains two separate timers, which are OR'ed together so that the fastest timer controls the closing of the output contacts. The A/O timer input is on Pin #2 and the B/O timer input is on Pin #6. The external timer rheostat for B/O is across Pins #7 and #8. All other connections are the same as the G5 board. The G6 board is only used on the SBC23C.

A/O Timer: In the quescent off state (not timing) Q1 is Off, Q2 is On, C3 is fully discharged, 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 a positive input signal. Q2 is Off and C3 is charging through R7 and the external rheostat. At pickup, C3 is charged to approximately 6.5 volts and Q4 base is positive, turning Q4 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, 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 megohm non-linear rheostat external to the printed circuit card.

The B/O timer operates in the same manner as the A/O timer, but the collector of Q8 is tied to the collector of Q4 (A/O) to form an OR gate function to drive Q5 and the output reed relay.

"C" CARD (Miscellaneous Function Card)

0165B4686 G1 (SBC23A): The Instantaneous Trip (IT) function on the "C" card is provided by a reed relay. (See Figure 29.) The input for the "IT function is at Pin #2. The output is a reed relay normally-open contact across Pins #12 and #13.

With zero signal at TP5, Q3 is Off, Q5 is Off, and Q6 is Off, thus keeping "IT" de-energized. When TP5 goes positive, Q3, Q5 and Q6 will turn On and "IT" begins to conduct current. Within 1.0 millisecond, "IT" will be fully energized and the associated contacts will be closed.

0165B4686 G3 (SBC23B and SBC23C): AND, OR Contact Converter, "IT" (See Figure 30.)

The inputs for the AND circuit are Pins #5 and #6. The output is Pin #15. For zero signal at either Pin #5 or #6, Q1 or Q2 is Off, thus holding Q4 On, with TP3 or Pin #15 low. If only one of the transistors (Q1 or Q2) is driven On, Q4 remains On. If both Q1 and Q2 are driven On, Q4 will drop out of saturation, allowing TP3 or Pin #15 signal to appear, through R18.

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

The contact converter input is Pin #8. When the CC1 contact is open (CC1 is a reed contact on the SBC "Z" card), TP7 and output Pins #17 and #18 are tied to reference by resistor R16. When the CC1 contact is closed, TP7 and the output points yield output voltage in accordance with resistor divider R15, R16, and load resistance.

The "IT" function operates the same as in the G1 card.

"X" CARD (Quad Full-Wave Bridge)

0165B4796 G1 (Figure 31):

This 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	Output
IA	#1, #2	PIN #9
IB	#3, #4	PIN #9
IC	#5, #6	PIN #9
$3I_0$	#7, #8	PIN #10

Reference is Pin #11

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

"Y" CARD (Zener Regulated Power Supply)

Voltage	GE Assembly	Figure
48	0183B8058G1	32
125	0183B8058G2	32
250	P183B8058G3	32

This card functions as a single-rated zener-regulated +10.2 VDC, -10.2 VDC power supply. The ohmic value of R6 (external to card) changes to provide single battery voltage ratings of 48V, 125V, 250V.

Note that for input connections, (+) rated DC and (-) DC are connected to Pins #10 and #6 respectively. **Exercise caution if testing while relay is energized.**

R6 is the dropping resistor that changes ohmic value as the DC rating changes.

The circuitry associated with Q1 and Q2 supports the level sense switching function. Q1 is the input to switch Q2. Q1 serves as the level detector. R1, R2 are voltage dividers across full battery voltage. ZD1 is a 6.2 volt zener diode whose temperature characteristic is compensated by the base emitter junction on Q1. This ensures temperature stability.

When the voltage at the base of Q1 exceeds 6.8 volts, Q1 turns on and pulls down the base of Q2. This allows current to flow through Q2 and charge C2 to the zener-regulated 20.4 volts at Pin #3.

Zener diodes ZD4 and ZD5 are the +10.2 volt regulators, and ZD6 and ZD7 are the -10.2 volt regulators. The cathode of ZD4 supplies 10.2 volts to the relay circuits. The anode of ZD5, common with the cathode of ZD6, provides relay circuit reference. The anode of ZD7 supplies -10.2 volts to the relay circuits. Capacitor C2 is the regulated DC ripple filter.

Resistor R6 ensures power supply load balance during the transient energization of the power supply.

"Z" CARD (Contact Converter Card)

This card functions as a single-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.

A jumper on the card must be inserted on the correct post corresponding to the DC rating of the relay. The GE assembly, 0183B2304G4, shown in Figure 33 has a rating of 48/125/250 VDC. The diode DZ1 and resistor RZ4 combination functions as a surge suppressor to the transients developed upon de-energizing the CC1 card.

The relay should be tested using pure DC, and not merely full-wave rectified power. Unless the rectified supply is well filtered, the relay may not operate properly due to the dips in the rectified power. Zener diodes, for example, can turn off during these dips. As a general rule, the DC source should not contain more than 5% ripple.

CURRENT DETECTORS

The following discussion applies to all models of the SBC relays.

The three phase elements (I_A, I_B, I_C, 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

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 I_A tap block screw is in the middle position (2A base) (See Figures 11, 12, and 13 for the details, and 14-16 for the larger view). The phase rheostat knob is pointing at the fourth mark from the left (1.6X range base). Since the relay is in the range 2-4A, the range base equals 2A. Multiplying the range base by the calibration mark multiple, we have: Pickup: 1.6 x 2 = 3.2A

   Approximately 3.2A RMS through the I_A current circuit is the level of current 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-hand position (2A base). The $3I_0$ rheostat knob is pointing at the second calibration mark from the left (1.2 X base range). Since the relay is in the range 2-5A, the $3I_0$ range base equals 2A.

   Multiplying the range base by the calibration mark multiple, we have: Pickup: 1.2 X 2 = 2.4A. So, approximately 2.4A RMS through the $3I_0$ current circuit level of residual current is nedessary to pick up the current detector.

RECEIVING, HANDLING AND STORAGE

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

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

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

ACCEPTANCE TESTS

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

CAUTION

When Hipotting the SBC, remove all external wiring from Terminal 10. Do not Hipot Terminal 10. The reason is that Capacitors C1-C12 are rated for 600 VDC and the hipot voltage may damage the capacitors.

These tests may be performed as part of either the installation or the 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 appplicable tests that may be performed on these relays.

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

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 10. 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 10 and the CURRENT DETECTOR part of the **CHARACTERISTICS** section for other parameters.)

The timer and its associated adjustment potentiometer are located on the "A" card (left-hand card, see Figures 14, 15, 16). Set up the test circuit shown on Figure 34 and perform the following instructions:

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

2. Make sure that the relay circuit currents are zero, by removing the lower connection block.

3. Make the oscilloscope and contact circuits described on Figure 34, being certain to observe the caution that the **scope power cord must be <u>ungrounded</u>.**

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 - 9.00 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.

CURRENT DETECTOR PICKUP TEST

Having checked or adjusted the fill-in time setting per above, set up the test current circuit of Figure 35.

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:

I_A	1
I_B	1
I_C	1
$3I_0$	0.5

2. Set both current rheostat pointers to the 1X range base (first calibration line going clockwise).

3. Apply current to the I_A terminal per Figure 35 until the oscilloscope indicates a continuous DC output. The input current must be approximately one (1) ampere.

4. Repeat Step 3. above for phase B and phase C.

5. Apply current to the $3I_0$ terminals per Figure 35 until the oscilloscope indicates a continuous DC output. The input current must 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 10. Also, see CURRENT DETECTOR, in the **CHARACTERISTICS** section, for other parameters.

CURRENT DETECTOR PICKUP SETTINGS

Use the procedure of the previous section, except set the current rheostats to the desired current pickup; then secure the rheostats.

TRIPPING TIMERS

The rheostat on the front of the relay associated with the trip timer is identified as A/O. 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" signifies a continuously adjustable pickup time delay in the range of 50 to 500 milliseconds. The "O" signifies that the timer resets "instantaneously" (in reality, in less than 200 milliseconds).

Set up the AC, DC and oscilloscope connections shown in Figure 36. Apply the current to the ground circuit on the 0.5 tap at X1 base pickup. Observe the following two cautions:

CAUTIONS

1. **The system side circuits of the BFT contacts must ber removed before the test connections are made (use of an XLA test plug is recommended).**

2. **The oscilloscope <u>must</u> <u>not</u> 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 36, 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 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/O timer rheostat is identified as such, and clockwise rotation increases the tripping time.

1. <u>SBC23A (A/O)</u> Initiate timing of the relay as explained above, by closing the BFI contact. Set the length of tripping time by adjusting the A/O rheostat. Lock the rheostat position and check several times that the tripping time is consistent.

2. <u>SBC23B (A/O)</u> Place the "timer link" in the "OR" mode and use the same test applied to the SBC23A.

3. <u>SBC23C (A/O)</u> Set "IN/OUT" link in the OUT" position and use the same test applied to the SBC23A.

<u>LOGIC FUNCTIONS, SETTINGS AND TESTS</u>

Having set the current detectors and the A/O timer, perform the following tests using the Figure 35 test circuit for the I_A configuration. Let the test current be 1.5X current detector pickup.

<u>SBC23A</u> Place the "IT" link in the "OUT" position and apply test current to the relay. With an ohmmeter across relay terminals #11 and #12, close and open switch (S1) and check that the ohmmeter continues to read infinite ohms.

Place the "IT" link in the "LD" (Level Detector) 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 infinite ohms while the switch is open.

Place the "IT" link in the mode of operation that is required in the system operation.

SBC23B

1. With an ohmmeter across relay terminals #11 and #12, hold the switch (S1) closed. Place the "IT" link in the "LD" position; check that the ohmmeter goes to "zero" when the test current is applied and goes to infinity when the test current is removed.

   Place the "IT" link in the "CC" position. Check that the ohmmeter goes to "0" ohms when the "AUX" contact is closed and goes to infinity when the "AUX" contact is opened.

   Place the "IT" link in the "OUT" position and check that the ohmmeter stays at infinite ohms, whether the test current is applied or the "AUX" contact is closed.

   Place the "IT" link in the mode that the system scheme requires.

2. Keep switch (S1) closed.

   Place the "timer link" in the "OR" position. Check that by either applying test current alone or closing the "AUX" 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 "AUX" contact is closed simultaneously.

   Place the "timer link" in the required mode of operation.

SBC23C

1. With an ohmmeter across relay terminals #11 and #12, hold the switch (S1) closed. Place the "IT" link in the "LD" position; check that the ohmmeter goes to "zero" when the test current is applied and goes to infinity when the test current is removed.

   Place the "IT" link in the "CC" position. Check that the ohmmeter goes to "0" ohms when the "AUX" contact is closed and goes to infinity when the "AUX" contact is opened.

   Place the "IT" link in the "OUT" position and check that the ohmmeter stays at infinite ohms, whether the test current is applied or the "AUX" contact is closed.

   Place the "IT" link in the mode that the system scheme requires.

2. Keep switch (S1) closed.

   Turn the A/O potentiometer fully clockwise and the B/O potentiometer fully counterclockwise. Place the "AND2" link in the "IN" position. Check that the BFT relay operates after about one-half second delay when test current alone is applied. Close the "AUX" contact and check that the BFT relay operates immediately when the test current is applied.

   Place the "AND2" link in the "OUT" position and check that the BFT relay operates with about 1/2 second delay when the test current is applied and the "AUX" contact is open.

   Set the A/O and B/O time delays as required for the system operation.

   Place the "AND2" link in the required mode of operation.

INSTALLATION PROCEDURE

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 Figure 1.

The internal connection diagrams for the relays are shown in Figures 23, 24 and 25. Typical wiring diagrams are given in Figures 2, 3, and 4,

One of the mounting studs or screws should be permanently connected to surge ground by a conductor not less than No. 12 B & S gage copper wire or its equivalent.

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 frequency plus harmonics of the fundamental frequency, it follows that alternating current devices (relays) will be affected by the applied waveform. Therefore, in order to test alternating current relays properly it is essential to use a sine wave of current and/or voltage.

CAUTION

When Hipotting the SBC, remove all external wiring from Terminal 10. Do not Hipot Terminal 10. The reason is that capacitors C1-C12 are rated for 600 VDC and the hipot voltage may damage the capacitors.

Since most operating companies use different procedures for installation tests, the section undr **ACCEPTANCE TESTS** 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:

TIMER TEST

Test per timing test as explained in section titled **ACCEPTANCE TESTS**.

CURRENT DETECTOR PICKUP SETTING

Set up the test current circuit of Figure 35.

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.

I_A	2A
I_B	2A
I_C	2A
$3I_0$	1A

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

Apply test current to each of the four current circuits per Figure 35 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 for the phase circuits, and 0.95-1.05A RMS for the 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 I_A current circuit of Figure 35, 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% 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 35 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. 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

A flexible burnishing tool should be used for cleaning relay contacts. This is a flexible strip of metal with an etched-roughened surface, which in effect resembles a superfine file. The polishing action of this file is so delicate that no scratches are left on the contacts, yet it cleans off any corrosion thoroughly and rapidly. The flexibility of the tool ensures the cleaning of the actual points of contact.

Fine silver contacts should not be cleaned with knives, files, or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent closing.

The burnishing tool described above can be obtained from the factory.

SERVICING

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

RENEWAL PARTS

Sufficient quantities of renewal parts should be kept in stock for 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 that 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 covered with a suitable high di-electrical 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 the name of the part wanted, quantity required, and complete nameplate data, including the serial number, of the relay for which the part is required.

Since the last edition, Figures 1, 26 and 35 have been changed, and several typographical errors corrected.

LIST OF FIGURES

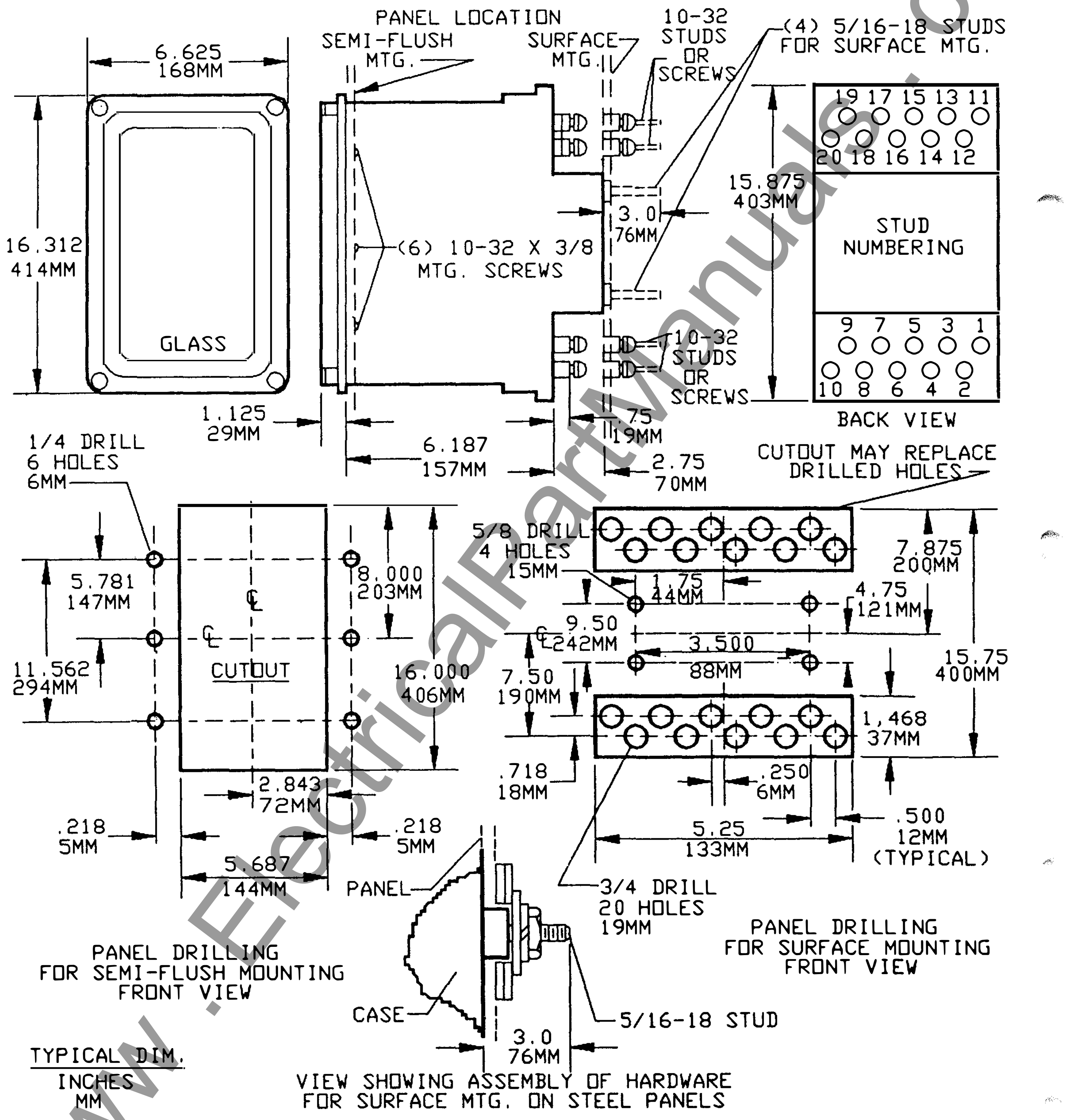
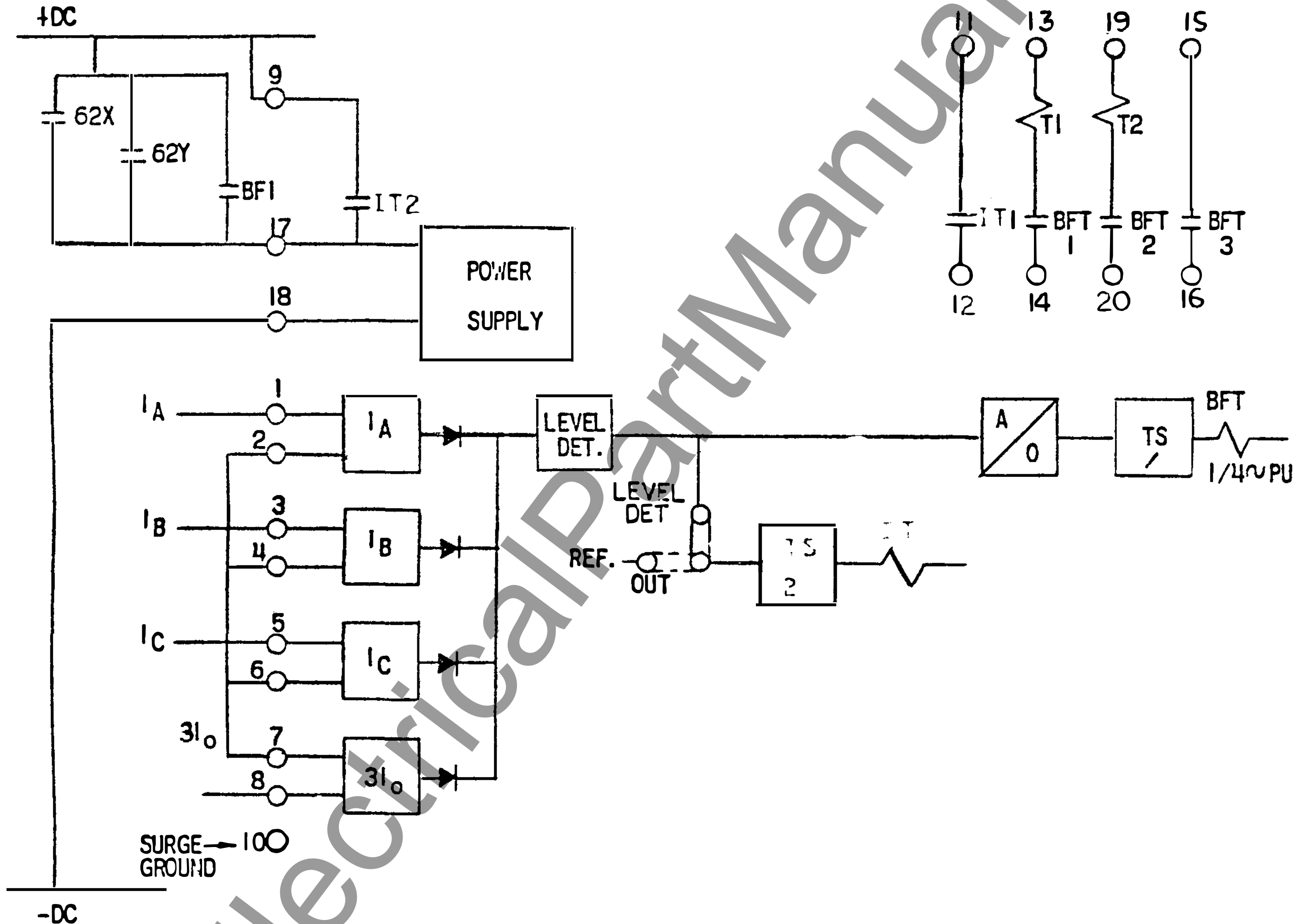


Figure 1 (0227A2485 [2]) Outline and Panel Drilling Dimensions for the SBC Relay



NOTE: CONNECT STUD 10 (SURGE GROUND) TO GROUND BUS ON PANEL

Figure 2 (0257A9648-1) Type SBC23A External Connections

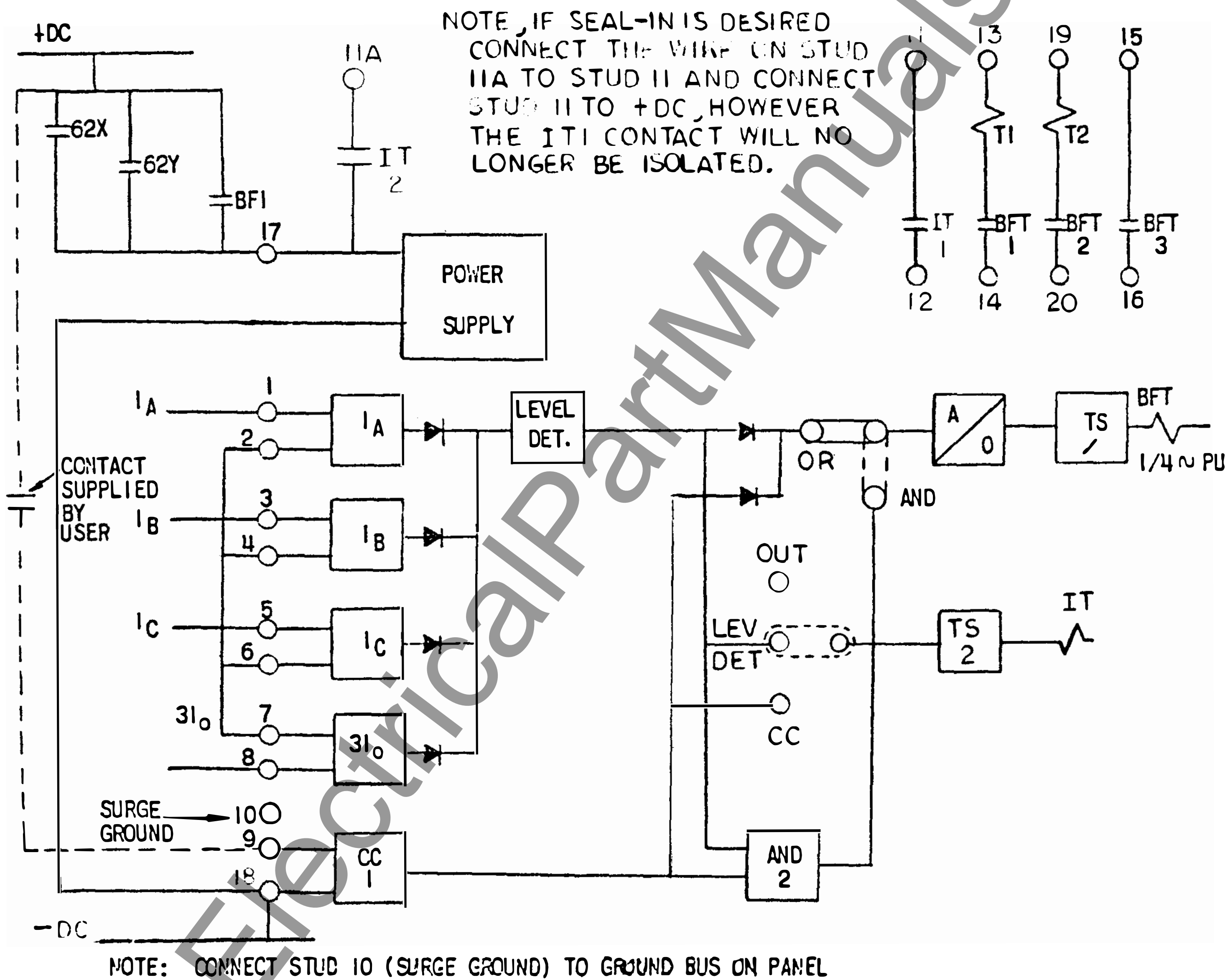


Figure 3 (0257A9649-1) Type SBC23B External Connections

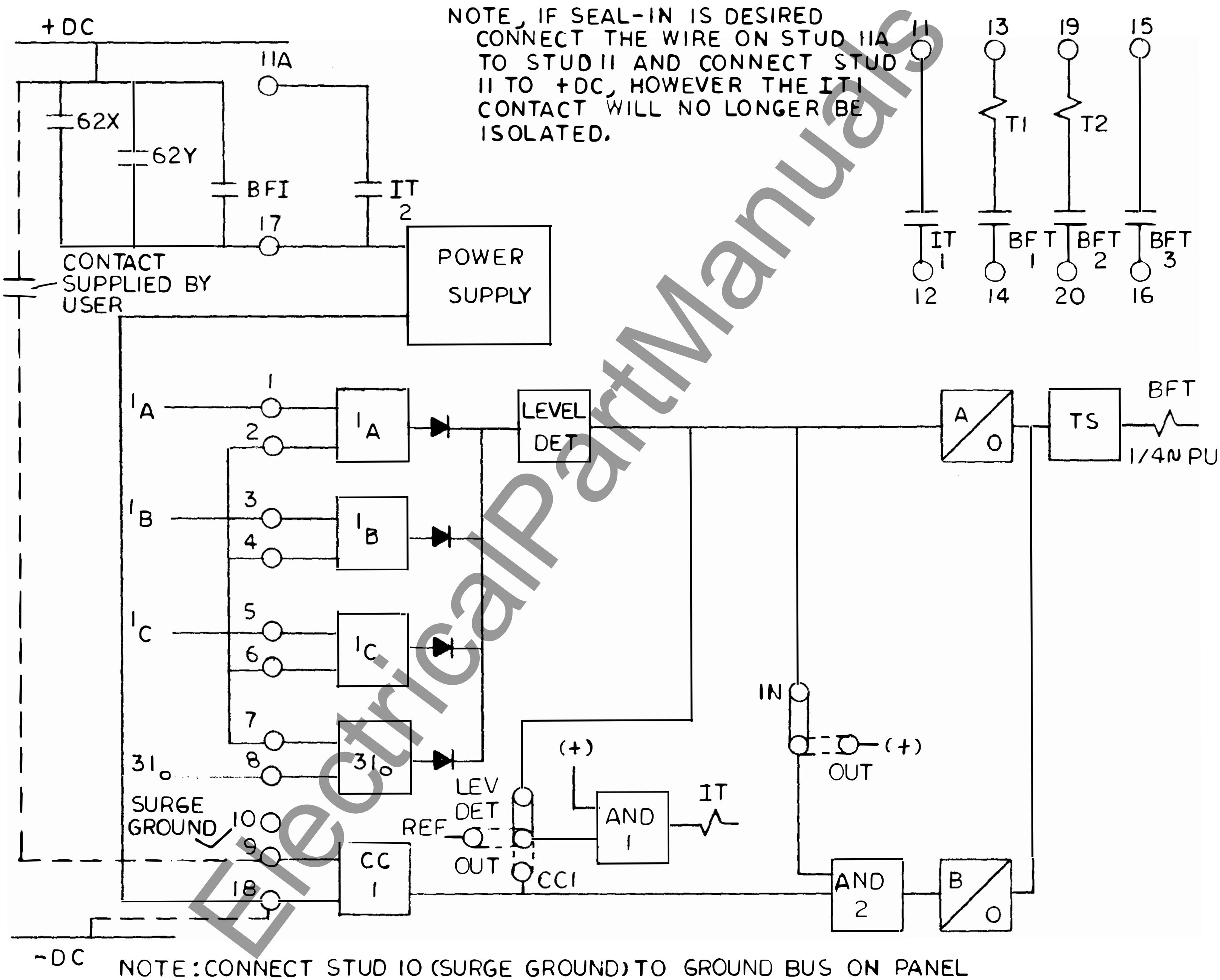


Figure 4 (0275A2057-0) Type SBC23C External Connections

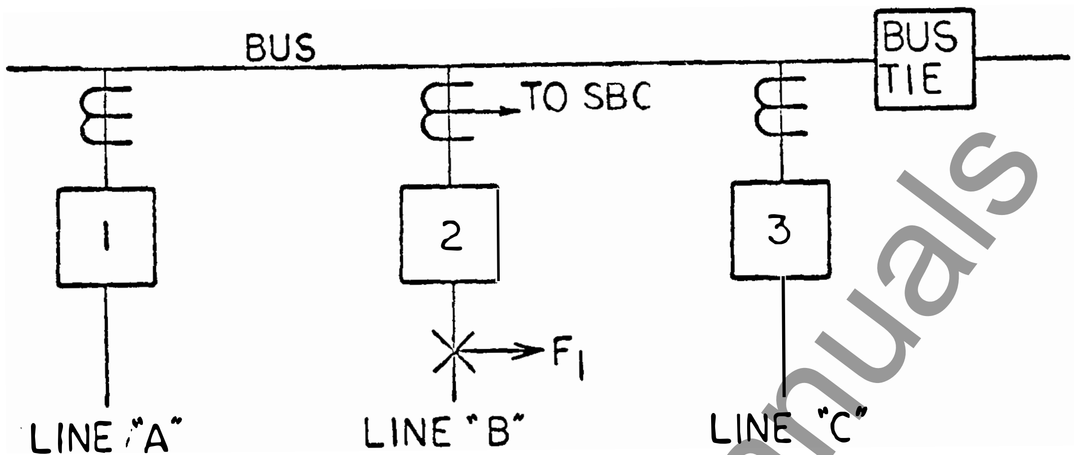


Figure 5 (0246A2279-1) Relay Application, Single Bus, Single Breaker

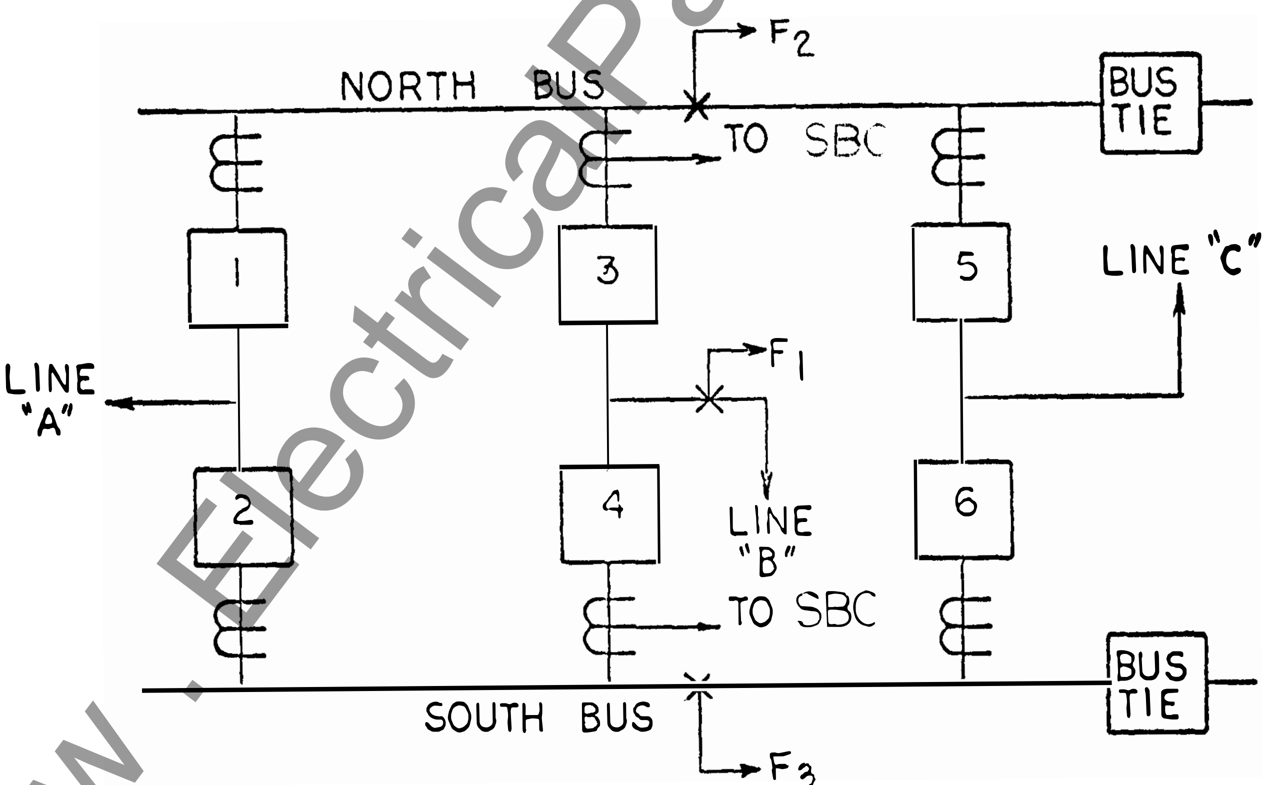


Figure 6 (0246A2277-2) Relay Application, Double Bus, Double Breaker

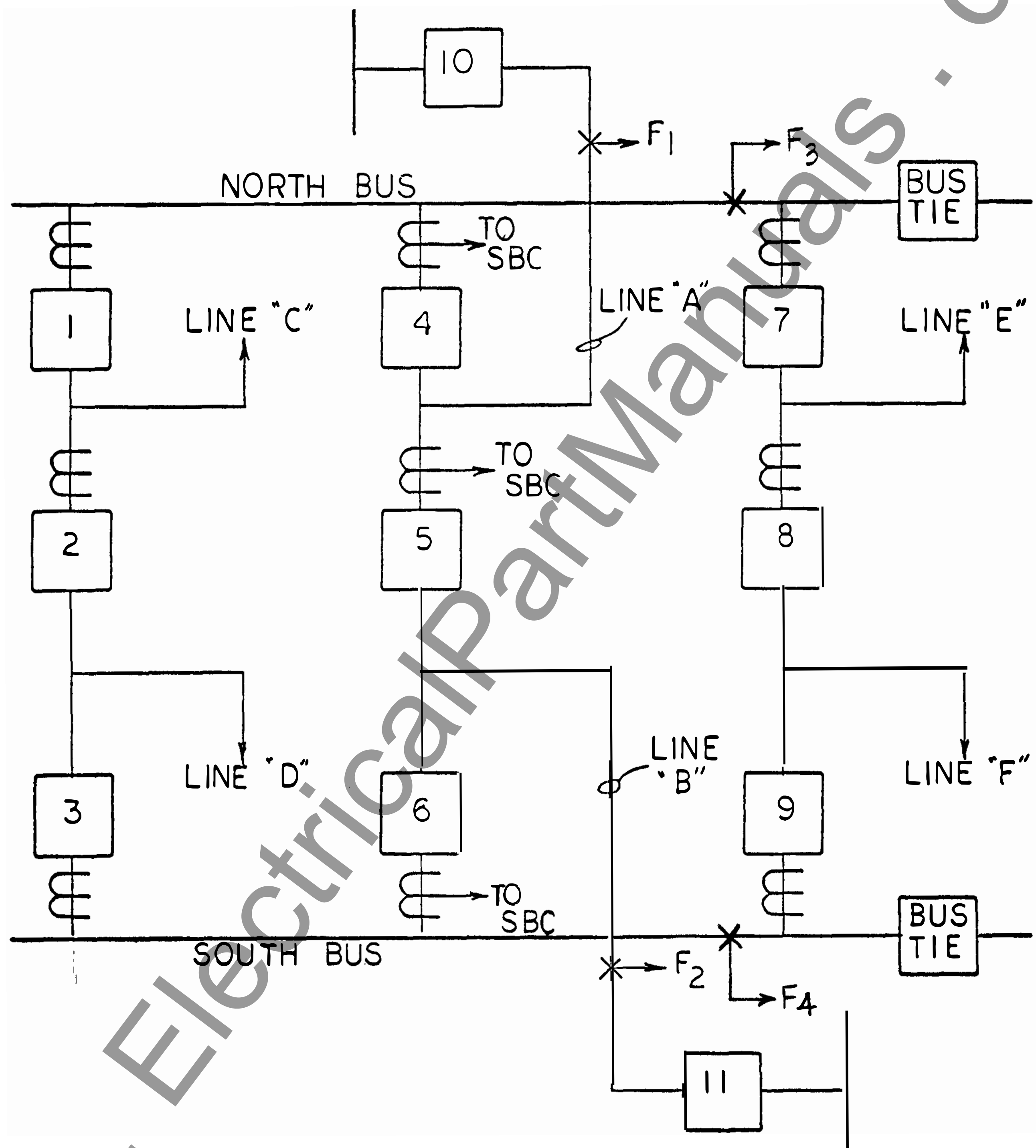


Figure 7 (0246A2280-2) Relay Application, Breaker-and-a-Half

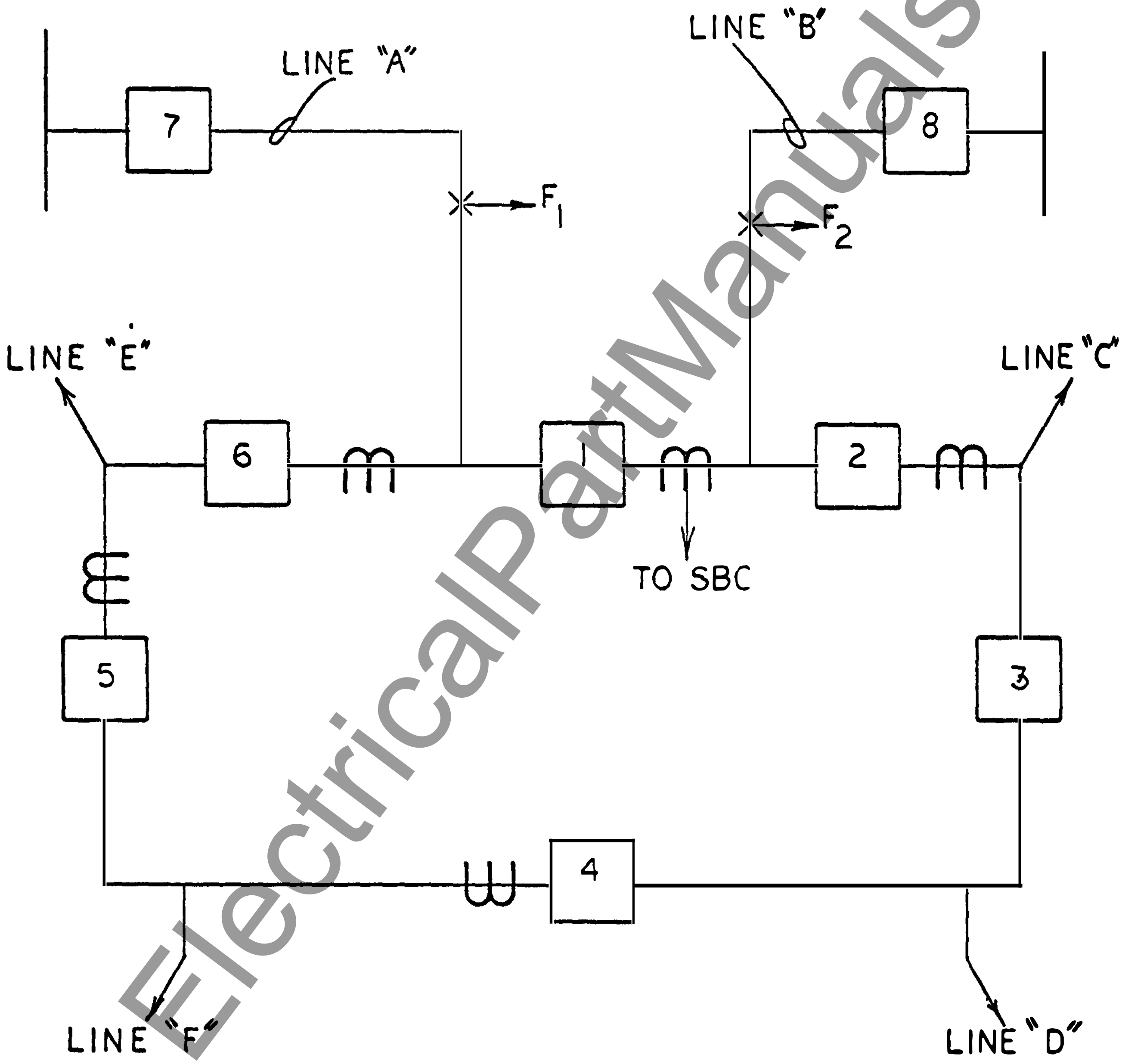


Figure 8 (0246A2278-1) Relay Application, Ring Bus

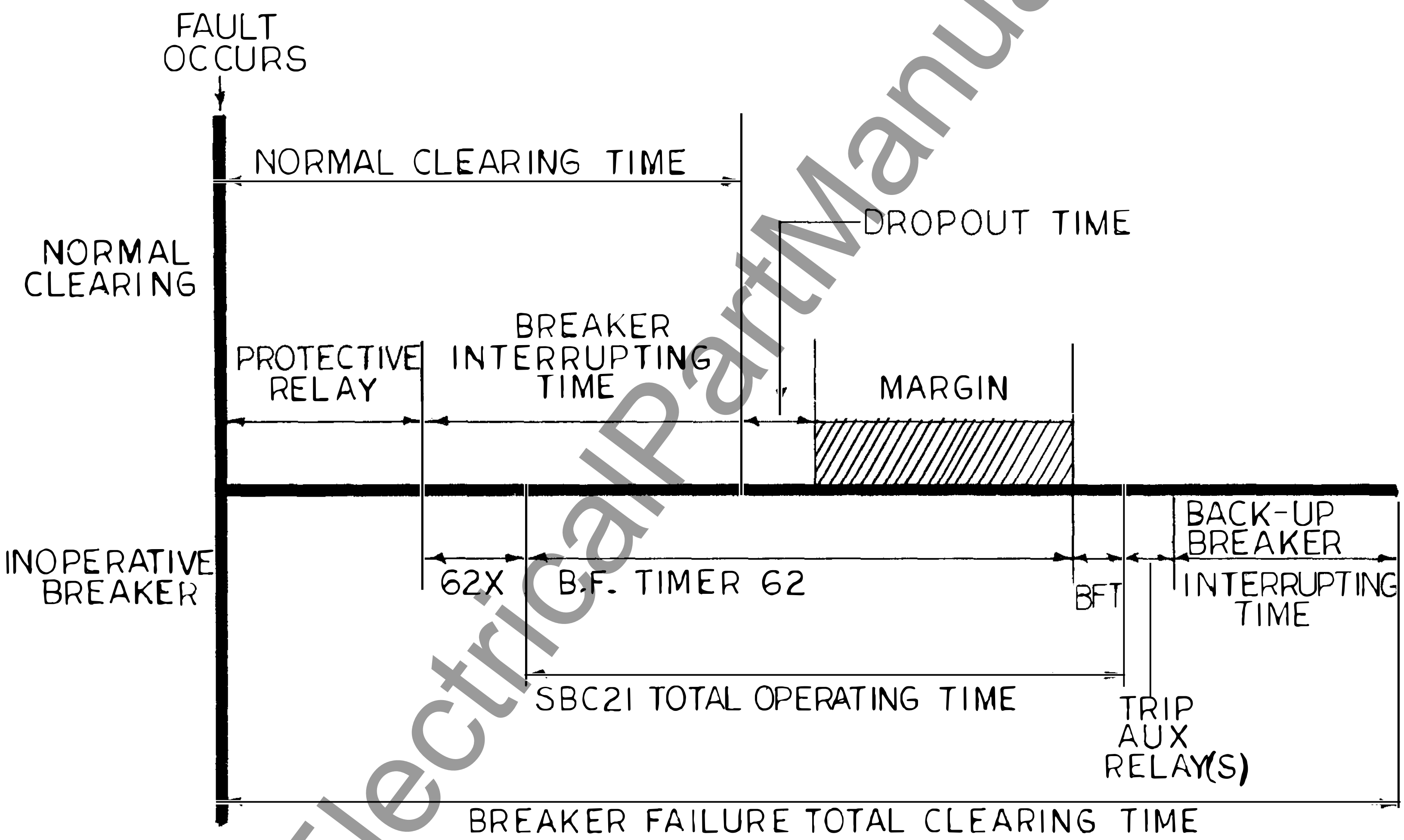


Figure 9 (0227A7128-1) Breaker Failure Time Chart for the SBC Relay

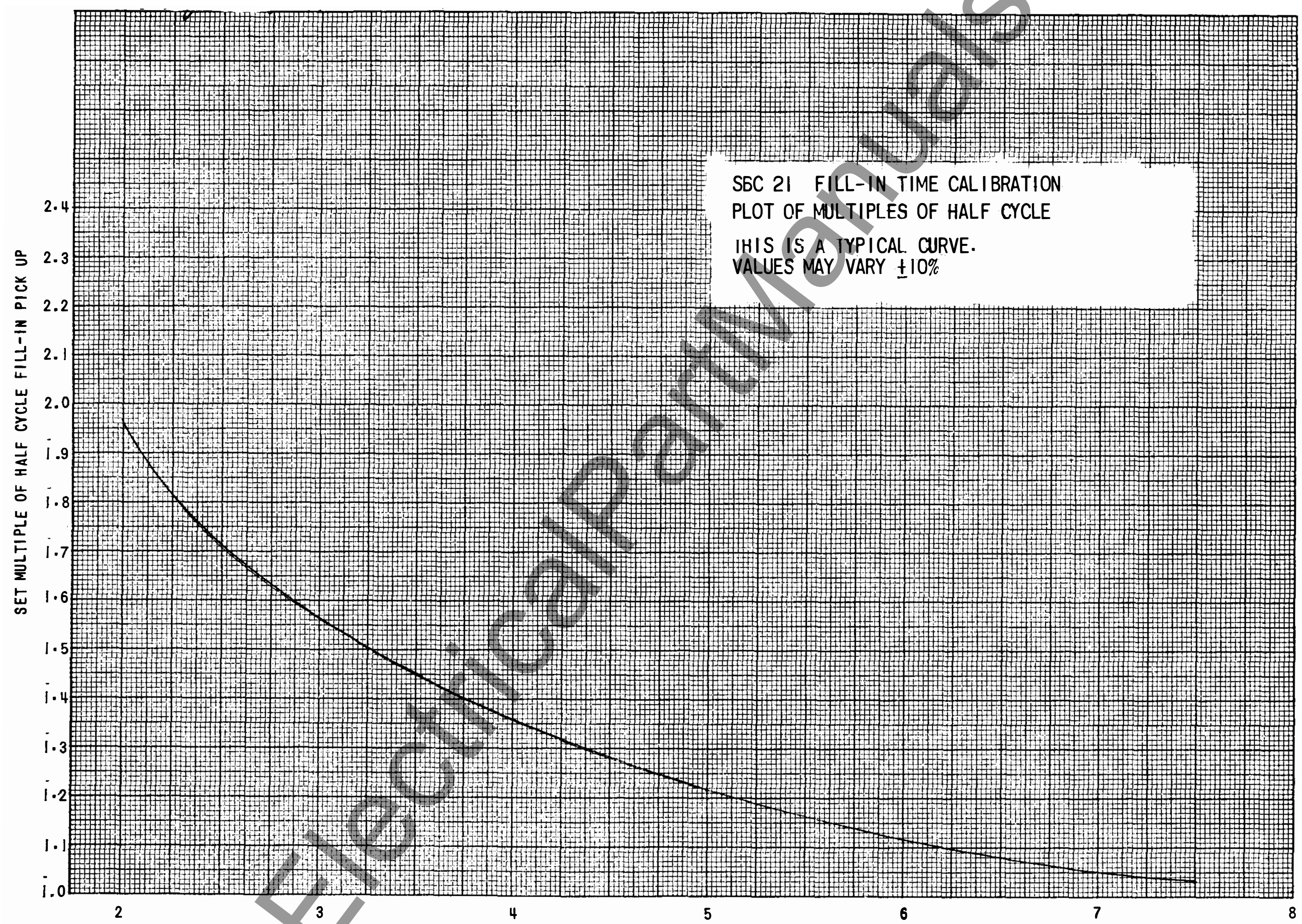


Figure 10 (0246A2206 Sheet 1) Fill-in Time Calibration Graph for SBC Relay

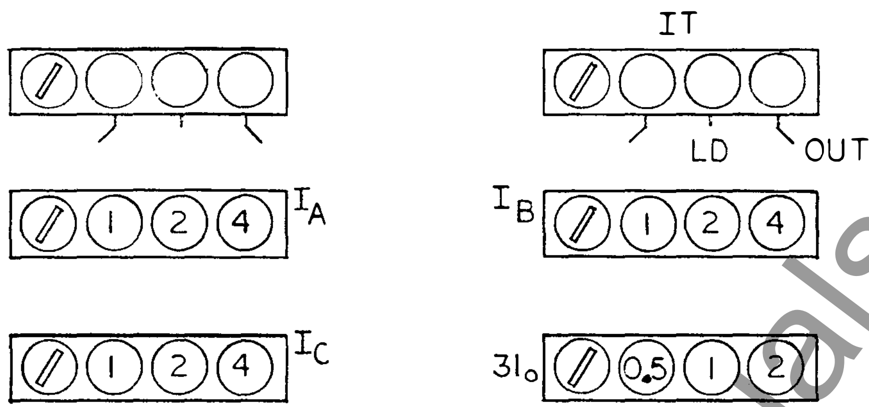


Figure 11 (0273A9510-0) SBC23A Tap Block Nameplates

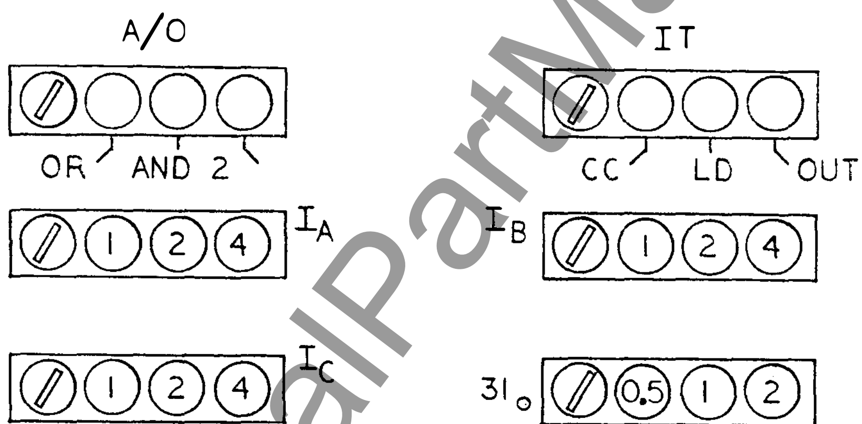


Figure 12 (0273A9511-0) SBC23B Tap Block Nameplates

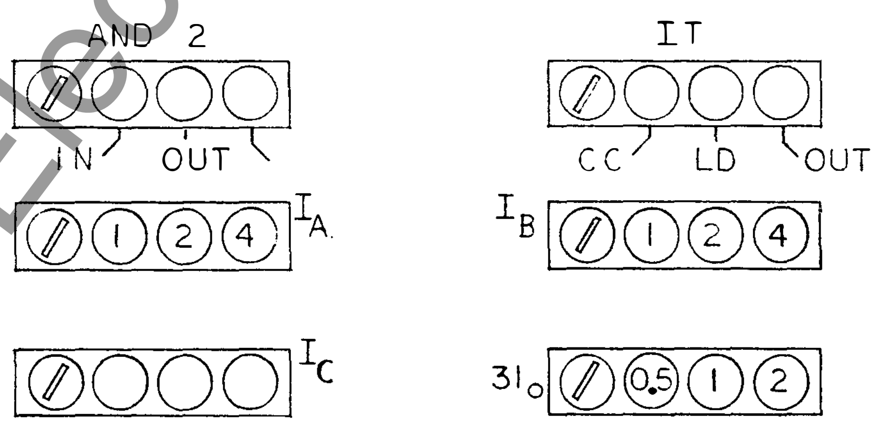


Figure 13 (0273A9512-0) SBC23C Tap Block Nameplates

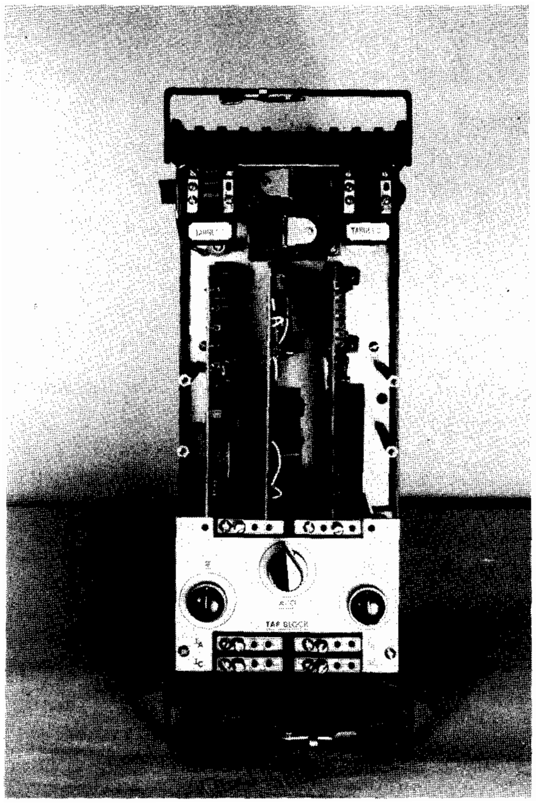


Figure 14 (8043385) SBC23A Relay Removed from Case (3/4 Front View)

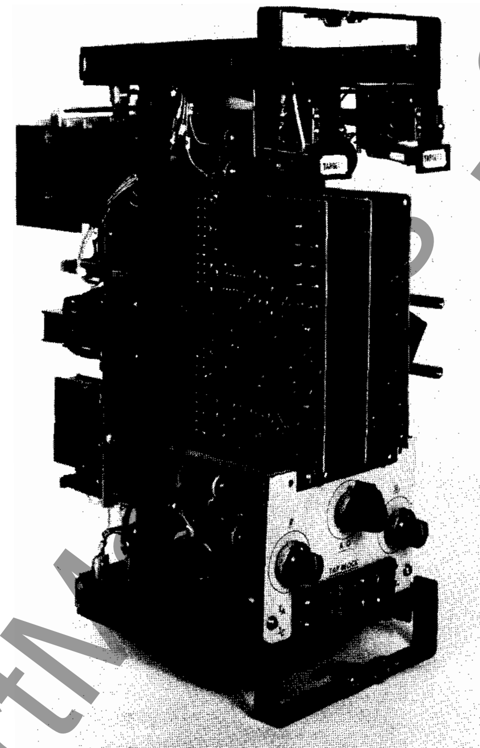


Figure 15 (8043386) SBC23B Relay Removed from Case (Front View)

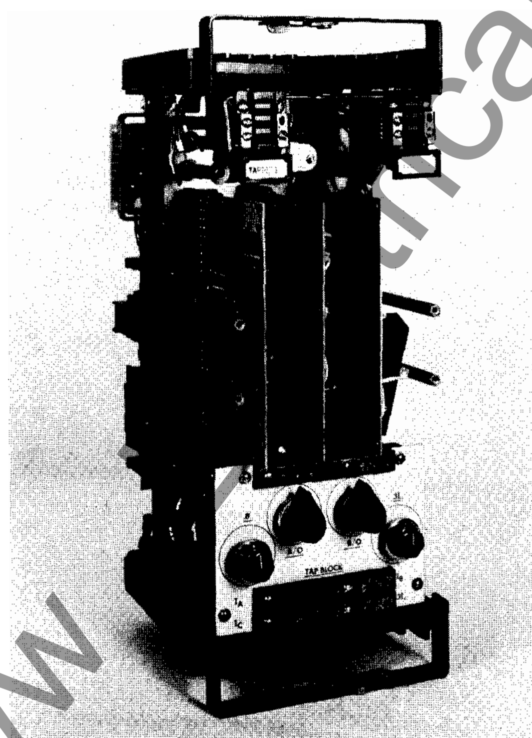


Figure 16 (8043387) SBC23C Relay Removed from Case (3/4 Front View)

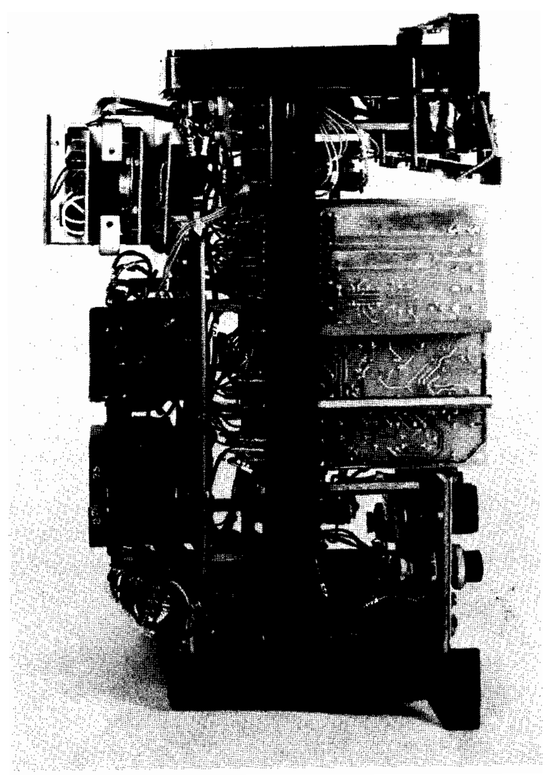


Figure 17 (8043404) SBC23C Relay Removed from Case (Side View)

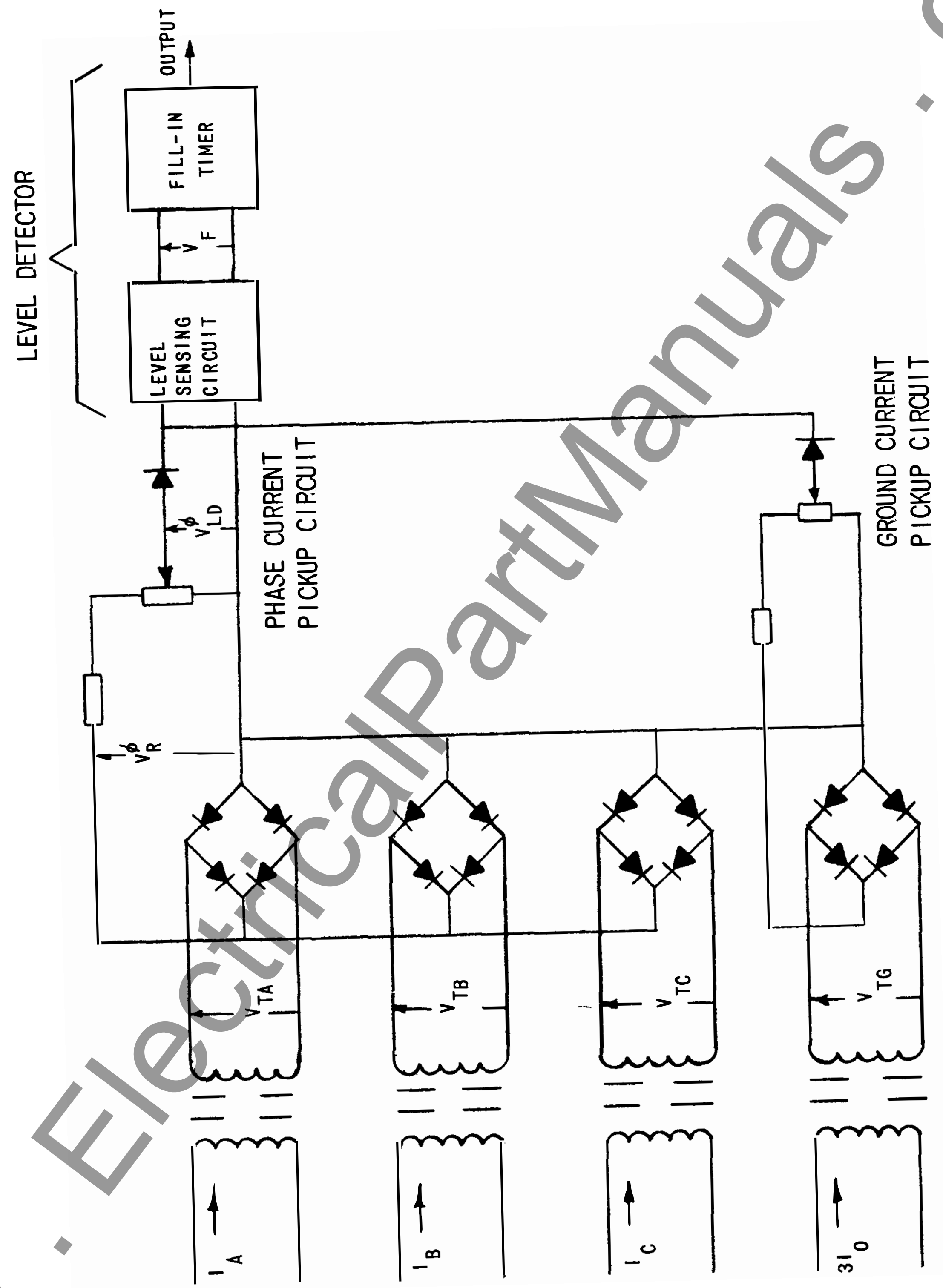


Figure 18 (0246A2272-0) Current Detector Circuit Illustration for the SBC Relay

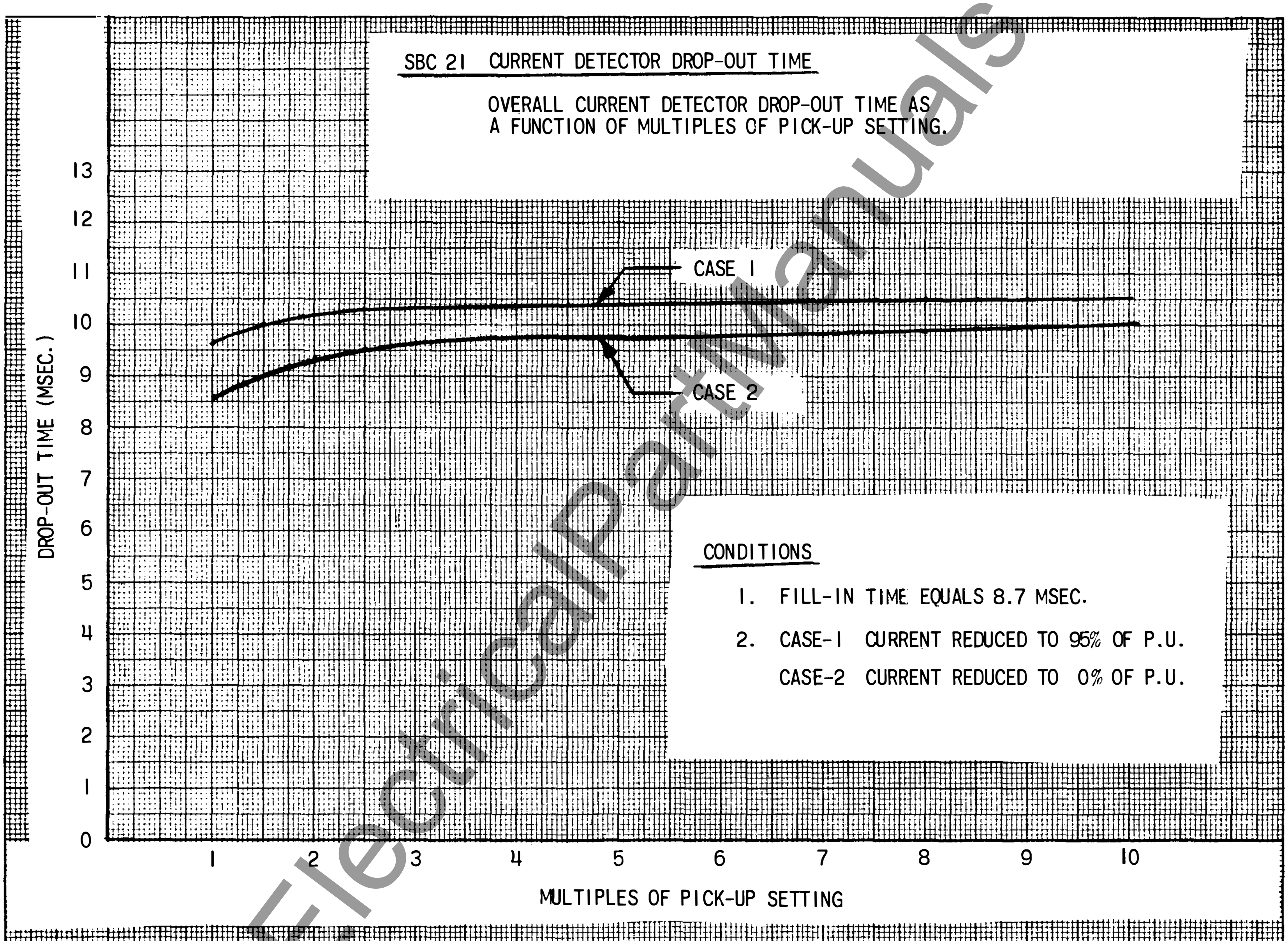


Figure 19 (0246A2206-1 Sheet 4) Current Detector Dropout Time Graph for the SBC Relay

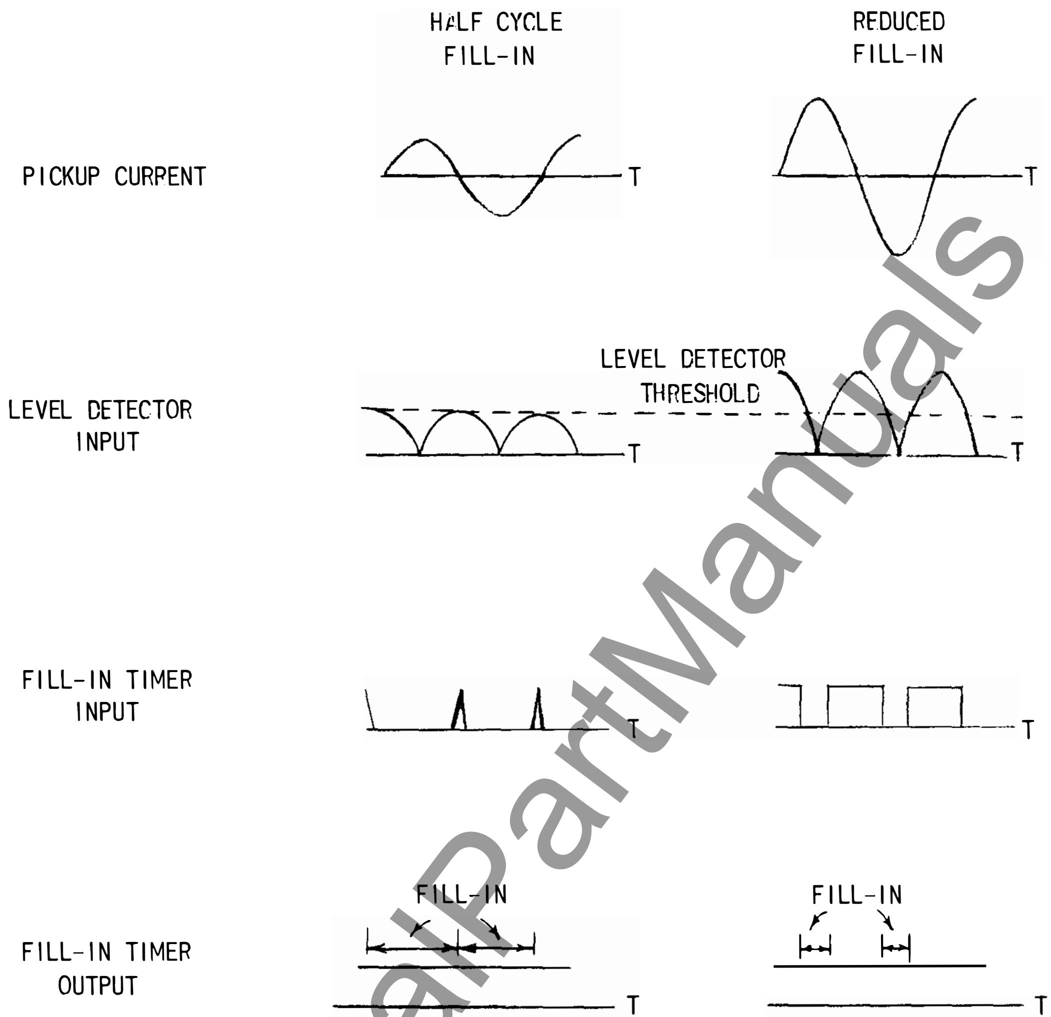


Figure 20 (0246A2273-0) SBC Current Detector Pickup Current for Reduced Fill-in Times

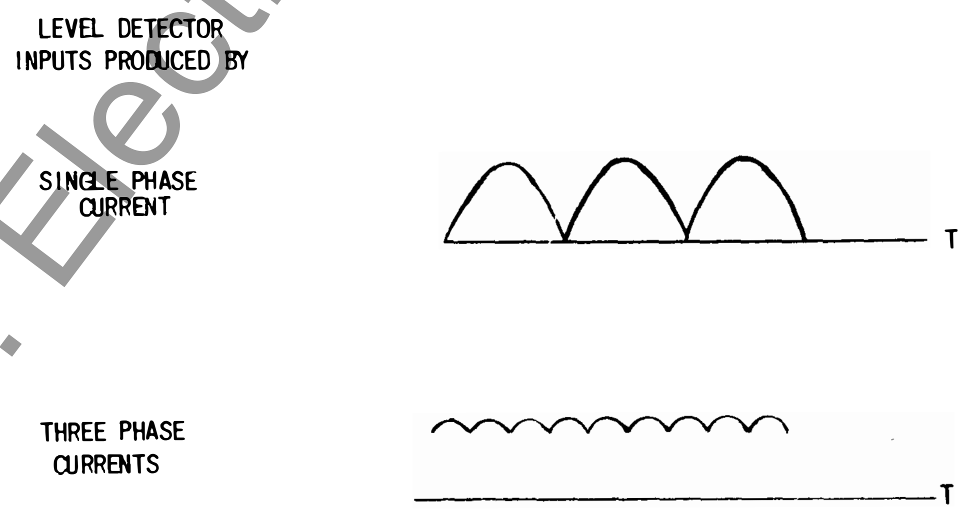


Figure 21 (0246A2274-0) Current Detector Level Detector Inputs Produced by Single-Phase and Three-Phase Currents for the SBC Relay

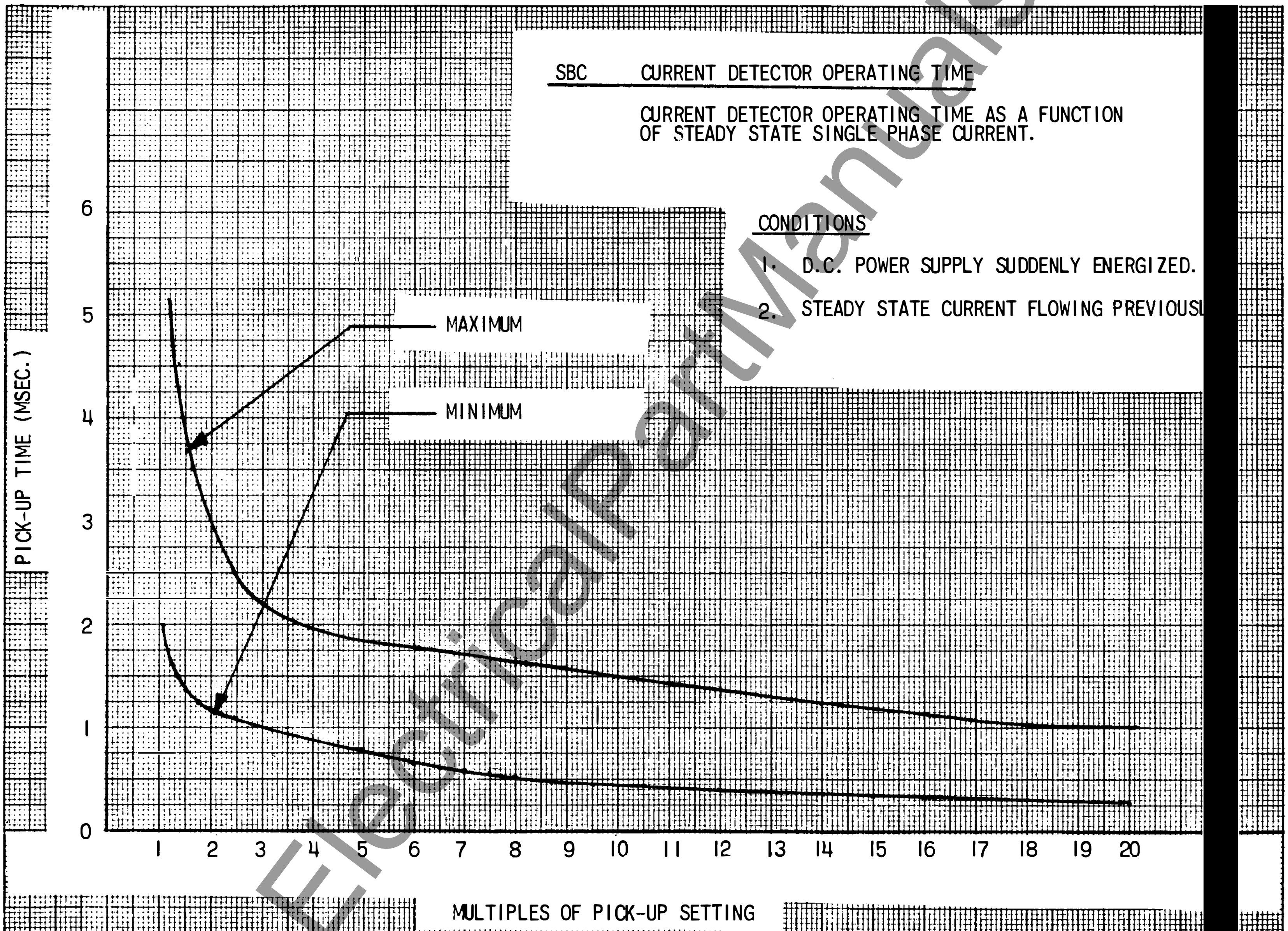
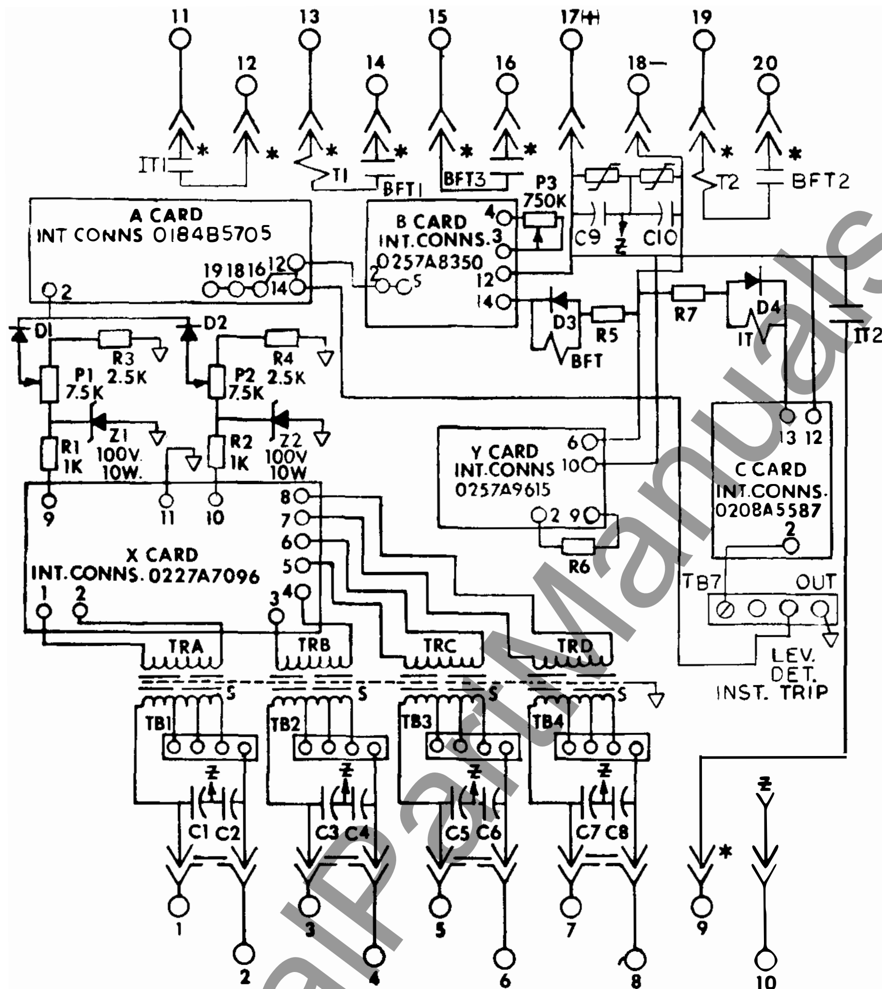


Figure 22 (0246A2206 Sheet 3 [0]) Current Detector Operating Time for the SBC Relay



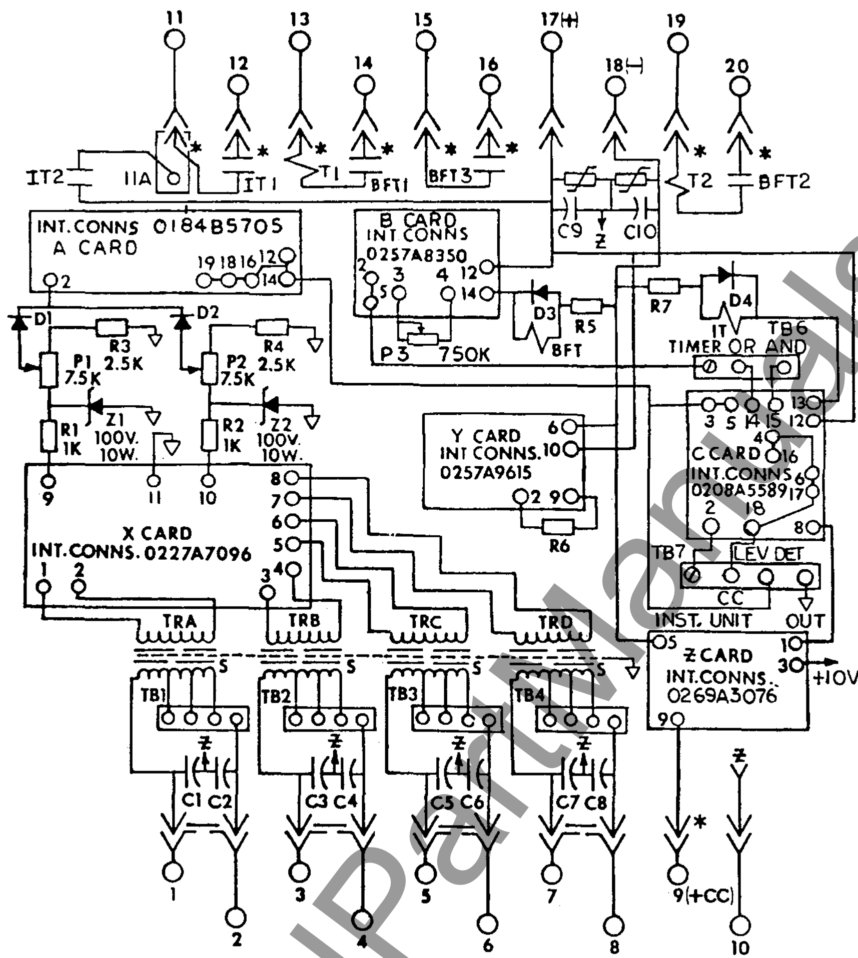
POWER SUPPLY CONNECTIONS
+10 VOLTS TO PINS A10, B10, C10, Y3
REFERENCE TO PINS A1, A20, B1, B20, C1, C20 X11, Y1
-10 VOLTS TO PINS A11, B11, C11, Y4

▽ = POWER SUPPLY REFERENCE
✱ = SHORT FINGER
T1 = LEFT HAND TARGET
T2 = RIGHT HAND TARGET
IT = INSTANTANEOUS TRIP
BFT = BREAKER FAILURE TRIP
TB = TAP BLOCK
TR = TRANSACTOR
Ƶ = SURGE GROUND TERMINAL 10

V.D.C.	R5 & 7 VALUE
48	500 Ω 12W
125	1500 Ω 12W
250	3500 Ω 12W

V.D.C.	R6 VALUE
48	250 Ω 25W
125	1000 Ω 25W
250	2000 Ω 50W

Figure 23 (0257A9626-2 Sheet 1 and 0257A9626-0 Sheet 2)
Type SBC23A Internal Connections Diagram



POWER SUPPLY CONNECTIONS
+10 VOLTS TO PINS A10, B10, C10, Y3
REFERENCE TO PINS A1, A20, B1, B20, C1, C20 X11, Y1
-10 VOLTS TO PINS A11, B11, C11, Y4

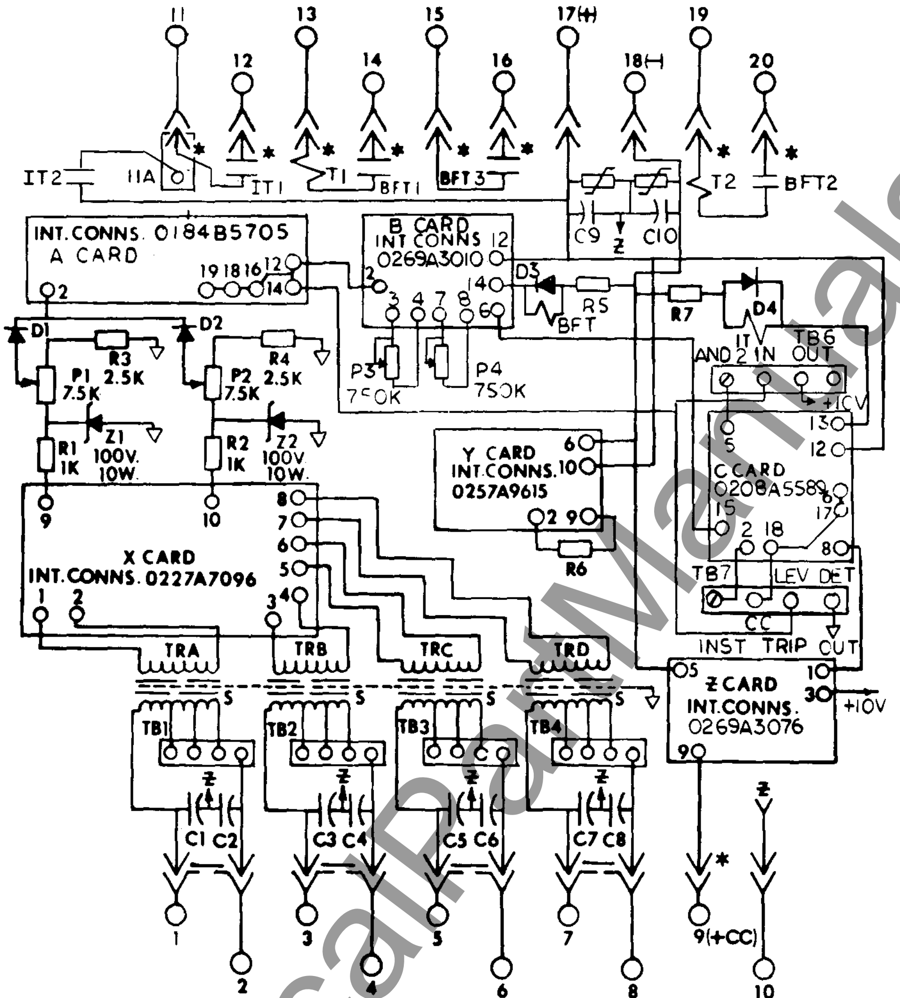
▽ = POWER SUPPLY REFERENCE
* = SHORT FINGER
T1 = LEFT HAND TARGET
T2 = RIGHT HAND TARGET
IT = INSTANTANEOUS TRIP
BFT = BREAKER FAILURE TRIP
TB = TAP BLOCK
TR = TRANSACTOR
→ Z = SURGE GROUND TERMINAL 10

CC = CONTACT CONVERTER

V.D.C.	R5 & 7 VALUE
48	500 Ω 12W
125	1500 Ω 12W
250	3500 Ω 12W

V.D.C.	R6 VALUE
48	250 Ω 25W
125	1000 Ω 25W
250	2000 Ω 50W

Figure 24 (0257A9632-2 Sheet 1 and 0257A9632-0 Sheet 2)
Type SBC23B Internal Connections Diagram



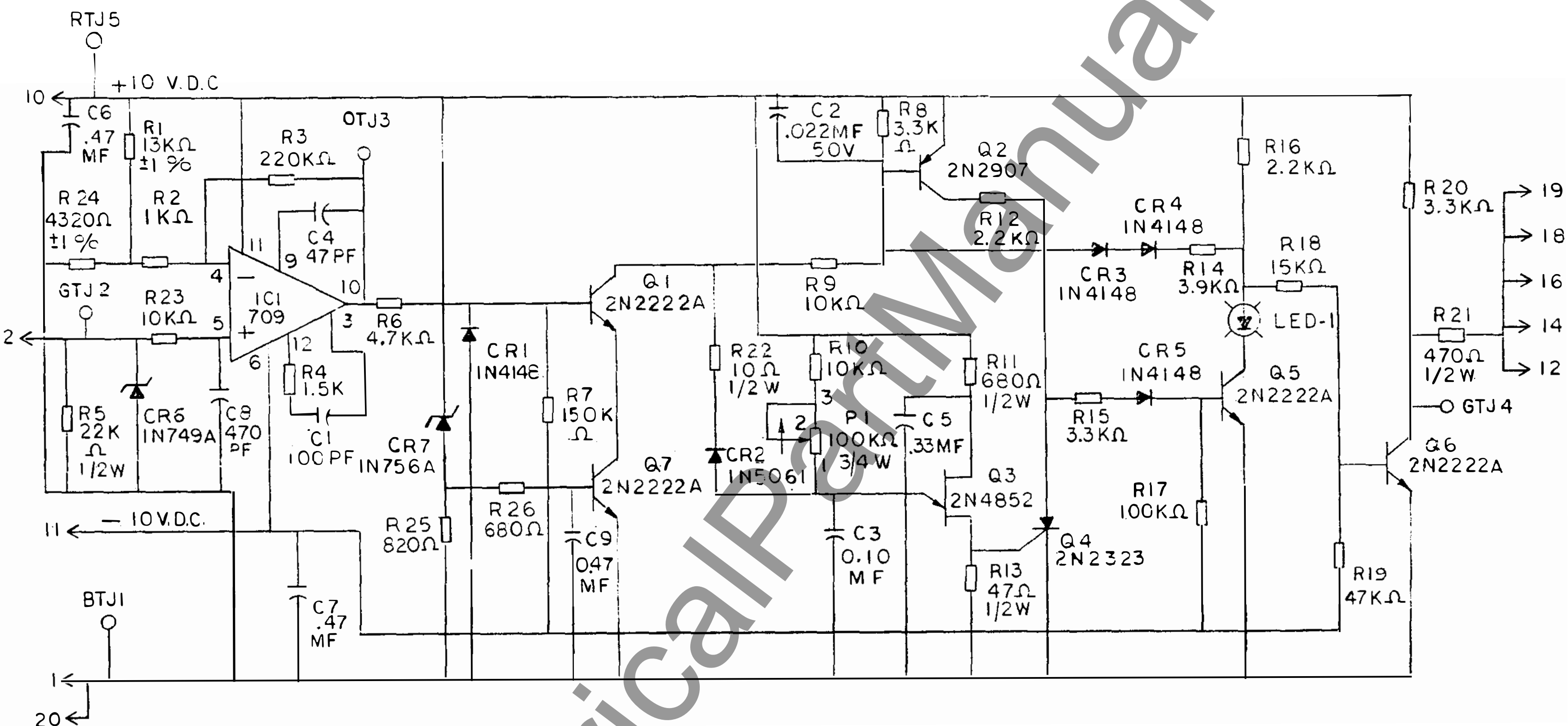
POWER SUPPLY CONNECTIONS
+10 VOLTS TO PINS A10, B10, C10, Y3
REFERENCE TO PINS A1, A20, B1, B20, C1, C20 X11, Y1
-10 VOLTS TO PINS A11, B11, C11, Y4

▽ = POWER SUPPLY REFERENCE
* = SHORT FINGER
T1 = LEFT HAND TARGET
T2 = RIGHT HAND TARGET
IT = INSTANTANEOUS TRIP
BFT = BREAKER FAILURE TRIP
TB = TAP BLOCK
TR = TRANSACTOR
→ Z = SURGE GROUND TERMINAL 10

V.D.C.	R5 & 7 VALUE
48	500 Ω 12W
125	1500 Ω 12W
250	3500 Ω 12W

V.D.C.	R6 VALUE
48	250 Ω 25W
125	1000 Ω 25W
250	2000 Ω 50W

Figure 25 (0275A2056 Sheet 1 [1] and 0275A2056 Sheet 2)
Type SBC23C Internal Connections Diagram



ALL RES $\frac{1}{4}$ W ± 5% UNLESS OTHERWISE NOTED

R5, 11, 13, 21 & 22 1/2W
R1 & 24 1/8W 1%

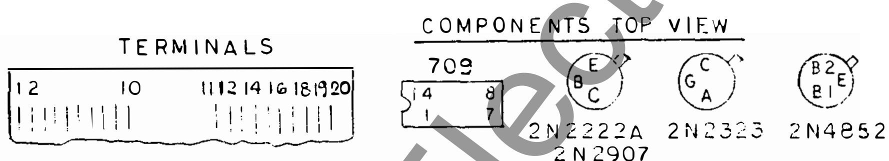


Figure 26 (0184B5705 Sheet 1 [2]) Level Detector and Fill-in Timer ("A" Card)

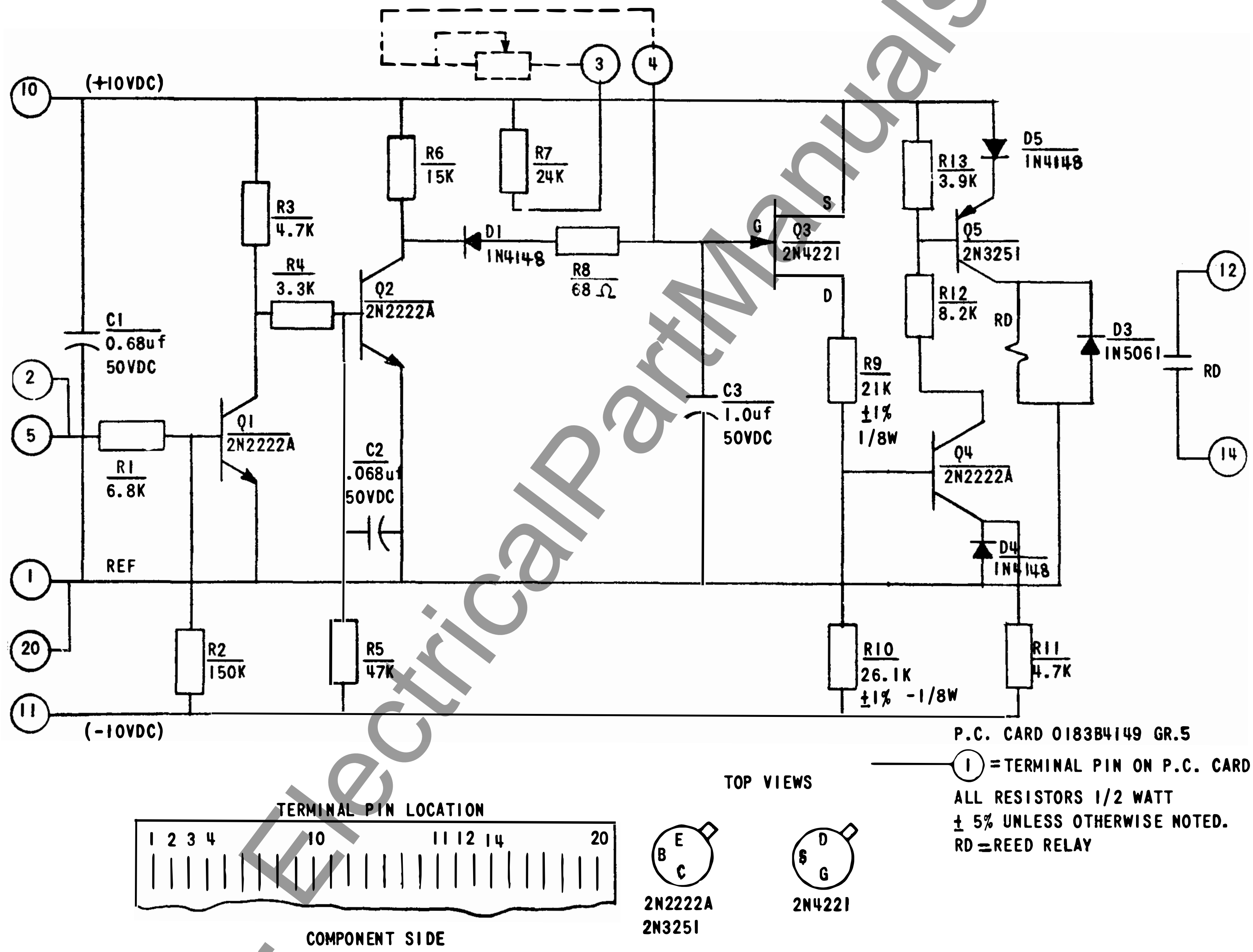


Figure 27 (0257A8350-1) A/O Timer and Reed Driver Card for SBC23A & SBC23B Relays ("B" Card)

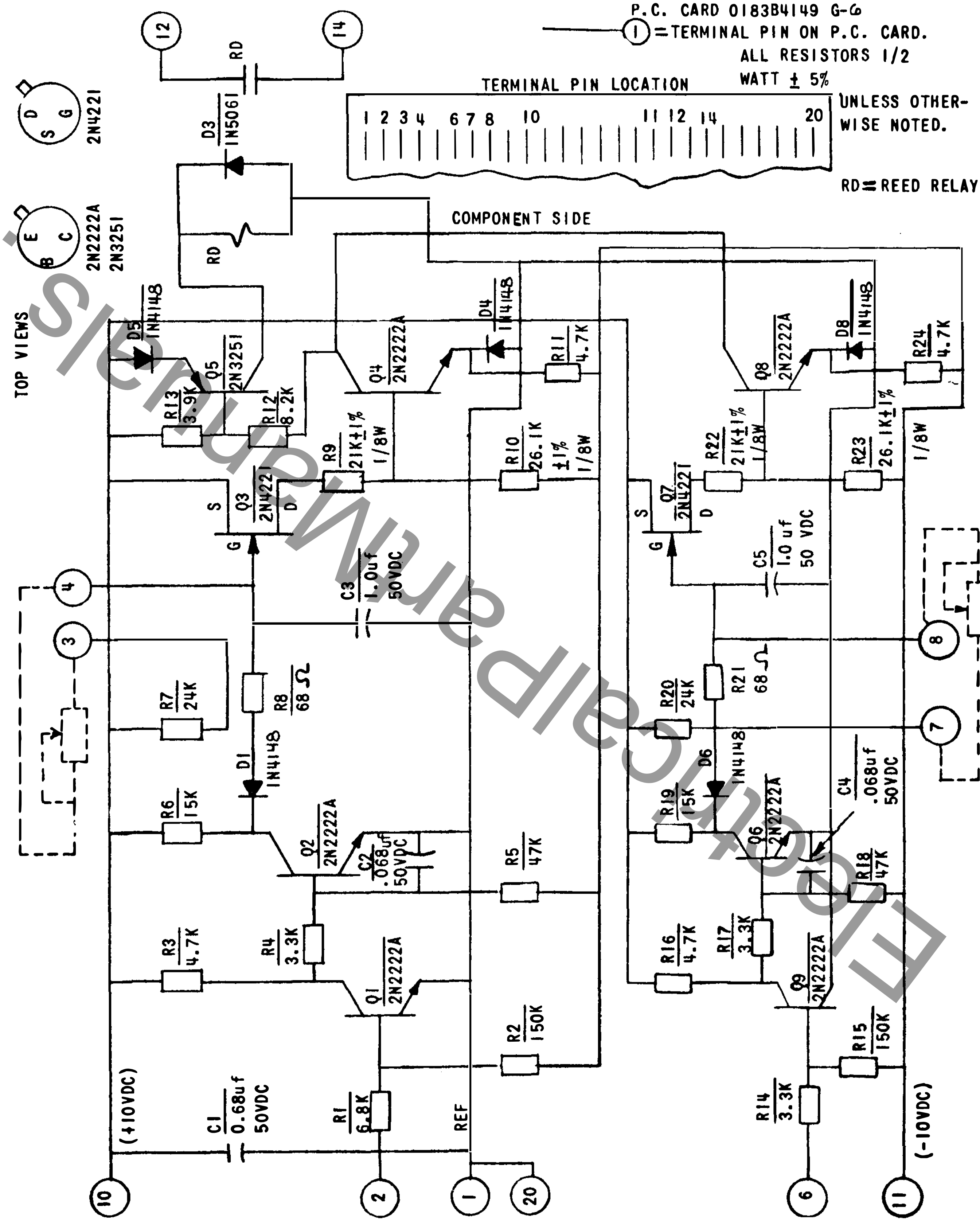


Figure 28 (0269A3010-0) A/O and B/O Timer and Reed Driver Card for SBC23C ("B" Card)

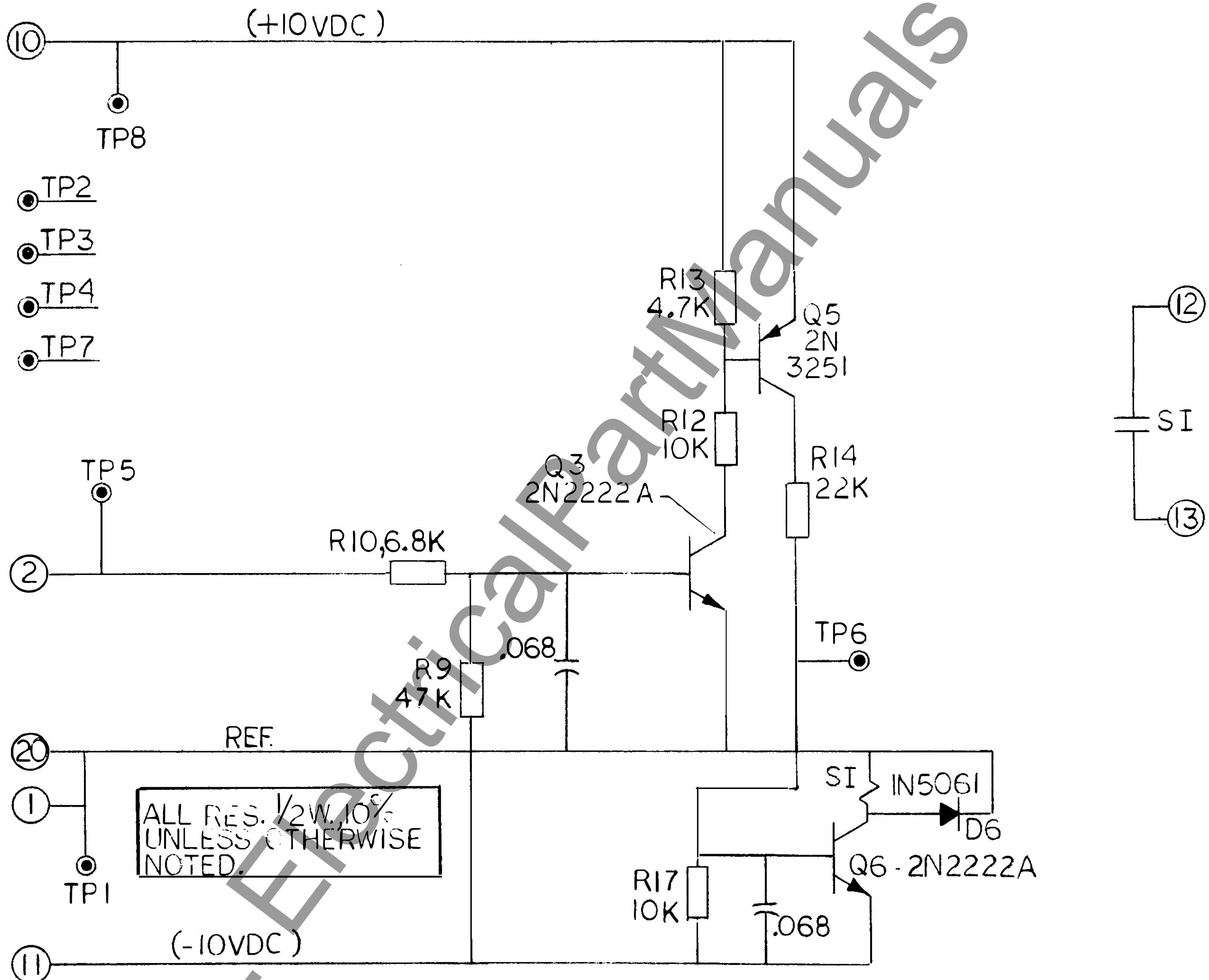


Figure 29 (0208A5587-2) Instantaneous Trip Card for the SBC23A ("C" Card)

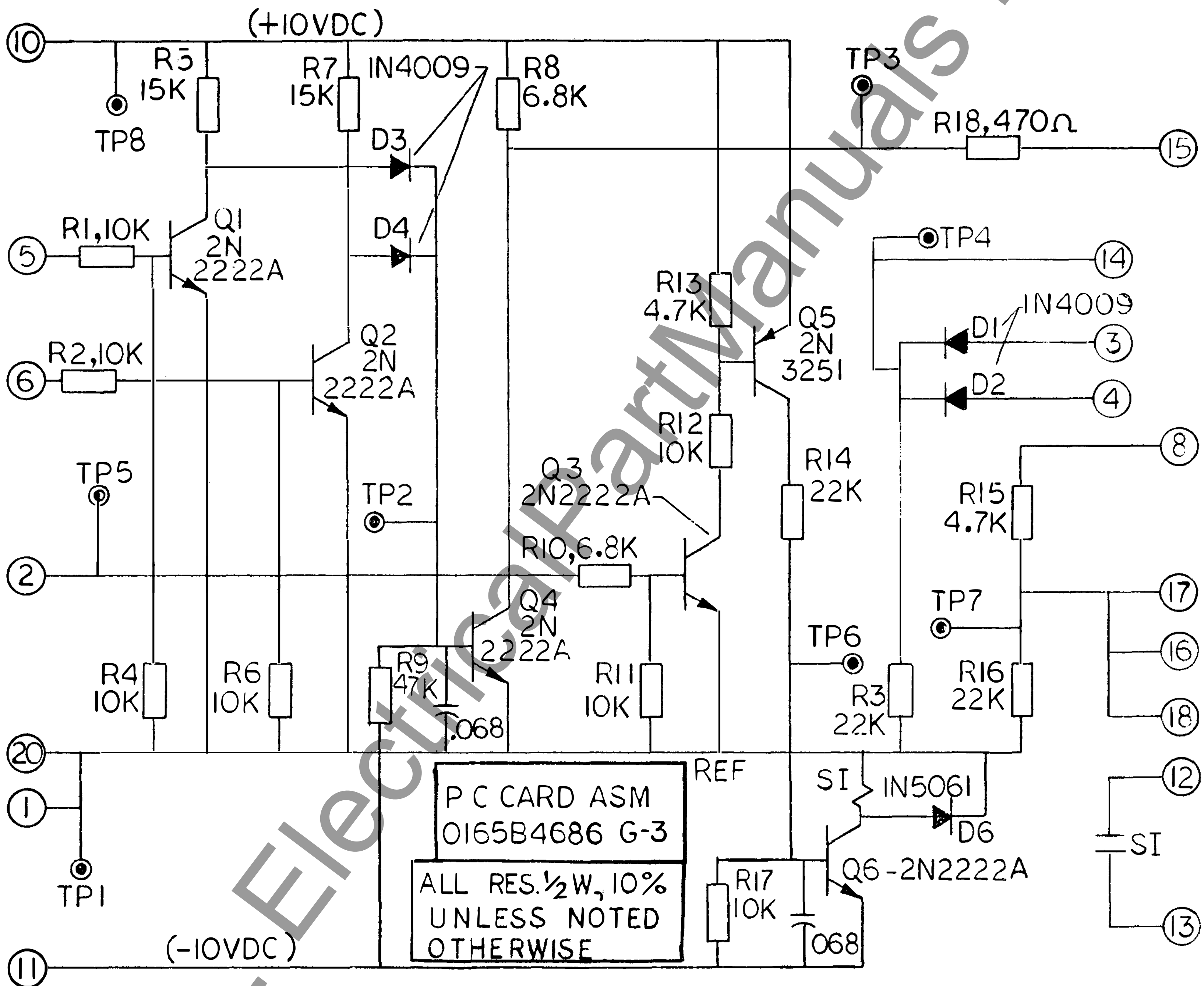


Figure 30 (0208A5589-4) Contact Converter Card for the SBC23B and SBC23C ("C" Card)

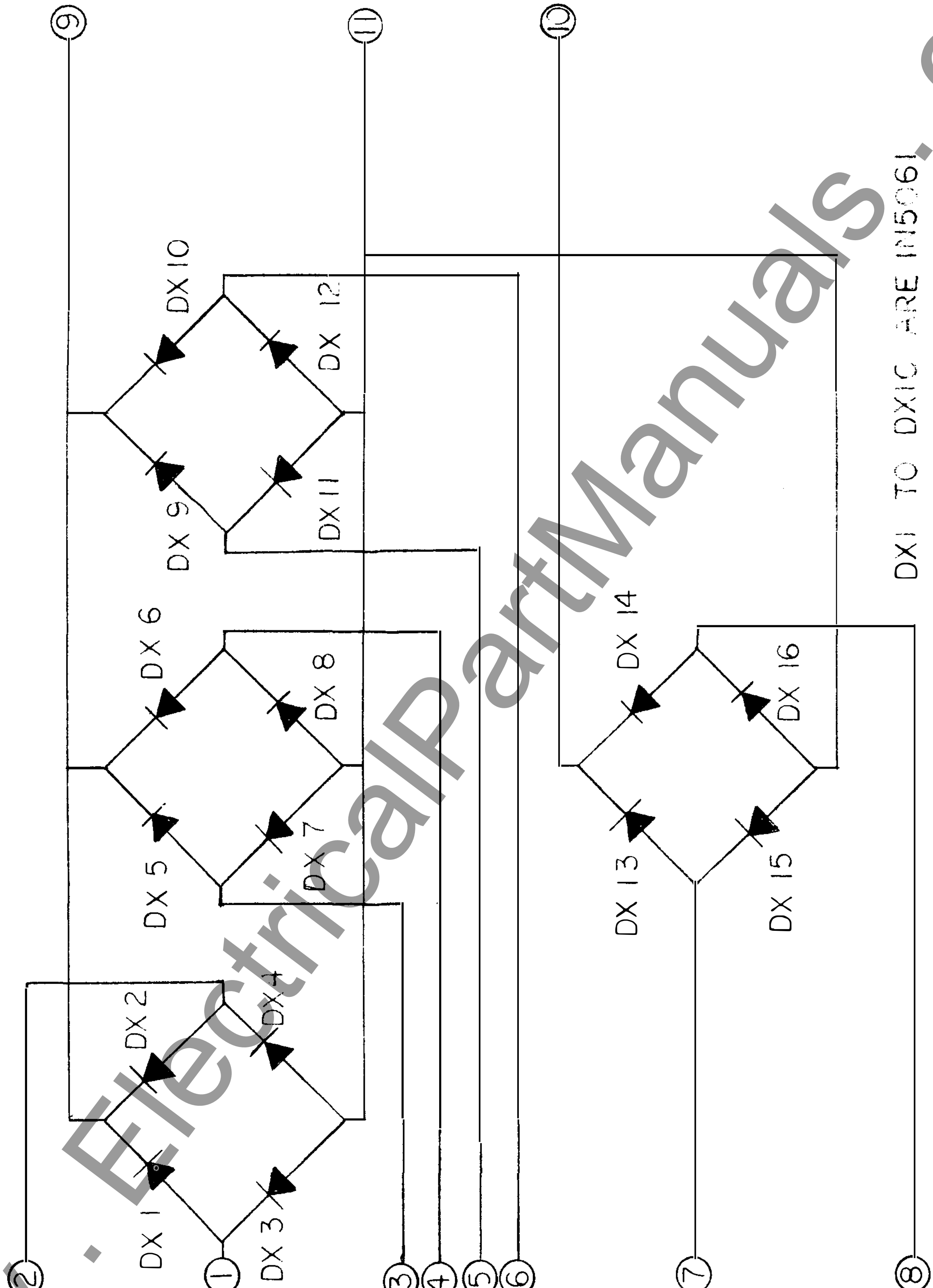
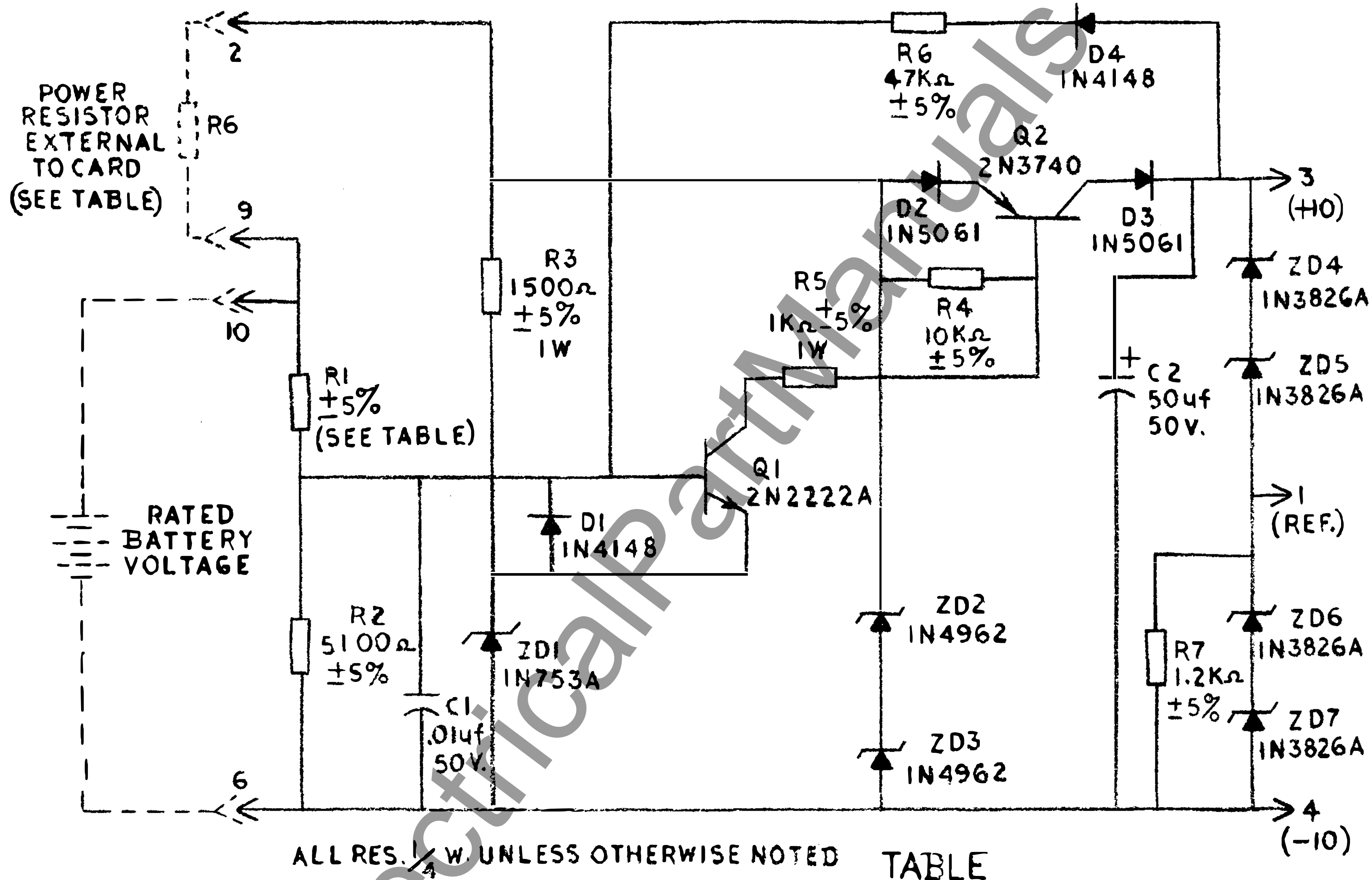
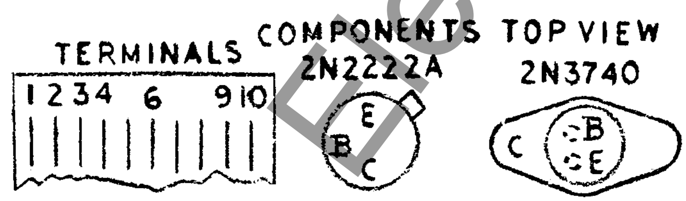


Figure 31 (0227A7096-0) Full Wave Bridges for the SBC Relay ("X" Card)





TABLE

P.C. CARD ASM.	VOLTS	EXT. RES. R6	R1
0183B8058 GR-1	48	250	18 KΩ 2W.
0183B8058 GR-2	125	1000	56 KΩ 2W
0183B8058 GR-3	250	2000	120KΩ 2W

Figure 32 (0257A9615 Sheet 1 [3]) Power Supply for the SBC Relay ("Y" Card)

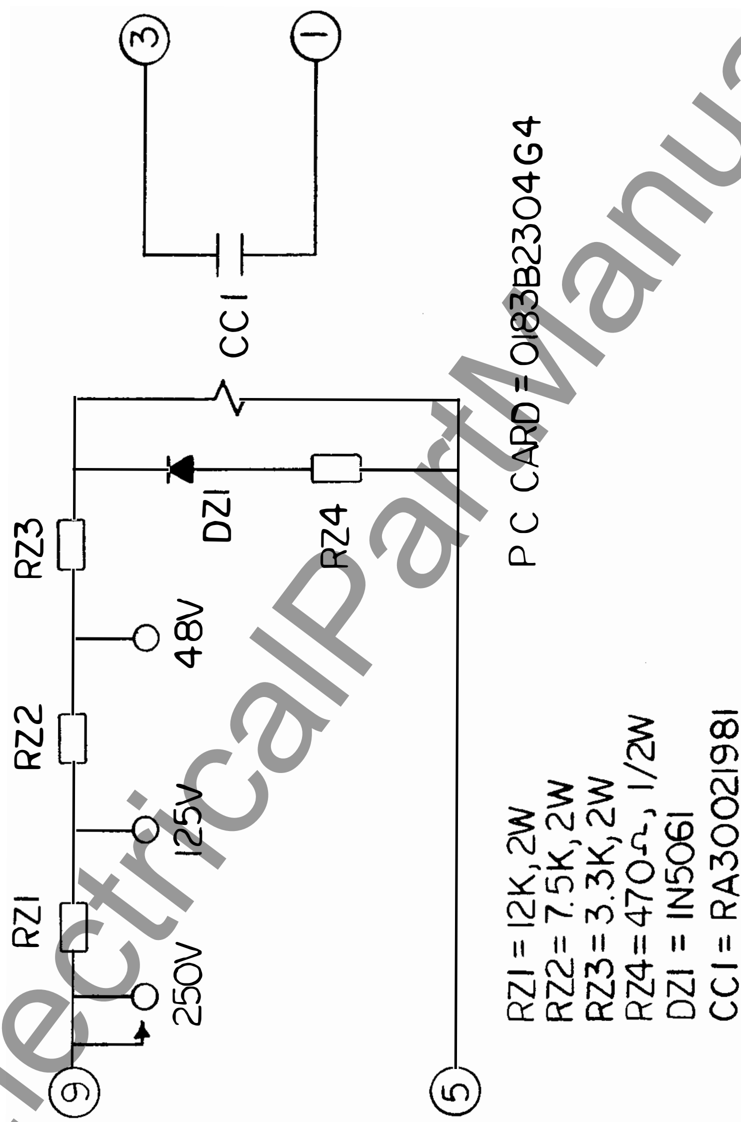
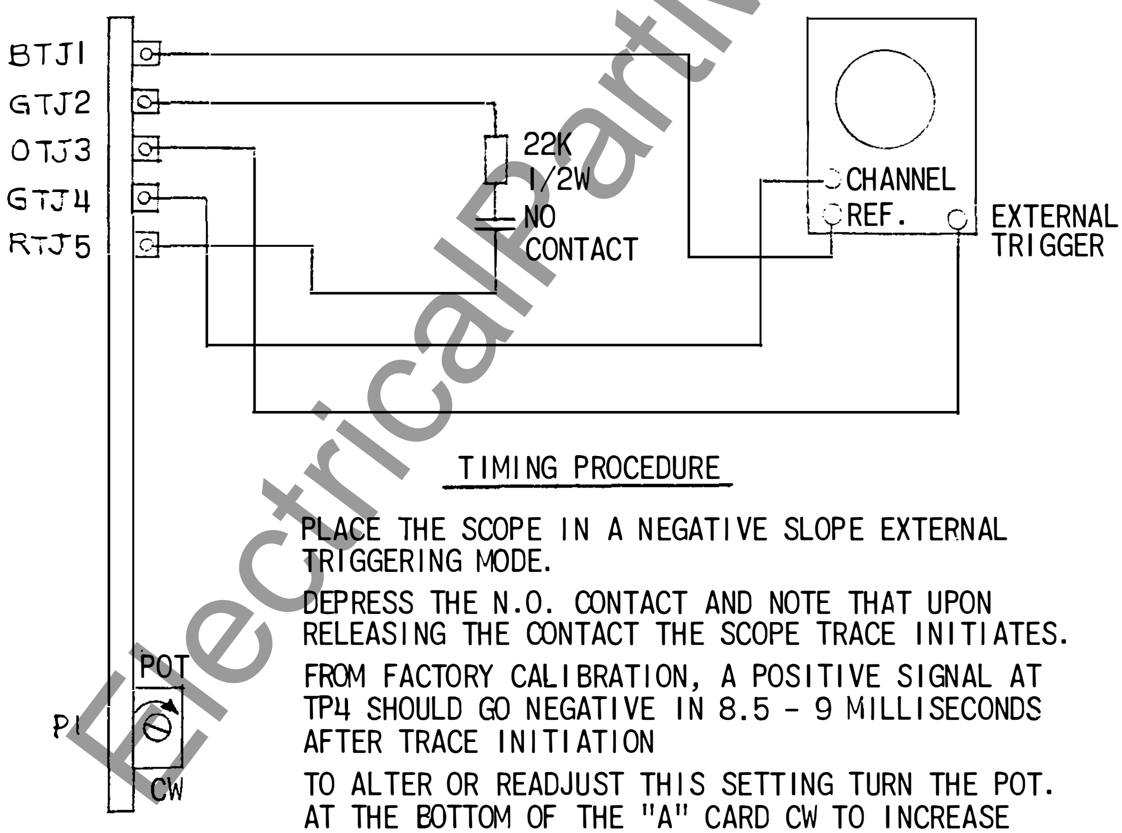


Figure 33 0269A3076-0) Contact Converter for the SBC Relay ("Z" Card)

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 CORD IS UNGROUNDED.



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

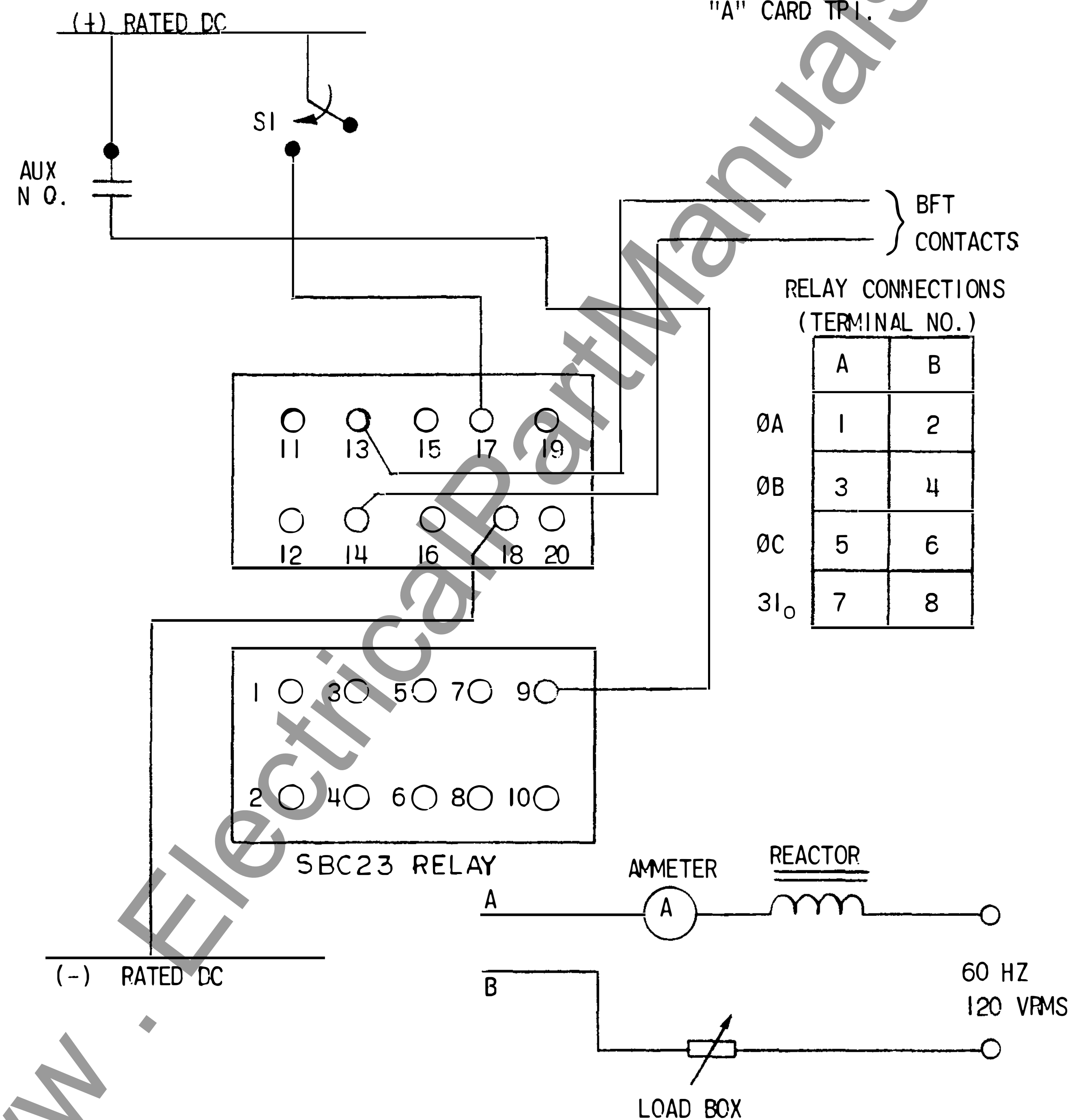
TO ALTER OR READJUST THIS SETTING TURN THE POT. AT THE BOTTOM OF THE "A" CARD CW TO INCREASE FILL-IN TIME OR CCW TO DECREASE THE TIME.

Figure 34 (0246A2203-1) Fill-in Timer Setting Test Circuit for the SBC Relay

CAUTION: USE XLA13 TEST PLUG

1. NOTE THE DC POLARITY ON TERMINAL #17 (+) & #18 (-).

2. PLACE AN OSCILLOSCOPE INPUT AT "A" CARD TP4 WITH REF. AT "A" CARD TP1.



RELAY CONNECTIONS (TERMINAL NO.)

	A	B
ØA	1	2
ØB	3	4
ØC	5	6
$3I_0$	7	8

Figure 35 (0246A2204 Sh.1 [3]) Current Detector Test Circuit for the SBC Relay

CAUTION: SYSTEM CIRCUITS AT CONTACT TERMINALS #13 AND #14 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.

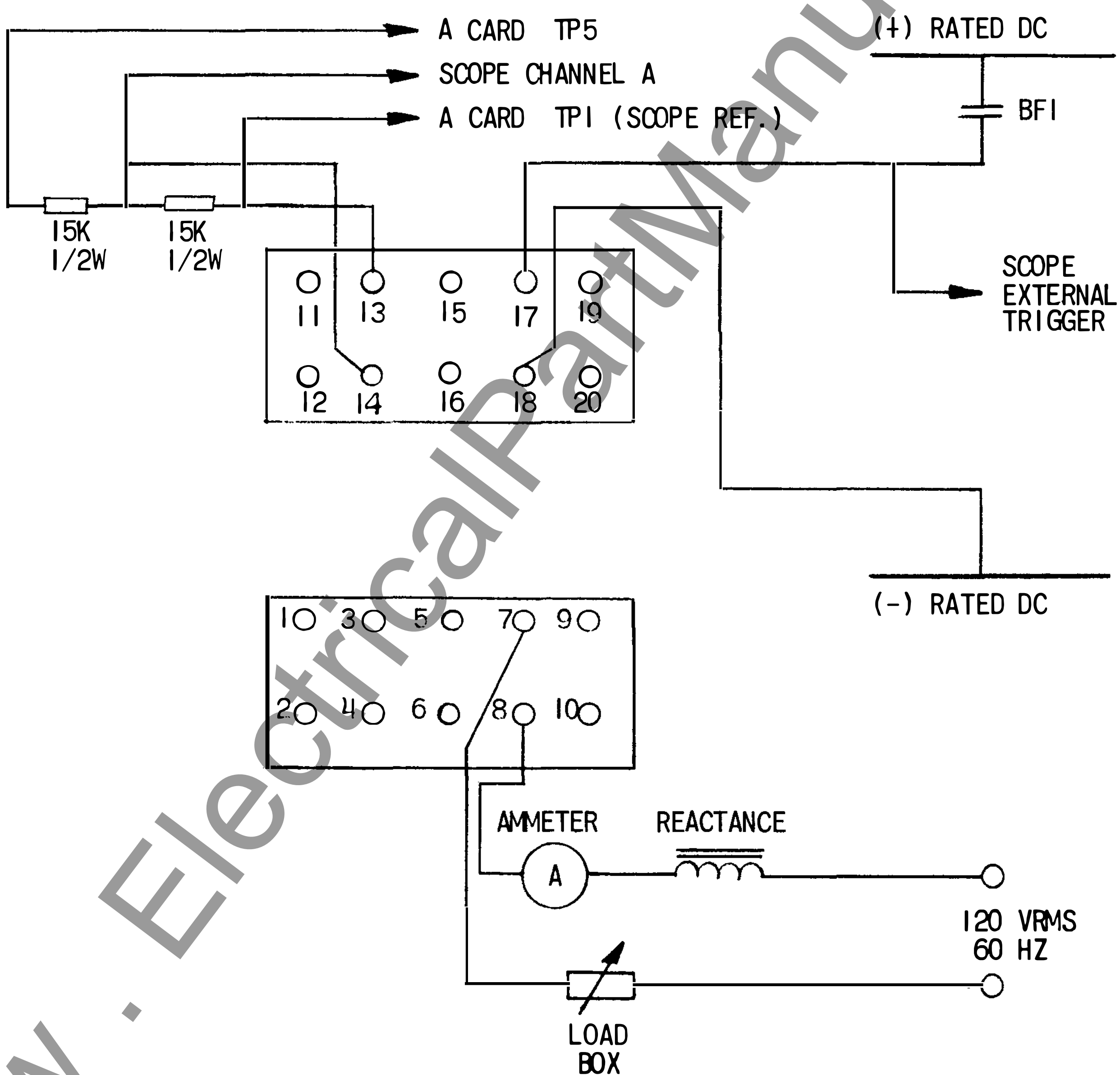


Figure 36 (0246A2202 Sheet 1 [3]) Overall Timing Test Circuit for the SBC Relay

Protection and Control

(3/94) (200)

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